ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF ONDO DEEP-SEA PORT FOR ONDO STATE GOVERNMENT.

FINAL DRAFT REPORT

SUBMITTED TO THE

FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

BY

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LIST OF ABBREVIATIONS AND ACRONYMNS USED.

AOI	=	Area of Influence
BH	=	Borehole
CO	=	Carbon monoxide
dB(A)	=	Decibel on Scale A
DO	=	Dissolved Oxygen
DPR	=	Department of Petroleum Resources
EIA	=	Environmental Impact Assessment
EMP	=	Environmental Management Plan
ESMP	=	Environmental and Social Management Plan
EMS	=	Environmental Management Systems.
EPFI	=	Equator Principles Financial Institution
ESMS	=	Environmental and Social Management systems
ESOH	=	Environmental Safety and Occupational Health
et al	=	et al. (and others)
FAO	=	Food and Agricultural Organization (of the United Nations)
FEPA	=	Federal Environmental Protection Agency
FMEnV	=	Federal Ministry of Environment
Fig.	=	Figures
GIS	=	Geographical Information System
GPS	=	Global Positioning System
HRA	=	Hazard Risk Analysis
Kg	=	Kilogram
Km	=	Kilometer
L (l)	=	Litre
LGA	=	Local Government Area
m	=	metre
Mg	=	Milligram
NA	=	Not Applicable
ND	=	Not determined / no data
NO_x	=	Nitrogen Oxides
OML	=	Oil Mining Lease
%	=	Per cent
^0C	=	degree Celsius
POOC	=	Pan Ocean Oil Corporation (Nigeria)
ppm	=	parts per million

QA	=	Quality Assurance
QA/QC	=	Quality assurance / quality control
QC	=	Quality control
R	=	River
ROW	=	Right of way
RRA	=	Rapid Rural Appraisal
S	=	second, siemens
SN	=	Serial number
sp	=	Species
spp	=	Species
SSSN	=	Soil Science Society of Nigeria
STEL	=	Short time exposure limit
THC	=	Total Hydrocarbon
TOR	=	Terms of Reference
TWA	=	Time weighted average
µ	=	micro
UNESCO	=	United Nations Educational Scientific and Cultural Organization
USA	=	United States of America
USDA	=	United States Department of Agriculture
USEPA	=	United States Environmental Protection Agency
VES	=	Vertical electrical sounding
VOC	=	Volatile Organic Compounds
$<$	=	Less than
$\leq$	=	Less or equal to
$>$	=	Greater than
$\geq$	=	Greater or equal to

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EXECUTIVE SUMMARY

The Ondo State Government plans to build a world class Deep-sea port piloted by Ondo State Development and Investment Promotion Agency (ONDIPA) in Erunna/Ogboti in Ilaje Local Government area in the coastal area of Ondo. The Project is anticipated to bring significant economic benefits to the region and the State in general through direct investment in the local economy.

This Environmental and Social Impact Assessment (ESIA) report presents the detailed environmental assessment and potential environmental and social impacts that may result from the Pre-Construction (design), Construction and Operational phases of the proposed Ondo State Deep-Sea Port.

It further provides detailed Environmental Management Plan (EMP) that outlines specific actions that will be required to be undertaken to ensure minimal environmental impacts (both positive and negative) on the marine and terrestrial that will arise from the project are presented.

It also presents an outline of the mitigation measures to prevent or reduce significant negative impacts to acceptable levels; and a proposal for review of the environmental management plan in tandem with project progress so that it addresses issues arising from periodical monitoring.

This study identified Three (3) possible integrated development alternatives: No-development opt ofion, delayed-action option and alternative technology option. The most logical option will involve immediate development of the proposed Deep-Sea port in the designated area using the available existing technology.

It was established that the proposed project is viable, sustainable economically, technologically and environmentally.

1.0 Introduction

The Ondo State Government plans to develop a Deep-Sea Port piloted by Ondo State Development and Investment Promotion Agency. The Project site is located in the marine waters of Erruna/Ogboti, Ilaje Local Government Area of Ondo State. The Project is anticipated to bring significant economic benefits to the region and the State in general through direct investment in the local economy.

This Environmental and Social Impact Assessment (EIA) Report presents the detailed environmental and social assessment and potential environmental impacts that may result from the Pre-Construction (design), Construction and Operational phases of the proposed Ondo State Deep-Sea Port.

It further provides detailed Environmental Management Plan (EMP) that outlines specific actions that will be required to be undertaken to ensure minimal environmental impacts (both positive and negative) on the marine and terrestrial that will arise from the project.

The Report presents an outline of the mitigation measures to prevent or reduce significant negative impacts to acceptable levels; and a proposal for review of the environmental management plan in tandem with project progress so that it addresses issues arising from periodical monitoring.

The Report also hinted at future studies to be executed to complement the ESIA Report and enhance the Perception Index (P.I) to would be investors and the World bank and its allies.

From the results of Risk Assessment analysis for the proposed deep-sea project, we arrived at a logical conclusion that the project has a likelihood risk of remote (< 1%) to unlikely risk of (1 to 10%). The rate of return (RRI) on investment over the years is excellent. Also, the project has insignificant to minor negative impacts, whilst the positive impact is rated major. The positive impacts outweigh the negative impact. The consequences of the project on people will be major; on properties and/or housing is rated moderate; on the environment is moderate, and on the harbor and stakeholders is rated major. This implies that the operational risk of the proposed Deep-Sea port is low to very low.

This study identified Three (3) possible integrated development alternatives: No-development option, delayed-action option and alternative technology option. The most logical option will involve immediate development of the proposed Deep-Sea port in the designated area using the available existing technology. It was established that the proposed project is viable, sustainable economically, technologically and environmentally.

This Executive Summary of the ESIA follows the World Bank prescribed format, including an overview of the project justification and description; policy, legal, and administrative framework; description of project environment; project alternatives; potential impacts and mitigation/enhancement measures; environmental hazard management; monitoring program; public consultations; and complementary initiatives.

2.0 Project Description and Justification

The purpose of the proposed Ondo Deep -sea Port is to serve the robust economic growth by activating the Ondo Free Trade Zone as a manufacturing and trade hub and exploit the inability of the Lagos ports to meet the demand for container port infrastructure and alleviate the congestion /grid lock that the port of Lagos has created as a result of the increased volume of cargo in and out of Nigeria. The Port of Ondo will be developed as a greenfield port, located along the coast of Ondo State. It aims to serve as a multi-purpose deep-sea port. The Port of Ondo will compete for Nigerian contestable demand in the general cargo, vehicles and dry bulk imports segments, as well as containerised cargo overflow from Lagos and future Lekki. Local demand is captured from the established ports which are geographically concentrated in either the west, the so-called 'Lagos port cluster' and in the east, the so-called 'Delta port cluster'. In recent years, container demand has increased at a rate 2.5 times Nigeria's GDP growth, or around 13 percent annually. The Port of Ondo is expected to gain 9.2% market share in the general cargo and vehicle cargo segments and 2.8% in the dry bulk imports segment in its third year of operations in 2028. The Port of Ondo demand forecast up to 2050 are for commodities with the best market potential, being containers, general cargo, vehicles, agribulk (dry bulk), cement (dry bulk), bitumen (liquid bulk), and an offshore supply base (*Source: The Port of Ondo Report*).

Building Ondo Deep-sea Port will allow for the efficient development of modern port infrastructure and provide new capabilities for Nigeria to serve the newest container ships and the artificial nature of the design with expansive land of 116hectares for future expansion to the Free trade zone of 2771.2 hectares of land is an advantage

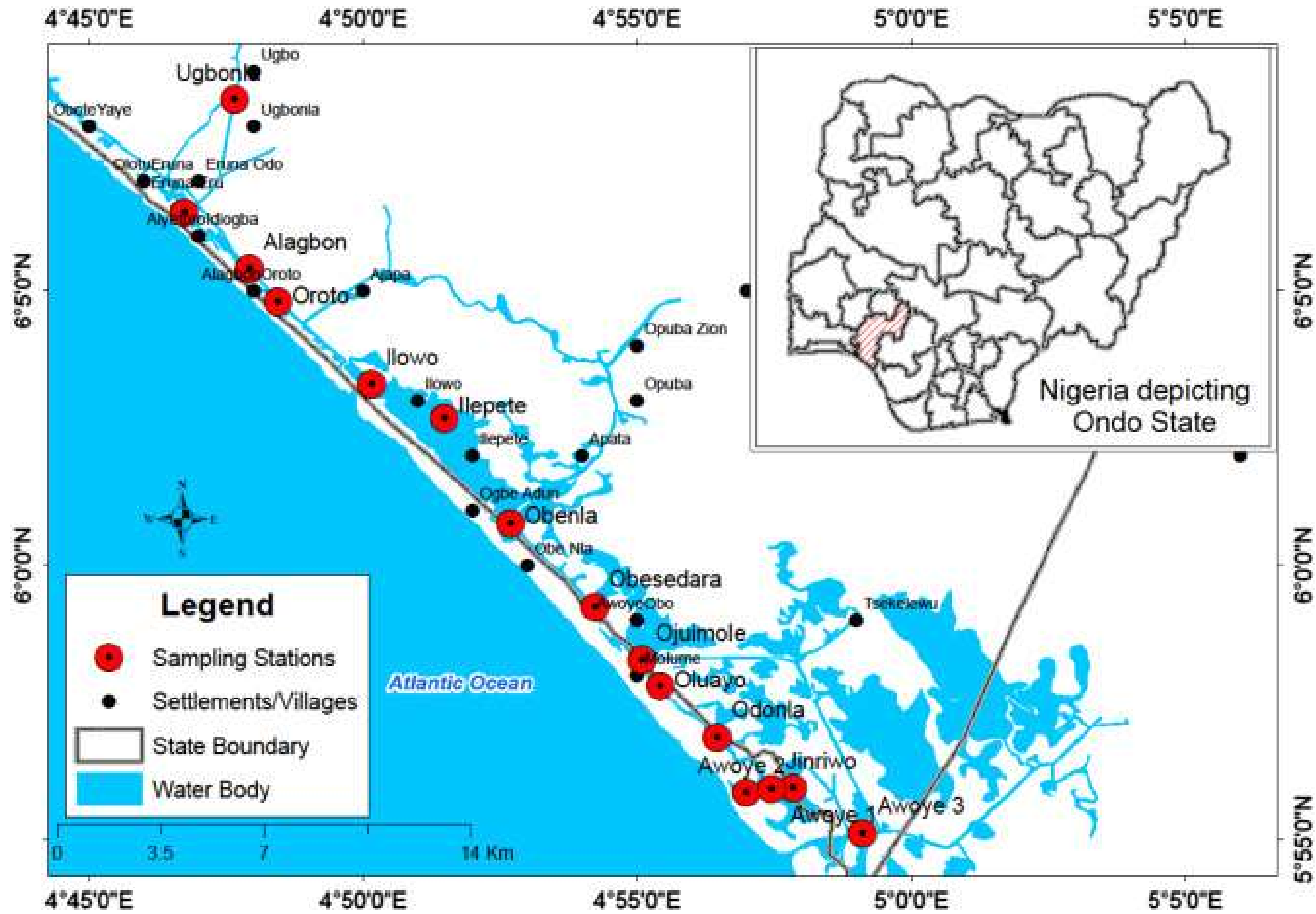
The Port of Ondo will be developed as a greenfield port, located along the coast of Ondo State. It aims to serve as a multi-purpose deep-sea port. The strategic positioning of the Port makes it economically viable. The market analysis, location analysis and design adopted to overcome the environmental site conditions are quite encouraging. It surely will open up Ondo state economically and ease the Apapa Port of the serious congestion. The Port of Ondo is located well to serve the middle of the country and will be the closest port to the capital of Nigeria; Abuja. It has existing road connections to the shore. The rate of return on investment on the project makes it a revolutionary turn around project to trigger the socio-economic life of the environment and Ondo state in general.

2.1 Port Location

Port location and site assessment

Through a multi-criteria analysis, (MCA) the preferred port site selected is located between Latitudes N06° 09’ 50.0″ and N06° 07′ 37.6″ and Longitudes E004° 47′ 34.8″and E004°45′01.4″ at Erunna/Ogboti in Ilaje Local Government area of Ondo State. The “Port of Ondo” is a greenfield port project consisting of an artificial island port proposed in front of the coastline of Ondo State. The artificial island Port design was selected based on a number of comparative analysis of which the muddy nature of the coastline is topmost. It would directly connect to a 2,771.2-ha free trade zone (FTZ) in which port related activities, industrial, commercial activities and an industrial city are planned. The location is considered the most central location for port development in the axis. Additional expansion maybe required subject to demand growth in the cargo segments for which an area of 116 ha is available for future port expansion. This encompasses a width of about 750 m available along the causeway with options to develop an additional 1,460 m of berthing lengths and beyond.

Fig 2: Map showing Project area in relation to communities. (*Source; goggle maps*)



2.2 Port Configuration

The "Port of Ondo" is a Greenfield port project consisting of an artificial island port proposed in front of the coastline of Ondo State. It would directly connect to a 2,771.2-ha free trade zone (FTZ) in which port related activities, industrial, commercial activities and industrial city are planned. The location is considered the most central location for port development in the axis with 116ha of land available for future port expansion. The Artificial Island Port -Single Basin is 2.8km from the shore. "Port of Ondo" is a greenfield port project consisting of an artificial island port proposed in front of the coastline of Ondo State. The lands of the free trade zone

(FTZ) is generally speaking not inhabited. The project will induce the growth of a lot of supporting infrastructure that will extend to other local government areas. The proposed port would encompass both marine and land infrastructure.

One of the unique selling points of OFTZ is the high propensity and value the site possesses in the development of a port facility. As a riverine area, close to the Atlantic Ocean, the proposal for development of a seaport is thus critical for the sustenance of OFTZ. Accordingly, the FTZ Plan earmarked land area for the development of a port in Sector C of the FTZ, with an initial 171.8 hectares (ha). To take advantage of the location close to the Atlantic Ocean, the Port was proposed for the southern axis. The OFTZ area has a 2.1 km boundary along the water.

Table : Distribution of Activities

USE	AREA (ha)	SHARE
Manufacturing	956.5	37.8
Residential	428.9	17.0
Commercial	73.2	2.9
Utilities and services	28.5	1.5
Port Development & Transport Park	283.2	11.2
Buffer Conservation	481.3	19.0
Total Area	2531.3	100

Fig: OFTZ layout and Sectoral Distribution of Activities (*Source: ONDIPA*)

The conceptual layout indicates the distribution of port facilities in the layout as shown in the Report.

2.2.1 Marine Infrastructure

The Project encompasses the following main elements:

• A connecting road of 3.2 km from existing roads in the free trade zone;

The Deep-Sea Port has;

- A bridge across the river of approximately 100 m;
- A dam of approximately 650 m from the river to the coastline;
- A trestle bridge of 1,500 m and a causeway dam to connect the island. The trestle bridge will allow currents and sediments to move along the coast and small boats to pass underneath;
- A causeway of 1,685 m from the trestle bridge to the port;
- The artificial island port at approximately 2,800km from the coastline which prolongs 1,100m outwards towards the sea; and
- The approach channel of approximately 10.8 km.

The Port of Ondo being a planned greenfield port development, there are no existing port structures on site, and therefore the port layout and orientation of berths, terminals, access channels, basins and buildings are based on examinations, calculations and discussions or consultations with the Client by the consultant.

The approach channel connects the port with natural deeper waters beyond the 16.m water depth. The channel will be dredged for 10.8 km length with CD -16.5 m depth. This is a limited length compared to other ports in Nigeria which have longer approach channels. The proposed width is 200 m, based on PIANC guidelines. A single bend of 15° with 1,000 m radius in the channel is planned to ensure the shortest distance to deeper water without hampering vessel navigation near the port. The access channel is a one-way channel with heading 231º till the bend and 216º thereafter till natural deep-water is reached. The access channel depth of CD -16.5 m was chosen to allow ships to enter or leave the port under almost all foreseeable weather conditions. A natural depth of CD -16.5 m is reached at 13.5 km offshore. The access channel width was designed according PIANC guidelines assuming one-way traffic only and the design ship beam has been taken as 50 m. This is to allow future container vessels with a capacity of up to 14,000 TEU to enter and leave the port.

The channel will be marked with red and green (lighted) side marker buoys according to IALA region A. approximately every 0.5 nm in the straight sections and at 0.25 nm in the bend to aid navigation. Pilots are to board incoming ships before the access channel is reached and to leave outgoing ships when the access channel is cleared.

Turning circle.

The access channel ends in a protected turning circle with 600 m diameter. Tugs will be attached to incoming ships before they pass the breakwater to assist with stopping. Ships are turned in the turning circle before or after berthing. For outgoing ships, tugs can detach after the ship is turned in the turning circle. The 600 m diameter is commonly applied by port to swing vessels up to 300 m or 360 m depending on the conditions.

Quays.

Considering the layout of the preferred port option, a total of 1,560 m of quay wall will be built in the initial phase and an additional 600 m of quay wall will be built in the expansion under phase I. The assumed deck height is CD +3.5 m. An option is included to increase the design of the container quay wall depth to CD -16m.The most feasible quay wall design to adopt is subject to further engineering soil tests.

Dredging and reclamation.

The total volume of dredged material required from calculations is estimated at 22,773,625metric tons of sand in the underlisted areas.

Based on the chosen design, dredging will be required in the following areas:

- Approximately 10.8 km long approach channel to a depth of CD -16.5 m;
- 600 m diameter turning circle to a depth of CD -16.5 m;
- The container and multi-purpose terminal harbour basin to a depth of CD -15.0 m; and,
- The RoRo, offshore supply base and cement harbour basin to a depth of CD -11.0m.

Breakwater and revetment.

Construction of the port includes the installation of slope protection structures, i.e., revetment and a breakwater, to protect the boundaries of the reclamation area and to reduce wave disturbance inside the harbour basin. The reclamation area is confined by the quay wall in the harbour basin and embankments around the perimeter of the port. These embankments will have to be protected against wave attack; therefore, it is required to install revetments as slope protection on the embankments of the terminal area. In addition, from initial data of the wave direction and magnitude in the proposed area, a breakwater of 150 m length has also been designed to reduce wave agitation in the harbour basin and turning circle.

Trestle bridge and causeway

Trestle bridge

The trestle bridge is located between the onshore dam and the causeway and connects the two structures, with a total length of approximately 1,500 m. The width of the bridge is planned at 30m covering four lanes of traffic. A pipe rack is planned for the required pipe connections. A railway connection is considered optional.

Causeway

Connecting the artificial island to the trestle bridge, an approximately 1,685 m long causeway is required. The causeway is planned to provide sufficient width to accommodate vehicle traffic, rail connection and utilities to and from the port. The causeway shall be designed to a level of CD + 3.5 m to match the height of the terminal area and the transition to the trestle bridge shall be designed in order to allow an adequate slope for smooth connection of the rail traffic to CD +4.5 m (less than 1%).

2.2.2 Land Infrastructure

The Ondo Deep-Sea Port will feature state of the art facilities in the various terminals and the services to be provided. The infrastructures include

- Container terminal with a 600 m length (future extension to 1,200 m), width of 460 m and CD -15.0 m depth (with option to increase to CD -16.0m);
- Multi-purpose terminal with a 310 m length (260 m at -15.0 m CD berth), width of 460 m and CD -15.0 m depth;
- Offshore supply terminal with a 250 m length (200 m at -11.0 m CD berth), width of about 350 m and CD -11.0 m depth;
- RoRo import terminal with a 260 m length, width of about 350 m and CD -11.0 m depth;

- Cement export terminal with a 240 m length. 150 m width and CD -11.0 m depth;
- Bitumen export dolphin berths at a depth of CD -11.0 m (also used for bunkering services);
- Reserved area for rail shunting yard with two rail lines at 500 m (future expansion to 600 m and 2 extra rails possible)
- Port services pontoon for pilot boat and tugs; and,
- Significant future expansion to the northeast of the port is possible in future.

Port operations would require installation of a utility infrastructure including water supply and distribution, wastewater treatment, communications networks, and electrical distribution and lighting, as well as firefighting facilities. Road networks are critical components to the various terminals and the OFTZ. Being a virgin area with no existing infrastructure, several buildings would be required at the terminal with specific Port operations.

2.3 Port Construction and operation

Port construction Phase 1 is expected to be completed in 2026. The construction will require complex mix of engineering works. Pre-construction works entail harbor and channel dredging, construction of marine structures, site preparation, and construction of landside structures. About 23million metric tons of sand will be dredged and the dredged material would consist of sand from the ocean bottom and existing beach.

The works will be required within the Phase 1 and OFTZ areas in advance of dredging, land reclamation, breakwater construction and quay wall construction. These works will include erecting a perimeter fence, clearing the site for UXO, site clearance works (e.g.

demolition of structures within the area, tree cutting and soil stripping), site drainage works (i.e. constructing a new drainage channel to divert the flow of existing drainage channels) etc.

Construction for the landside portion of the port would encompass the following key activities:

- Site clearance works
- Unexploded ordinance clearance
- Site clearance works e.g. soil stripping
- Site drainage works
- Removal of existing breakwater structures if any.
- Marine construction works includes
- Dredging for Navigation
- Land Reclamation
- Re-use of dredged materials
- Breakwater Construction
- Quay wall Construction
- Service Berths and Coast guard base construction
- Aids to Navigation Installation

Landside works includes;

- Container yard Construction
- Truck Gate construction
- Intermodal Yard Construction
- Building Construction
- Utilities Installation
- Construction of Equipment

- Construction of waste management facilities.

  The project will directly and indirectly create new employment opportunities. Preliminary investigations estimated the peak construction work force is to reach 5000 workers with about 350 expatriates while about 2000 jobs will be created for the undertaking of port operations at the port. In addition, about 1,700 jobs will be created in the port's hinterland, especially associated with the transport of cargo to and from
- Port operations would be conducted by terminal operating companies that enter into sub-concession agreements with the project sponsor overseeing the following operations;

- Container Handling and movement,
- Container Storage,
- Port Lightening,
- Storm water collection,
- water treatment and Breakwater.

The development of the Port of Ondo will have a disruptive impact on the current port sector market share distribution as the port is situated in the centre of the two main port clusters: the Lagos cluster and the Delta cluster because of its strategic location. The number of vessels is projected to increase from 375 in 2026 up to 2,335 in 2050 (CAGR: 7.9%). The jump in traffic from 2039 onwards is due to the envisioned container terminal expansion. **Port of Ondo Traffic forecast results (*Source: MTBS Port of Ondo Report*)**

Provides the Port of Ondo demand forecast up to 2050 for commodities with the best market potential, being

- containers, general cargo, vehicles, agribulk (dry bulk), cement (dry bulk), bitumen (liquid bulk), and an offshore supply base. The drivers for the respective cargo segments are the following:

  i. **Containers**: Given a 9.2% market share in 2028, volumes increase from 0.1 M TEU in 2026 to 2.3 M TEU in 2050 (CAGR 14.6%). Till 2039, growth is driven by shifting traffic flows; later overflow from the Lagos ports will be the main growth driver.

  ii. **NC General Cargo****: Given a 9.2% market share in 2028, volumes increase from 0.3 M tons in 2026 to 1.2 M tons in 2050 (CAGR 6.7%). Shifting traffic from the Lagos and Delta ports to the Port of Ondo is the main growth driver for this commodity.

  iii. **Agribulk**: Given a 2.8% market share in 2028, volumes increase from 0.1 M tons in 2026 to 0.5 M tons in 2050 (CAGR 7.7%). Shifts in traffic flows from the Lagos ports in particular to the Port of Ondo is the main growth driver for this commodity.

  iv. **Vehicles**: Given a 9.2% market share in 2028, volumes increase from 53,000 units in 2026 to 373,000 units in 2050 (CAGR 8.5%). As Lagos is the single main port of entry for vehicles, the Port of Ondo geographic located is more advantageous.

  v. **Cement**: Dangote is developing a 6.0 M ton capacity p.a. cement plant in Edo State. It is assumed that the Port of Ondo can capture 25.0% for export purposes.

  vi. **Bitumen**: Ondo State has a large deposit of bitumen. The option is included in the master plan to export 1.25 M tons of the bitumen exploration per year.

vii. **Offshore supply**: a multi-user offshore supply base terminal is assumed facilitating up to four clients, who will make 180 calls per year with an average call size of 500 tons.

3.0 Policy, Legal and Administrative Framework

The Federal Government of Nigeria enacted the Environmental Impact Assessment (EIA) Act No. 86 of 1992 as a demonstration of its commitment to the Rio Declaration. It makes an EIA mandatory where proposed projects or activities are likely to cause significant environmental effects. The EIA Act gave the Federal Ministry of Environment (FMEnv) the implementing mandate and requires mandatory application of the EIA process in all major development projects right from the planning stage. The FMEnv gave its approval to the Application to commence the EIA process in November 2019.

The current ESIA has been prepared to meet the specific performance standards, guidelines, and safeguards issued by the World Bank, AfDB and Equator Principles Financial Institutions (EPFIs). The summary of the applicable environmental and social policies and guidelines for all the institutions mentioned are as follows: the Policy on Poverty Reduction; the Policy on the Environment; the Gender Policy; the Policy on Disclosure and Access to Information; the Cooperation with Civil Society Organizations – Policy and Guidelines; and the Policy for Integrated Water Resources Management.

The ESIA follows the most stringent requirements where AfDB and EPFIs differ. The EPFIs requirements are modelled on the environmental and social standards and policies of the World Bank and the International Finance Corporation (IFC). Upon approval of the ESIA from AfDB, EIB, MIGA and the EPFIs, construction and operation of the port would be required to comply with the environmental safety and health conditions set by these institutions as well as with the laws, regulations, and policies of the Nigerian Federal, State, and local governments.

4.0 Description of the Project Environment

The "Port of Ondo" is a Greenfield port project consisting of an artificial island port proposed in front of the coastline of Ondo State. It would directly connect to a 2,771.2-ha free trade zone (FTZ) in which port related activities, industrial, commercial activities and industrial city are planned. The location is considered the most central location for port development in the axis with 116ha of land available for future port expansion. The proposed Deep-Sea port area predominantly belongs to the transgressive mud-beach coast of southwest Nigeria. The mud beach coast evolved from the growth of the Niger delta into the Gulf of Guinea following gradual retreat of the sea after a short-lived Paleocene transgression (Wright *et al.,* 1985). Of the four distinct geomorphic zones along the 800 km of Nigeria's coastline, Ondo State coastline is along the 75 km eastern boundary mud beaches which terminate at Molume, the boundary with Delta State of the western flank of the Niger Delta. Ondo State is between Latitudes 5° 45' and 8° 15' N and Longitude 4° 45' and 6° E with its south being the coastline bounded by the Atlantic Ocean. The site is habited, and resettlement action would be required.

4.1 Physical Environment

4.1.1 Climate, Air Quality, and Noise

The climate of the study area is similar to other parts of southern Nigeria. Following the classification scheme of Papadakis (1965), the survey area is of the moist monsoon Humid semi-hot equatorial climate. The climate is characterized by a humid season stretching from March to October and rainfall surplus over 1000mm per annum. Mean annual rainfall is about 2400 mm (96 inches). The rainfall is highest in the months July and September between resp. 215.0 mm and 199.0 mm as monthly averages

Monitoring data from the site during November 2019 and March 2020 data show generally good air quality as expected due to the absence of any major industrial activity and good coastal air circulation. Noise levels monitored during the same period were well below FMEnv standards and WHO guidelines.

4.1.2 Soil

The soil in the free trade zone and coastline consists of clay layers. This is up to a depth of 12.0 m to 20.0 m;

- The terrain is characterized as flat only 0.7 m above mean sea level; and,
- The terrain is characterized as wet land with some pools and small creeks

Note that the soil data presented, is unfavourable for construction in general and significant soil improvement are required. In case of the dig out port option, material dredged/removed could not be used for reclamation or fill and must be disposed. There is no evidence of adverse human-induced impacts and the soil environment is largely hydric.

4.1.3 Geology, Morphology and Hydrology

Coastline geology

Generally, there are two distinct geological regions in Ondo State, the region of the sedimentary rocks along the coast in the south and the region of Precambrian basement rocks in the north. The area between the shoreline and Okitipupa is characterized by sand ridges, lagoon and swampy flats of sedimentary terrain. The terrain is flat with gently undulating topography. The geomorphologic units in the area include sand ridges, lagoons, swamp flats and creeks.

The Nigerian coast in front of Ondo State is low-lying and almost devoid of any sand beaches but composed of mud shoreline.

The 853 km long Nigerian coastline runs through seven of the Southern States: Lagos, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross Rivers bordering to the Gulf of Guinea in the Atlantic Ocean with its continental shelf, the coastal fresh water and brackish wetlands ramified by an atomizing network of rivers and creeks4. The coast in front of Nigeria is composed completely of quaternary deposits, which are the youngest sediments. Therefore, the coast experiences high rates of subsidence, due to natural compaction and dewatering of the soil. The 75km '(Mahin) Transgressive Mud Coast' of Ondo coact line consists of mud and wetland to the east. The mud coast, which is situated on the shores of Ondo State, is low-lying and almost devoid of any sand but composed of mud shoreline. The Transgressive Mud Coast consists of a gentle sloping mud beach that is backed by freshwater swamps and creeks. Numerous rivers flowing southwards to the Atlantic Ocean drain the basin. The upper courses of these rivers draining the area are characterized by steeply incised valleys. The river flows in a South-West direction to join other rivers. The river is characterized by a rather deep incised channel and tortuous course along the five traverses studied.

These rivers include the Owena, Oluwa, Oni, Ogbese, Ose, Ominla, Akeun and Ufara. The major rivers flow through the sedimentary rocks in deeply incised valleys aligned in a north-south direction, into the coastal lagoons.

The absence of sand is explained by the presence of the Avon and Mahin canyons, in which sand would be caught and brought offshore instead of to the coastline.

The presence of muddy sedimentation on the shoreline without any ‘proper’ sand in close proximity is an issue when constructing a port for adequate sand is required for the construction of port infrastructure into the sea (land reclamation); and, mud is light and easily transported by ocean currents thereby increasing flow of sedimentation and consequently the added requirement of access channel maintenance dredging in case a deep-sea port must be constructed and maintained.

4.1.4 Oceanography and Hydrodynamics.

Waves reaching the West African coast are of two origins: sea waves generated by the local weak south-westerly winds and swells generated by storms in the southern part of the Atlantic Ocean. The tidal current along the Nigerian coast is relatively weak. The Guinea current flows east at approximately 3°N and originates from both the North Equatorial Counter current and the Canary Current. Littoral drift along the Nigerian coast is mainly driven by wave action, resulting in the transportation of sediment along the coast in a north westerly direction in the Project area. Nearshore currents are controlled by both breaking waves and tides. The maximum significant wave height in the port area from available data is in the range of approximately 1.5 m to occasionally 3.0 m. Significantly large wave would not be possible due to the depth limitation. The waves mainly come from the SSW with peak periods up to 14s.

Along the coast, waves have a south-westerly approach and break obliquely with breaker angles ranging from 15 to 25 degrees, to the shore normal. This results in a long shore current that transports sediments from west to east. The persistent nature of the waves from the ocean and their oblique approach angle results in high sediment transport rates along the West African coast. Coastal erosion has been widespread along most of the West African coastline, including the Nigerian coast. Causes for erosion include low-lying coastal topography, intensity of waves, vulnerable soil characteristics, the nature of shelf width and harbor and shoreline protection structures, such as moles.

4.1.5 Water Resources

The hydrology of Ilaje Area in Ondo State is slightly salty or brackish. This is as a result of the influence of sea water. Fresh water though not hygienic from creeks are the main sources of drinking water. From the 331 interviewed, about 68% confirmed streams, creeks to be their source of water even though the creeks are also used for transportation. There are boreholes from which 15% persons mainly around Igbokoda obtain water and 29% rely on tanker services. There are no freshwater surface water bodies within the project site. Treated water will be the main source of water from the ocean.

4.2 Biological Environment

4.2.1 Soil Microbiology

Soil microbiology field investigations indicated a distribution of organisms normal for similar environments. Coliforms were absent in almost all the samples analyzed, and petroleum-consuming bacteria were also present in very low densities, indicating no contamination at the project site. The value of HDF / THF occurred in the range of 0.5 – 65.9% (median = 12.5%) suggesting the some of the fungi are hydrocarbon degraders. Mean abundant tended to decrease from surface soil through mid-subsurface soil to bottom subsurface levels. On the whole, microbial abundance occurred within the known levels in unpolluted soils.

4.2.2 Marine Biota

Marine biota populations investigated included plankton (phytoplankton and zooplankton) and benthic (bottom dwelling) organisms. The results indicated high levels of phytoplankton, poor levels of zooplankton, and no bottom dwelling organisms. The flora was dominated by green algae notably desmids while the other algal groups were poorly represented. The most abundant species were dominated by the desmid *Staurodesmus clepsydra* (2,750 org/m^3), the blue-green *Nemoderma tingitana* (V250 org/m^3) and *Actinotaenium cucurbitum* (1,100 org/m^3). The dominance of desmids in the flora is indicative of a very dilute freshwater. The zooplankton fauna was represented by rotifers and copepods. Typical of most Nigerian waters the rotifer fauna was dominated by a member of the family Brachinodae while the copepods were dominated by Nauphius larvae. *Brachionus dimidiatus* was the most dominant taxon of the zooplankters.

4.2.3 Fisheries

A total number of 67 species belonging to 36 families were identified in the coastal waters of Ondo state. Out of the 36 families, 25 were represented by just one species generally described as finfishes are. *(Bolarinwa, Agboola and Anetekhai,2008*). The Mahin axis is richer in fishes because of the freshness of the water when compared to Ugbo-Nla Aiyetoro axis with salty waters and oil pollution since it is an oil prospecting area. The common species found in the immediate area of study are as reported Mormyridae Characidae, Cyprinidae, Clariidae, Mochochidae comprise ten species belonging to ten (10) genera and eight (8) families Tilapia guineensis, Sarotherodonmelanotheron, mullets and the bonga which respond with salinity. They occur more during the higher salinity of the dry season from January-April *(Bolarinwa,* *1984; Agboola and Anetekhai, 2008).* The onset of rainy season in May brings in young Heterotisniloticus called 'Pete' and the clariids.

The fisheries resource constitutes a major source of livelihood for a substantial number of stakeholder community residents. Ondo State has coastal areas estimated to be about 60,000 hectares with rich biodiversity containing a diverse assemblage of fish, shellfish, finfish species, reptiles and other organisms (*Solarin et al., 2010*). Decapod crustaceans found in the area include white shrimps, brackish river prawn, Africa river prawn, West Africa freshwater crab, Tiger prawn and pink shrimps (*Olawusi-Peters & Ajibare, 2014). Bolarinwa et al, (2015)* conducted an eighteen-month study using fishing villages in Ilaje and thereafter revealed the presence of 67 finfish species belonging to 36 families out of which 25 were mono-specific. The study indicated that fishing practices were mainly the profession of the young persons and that the educational level of fisher folks was high in the area. Findings also showed that the average annual household income of fisherfolk households was comparable to most government/public employees holding equivalent qualifications in the neighbouring area. Construction of the sea port must be managed so as not to destroy the source of livelihood from fishing.

4.2.4 Marine Turtles and Marine Mammals

Marine turtles are present in the West African sea waters and nest in the coasts from Congo to Sierra Leone stretching about 4,000 km. Sea Turtles are endangered species found in brackish and marine environment. They nest along the Nigerian beaches and inhabit mainly coastal waters. Five Species of sea turtles occur in Nigerian waters (Amadi,1991), Caretta caretta (Atlantic Loggerhead), Chelonia mydas (Atlantic Green turtle), Lepidochelys olivacea

(Olive ridley turtle), Eretmochelys imbricata (Atlantic Hawksbill turtle) and Demochelys coriacea (Leatherback turtle).In Ondo state coastal waters, two species of sea turtles (Lepidochelys olivacea, Dermochelys coriacea) are foraging in the area, although L. olivacea was mostly encountered. These sea turtles migrate into the area from April and vacate around October in each year. During this period, some L. olivacea individuals were accidentally trapped inside nets set for hunting crustaceans especially Malacostraca: Decapoda.

Informations gathered from the fishermen indicated that marine turtles are present in the surrounding area but their frequency and distribution as well as nesting activity was not confirmed. There has been limited research on marine mammals in Nigerian waters. However there has been incidences of strayed whales been captured and devoured by the people.

Major threats to Sea turtles in Nigeria are increasing daily mainly due to development pressure. Man-made impacts tend to affect this species population. These include Pollution from oil activities, marine debris, entanglement in fishing nets mainly gill nets, captures when they venture ashore to nest, storm surges eradicating nesting beaches, coastal development, dredging and sand mining and pollution of coastal waters.

4.2.5 Vegetation

The coastal landscape in Nigeria is dynamic due to several natural and anthropogenic processes *(Fabiyi, 2011)*. The processes influence vegetation nutrients, plant productivity, soil fertility, water quality, atmospheric chemistry and many other local and global environmental conditions (Sahid et al, 1999).

Ilaje Area of Ondo State being part of the coastal environment is mainly made of mangrove forests which has been so much disturbed as a result of oil exploitation.

The number of vascular plant species (flowering plants, conifers, cycads and fern species) in Nigeria is between 4600 and 4715 (Abiodun and Yong, 2012).

The project site contains flora habitats of higher biodiversity with the exception of small forested habitat traversed by the oil pipeline. The existence of these rich biodiversity zones in Ilaje revealed that the area is a rich coastal environment that is yet undisturbed by man's activities. Within the marine ecosystem are woodland and grassland to the north of the coastline, littoral rainforest evergreen forest, Atlantic forest mangrove and swamp forest. The presence of two kinds of rainforest habitats in the study area reveals that the area is very rich in a variety of plants and animal species as rainforest habitats are known for varieties of evergreen trees that retain green foliage all year round. Also, the mangrove is a unique marginal bio-rich zone that is invaluable for its mangrove stands. The natural vegetation is the high forest, composed of many varieties of hardwood timber such as Melicia excelsa, Antaris africana, Terminalia superba, Lophira procera and Symphonia globulifera. The swamp flats are the domain of the fresh water swamp forests in the interior and the units of mangrove vegetation near the coast.

Inland areas are sandy and mostly inhabited by button wood mangroves (Conocarpus erectus) and grass species while seaward areas are mostly inhabited by red (Rhizophora racemosa), black (Laguncularia racemosa) and white (Avicennia germinans) mangroves species. Anthropogenic activities such as oil and gas exploration, deforestation, dredging, urbanization and invasive nypa palms. Muddy soil supports nypa palms while sandy soil supports different grass species, core mangrove soil supports red mangroves (R. racemosa), which are the most dominant of all species, with importance value. The red mangroves are adapted to the swampy soils. They possess long root system (i.e. 10 m) that originates from the tree stem to the ground, to provide extra support. The red mangrove trees are economically most viable as the main source of fire wood for cooking, medicinal herbs and dyes for clothes.

4.2.6 Fauna

Wildlife populations within the project site are sparse and of low diversity. Human activity has significantly reduced the presence of wildlife to only a few species with rodents such as grasscutters, African Grass Rats, porcupines, and squirrels the dominant mammals. No known threatened or endangered species reside on the proposed site, nor is the site classified as an important bird area.

4.3 Human Environment

The Ondo Deep-Sea Port and the Free Trade Zone is located within the Ilaje Local Government Area of Ondo State, Nigeria. The Investigated Deep Port site is located between Latitudes 6°5’58.12” N and 6°24’8.3” N, and Longitudes 4°28’36.56” E and 4°59’58.95” E. The site is connected by a single road at 91 km distance of the highway at Oro. The road crosses several creeks and wetlands. The host communities in the project area includes Ugbo, Ugbonla, Eruna Ado, Eruna Asuku, Eruna Ero, Abe Okun Ipin, Olotu Temuhi, Olotu Kwo, Olotu – Yara, Olutu Niyi, Yaye, Ojabineni, Womitere. Ogboti, Lepe, Ayadi, Idiogun, Zion -Ehimoren, Ehimoren and Aiyetoro within the Ugbo axis are included in the area of influence of the project despite the artificial island design of the project.

Ugbo, Aheri and Etikan zones spread on the swampy terrain of the Atlantic Ocean and are affected and the communities in those areas would need to be relocated.

4.3.1 Land Use

The AOI is rural, similar to the rest of the LGA. There are no heavy industrial activities in the proposed Ondo AOI. Residents from surrounding communities engage in agricultural cultivation of a variety of cash and subsistence crops including cassava, plantain, corn, yam, sweet potato, and mango. The original vegetation types consist of heavy forests and creepers, mosaic of forest and raffia complexes, and some red mangrove (*rhizopora*) around the coast (Akegbejo-Samson, 2008). However, with active forest removal going on in the northern axis and extensive areas of marsh and mangrove forests being decimated in the southern parts, a large stretch of land along the coastline is now permanently inundated.

The inhabitants of upland settlements are peasant farmers while the coastal communities rely on the inland ponds, lakes and small lagoons for fishing. Some relatively bigger communities also thrive on native gin (locally called '*ogogoro*') production from raffia palms that dominate the palm-swamp ecology of the creeks. Lumbering is also an important and lucrative trade as suggested by large number of logs on the creeks waiting to be floated to sawmills. Agricultural products include Fish, Poultry, piggery, Maize, Palm oil, Vegetables, Timber, Rafia, Poultry, Copra, cocoyam, Bananas and Cassava. The natural environment of Ilajeland is particularly suitable for the development of large-scale rice plantations and the salt industry. A mixture of residential and agricultural land uses were observed within the resident communities. Lands around the residential properties are cultivated with a variety of farm produce primarily as a form of subsistence farming.

4.3.2 Population, Demographics and Income

Ilaje Local Government is the largest local Government in Ondo State in terms of its landmass. (277,034 According to the 1991 National Population Census), the Local Government is one of the most populated in Ondo State, with a population figure of two hundred and seventy-seven thousand and thirty-four) land area of 1,318 km²

A household baseline survey was conducted during the first season for the stakeholder villages surrounding the proposed port site that constitute the AOI. A head count was done partially through oral interview of the youth leaders and Obas, the total population was estimated at 96,459 with Ugbo-land having 45,059. The male population is 52% while the female population is 48% of the total population.

As in other parts of Nigeria, the population in the AOI is often multilingual: 97 percent of the population speaks Yoruba or the Yoruba dialect Ilaje, 77 percent speak English, and 10 percent speak another Nigerian language. The religions of the people of Ilaje are predominantly Christianity. Their sources of livelihoods are fishing, farming, lumbering, artisans etc, but dominantly fishing on the coastline.

4.3.3 Education and Infrastructure

The Local Government Area has a total of 117 institutions of learning. This comprises 96 primary schools; 20 secondary schools and Technical College at Ayetoro, established by the community itself and the University of Science and Technology Okitipupa established by Governor Olusegun Agagu and recently renamed after him. In the AOI, there is C/S Primary school Ugbo-Nla and Community Grammar School, Eruna.

The level of infrastructure is below average and, on the infrastructure, index defined as poor, however the interventions of NDDC and OSOPADEC is gradually ensuring some semblance of civilisation. there is a road into the project area which terminates at Igbokoda, The Akeredolu led administration is committed to opening up the coastal area of ondo state because of its vast economic potential. The N9.3 billion Ilaje/Lekki road project was inaugurated in 2019 by Governor Rotimi Akeredolu at Araromi seaside in Ilaje local government area of Ondo State to open up the coastal area to the outside world. The 50km road is expected to be completed in 36months with 67 culverts, carriage width of 7.3 meters, shoulder width of 2.7meters on both sides of the road and a total pavement thickness of 400 millimeters

There has not been power supply in the area for about twelve years while sources of portable water are boreholes and handpump wells in Igbokoda, the people interviewed depend on the waters around them. AOI village communities have limited access to primary healthcare services and facilities for the communities are served through mobile clinics

5.0 Project Alternatives.

No-development option

This option implies that the proposed project will not be carried out by the project proponent. This option was not adopted by ONDIPA because it negates the essence of its goal in diversifying the economy of Ondo State and at variance with a major national priority of Nigeria. The option is also un-business – like and will be of no financial benefit to either the stakeholders or the country.

Delayed-action option

This option implies that the project is delayed to sometime in the future due to political position, public opinion and/or availability of funding rather than been executed as scheduled for 2026. ONDIPA has not adopted this option because it implies that the much-needed revenue generation will continue to be abandoned. The two direct outcomes of a significant delay or delays in the project are escalating project costs which could jeopardize the financial feasibility of the Project.

Alternative technology option

The present option of developing the project will involve immediate development of the proposed Deep-Sea port in the designated area using the available existing technology. The proponent has rejected the option of non-development. The present option of project development is thus the best of all the possible options considered economically

6.0 Potential Impacts and Mitigation/Enhancement Measures

Environmental and social impacts arise during both the construction/development phase and the operational phase of a project. In general, operation impacts tend to be of greater magnitude than those arising from construction, largely because of the long-term nature of operation impacts. Many construction impacts such as noise and air quality impacts are temporary and reversible. The port location being a virgin area with no exiting development is an advantage that minimises the consequences of any major impact from construction/development. However, the coastal areas estimated to be about 60,000 hectares with rich biodiversity containing a diverse assemblage of fish, shellfish, finfish species, reptiles and other organisms (*Solarin et al., 2010*) may loose some of the species. Decapod crustaceans found in the area include white shrimps, brackish river prawn, Africa river prawn, West Africa freshwater crab, Tiger prawn and pink shrimps (*Olawusi-Peters & Ajibare, 2014).*

The existence of these rich biodiversity zones in Ilaje revealed that the area is a rich coastal environment that is yet undisturbed by man's activities. The major impact will be loss of the flora especially the monogenetic species. The selected design for the port being an artificial island at 2.8 km into the sea will have little effect on the coast line. Long-term operation impacts, including the induced impacts, would likely catalyse changes in land use patterns, economic activities, biological habitats, air quality, and noise levels of the AOI. Nonetheless most impacts would be moderate or less. Mitigation measures would ensure that all residual adverse impacts would be less than significant. For example, mitigation measures are prescribed to reduce lighting impacts from significant to minor. The mitigation measures employed to address anticipated project impacts would also reduce overall community risks as well as reduce risks and impacts to ecosystem services such as fisheries.

6.1 Construction-Related Impacts

6.1.1 Human Environment

Construction impacts to the human environment both beneficial and adverse include:

- Moderate beneficial impacts to the economy from employment of work force from within host communities during construction phase and from increased demand for services;
- Adverse impacts to land use, visual characteristics, and transportation; Minimal but possible increased demand for housing, water, and electricity;
- Adverse impacts to health and safety, archaeological resources, and public services;
- Adverse impacts to traditional livelihoods; fishing would likely be restricted from operating in the channel area during dredging and marine infrastructure construction;
- Adverse impacts due to disturbance from increased noise from trucks and construction activities and equipment.

There would be no loss of a unique or significant ecosystem. Long-term operation impacts, including the induced impacts, would likely catalyse changes in land use patterns, economic activities, biological habitats, air quality, and noise levels of the AOI. Nonetheless most impacts would be moderate or less. Mitigation measures would ensure that all residual adverse impacts would be less than significant. For example, mitigation measures are prescribed to reduce lighting impacts from significant to minor. It is also employed to address anticipated project impacts so as to reduce overall community risks and impacts to ecosystem services such as fisheries.

6.1.2 Physical and Biological Environment

Overall impacts to the physical and biological environment during the construction phase are projected to be moderate, mainly caused by the construction of structures (both landside and marine) and dredging activities. Impacts include:

- Adverse impacts to terrestrial ecosystem from removal of project site vegetation, soil, and removal of wildlife habitat from the 2,271ha project site;
- Adverse impacts to soil due to permanent removal and paving of site;
- Adverse impacts to marine ecosystem from dredging of harbor and access channel, construction of marine infrastructure, and disposal of dredged material;
- Adverse impacts to marine water quality from dredging;
- Adverse impacts to air quality from dust generation and equipment emissions;
- Adverse impacts from temporary generation of solid waste and wastewater;
- Adverse impacts to marine sediment from an imbalance in sand movement along the coast caused by the construction of marine structures and dredging resulting in accretion and erosion;
- Adverse impacts to biodiversity from transformation of port site; and.

6.2 Operation-Related Impacts

6.2.1 Human Environment

Impacts to the human environment range from moderate to significant, both beneficial and adverse, which include:

- Significant beneficial impacts to the economy from direct, indirect, and induced economic activities in the AOI from port operations;
- Adverse impacts to visual characterization from night-time lighting and overall facility configuration;

- Adverse impacts from noise and air pollution from unloading/loading of vessels, trucks, traffic and equipment necessary for port operations;
- Adverse impacts to transportation from increase traffic;
- Adverse impacts to land use from long-term induced urbanization; and
- Adverse impacts to health and safety from increased traffic and worker inflow to the area.
- Averse impacts to surface water and groundwater.

6.3 Community Health and Safety Risk and Impact Assessment

Based on a scoping process conducted via public consultations with AOI stakeholders, eight resources were scoped into the Community Risk Assessment (CRA): air quality, noise, traffic (pedestrian safety), visual (lighting), water quality (groundwater), fishing, flora &fauna, traditional livelihoods, and community health. The CRA evaluates potential risks to valued environmental components, their magnitude, frequency, extent, and nature and prescribes mitigation measures. Each resource was assigned a pre-mitigation risk ranking for both construction and operation phases based on the severity and probability of potential risk. Prescribed mitigation measures would reduce all community risks to medium or lower, and most residual risks post-mitigation would be very low (8 out of the 13 scoped risk rankings).

6.4 Ecosystem Services Assessment

The ecosystem services assessment identified 21 ecosystem services within the AOI. Through scoping, each was assessed for its importance and value to beneficiaries to determine the anticipated magnitude of impact to each ecosystem service. Of the 21 ecosystem services assessed, four were assessed as having moderate impacts: food from wild-caught fish, soil quality, water drainage and flows, and water purification.

Mitigation measures, including wetland area enhancement and contributions to the Nigerian Conservation Foundation, were prescribed to offset the residual impacts.

6.5 Cumulative Impacts

Cumulative impacts from past, present, and foreseeable future projects were assessed qualitatively. The prominent future projects that would likely contribute to cumulative impacts are the Ondo Free Trade Zone and the Igbokoda to Lagos 53 km Road over the Atlantic Ocean. Numerous other projects are planned under the Master Plan, but they remain concepts on paper and are too uncertain to include in the cumulative impact's assessment. The Free Zone and road projects would contribute to regional traffic congestion, air quality degradation, marine water quality impairment, and land use pattern changes. Expected impacts are moderate in magnitude. Note that these projects would act synergistically to promote economic development in the region and generate substantial long-term economic benefits.

6.6 Mitigation Measures

The following table summarizes mitigations prescribed to reduce moderate and significant impacts and potential impacts to the human, physical and biological environments.

Human Environment	
Increased demand for housing, water and electricity	Worker camp to be established for non-native construction workers.
Increased traffic and road use	Equipment and materials to be transported by water when possible.
Increased population could lead to more disease especially virus infection like COVID 19 and increased negative social vices such as drugs, prostitution etc	Health screenings of employees will be made compulsory and ensure daily check of vital signs, including documenting and reporting on existing diseases. Also, strict rules of conduct will be enforced at worker construction camp. Health professional to work with the local community and temporary workers on health-related issues. The law enforcement agencies like Civil defence and Nigeria Police presence be encouraged and non-profit organisations be encouraged to regularly monitor the social activities from inception as indicated in the EMP.
Increased noise from construction activities	Conduct noisier operations during the day; reduce night-time construction; fit vehicles with effective exhaust silencers and mufflers.
Disturbance from increased lighting	Cluster temporary lighting away from perimeter areas near villages. Angle lights in a manner to minimize spill over effects.
Reduced air quality	Minimize vehicle idling; apply speed restrictions; prohibit open burning; and purchase low CO_2 emission machinery, equipment,

due to dust and noise	vehicles and materials when possible.
Destruction of vegetation and wildlife habitat	Maintain landscaping to minimize bare areas; use native vegetation to the extent practicable; monitor for the presence of any threatened or endangered species and, if such a species is discovered, coordinate with the government of Nigeria to determine appropriate mitigation measures.
Re-suspension of sediments within water column	Use appropriate silt curtains and other appropriate approaches to minimize the development of a plume of suspended sediment.
Sea turtles	Sea Turtle Management Plan will be prepared to protect turtles at sea or on land (including nesting turtles) from construction activities.
Coastal erosion and sand imbalances	Develop an Erosion and Sediment Control Plan prior to construction that identifies specific measures to reduce impacts from soil erosion.

Disturbance from noise pollution.	Conduct truck operations during the day to minimize impacts to residents; use exhaust silencers; use acoustic insulation in areas where noisy operations occur.
Disturbance from increased lighting	Set light fixture angles so that unnecessary spread of light is kept to a minimum; switch off unnecessary lighting to minimize impacts to nearby residents; creating a buffer zone with vegetation could also reduce light pollution.
Increased traffic and possible accidents	Apply demand management to minimize use of roads during morning and afternoon peak hours. Coordinate planning with Lagos State Government and Federal Ministries on the improving overall road network in the AOI. Conduct training programs for truck drivers to drive at slower speeds; installation of pedestrian barriers on road segments heavily used by school children or heavy pedestrian crossing.
Communicable Diseases	Emphasize prevention of STDs during health and safety trainings provided to employees, truck drivers, and community members.
Air quality degradation	Monitoring equipment and emissions to ensure emissions standards are not exceeded; prohibit open burning; minimize vehicle idling and unnecessary trips.
Marine water quality and bottom sediment	Appropriate measures used during maintenance dredging to minimize the development of a plume of suspended sediment,

contamination	including the use of appropriate silt curtains; regular maintenance of the oil/water separator to prevent oil from entering the outfall and into the ocean.
Marine biota losses	Ongoing good housekeeping to prevent litter and other wastes associated with site activities from entering offshore areas; develop contingency measures and emergency response procedures to allow immediate response to accidental spillage/release of chemicals or other hazardous materials; care taken to minimize damage to marine habitat and fauna during dredging and excavation activities through adequate planning and execution.
Sea turtles	Sea Turtle Management Plan will be prepared to protect turtles at sea or on land (including nesting turtles) from port operations.
Terrestrial flora and fauna losses	Maintain landscaping where possible to minimize bare areas; use native vegetation to the extent practicable; monitor for the presence of any threatened or endangered species and, if such a species is discovered, coordinate with the government of Nigeria to determine appropriate mitigation measures.
Soil and groundwater quality degradation	Develop a spill prevention contingency control plan with standard operating procedures in the event of a release; remove solid wastes from facilities and dispose of properly in an environmentally sound manner; ensure concrete structures of facilities are intact to minimize seepage into the ground

7.0 Environmental Hazard Management

The ESMP and the resultant Environmental and Social Management System (ESMS) are designed to minimize risks of environmental hazards during the construction and operation of the port. The Hazard Risk Analysis (HRA) presented in the ESIA identifies and ranks risks of concern in terms of overall likelihood of occurrence and magnitude of consequences. The environmental and social management system will include the preparation of detailed standard operating procedures for all port activities as well as comprehensive emergency preparedness and response plans to deal with accidents that could threaten the health and safety of workers, nearby residents, and the environment.

8.0 MONITORING PROGRAM

The ESMP establishes a comprehensive monitoring plan to ensure that construction and operation of the proposed port would remain fully compliant with performance standards, guidelines, and safeguards established by the lenders as well as the laws and regulations of the Nigerian government. A key objective of (performance) monitoring will be to identify any unanticipated changes to the biophysical, health, and social environment brought about by the proposed project. Baseline information, against which development and post development impacts and mitigation measures can be measured and compared, has been established. Monitoring also serves to identify environmental, health, and safety issues before they become significant and allows for more effective corrective action. Ondo Port's ESMP requires monitoring for all aspects of the project including but not limited to water quality (marine, surface, groundwater), air quality, noise levels, marine sediments, and terrestrial biology. The monitoring plan also encompasses monitoring of the health and safety of port employees and the socioeconomic and health wellbeing of the stakeholder community.

ONDIPA should develop specialized plans and systems to support its environmental and social management and monitoring efforts and this includes

- an ESMS to ensure that there is consistency in its approach to assessing and managing environmental and social issues.
- ONDIPA should also develop management plans centered on: Ambient Air Quality Monitoring; Noise Monitoring; Marine Water and Sediment Quality Monitoring; Freshwater Pond Water Quality Monitoring; Sill Prevention Contingency Control; Groundwater Quality Monitoring; Marine Outfall Monitoring; Potable Water Monitoring; Terrestrial Environmental Monitoring; Ballast and Blige Water Management; Invasive Species Management; Solid and Hazardous Waste Management and Monitoring; Integrated Pest Management; Socio-economic Monitoring; Resource Conservation Management; Erosion and Sediment Control; Ship Garbage Management; Port Facility Security; and Traffic Safety Management.
- ONDIPA should also develop a Supply Chain Management Plan, a Labour Management Plan, an Influx Management Plan, a Community Development Plan, an Occupational Health and Safety Plan; a Dredging Management Plan; and a Biodiversity Action Plan (containing a management and monitoring plan).
- ONDIPA should develop a Stakeholder Engagement Plan, which will be further strengthened.

  All of the specialized environmental and social management and monitoring plans must be developed according to international specifications sufficiently to be able to give the needed confidence to attract investors as the desired goal of ONDIPA.

In terms of organization of the ESMP, Jabridep Nig Ltd is willing to retain the primary responsibility of ensuring that environmental commitments are met throughout the life cycle of this project if granted the opportunity. The management team of the Port would include an environmental safety and occupation health (ESOH) division with several subordinate departments responsible for managing the environmental, health, and safety of the port's workers and stakeholder communities and protecting the environmental resources of the affected area.

9.0 PUBLIC CONSULTATIONS AND PUBLIC DISCLOSURE

Public consultations started in November 2019 and a major one in February 2020 when a series of public meetings were held with primary stakeholder communities. Prior to this, there were several engagement meetings with people from the zone who are so excited on the positive impact the project will have on their communities.

The stakeholder's meetings at every stage adopted the Standard practice. The techniques adopted are use of information center, correspondence by phone/email, structured one-one interviews and formal public meetings and surveys. The consultation group 332 in attendance was robust and spread across all strata of the society which includes government officials, neighboring communities, vulnerable groups, non-government organisations, Areas directly under the Influence of the project (AOI). The entire process is hinged on commitment, integrity, respect, transparency and inclusiveness of all stakeholders At the stakeholders meeting where the governor was physically present, all issues raised by the stake holders were addressed and all the people thanked the government and pledged their cooperation in ensuring the safety of all workers and contractors associated with the project. The language of communications was English, Yoruba, Ilaje and sine language for the deaf and dumb so that all stakeholders can effectively engage in communication.

10. **Complementary Initiatives**

Previous Resettlement Activity and Site Acquisition

The land proposed for development as the Ondo Port and the Ondo Free Trade Zone (OFTZ) is 2771 and the communities within the area will require relocation and compensation which is outside the scope of our TOR.

11. Conclusions

Anticipated impacts from construction and operation of the proposed Ondo Port and the Free trade zone. It is anticipated that the adverse impacts to the physical and biological environment should be managed and mitigated through implementation of a comprehensive ESMP that would conform to and comply with International guidelines.

12. References and Contacts

Reference cited in the ESIA is presented at the end of the document. The details for the relevant contact person is as follows:

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CHAPTER ONE

1.0 INTRODUCTION

The Ondo State Development and Investment Promotion Agency (ONDIPA) engaged Jabridep Nigeria Limited to carry out Environmental Social Impact Assessment (ESIA) for the development of the Port of Ondo Multi-Purpose Deep-Sea Port at Erruna/Ogboti in Ilaje Local Government, Ondo State to be operational in Ondo State in 2026.

The "**Port of Ondo**" is a Greenfield port project consisting of an artificial island port proposed in front of the coastline of Ondo State.

The Investigated Deep Port Site is located between Latitudes 6°5'58.12" N and 6°24'8.3" N, and Longitudes 4°28'36.56" E and 4°59'58.95" E (**Figure 1**). The site is connected by a single road at 91 km distance off the highway at Oro. The road crosses several creeks and wetlands.

The aim of the Environmental and Social Impact Assessment (ESIA) is to notify the Federal Ministry of Environment of the intention to construct a Deep-Sea port in Ondo State according to the laws in ensuring that the environment is protected against adverse environmental impacts due to the construction of the Port.

Figure 1: Administrtative Map of Ondo State Showing the Project Location
(Source, ONDIPA, 2018)

1.1 BACKGROUND INFORMATION

The "Port of Ondo" is a Greenfield port project consisting of an artificial island port proposed in front of the coastline of Ondo State. It would directly connect to a 2,771.2ha free trade zone (FTZ) in which port related activities, industrial, commercial activities and industrial city are planned. The location is considered the most central location for port development in the axis. In the very near future, additional expansion may be required subject to demand growth in the cargo segments. An additional area of 116ha is available for the port expansion.

A port is usually an area or platform entered into from the sea, by vessels, boats, ships, which also allows for protected staging and anchoring or docking for these ships to load and unload consignments and continue towards their destination. Section 445 of the Merchant Shipping Act of 2007, defines a Port as: "*a place* for *arriving, loading and unloading of ships and includes a harbour, piers, jetty and lighter terminals.*"

A deep-water port, from its nomenclature, is different from regular ports with respect to the depth of water. A regular port ranges from about 6-9 meters of depth, while that of a Deep-Sea Port is 18 meters. Some maritime experts have opined that a Deep-Sea Port must be able to accommodate a Panamax Ship. A Deep-Sea Port is usually made for the usage of very large and heavily loaded ships. The depth of water helps get them access to the deep-water ports.

The proposed Deep-Sea port area predominantly belongs to the transgressive mud-beach coast of southwest Nigeria. The mud beach coast evolved from the growth of the Niger Delta into the Gulf of Guinea following gradual retreat of the sea after a short-lived Paleocene transgression (Wright *et al.,* 1985). Of the four distinct geomorphic zones along the 800 km of Nigeria's coastline, Ondo State coastline is along the 75 km eastern boundary mud beaches which terminate at Molume located at the boundary with Delta State of the western flank of the Niger Delta. Ondo State is between Latitudes 5° 45' and 8° 15' N and Longitude 4° 45' and 6° E with its south being the coastline bounded by the Atlantic Ocean (Figure 2). The coastline is predominantly of medium to coarse, poorly sorted, finely skewed and platykurtic to leptokurtic silt beach. It is also a mesotidal (2 – 4 m tidal range) beach with largely fine grained (0.18 – 0.34 mm) sediment and are of low gradient (< 80).

Due to the low mean tidal range, the coast has a relatively high and consistent intensity of wave action. Large swell waves are, therefore, common in the area, which are generated by the prevailing south-westerly winds and the flooding driven by high tides. This low lying mud coastline has an elevation varying between 0.5 to 2 m above mean sea level and persistent significant wave height (hs) of the order of 1.4 m – 2.5 m with the prevalence of longshore currents at the near shore zone. The continental shelf in the study area is narrow, relatively gently sloping with bathymetric lines running generally in parallel to the coastlines (**Figure 2**).

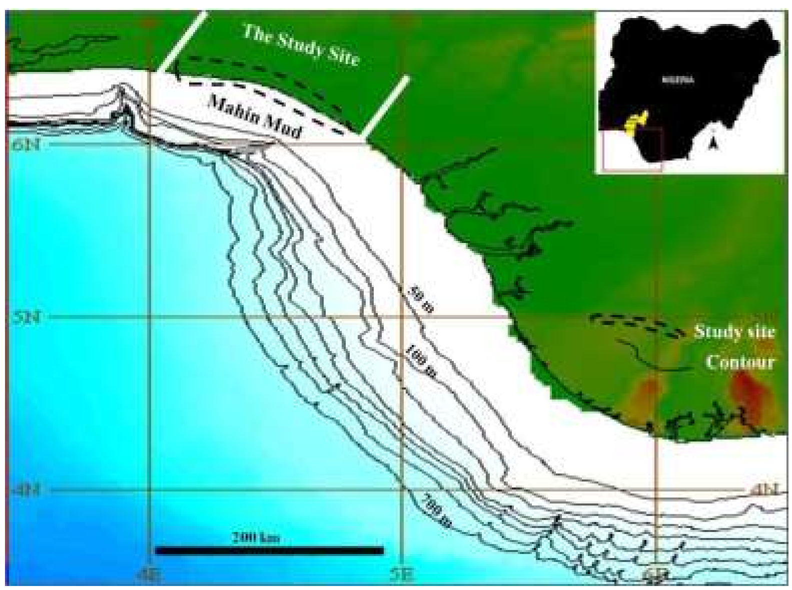


Figure 2: Nigeria's Atlantic Gulf of Benin showing Ondo State coastline
(Sources: Port of Ondo Report)

The general climate is tropical humid condition of the Koppen-Geiger *Am* classification (Kottek *et al*., 2006). The mean annual rainfall is about 2,721mm, mean annual number of rain days around 170, mean monthly rainfall around 229 mm and mean annual temperature of about 27.8^{0}C (Fasona, 2007).

The original vegetation types consist of heavy forests and creepers, mosaic of forest and raffia complexes, and some red mangrove (*rhizopora*) at the coast (Akegbejo-Samson, 2008). However, with active forest removal going on in the northern axis and extensive areas of marsh and mangrove forests being decimated in the southern parts, a large stretch of land along the coastline is now permanently inundated.

The inhabitants of the upland settlements are peasant farmers while the coastal communities rely on the inland ponds, lakes and small lagoons for fishing. Some relatively bigger communities also thrive on native gin (locally called '*ogogoro*') production from raffia palms that dominate the palm-swamp ecology of the creeks. Lumbering is also an important and lucrative trade as suggested by large number of logs on the creeks waiting to be floated to sawmills.

1.2 TERMS OF REFERENCE

The Terms of Reference (ToRs): The terms of reference include the consideration of the following:

1.2.1 Physical Environment:

i. Description of the existing hydrology
ii. Water quality of groundwater, surface waters (lagoons, rivers etc.), including ambient temperature, biocide and other chemical data with sampling activities

iii. Air quality in the area of influence via examination of existing measurement data together with other data to be collected, as well as dispersion modeling data for the existing sources as needed.
iv. Meteorological information- wind speed and direction, precipitation, relative humidity and ambient temperature
v. Storm water run-off and drainage pattern – geology and hydrology
vi. Noise level impact of proposed project in relation to existing site conditions (nighttime and day time)
vii. Topographic and soil conditions

1.2.2 Biological Environment: Flora, Fauna, rare and endemic

- Description of the flora and fauna of the proposed site, with emphasis on any rare, endemic or endangered species. Both terrestrial and aquatic flora and fauna shall be discussed in detail.

1.2.3 Social and Cultural Environment:

i. A description of the present human/land use of the proposed site area and adjacent waters
ii. A description of the social and economic characteristics of the communities around the project area; and
iii. The identification and brief description of industrial activities, within a 5-kilometre radius of the of the proposed project site.

1.2.4 Waste Inventory:

i. Waste generation
ii. Collection, storage and transport
iii. Disposal system

iv. Waste management
v. Pollution control

1.2.5 Impact Prediction and Evaluation

Assessment of environmental impacts – direct, indirect and cumulative issues identified through scoping and modeling, will include use of natural resources, the emission of pollutants, the creation of nuisances, and the elimination of waste.

The impact prediction shall be related to the proposed activities during construction and operation on the surrounding areas and shall be separated as such, to include:

i. Change in drainage pattern – flooding potential
ii. Air pollution, to include dust from construction activities as well as the cumulative impact within the area of influence
iii. Risk assessment to include the environmental and safety implications of fires and explosions on residential communities and industrial facilities, natural hazard vulnerability, and the transition of liquefied natural gas
iv. Water pollution (surface & underground) including thermal impact and the impact of biocide or any other chemical used for cleaning and maintenance
v. Landscape impact- storage site
vi. Impact on noise generation
vii. Impact of waste generation and disposal
viii. Impacts on flora and fauna
ix. Impacts on communities and their economic activity
x. Impacts arising from land acquisition and resettlement
xi. Impacts on cultural heritage
xii. Impacts on aesthetic and landscape
xiii. Impacts on human health and safety; and

xiv. Impacts on road traffic and vehicular movement

Mitigation Measures

Based on the aforementioned processes, the significant impacts of the project shall be obtained and corresponding mitigation measures will be identified and itemized due to the proposed project construction and operation and an environmental monitoring and management plan will be prepared to monitor the implementation of the mitigating measures being proposed.

The mitigation measures shall speak specifically to the impacts that would be generated based on the detailed review of existing conditions and the details of the technical design and specification of the proposed project.

1.3 DECLARATION

Jabridep Nigeria Limited in its capacity as the Consultant to ONDIPA on Environmental and Social Impact Assessment, and on behalf of her partners, hereby declares her intention to abide by the existing international and national laws and regulations regarding environmental protection in the execution of the Project. Jabridep Nigeria Limited hereby declares that it has prepared this EIA report using the best available expertise in personnel, equipment, and internationally acceptable methods.

1.4 STRUCTURE OF THE EIA REPORT

The format of the EIA Report is as outlined below:

i ***Title Page***
ii ***Acknowledgement***
iii ***EIA Preparers***

iv *Table of Contents*

- Chapter – Titles and Pagination
- List of Maps, Illustrations and Figures
- List of Tables
- List of Acronyms and Abbreviations

v ***Executive Summary***: A non-technical summary of the main findings and conclusion of the study. It should cover the main issues discussed, a brief description of the project and the environment, the main mitigation measures to be undertaken, any significant residual impact, a brief description of how data were obtained and an indication of the confidence limit which can be placed on them.

vi ***Chapter One*** – Introduction, Background Information, Administrative and Legal Framework, Terms of Reference, and Declaration.

vii ***Chapter Two*** – Project Justification; Project Background; Project Objectives; Need for the Project; Value of the Project; Envisaged Sustainability; Project Alternatives (including no project alternative); Development Options; and Site Selection.

viii ***Chapter Three*** – Policy, legal and administrative framework. NIGERIAN ADMINISTRATIVE FRAMEWORK- Introduction: Nigeria Administrative Framework; National Legislations: National Regulatory Requirements,

National Guidelines and Standards for Environmental Pollution Control in Nigeria. NIGERIAN REGULATORY FRAMEWORK - National EIA Procedures. NIGERIAN ENVIRONMENTAL LEGISLATIONS. LEGAL FRAMEWORK REGARDING DEEP-SEA PORTS. International Laws and Regulations ix *Chapter Four* – Project Description; Type of project, scope, location, design. Criteria, material input/output and by-products (mass balance), waste generation, technical layout (including drainage and access ways) and process, Project Information to be described in terms of activities such as site preparations, construction, operation and decommissioning. All major activities within this classification should be shown in the form of bar chart to convey the timing for implementation, operation and decommissioning of the project.

x *Chapter Five* – Baseline Environmental Conditions; Study approach – literature review, baseline data acquisition method (field data collection, laboratory analysis and QA/QC). Description of the natural environment which includes terrestrial (geographical location, climatic conditions, air quality, noise level, vegetation, land-use and landscape pattern, ecologically sensitive areas and soil) and Aquatic environment (ground water resources, quality of surface water, surface water resources). Description of the human environment which includes the health and social environment. Inclusion of maps (political, topographical, aerial maps, etc), and the use of Geographical Information System (GIS) for the mapping and data collection.

xi *Chapter Six* – Associated and Potential Environmental Impacts; Scoping impacts prediction methodology, impacts of project activities (site preparation, construction, operation, and decommissioning), impacts on resource utilization. Short term / Long term impacts, adverse / beneficial impacts, risk assessment (HAZOP, HAZID, and QRA), Social impacts, Health impacts, etc. Contingency plan and modeling of the operations of key components of the project.

xii ***Chapter Seven*** – Mitigation Measures and Alternatives; Control technology, Compensation, Alternative site, Alternative route or location, Compliance with health and safety hazard requirements.

xiii ***Chapter Eight*** – Environmental Management Plan; Community Development Plan – where applicable; Guidelines for specific project activities; Emergency requirements; Monitoring program (scope, parameters, frequency, location, methodology, etc); Auditing and Inspection procedures; Waste handling procedures; Training programs; and Roles and responsibilities.

xiv ***Chapter Nine*** – Consultations; Identification of Stakeholders, Consultations with Regulators, Project Affected Persons and Communities, Community concerns and observations, and Participatory Rural Appraisal (PRA) and proof of community consultations must be attached.

xv ***Chapter Ten*** – Conclusion and Recommendations

xvi ***References***

xvii ***Appendices***

xviii ***Annexures***

CHAPTER TWO

2.0 PROJECT JUSTIFICATION

In this section of the report, we provide a justification for the proposed project based on the need, the benefits and the value of the Project. In addition, we provided an analysis of the different alternatives for the Project, in line with the Nigerian EIA Guidance.

2.1 PROJECT OBJECTIVES

The objectives of the project EIA are to:

i. Determine baseline conditions of the environment as well as the socio-economic and health conditions of the host communities;

ii. Evaluate the residual impacts of the existing facilities on the receiving environment;
iii. Determine and evaluate the potential impacts of the proposed project activities on the environment, using the current environmental conditions as the baseline;
iv. Identify and evaluate the potential socio-economic effects of the project on the communities including impacts on cultural properties, social infrastructures, natural resources and impact on lifestyles/values;
v. Identify health hazards that may result from the different phases of the project during execution (including operation & decommissioning) and evaluate local population exposure to these hazards;
vi. Develop cost effective mitigation measures and appropriate Environmental Management Plan (EMP) for all identified impacts.

2.2 PROJECT NEED

With Nigeria's population getting wealthier and growing at a rapid pace, it is expected that the import of consumer goods into the country will increase rapidly, leading to a request for additional container capacity in its ports. Also, with the constant and very remarkable growth of container traffic and congestion experienced so far, and foreseen for the future in the Lagos axis, building a new sea port in Ondo State to accommodate more maritime traffic, ever larger containerships, and therefore larger inland container traffic will be of great economic advantage.

The proposed Ondo State Deep-Sea Port aims to become the western gateway of Nigeria for providing vital port capacity for the country. The existing gateway situated in Lagos is severely congested from the sea and land sides, leading to delays for ships entering the port and within the port due to capacity constraints on the terminals. Establishing the project in Ondo State would further lead to industrial developments. Thus, a new and modern port with direct motorway and railway connections, built using state-of-the-art technologies, is an efficient and sustainable transport solution.

The project is intended to provide following needs:

i. Container handling and storage capacity;
ii. Import capacity for petroleum products;
iii. import capacity for vehicles;
iv. Dedicated import capacity for food and agricultural products;
v. Dedicated export capacity for industrial output and natural resources;
vi. A supply base for the regional oil and gas sector;
vii. A shipyard and dry dock for shipbuilding, vessel maintenance and repairs, and
viii. A logistics base and regional trading hub in West Africa.

2.3 Project Alternatives

There are usually several alternatives to a project design and in this sub-section, a number of alternatives are considered. In assessing alternatives, there are often many influencing factors including economic feasibility, level of political support for the Project (in line with Government policies) and social-environmental feasibility and sustainability

In conceiving the present development project ONDIPA must have taken into consideration a number of options and/or alternatives with regard to technology, site, location and schedule. Some of these options are as follows:

Three (3) possible integrated development alternatives/scenarios were identified:

Scenario 1: No-Development Option/Do nothing

Scenario 2: Delayed-Action Option

Scenario 3: Alternative technology option

2.3.1 No-development option

This option implies that the proposed project will not be carried out by the project proponent. This option was not adopted by ONDIPA because it negates the essence of its goal in diversifying the economy of Ondo State and at variance with a major national priority of Nigeria. The option is also un-business – like and will be of no financial benefit to either the stakeholders or the country.

2.3.2. Delayed-action option

This option implies that the project is delayed to sometime in the future due to political position, public opinion and/or availability of funding rather than been executed as scheduled for 2026. ONDIPA has not adopted this option because it implies that the much-needed revenue generation will continue to be abandoned. The two direct outcomes of a significant delay or delays in the project are escalating project costs which could jeopardize the financial feasibility of the Project.

2.3.3 Alternative technology option

The present option of developing the project will involve immediate development of the proposed Deep-Sea port in the designated area using the available existing technology. The proponent has rejected the option of non-development. The present option of project development is thus the best of all the possible options considered economically, technologically, logistically and environmentally.

2.4 The Value and Benefits of the Project

The proposed project is an outlay of a lot of hard currency by the proponent to finance the various activities and personnel that will be involved in its execution. However, it is of great benefits considering the following:

i. Man power development and technology transfer to local personnel;
ii. Increased job opportunity for more Nigerian especially the youths from the project area;
iii. Increased financial status, improved quality of life, social harmony and peace in the project area;
iv. Reduced youth restiveness and delinquency and
v. Industrial development and good governance in the project area.

2.5 Project Sustainability

The proposed project is sustainable economically, technologically and environmentally. The State is looking for investors that has the financial resources and/or access to the required credit to finance the project and has made the necessary arrangement to this effect. ONDIPA is making effort with some foreign technical partners and has made the necessary appraisal of the technology required and put in place the best engineering practice and most environmentally friendly options for the job. All engineering design standard, codes and practices for the project are in compliance with national and international standards regulations and procedures.

ONDIPA will only take the minimal land required for the project and ensure that the natural quality and integrity of the project area are preserved by adhering strictly to a sound environmental management plan developed for the project implementation including adequate training and re-training of all staff that will be involved in the project.

2.6 Site Selection

Four potential port locations in Ondo State have been holistically evaluated through a multi-criteria analysis (MCA). The preferred port site has been selected to be located at Erunna/Ogboti in Ilaje Local Government area of the State. The site is connected by a single road at 91 km distance off the highway at Ore. The road crosses several creeks and wetlands.

CHAPTER THREE

3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The EIA was carried out in accordance with the Federal Environmental Protection Agency (Now FMEnv) Act No. 58, 1988, the National Inland Waterways Authority Act No 13 of 1997, International Laws and Regulations (World Bank Guidelines on Environmental Assessment {EA} (1991), International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines, Convention on the Migratory Species of Wild Animals (Bonn Convention), Convention of Biological Diversity, Convention Concerning the Protection of the World Cultural and National Heritage Sites (World Heritage Convention), Nigerian Ports Authority Act No

38 of 1999 and the Endangered Species (Control of International Trade and Traffic) Act 11 of 1985. This document sets down the guidelines for an enhanced, cost effective and improved EIA process, which fully incorporates Social Impact Assessment (SIA), Health Impact Assessment (HIA) and effective consultation with all the Stakeholders in the EIA.

3.1 NIGERIAN ADMINISTRATIVE FRAMEWORK

3.1.1 Introduction: Nigeria Administrative Framework

In Nigeria, there are several legislative and regulatory requirements controlling port related activities (dredging for infrastructure, reclamation, and dredging associated with aquaculture etc.). These regulations include local laws as well as some international treaties, acts and conventions. In this section, overviews of the laws for development projects are presented below.

The Local regulations fall under the jurisdiction of two main government agencies: The Federal Ministry of Environment (FMEnv), and State Environment laws. These following regulations are of relevance:

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

3.1.2 National Legislations: National Regulatory Requirements

The Federal Environmental Protection Agency (FEPA) was established in 1988 (with the modifications of the enabling law in 1992 and later in 1999). The Agency was charged with the responsibility of overseeing sustainable development through environmental protection and conservation of natural resources. The Agency was upgraded to become a ministry and in 1999, the Federal Ministry of Environment

(FMEnv) was established by the civilian administration to implement laws related to the environment and sustainable development. FMEnv brought under one roof all the federal government's agencies and departments whose activities related to environment, with FEPA as the nucleus.

The primary mandate of FMEnv is to achieve environmental objectives as expressed in Chapter II Section 20 of the 1999 Constitution of the Federal Republic of Nigeria, whose basic premise is "to protect and improve water, air, land, forest, and wildlife of Nigeria". Most activities of FMEnv involve policy formulation, project implementation and compliance monitoring. The Ministry is responsible for ensuring the formulation and compliance monitoring of environmental standards. The Ministry has very wide powers covering all the major economic industries.

3.1.3 National Environmental Standards and Regulations Enforcement Agency (NESREA) Act

In order to achieve effective enforcement of environmental laws, standards and regulations in the country, the National Environmental Standards and Regulations Enforcement Agency (NESREA) was established as a parastatal of the Federal Ministry of Environment. The NESREA Act was accented to by Mr. President on July 30, 2007. By the NESREA Act, the FEPA Act Cap F10 LFN 2004 has been repealed.

NESREA is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria, with the exception of oil and gas. It also has the responsibility to enforce compliance with provisions of international agreements, protocols, conventions and treaties on the environment (for more details on NESREA relevant to the project, see http://www.nesrea.org/about.php).

Some of the responsibilities of NESREA include the following:

1. Enforce compliance with laws, guidelines, policies and standards on environmental matters;
2. Liaise with, stakeholders, within and outside Nigeria on matters of environmental standards, regulations and enforcement;
3. Enforce compliance with the provisions of international agreements, protocols, conventions and treaties on the environment including climate change, biodiversity conservation, desertification, forestry, oil and gas, chemicals, hazardous wastes, ozone depletion, marine and wild life, pollution, sanitation and such other environmental agreements as may from time to time come into force;
4. Enforce compliance with policies, standards, legislation and guidelines on the following:
    i. water quality, Environmental Health and Sanitation, including pollution abatement;
    ii. sustainable management of the ecosystem, biodiversity conservation and the development of Nigeria's natural resources;
    iii. sound chemical management, safe use of pesticides and disposal of spent packages thereof; and
    iv. regulations on the importation, exportation, production, distribution, storage, sale, use, handling and disposal of hazardous chemicals and waste, other than in the oil and gas sector;

5. Enforce through compliance monitoring, the environmental regulations and standards on noise, air, land, seas, oceans and other water bodies other than in the oil and gas sector;
6. Ensure that environmental projects funded by donor organizations and external support agencies adhere to regulations in environmental safety and protection;
7. Enforce environmental control measures through registration, licensing and permitting Systems other than in the oil and gas sector;
8. Conduct environmental audit and establish data bank on regulatory and enforcement mechanisms of environmental standards other than in the oil and gas sector;
9. Create public awareness and provide environmental education on sustainable environmental management, promote private sector compliance with environmental regulations other than in the oil and gas sector and publish general scientific or other data resulting from the performance of its functions; and
10. Carry out such activities as are necessary or expedient for the performance of its functions.

3.1.4 State Legislations: States Environmental Protection Edicts

The responsibility for environmental management in Nigeria is shared between the three tiers of government as enshrined in Chapter II Section 20 of the 1999 Constitution under the fundamental objectives and directive principles of state policy. It stipulates: "States shall protect and improve the environment and safeguard the water, air and land, forest and wild life of Nigeria". This section of the Constitution refers to Nigeria as a Sovereign State and empowered federating states to legislate on environmental issues. As a result of the law, many State governments in Nigeria have established their Ministries of Environment; in some states as a separate ministry and in others as a part of the Ministry of Water Resources or Agriculture. Almost all of the 36 States (and the Federal Capital Territory, Abuja) have in addition created a State Environmental Protection Agency (SEPAs) whose duty is to implement state environmental policies with particular attention to solid waste removal and industrial pollution control.

Furthermore, in accordance with Section 24 of the Federal Environmental Protection Agency (FEPA) Act, Chapter 131 of the Federal Republic of Nigeria, 1990, (as amended) by Decree No. 59. of 1992, the State Environmental Protection Edicts were enacted. The Edicts empower the State Ministry of Environment to establish such environmental criteria, guidelines/specifications or standards for the protection of the state's air, lands and waters as deemed necessary to protect the health and welfare of the people.

3.1.5 Nigeria's National Policy on the Environment (1989, Revised 1999)

The National Policy on Environment, 1989, identified the key sectors in which environmental concerns were to be integrated with sustainable development. It presented specific guidelines for achieving sustainable development in the following fourteen sectors of Nigeria's economy: Human Population; Land Use and Soil

Conservation; Water Resources Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working

Environment; Settlements; Recreational Space, Green Belts, Monuments; and Cultural Property.

This Policy defines guidelines and strategies for achieving the policy goal of sustainable development in Nigeria, and, in particular to:

i. Secure a quality of environment adequate for good health and well-being;
ii. Conserve and use the environment and natural resources for the benefit of present and future generations;
iii. Restore, maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of living natural resources and ecosystems;
iv. Raise public awareness and promote understanding of the essential linkages between the environment, resources and development, and encourage individual and community participation in environmental improvement efforts; and
v. Co-operate in good faith with other countries, international organizations and agencies to achieve optimal use of transboundary natural resources and effective prevention or abatement of transboundary environmental degradation.

3.1.6 National Guidelines and Standards for Environmental Pollution Control in Nigeria

Based on the 1989 National Policy on Environment, the National Guidelines and Standards for Environmental Pollution Control in Nigeria were enacted in March,1991 to serve as a basic instrument for monitoring and controlling industrial and urban pollution. These guidelines and standards were put in place to ensure the sustainability of Nigeria's industrial and agricultural practices, and sent to plant managers and operators to help them improve their operations. The guidelines relate to six key areas of environmental regulation:

i. Effluent limitations;
ii. Water quality for industrial water uses at point of intake;
iii. Industrial emission limitations ;
iv. Noise exposure limitations ;
v. Management of solid and hazardous wastes and
vi. Pollution abatement in industries.

The Ministry of Environment (local and Federal) enforces the provisions to ensure compliance.

3.2 NIGERIAN REGULATORY FRAMEWORK

3.2.1 National EIA Procedures

The EIA procedure of Nigeria is outlined below. The State Environmental Authority works together with FMEnv to ensure the execution on sustainable EIA studies.

There is an Environmental Regulation Framework in Nigeria (for EIA and environmental pollution and protection). The requirement for compliance with EIA in all parts of Nigeria derives from the following general laws and enactments that stipulate and mandate project proponents to abide by the standard requirements for sustainable development.

Owing to the dynamic nature of the legal system and the changes that often occur in response to local demands, some of these general laws (applicable to this type of project) are included below; however, the list is not exhaustive:

Environmental Impact Assessment (EIA) Act No. 86 of 1992

This is the core legislation that governs EIA in respect of proposed projects in Nigeria and flows directly from the provisions of Principle 17 of the Rio Declaration:

"Environmental Impact Assessment as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority" (31 I.L.M. 874 (1992): Adoption of Agreement on Environment and Development; the Rio Declaration on Environment and Development).

The Nigerian EIA Act No. 86 of 1992 -Section (1(a) makes it mandatory that before the final decision is taken or approval given for any activity likely to significantly affect the environment, the effect of such activity shall first be taken into account. This is very important because this stresses the need to have an environmental assessment of a project in such a way that the action will be environmentally friendly and will not cause serious hazards to the people and the ecosystem.

Federal Environmental Protection Agency, Act 1988, (1988 No. 58), National Guidelines and Standards for Industrial Effluents, Gaseous Emissions and Hazardous Waste Management in Nigeria states that Environmental Auditing of existing industries EIA of new industries and major developmental projects shall be mandatory.

The FMEnv administers and enforces environmental laws in Nigeria. It took over this function in 1999 from the Federal Environmental Protection Agency (FEPA). FEPA was absorbed and its functions taken over by the FMEnv in 1999. A vital role played by FMEnv relates to the approval of EIA. New projects require the EIA to be approved by the Ministry before any construction can commence. In addition, there is a public hearing which is an innovation to the approval process. Members of the wider community, particularly those potentially affected by the project have a forum to modify the way potential impacts are mitigated by project sponsors.

The State Environmental Protection Agencies (SEPAs) have enabling instruments which permit them roles and responsibilities in the conduct of EIA. This means that different States within Nigeria also have the power to make laws to protect the environment within their respective jurisdiction.

Apart from publishing the National Policy on the Environment (NPE) in 1989, with the policy goal of achieving sustainable development, FEPA (now FMEnv) published other sectoral regulations including the National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulation 1991 wherein an EIA was made obligatory only when so required by FEPA (FMEnv) and compliance must be within 90 days of such demand.

> *Regulation 11 of the National Environment Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations* provides that the collection, treatment, transportation and final disposal of waste shall be the responsibility of the industry or facility generating the waste. The ultimate responsibility lies with the producer, because under Nigerian law, the "polluter pays" principle applies.

3.3 NIGERIAN ENVIRONMENTAL LEGISLATIONS

Some of the above treaties are also cited among the World Bank's list of key international agreements on environment and natural resources (Environmental Assessment Sourcebook- update 10 of the World Bank).

3.3.1 Some of the National/ Local regulatory laws relevant to the Project are:

1. *Environmental Impact Assessment Act No. 86 of 1992 (EIA Act);*
2. *National Policy on Environment;*
3. Harmful Wastes (Special Criminal Provisions etc.) Act of 1988 (Harmful Wastes Act);
4. *Federal Ministry of Environment (FMEnv) Statutory Instrument (S.I.8) National Environmental Protection (Effluent Limitations) Regulation of 1991;*
    i. Section 1 – No industry or facility shall release hazardous or toxic substances into the air, water or land of Nigerian's ecosystem beyond limits approved by the Agency;
    ii. Section 17 – An industry of a facility which is likely to release gaseous, particulate, liquid or solid untreated discharges shall install into its system appropriate abatement equipment in such manner as may be determined by the Agency;
5. *National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations of 1991.*

    Regulation 10 of National Environment Protection (Pollution Abatement in Industries and Facilities Generating Wastes) provides that no person shall be engaged in the storage, treatment or transportation of harmful toxic waste without a permit issued by FEPA. Therefore, where harmful toxic waste is produced on- site, it may only be stored or disposed on-site where a permit has been issued to the producer of such waste. Where it is environmentally safe to do so, solid waste may be stored or disposed of on-site, subject to the issuance of the requisite permit as prescribed by Regulation 16.

Producers of waste may retain residual liability, particularly where a transferee or person engaged to dispose of the same absconds. If the regulator is able to trace the waste back to the producer, he would be liable for clean-up.

6. *The Endangered Species Act 11, 1985.*

   The Act makes general provision for the protection of flora and fauna.

7. *Water Resources Act CAP W.2 Laws of the Federation of Nigeria (LFN) 2004.*

   The Water Resources Act is targeted at developing and improving the quantity and quality of water resources. The following sections are pertinent:

   Section 2 – made provisions for the rights to take and use water generally in Nigeria.

   i. Section 3- provides for acquisition of rights to use or take water in any part of the country.
   ii. Section 5 and 6 provides authority to make pollution prevention plans and regulations for the protection of fisheries, flora and fauna.

8. *Nigerian Ports Authority Act No 38 of 1999*

   The Nigerian Ports Authority (NPA) is a federal government agency that governs and operates the ports of Nigeria. NPA was established in 1955 by the Port Act Cap 155 Laws of the Federation of Nigeria and Lagos as a corporate body with perpetual succession. The enabling statutes have been amended several times. The successor law is the Nigerian Ports Authority Act No 38 of 1999. By Act No. 38 of 1999, Nigerian Ports Authority owns the ports and controls all public and private tasks.

Under Section 7 of the NPA Act No. 38 of 1999, the functions of the Authority in summary are too:

i. Provide and operate port facilities and services;
ii. Maintain, improve and regulate the use of the ports;
iii. Ensure efficient management of port operations; and
iv. Control pollution arising from oil or any other from ships using the port limits or their approaches.

Section 8 of the Act gives the Authority very wide powers. These include power to:

i. Build and develop port docks, harbours, piers, wharves, canals, jetties, embankment and water courses;
ii. Invest the funds of the Authority;
iii. Act as consultants in relation to port and port operations in Nigeria or any part of the world;
iv. Act as carrier by land or sea, stevedore, wharfinger, warehouseman or lighterman
v. Appoint, license and manage pilots of vessels;
vi. Reclaim, excavate, enclose, raise or develop any of the lands acquired by or vested in the authority; and
vii. Win sand from the ports and their approaches for such purposes as it may deem fit.

9. *National Inland Water Ways (NIWA) Act No. 13 of 1997*

NIWA was established in 1997 (Act No. 13 of 1997) as a Parastatal from the erstwhile (old Marine) Inland Waterways Department (IWD) of the Federal Ministry of Transport, which itself was established in 1956. Some of the key functions of NIWA include:

i. Improve and develop inland waterways for navigation;
ii. provide an alternative mode of transportation for the evacuation of economic goods and persons;
iii. Execute the objectives of the national transport policy as they concern inland waterways; and
iv. Subject to the provisions of the EIA Act, carry out environmental impact assessment of navigation and other dredging activities within the inland water and its right-of-way.

10. *Sea Fisheries Act, CAP S4, LFN 2004.*

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

i. Section 1 prohibits any unlicensed operation of motor fishing boats within Nigerian waters;
ii. Section 14 (2) provides authority to make for the protection and conservation of sea fishes.

11. *Inland Fisheries Act, CAP I10, LFN 2004.*

The Inland Fisheries Act focused on the protection of the water habitat and its species; the following sections are useful:

i. Section 1 prohibits unlicensed operations of motor fishing boats within the inland waters of Nigeria;
ii. Section 6 prohibits the taking or destruction of fish by harmful means.

12. Nigerian Maritime Administration and Safety Agency (NIMASA) Act. 2007

The Nigerian Maritime Administration and Safety Agency, NIMASA, focal areas include effective Maritime Safety Administration, Maritime Labour Regulation, Marine Pollution Prevention and Control, Search and Rescue, Cabotage enforcement, Shipping Development and Ship Registration, Training and Certification of Seafarers, and Maritime Capacity Development.

In summary, some relevant functions of the Agency are to:

i. Pursue the development of shipping and regulate matters relating to merchant shipping and seafarers;
ii. Administering the registration and licensing of ships;
iii. Regulate and administer the certification of seafarers;
iv. Regulate the safety of shipping as regards the construction of ships and navigation;
v. Provide directions and ensure compliance with vessel security measures;
vi. Carry out air and coastal surveillances;
vii. Control and prevent maritime pollution
viii. Enforce and administer the provisions of the Cabotage Act 2003;
ix. Receive and remove wrecks; and
x. Provide National Maritime Search, Rescue Services and Maritime Security.

13. Land Use Act No.6 of 1978

The Land Use Act of 1978 vested all Land situated in the territory of each State (except land vested in the Federal Government or its agencies) solely in the Governor of the State, who would hold such Land in trust for the people and would henceforth be responsible for allocation of land in all urban areas to individuals resident in the State and to organisations for residential, agriculture, commercial and other purposes. Similar powers will with respect to non-urban areas are conferred on Local Governments. The Law commenced from March 27, 1978.

14. The Nigerian Minerals and Mining Act 2007 ("the Act")

The Act was passed into law on March 16, 2007 to repeal the Minerals and Mining Act, No. 34 of 1999 for the purposes of regulating the exploration and exploitation of solid materials in Nigeria. The Act vests control of all properties and minerals in Nigeria (in, under, or upon any land in Nigeria, its contiguous continental shelf and all rivers, streams and water courses throughout Nigeria, any area covered by its territorial waters or constituency and the exclusive economic zone) in the State and prohibits unauthorized exploration or exploitation of minerals.

3.4 LEGAL FRAMEWORK REGARDING DEEP-SEA PORTS

The construction of a Deep-Sea Port in Nigeria would require compliance with several Governmental Authorities' Laws/Regulations and Guidelines for Approvals, Permits and Consent. For a sea port declaration needs the approval from only the Minister of Transportation as provided by law. The Infrastructure Concession and Regulatory Commission (ICRC) as a regulatory agency responsible for concessions has also laid out detailed processes that will lead to the establishment of a port.

(a) The Federal Ministry of Transport, Nigerian Ports Authority – NPA Act, and ICRC regulatory guidelines

The mandate of the Federal Ministry of Transportation is to ensure fast, safe, efficient, affordable, convenient, integrated and international transport system that facilitates Nigeria's socio-economic development needs and enhances the quality of the of life of the public and NPA is the Regulatory agency to regulate Port activities.

Application for the Declaration of area as a Port Area to the Public – pursuant to Section 30 of NPA Act should address the following conditions

i. Design and approval of engineering design and other technical documents;
ii. Application for Building permits;
iii. The NPA has the power to seek, through the President of Nigeria, that any land or building is declared as being required by the NPA for a public purpose and that same be acquired – pursuant to the provisions of the Lands Use Act, Cap. L5, LFN, 2004;
iv. Dredging and Dumping/Reclamation Permit - pursuant to sections 8(n), (o) and 9 which states that NPA can reclaim, excavate, enclose, raise or develop any of the lands acquired by or vested in the Authority;
v. Notification of port coordinates and layout of sub-sea communication cables to the UK Hydrographic Department, through the NPA; and

vi. Approval from the Federal Ministry of Transport for NPA's expenditure above N250 Million.

In addition to the power given to the Minister to declare any place in Nigeria as a port, the Nigeria Ports authority has been empowered by the NPA Act to perform a number of functions that are critical to the operations of ports and maritime activities. These powers are exercised by the NPA to the exclusion of all other agencies or authorities. Some of these powers include power to appoint port managers, power to make port regulations, restriction and license on the erection of piers, power to set apart Customs Area, power to make bye laws for control of wharves, power of the Minister to establish pilotage districts in any port, territorial waters of Nigeria or Exclusive Economic Zone of Nigeria, Power to license pilots, prohibition of entry into Nigeria of ships in certain cases among others. Although the NPA is an operator, it also exercises regulatory powers over ports operations and activities.

(b) The State Government of the area where the Port would be located

Application for a Right of Occupancy in respect of foreshore land adjacent the sea and coastal land – pursuant to the Lands Use Act, Cap. L5, LFN, 2004 or create security over land interest such as Governor's Consent; and

Operations Permit for dredging and developmental activity (reclaiming land) along the waterfronts (for example, the law in Lagos State - Waterfront Infrastructure Development Law, 2009).

(c) Nigeria Maritime Safety and Administration Agency ("NIMASA")

Permit to do any act that may affect maritime safety obtainable from the NIMASA Director General – pursuant to Section 22, NIMASA Act, 2007

(d) Board of Customs and Excise

Application to the President (through Customs) for the designation of the Port Area as a Customs Port – pursuant to Section 12, Customs and Excise Management Act, Chapter C45, Laws of the Federation of Nigeria, 2004; and Approval of a place as a wharf at a Customs Port – pursuant to Section 14, Customs and Excise Management Act, Chapter C45 Laws of the Federation of Nigeria, 2004.

(e) Ministry of the Interior/Immigrations

Application to the Minister for Interior for recognition of the Port as a port of entry – pursuant to Section 14, Immigration Act, CAP 11, Laws of the Federation of Nigeria, 2004.

Other Regulatory Bodies and legal issues

3.4.1 Other legal issues of relevance

There are several legal aspects around issues of relevance. The following issues are described:

i. Rules and regulations regarding public and private financing of port assets;
ii. Encroachment and compensation;
iii. Environmental obligations - legal environment;
iv. Ondo State Environmental Protection Agency Law;
v. Legal issues around functioning of FTZ;
vi. Incentives and export processing zones; and, • Nigerian manpower legal issues and foreign expats.

3.4.2 Other Regulatory Bodies

i. National Environmental Standards and Regulations Enforcement Agency ("NESREA");

ii. The Federal Ministry of Environments;
iii. Nigeria Export Processing Zone/ State Free Trade Zones;
iv. Nigerian Civil Aviation Authority ("NCAA").

Rules and Regulations Regarding Public and Private Financing of Port Assets

There are no rules or regulations that limit investment by the public or private sector in ports assets. There is a difference between brown field projects such as the existing ports owned by the Federal Government that were concessioned to private parties where the landlord model was used by the NPA and a greenfield project such as the Ondo deep-sea port. The level of investments required for a greenfield are huge. In most cases, the private party takes a comfortable majority in the SPV which then allows them to take investment decisions that are in the best interest of the project, without much interference.

Encroachment and Compensation

Ondo State Government indicated that some 2,771.2 hectares is required for the Project. It incorporates both Port and free trade zone areas in a new Industrial City. From a legal perspective, this raises a number of issues which are most germane to the execution and operation of the Project. The controlling statutory enactment in this regard is the Land Use Act (LUA), which vests all land in a State in the Governor of that State and also vests power in the local government to allocate land in non-urban areas. The LUA creates a regime for the grant of statutory rights of occupancy (which is expressed as a term of years – usually 99 years) in any land and requires that the prior consent of the Governor be obtained for any alienation of interest in real property. In this connection, it will be necessary to assess the nature and term of interest in the Project site, as well as to obtain all legally required approvals and comply with all registration requirements.

There are different rights that may be granted by the Governor upon allocation of land, which may include the grant of a statutory right of occupancy, the grant of easements appurtenant to statutory rights etc. and as aforesaid, Local Governments are also vested with power to vest customary rights to land in a non-urban area to applicants. However, the right of Local Governments to allocate land in non-urban areas does not preclude the right of the Governor of a State to allocate any land in the non-urban area.

Upon grant of a statutory or customary right of occupancy, the grantee is required to obtain the consent of the Governor or the Local Government as the case may be prior to alienating the right of occupancy by assignment, mortgage, transfer of possession, sublease or otherwise. It is also useful to note that the grant of a right of occupancy is not absolute, as the LUA preserves the right of the Governor to revoke the right of occupancy for overriding public interest and on conditions listed in section 28 of the LUA and subject to the payment of compensation as the case may require under section 29 of the LUA.

Where a debt financing is contemplated, we envisage that the Project lenders may want to take a mortgage over the Project Site as part of the security package for the financing of the Project and in this regard the consent of the Governors of Ondo States would have to be sought and obtained for the mortgage. Furthermore, we understand that there is considerable support for the Project from the State Governments, in whom the lands required for the Project would ordinarily be vested.

The Ondo State Government acquired the land for the free trade zone and the deep-sea port by way of government acquisition in accordance with the provisions of the Land Use Act.

In this regard, it may be useful to bear in mind that whilst the legal obligation to pay compensation rests on the revoking authority i.e. the State Government, it is typical for the project developer to participate actively in the payment of such compensation, usually by paying a portion of the compensation due to the previous occupants of the compulsorily acquired land, especially in circumstances where the amounts of compensation involved cannot be accommodated by the State Government due to budgetary or fiscal constraints.

Environmental Obligations - Legal Environment

To assure the successful implementation of the Project, particular attention will have to be paid to environmental issues, especially where the existing ecosystem will be disturbed to build a new plant. It is also useful point out that the EIA for the free trade zone has already been conducted.

Furthermore, it will be important to understand land use constraints of the Project Site, as strict and other legal liability for environmental damage and degradation under statute (such as the NESREA Act and the various regulations made pursuant thereto), and common law, are vital bankability issues that crop up in power project finance, particularly given the growing sensitivity to sustainable development and good corporate citizenship, both in Nigeria and abroad. Thus, lenders would naturally be concerned about any possible uncertain or unmanaged risks posed by project environmental damage resulting through their holding or enforcing any security, exercising step-in rights, or otherwise.

3.4.3 Existing Legal Framework for Controlling Marine Pollution (Imo/Marcol Convention 73/78)

The International legal framework for addressing vessel source pollution is described in the United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS provides that the legislative and enforcement jurisdiction of a state over a particular vessel varies depending on whether the state is a flag, coastal or port state. The convention has created a uniform system that seeks to safeguard the freedom of navigation and the interest of coastal states in protecting and preserving the marine environment within their jurisdiction. In addition to UNCLOS, vessel source pollution is governed by the various conventions adopted by the International Maritime Organization (IMO). The global mandate of the IMO is implicitly acknowledged in UNCLOS through the expression “competent international organization.” The IMO is responsible for setting the standards at the international level to prevent vessel source pollution. These include: discharge and emission standards; construction, design, equipment, manning standards and navigational standards. Parties to all Imo conventions are under obligation to domesticate the provisions of the conventions in their national laws. It is also expected that relevant government agencies or designated organization are set up to enforce compliance to these laws.

In Nigeria, the scope of legal framework in place mainly covers prevention of oil pollution in the petroleum sector. Typical examples of these laws/Acts are Mineral Oil Safety Regulation 1963, Oil in Navigable Waters Regulation 1968, Petroleum

Regulations 1967, Petroleum (Drilling and Production) Regulation 1973 and Petroleum Refining Regulation 1974.

Other regulatory measures relating to pollution control can be inferred from the mandate of some of the Nigerian government parastatals established to regulate oil pollution. Examples include: the Federal Environmental Protection Agency (FEPA), now subsumed under Federal Ministry of Environment (FME), which issues standards for water, air, land quality and oil companies operations, The Nigeria Environmental Protection and Department of Petroleum Resources (DPR); which issue environmental guidelines and standards for the petroleum sector in Nigeria and National Oil Spill Detection and Response Agency (NOSDRA) which mandate is to co-ordinate and implement the national oil spill contingency plan. The Nigeria Ports Authority (NPA) as the custodian of Nigeria ports has institutional mandate to provide waste reception facilities. The Authority maintains a pollution monitoring unit even though it has contracted out its waste management responsibility to a private company. However, the Nigeria Maritime Administration and Safety Agency (NIMASA) by the decree establishing it, appears to be the only parastatal with specific mandate to ensure pollution prevention and control in the marine environment through implementation of domesticated international maritime (IMO) conventions. Thus, the administrative framework in place for controlling pollution in Nigeria depicts overlapping functions of the parastatals involved and represents a potential source of conflict.

The International Maritime Organization (IMO) convention on Marine Pollution MARPOL 73/78 outlines measures aimed at completely eliminating the willful and intentional discharge into the seas of oil and noxious or hazardous substances—chemicals, packaging, sewage and garbage. Specifically Annexes I, II, III, IV, V and VI of MARPOL 73/78 identify these sources and by their provision, port authorities are obligated to provide reception facilities for the handling of a range of waste including oil, chemical and garbage. Ports are also required to produce a Port Waste Management Plan, including information on the type and location of facilities, notification requirements, details of providers and costs. These plans are to be made available to port users, to ensure that vessels need are met promptly with no undue delay.

Article 1(4) of the 1982 United Nations Convention on the Law of the Seas (UNCLOS) defines pollution of the marine environment to mean the introduction by man, directly or indirectly, of substances or energy into the marine environment which are likely to result in negative effects on living resources, are hazardous to human health, a hindrance to marine activities including fishing and other legitimate uses of the sea, cause an impairment in quality for seawater uses and the reduction of amenities. On a global scale it is generally recognised that marine pollution is mainly caused by human activities based on land and much less by human activity taking place at sea. Specifically, shipping impacts on the marine environment in a number of ways and these according to reference include:

i. Pollution by oil and hazardous or toxic substances from incidental, operational and illegal discharges;
ii. Air pollution through emissions and particulate matter from engine exhaust gases and cargo tanks which may be carried over long distances;
iii. Discharge of operational waste from ships, including discharge of raw sewage and garbage (litter);
iv. Release of toxic chemicals used in anti-fouling paints and leaching of heavy metals from anodes;
v. The introduction of non-indigenous organisms through ships' ballast water and associated sediments, and fouling on ships' hulls;
vi. Pollution and physical impact through loss of ships and cargo;

vii. Physical and other impacts including noise and collision with marine mammals. The effects of these are mainly noticeable in busy shipping lanes and harbours; impact in or close to ecologically sensitive areas may be more significant in coastal areas. Ship generated wastewater are grouped by three basic types: bilge wastewater, black wastewater (sometimes grey wastewater is included to describe wastewater free from human faeces) and ballast wastewater.

Marine Environment Management Department in NIMASA is statutorily responsible for ensuring a clean marine environment through the implementation of all relevant IMO Conventions. It draws its statutory powers from Part XXIII Section 335 of the Merchant Shipping Act 2007 and Sections 22(2); 23 (9) (b) of the NIMASA Act, 2007. This responsibility is expected to achieve a friendly marine environment free of pollution that will enable shipping activities to be conducted in a conducive and healthy setting. It will also prevent the extinction of marine lives; thus, the food chain will remain unaltered and human existence will be assured. The objectives are the department within NIMASA are:

i. To continuously solve a wide variety of problems associated with coastal and maritime transport in order to preserve precious marine ecosystems;
ii. To protect nearshore areas and offshore facilities from marine disasters; and:
iii. To effectively utilize sea space and resources in line with the overall mission of NIMASA. in order to ensure safe and cleaner oceans.

FUNCTIONS

The functions of the Marine Environment Management Department are generally derived from the IMO Conventions relating to the protection of the marine environment against pollution and any other related Conventions adopted by the IMO from time to time.

MARINE POLLUTION PREVENTION:

The Marine Pollution Prevention Division (MPPD) is designed to articulate and implement the strategy for the prevention of marine pollution from ships and land-based sources. Amongst others, the IMO Conventions aimed at protecting and preserving the marine environment and resources include the following; MARPOL 73/78, London Convention 1972, Protocol 1996, Ballast Water Management Convention 2004, Intervention Convention 1969. Accordingly, national guidelines are formulated to ensure compliance with these conventions through the following functions:

i. Monitoring and Enforcement
ii. Shore/Offshore and Port Reception Facilities.
iii. Meetings/Training.

i. MONITORING AND ENFORCEMENT

- Monitoring of the Nigerian territorial waters through aerial surveillance and routine patrol.
- Monitoring of oil cargo tank washing exercises of tankers to ensure compliance with Annex 1, Reg. 13 & 13A of MARPOL and other Environmental standards.
- Inspection of reception facilities at NNPC/PPMC loading terminals and private jetties, shipyards, coastal industrial outlets, seaports and harbors to ensure regulatory compliance.
- Issuance and Inspection of oil and garbage record books onboard vessels to ensure utilization in line with Annex 1, Reg. 20 of MARPOL Convention.

- Monitoring and issuance of International Oil Pollution Prevention Certificates (IPPC) as contained in Annex 11, Reg. 5(3.2) of MARPOL.
- Monitoring and issuance of International Pollution Prevention Certificates (IOPP) in line with Annex 1 Reg. 5 of MARPOL.
- Supervising the carting away and disposal of garbage, sludge, and bilge oil from vessels.
- Inspection of anti-pollution equipment on board vessel.
- Ensuring that all marine environmental-related projects be conducted in line with best management practices subject to the development of Environmental Impact Assessment (EIA) before embarking on the projects.
- Carrying out routine marine environmental auditing and post-impact assessment based on laid down regulations.

ii. SHORE/OFFSHORE AND PORT RECEPTION FACILITIES

- Inspection of offshore installations of oil companies and tankers for the prevention of Marine Pollution from oil through laid down monitoring strategies
- .Monitoring deballasting and loading operations of oil tankers at offshore and onshore terminals to ensure compliance with international standards.
- Ensure adequacy of all MARPOL Port Reception Facilities at the nation's ports, jetties, and terminals to ensure availability and maximum utilization by visiting ships as provided for in Annex 1, Reg. 12 MARPOL convention.
- Develop and periodically review payment of environmental dues for the provision of reception facilities for offshore installations such as Floating Production Storage and Offloading (FPSO), Floating Storage and Offloading (FSO) and other platforms.

- To establish and maintain a Marine Environment information database, modelled like the GISIS platform of IMO e.g. Port Reception Facilities database, BWM database, Ship recycling website, etc.
- To participate in the conduct of Environmental Impact Assessment (EIA) of new designs/constructions of offshore installations within the Marine Environment.

iii. MEETINGS, TRAINING AND WORKSHOPS/SEMINARS

- Organize educative and public awareness programs such as workshops/seminars for all stakeholders in collaboration with Governmental and Non-governmental Organizations on current issues on pollution prevention in Nigerian waters
- Organize Inter-agency meetings to discuss the way forward on the need to protect and prevent pollution of the marine environment.
- To participate at all IMO meetings and programs on the marine environment at the International, Regional and National levels.
- Championing with FMOT and Legal Unit of the Agency on the ratification and domestication of IMO International Convention on the marine environment, relating to pollution prevention which is yet to be ratified and domesticated.

iv. **MARINE POLLUTION CONTROL**

- The functions of the Marine Pollution Control Division are derived from the Coastal State's duties. This involves controlling the actions of ships while operating within Nigeria's jurisdiction, i.e. 200 nautical miles from the coastline corresponding to the Exclusive Economic Zone (EEZ), including fixed and floating off-shore oil platforms. The Division implements the following IMO Conventions designed to control ship-source pollution:

- International Convention on Oil Pollution Preparedness,
- Response and Co-operation, (OPRC), 1990;
- OPRC – HNS Protocol 1996;
- Civil Liability Convention (CLC);
- International Oil Pollution Compensation Fund 1992 (IOPC);
- International Convention on Hazardous and Noxious Substances 2000 (HNS Convention);
- Bunkers Convention;
- Wreck Convention 2007;
- IMDG Code etc.

The Marine Pollution Control Division also implements the Nigerian Merchant Shipping Act (2007) especially XXV – Limitation of Liability for Maritime Claims and XXVI – Wrecks and Part X of the NIMASA Act (2007).

The aforementioned Conventions & Acts are implemented through the under-listed functions

RESPONSE AND LABORATORY ANALYSIS FUNCTIONS

i. Establish jurisdiction: Marine and Coastal areas.
ii. Conducting regular boat patrols and aerial surveillance of our coasts.
iii. Pollution detection: violation may be detected outside the port, within the territorial waters, or even the EEZ, using both aerial surveillance and boat patrols.
iv. Investigation of violation reported or otherwise detected.
v. Evidence gathering including laboratory analyses of polluted samples.
vi. Prosecute and punish violators.
vii. Penalize violators i.e. collection of fine imposed according to the polluter-pays-principle.

viii. Environmental Sensitivity Index mapping to determine resources at risk which will require protection in the event of pollution.
ix. Contingency planning for the control of marine oil and chemical spills.
x. Approval of Shipboard Oil Pollution Emergency Plan (SOPEP) and Shipboard Marine Pollution Emergency Plan (SMPEP) for all Nigerian flag vessels and offshore installations.
xi. Conducting regular drills on oil spill clean-up.
xii. Response to marine oil and chemical spills.
xiii. Coordinate clean-up of polluted areas in collaboration with relevant stakeholders.
xiv. Conducting post-spill surveys and restoration of affected areas.
xv. Cooperation with other countries on oil and chemical spill response – seeking and rendering assistance.
xvi. Development and maintenance of marine pollution incident database.
xvii. Development of Marine Pollution Incident Reporting System both national and regional.
xviii. Intervention in cases of incidence on the high sea as regards pollution by oil and other substances.
xix. Approval of waste management plan of all-at-sea activities including oil terminals.
xx. Production of baseline data for marine environment laboratory index for physio-chemical and microbiological status of unpolluted marine environment.
xxi. Establishment of clean-up equipment stockpile.
xxii. Ensure compliance with the International Safety Management (ISM) Code with respect to the requirements for every shipping company including tankers for pollution control aspects of their operations.

xxiii. Establishment of a proper system for the carriage of Maritime Dangerous Goods.

xxiv. Research and Development on all issues of marine pollution response including future technologies.

xxv. Coordinate regional Agreements on Marine Emergencies.

xxvi. Identify the Scientific Group of Experts for carrying out further research as needed.

B. LIABILITY AND COMPENSATION FUNCTIONS

i. Issuance of Civil Liability Certificates to Nigerian flagged vessels.

ii. Ensuring that all shipowners make adequate financial provision for pollution damage (i.e. compulsory insurance.)

iii. Ensuring that all importers of Oil and HNS contribute to the IOPC Fund.

iv. Production of the statistical digest of all importers of oil and chemicals.

v. Collation and submission of oil and chemical reports to the Fund Secretariat.

vi. Issuing oil and chemical import permits to importers.

vii. Maintaining registers of possible victims of oil and chemical pollution damage – fishermen cooperatives, hoteliers and all owners and types of businesses in the coastal region.

viii. Development of Claim Management System for claimants.

ix. Ensuring prompt and adequate compensation of victims of oil and chemical damage arising from spills from ships on voyage.

x. Coordinating with the IOPC Fund Secretariat in matters of compensation.

xi. Establish and manage marine oil and chemical spill fund.

xii. Awareness creation for all possible victims of oil and chemical pollution damage.

3.4.4: International Laws and Regulations

Nigeria is signatory to several laws, treaties and regulations that govern the environment. Among these are:

(i) World Bank Guidelines on Environmental Assessment {EA} (1991)

(ii) International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines

(iii) Convention on the Migratory Species of Wild Animals (Bonn Convention)

(iv) Convention of Biological Diversity

(v) Convention Concerning the Protection of the World Cultural and National Heritage Sites (World Heritage Convention)

(vi) Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal and.

(vii) United Nations Framework Convention on Climate Change (1992)

World Bank Guidelines on Environmental Assessment {EA} (1991)

The World Bank requires the execution of an EIA on a proposed industrial activity by a borrower as a pre-requisite for granting any financial assistance in form of loans. Details of World Bank's EIA procedures and guidelines are published in the Bank's EA Source Book vols. I - III of 1991. Potential issues considered for EA in the upstream oil and gas industry include the following:

i. Biological Diversity

ii. Coastal and Marine Resources Management

iii. Cultural Properties

iv. Hazardous and Toxic Materials and

v. International waterways.

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

The Bonn Convention concerns the promotion of measures for the conservation and management of migratory species.

Convention on Biological Diversity

The objectives of the Convention include the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

Convention Concerning the Protection of the World Cultural and Natural Heritage Sites (or World Heritage Convention)

The convention sets aside areas of cultural and natural heritage for protection. The latter is defined as areas with outstanding universal value from the aesthetic, scientific and conservation points of view.

United Nations Framework Convention on Climate Change (1992)

In order to achieve sustainable social and economic development, energy consumption for developing countries needs to grow taking into account the possibilities for achieving greater energy efficiency and for controlling greenhouse gas emissions in general. This also includes the application of new technologies on terms which make such an application economically and socially beneficial, determined to protect the climate system for present and future generations.

CHAPTER FOUR

4.0 Project Area Description and Existing Environmental Condition

4.1 Introduction to the Section

This Section provides an overview of the technical design and operation of the proposed Deep-Sea port project together with an assessment of the how the design compares to international best available techniques. The Section also details an overview of the alternatives to the project design and location.

The Ondo State Government planned to design, construct and operate a Deep-Sea port through the public private partnership (PPP). The port will be developed in three phases over a period of ten years between 2018 and 2028. The Phase 1 of the Deep-Sea Port Development (i.e. the Project) will realize the development of the port to handle approximately 10 million tons of containerized cargo per annum; which equates to approximately 900,000 twenty-foot equivalent unit (TEU) containers. It will provide the port infrastructure and facilities to accommodate container vessels with cargo capacities up to 10,000 TEU.

The main key characteristics of the port infrastructure are the following:

i. **Single-lane access channel** with width of 200 m, a length of 10.8 km and depth of CD 16.5m;

ii. **Turning circle with a diameter** of 600 m and depth of CD-16.5 m;

iii. **Main basin** with a depth of CD-15 m/CD-11 m and a minimum width of 250 m in the southeast, widening slightly towards the northwest to reduce potential harbor seiches (standing wave);

iv. **Sub-basin** at CD-11 m with length of 400 m and a width of 120 m for bitumen and bunkering services;

v. **Reserved area for rail shunting** yard with two rail lines at 500 m (future expansion to 600 m and 2 extra rail possible);

vi. **Post services pontoon** for pilot boat and tugs; and in order to connect the port to the free trade zone (FTZ), a causeway bridge, dam and bridge have been planned, with the following extents of each: Bridge across river – approximately 100 m from the FTZ across the river;

vii. **Dam across beach –** approximately 650 m from the river to the shoreline;

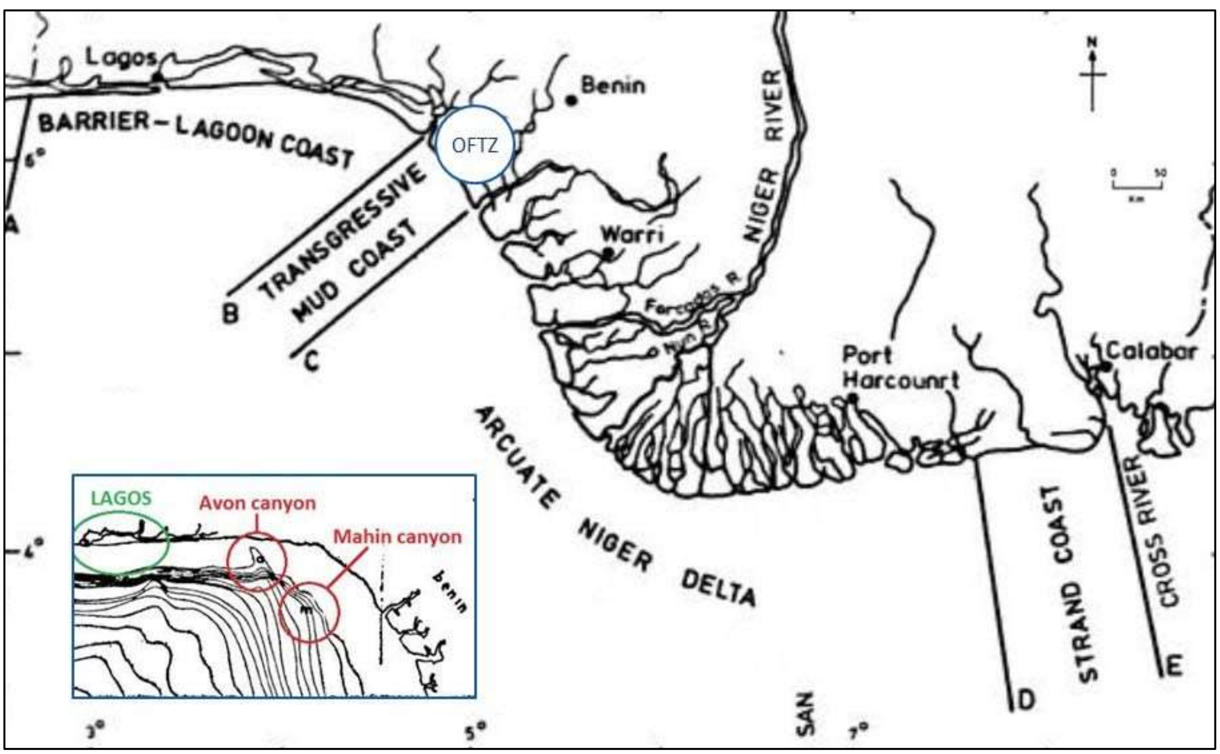
viii. **Trestle Bridge-** approximately 1,500 m from the river to the shoreline to the causeway. The trestle bridge will allow current and sediment to move along the coast and small boats to pass underneath;

ix. **Causeway –** approximately 1,685 m from the trestle bridge to the port. Additional expansion may be required subject to demand growth in the cargo segment. An additional area of 116 ha is available along the causeway with options to develop an additional 1,460 m of berthing lengths and beyond to the port.

The Project will stimulate a number of future developments in the adjoining communities and villages including the subsequent phases of the port development and a Free Trade Zone (FTZ). The Government of Ondo State is planning the development of a Free Trade Zone on land area close to the proposed Deep-Sea port. The FTZ is expected to accommodate business sectors including light industry, food and beverage industry, logistics, tourism and real estate, training and development and a financial center.

4.2 MARINE INFRASTRUCTURE- SHORELINE PROTECTION

Figure 1-A Morphological zones along the Nigeria coastline.

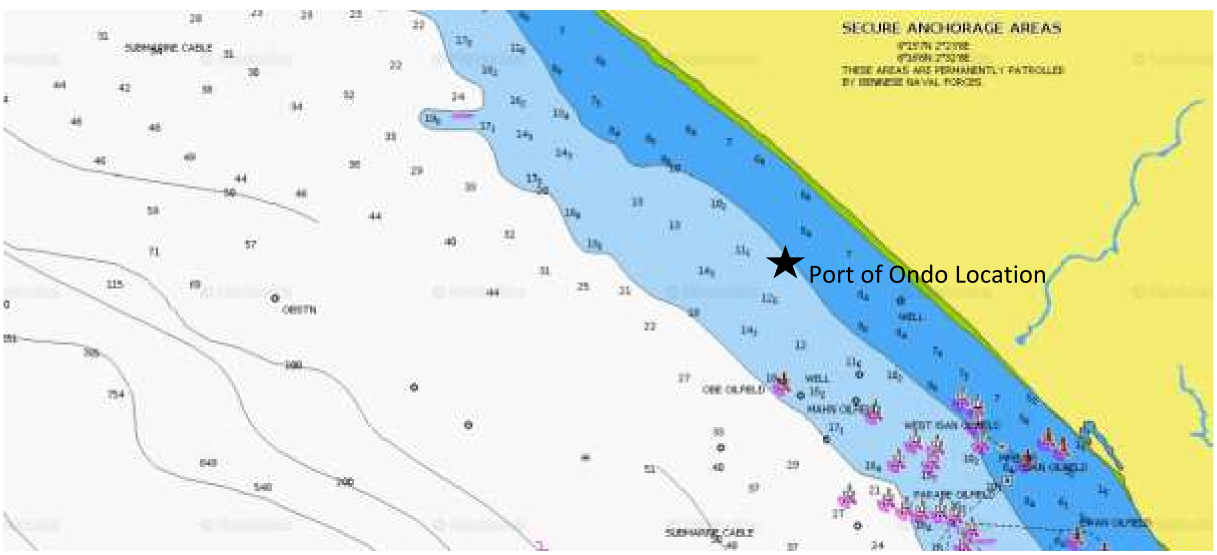


Source: Bentum (2012), The Lagos Coast: Investigation of the long-term morphological impact of the Eko Atlantic City Project

The main project site conditions are characterised by mud sedimentation near the coastline, a marine seabed clear of any hazards with a gradual slope to deeper waters (>16.5 m at a distance of 13.5 km), wetlands and a river between the free trade zone and the beach. The site has calm wind conditions (<8 knots) and one dominant wave direction from SSW.

The maximum significant wave height in the port area from available data is in the range of approximately 1.5 m to occasionally 3.0 m. Significantly large wave would not be possible due to the depth limitation. The waves mainly come from the SSW with peak periods up to 14s.

Figure 1-B Broader Project area bathymetry



Source: webapp.navionics.com

Topography and geotechnical survey of the site

Topographic and geotechnical information of the Project area is available from a topographic and geotechnical survey performed in September 2018 *“geotechnical investigation works for the development of deep-sea port and industrial city with free* *trade zone status at Erruna/Ogboti in Ilaje Local Government Area (LGA), Ondo State (milestone 3)" executed by Humber Marine Werks Co. ltd.* The Topographic Survey covered 2,771.2 Hectares area at Erruna/Ogboti in Ilaje LGA. In general, the FTZ area covering the potential port development is at approximately 0.7 m above Mean Sea Level.

The investigation program included the following components:

- Soil resistivity tests along Project area;
- Boring and sampling within Project site;
- Drilling, SPT and ground water test;
- Cone penetration test up to point of refusal; and,
- Sand search along channel to FTZ.

The main conclusions of the study are:

The soil in the free trade zone consists of clay layers. This is up to a depth of 12.0 m to 20.0 m;

The shore line is a muddy beach which extends for 75 km, terminating at the Benin River mouth on the northwest flank of the Niger delta. The mud coast is low lying and almost devoid of any sand but composed of mud shoreline. The coast (transgressive mud coast) is backed by freshwater swamps and terminates at the mouth of Benin River. The cycle of transgression and regression of sea has caused severe damage to the coast line, submergence of communities, destruction of properties and eventual relocation of communities. The 8th of May 2020 still witnessed another devastating effect of the sea. It is important to ensure that the coast line is protected because of this laudable development, knowing that previous investments in that area by NDDC and Federal Government has not been too successful. The common methods for shoreline protection are non -structural and structural methods.

i. Managing the land use.

ii. Vegetate

iii. structural methods which includes harden bulkheads, seawalls, revetments, breakwaters and sills and

iv. Trap and /or add sand. However, hardening is recommended based on the write up and field visits below. The Federal Government is determined to protect the coast line and we hope this will complement efforts being made during the construction of the sea port.

Coastal risk reduction can be achieved through several approaches, which may be used in combination with each other. It is pertinent to note that the types of risk reduction measures employed depend upon the geophysical setting, the desired level of risk reduction, objectives, cost, reliability, and other factors.

USACE (1995) and USACE (2001) recognize the value of an integrated approach to risk reduction through the incorporation of natural and nature-based features in addition to non-structural and structural measures to improve social, economic, and ecosystem resilience.

In order to determine the most appropriate shoreline protection technique, several site-specific conditions must be assessed.

For the project at hand, the following coastal conditions, along with other factors, were used to determine the most appropriate solutions for the shoreline protection of the Ondo State Deep-Sea Port:

a) Reach: A longshore segment of a shoreline where influences and impacts, such as wind direction, wave energy, littoral transport, etc. mutually interact.
b) Resilience: The ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or man-made, under all circumstances of use. This definition also applies to engineering, ecological, and community resilience.
c) Fetch: A cross shore distance along open water over which wind blows to generate waves. For any given shore, there may be several fetch distances depending on predominant wind direction.
d) Physical conditions: The slope of the foreshore or beach face, a geologic condition or bathymetry offshore.
e) Tidal Range: The vertical difference between high tide and low tide.
f) Storm Surge: The resulting temporary rise in sea level due to the action of wind stress on the water surface and low atmospheric pressure created during storms which can cause coastal flooding. Surge is the difference from expected tide level. Storm tide is the total water level.
g) Wave Energy: Wave energy is related to wave height and describes the force a wave is likely to have on a shoreline. Different environments will have lower or higher wave energy depending on environmental factors like shore orientation, wind, channel width, and bathymetry. Boat wakes can also generate waves.
h) Low: Limited fetch in a sheltered, shallow or small water body (estuary, river, bay) i.e. < 2 ft.
i) Medium: A range that combines elements of low and high energy (e.g., shallow water with a large fetch or partially sheltered) i.e. 2 - 5 ft.
j) High: Large fetch, deep water (open ocean).

However, based on the field situation encountered both during the dry season and rainy season sampling at the proposed Ondo State Deep-Sea Port, we arrived at logical conclusion that the most plausible solution for protecting the shoreline in the project area is the combined structural and non-structural approaches which are recommended for appropriate implementation for shoreline protection:

1) **Structural measures**: Structural measures include sea walls, groins and breakwaters. These features reduce coastal risks by decreasing shoreline erosion, wave damage, and flooding.

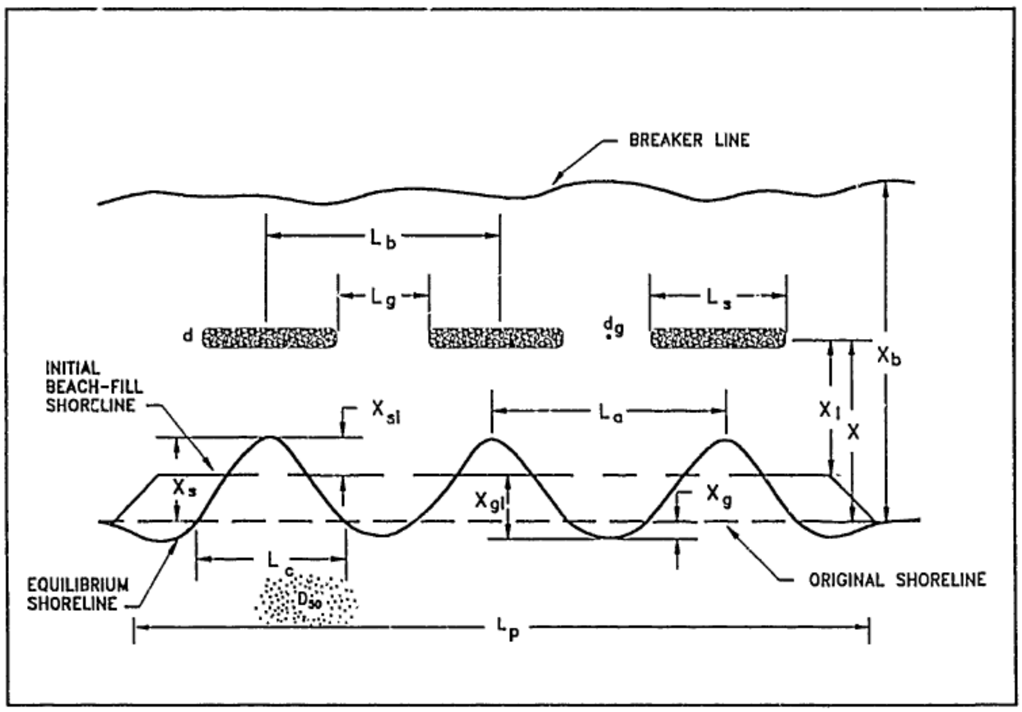
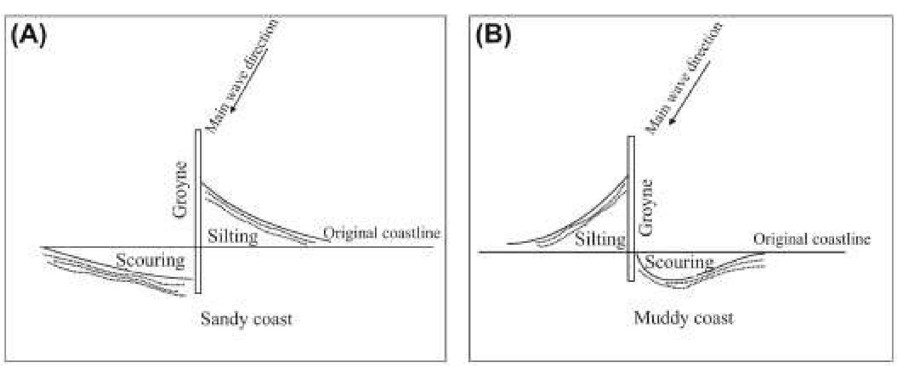


Figure Ic: Diagrammatic Expression of Shoreline Breakwaters Protection Techique



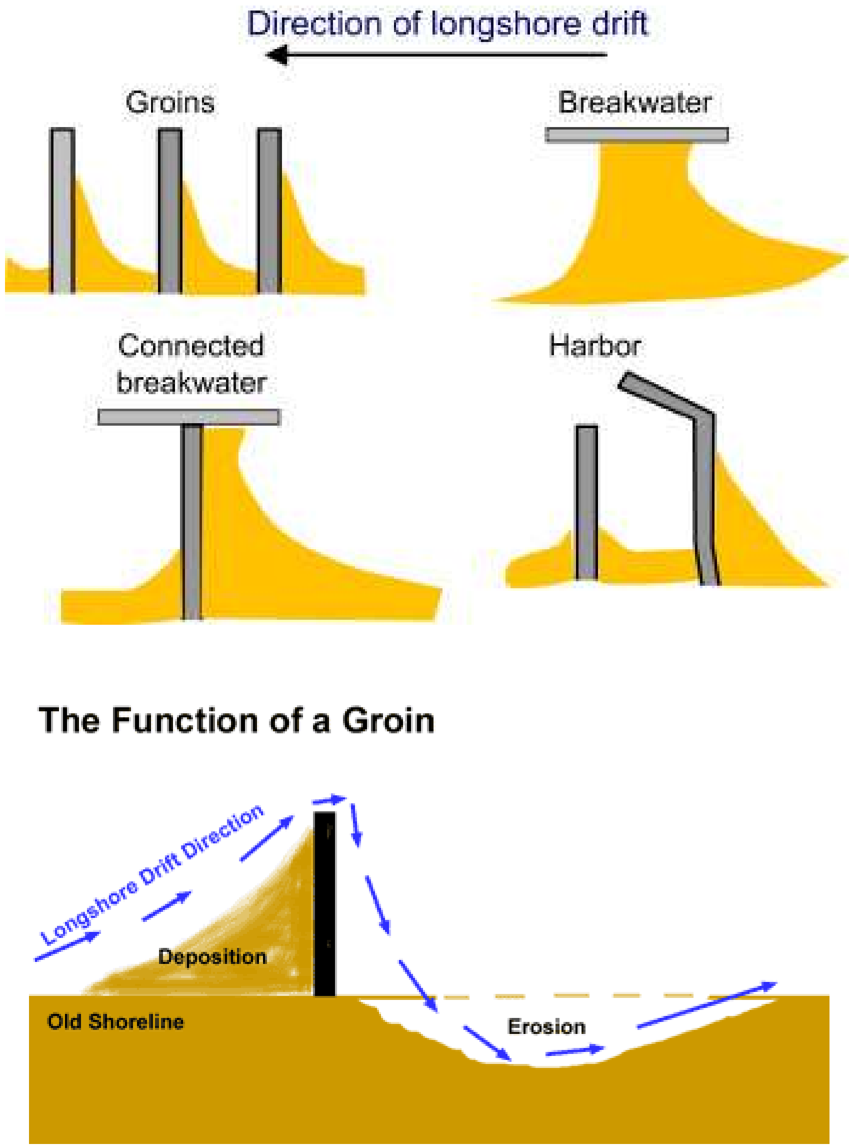
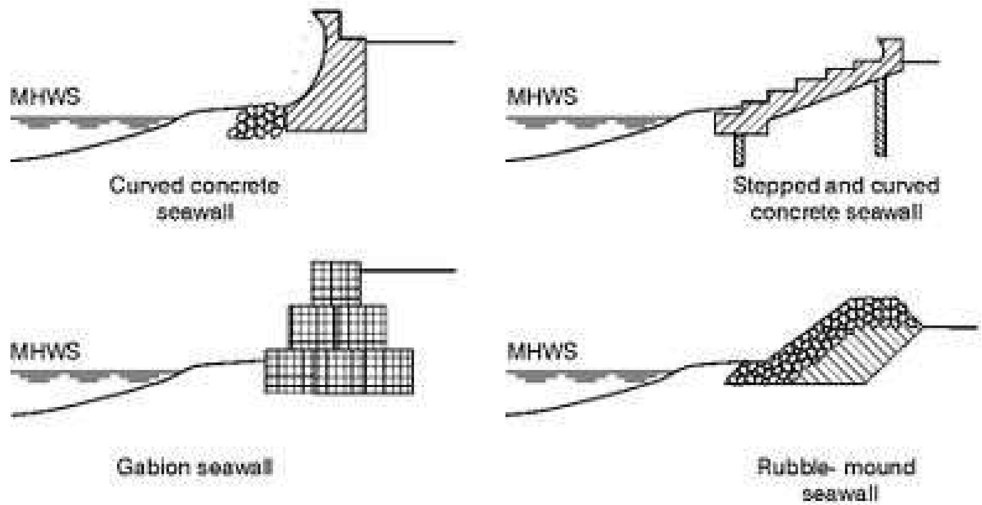
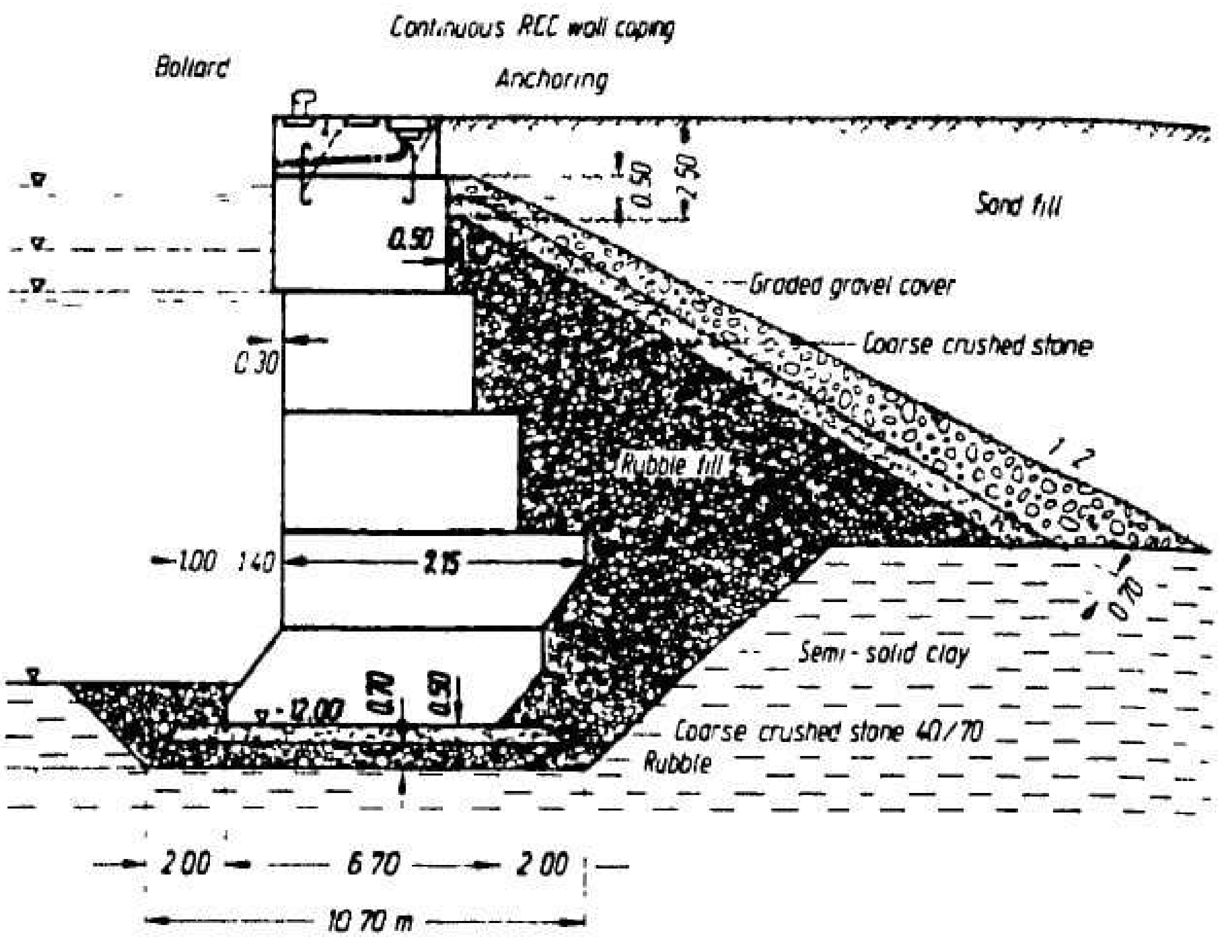


Figure 1D: Diagrammatic Expression of Groins Shoreline Protection Technique


MHWS
Curved concrete seawall
MHWS
Stepped and curved concrete seawall
MHWS
Gabion seawall
MHWS
Rubble- mound seawall


Continuous RCC wall coping
Bollard
Anchoring
0.50
2.50
Sand fill
0.50
Graded gravel cover
0.30
Coarse crushed stone
Rubble fill
1:2
1.00
1.40
2.15
0.70
Semi - solid clay
-12.00
0.70
0.50
Coarse crushed stone 40/70
Rubble
2.00
6.70
2.00
10.70 m

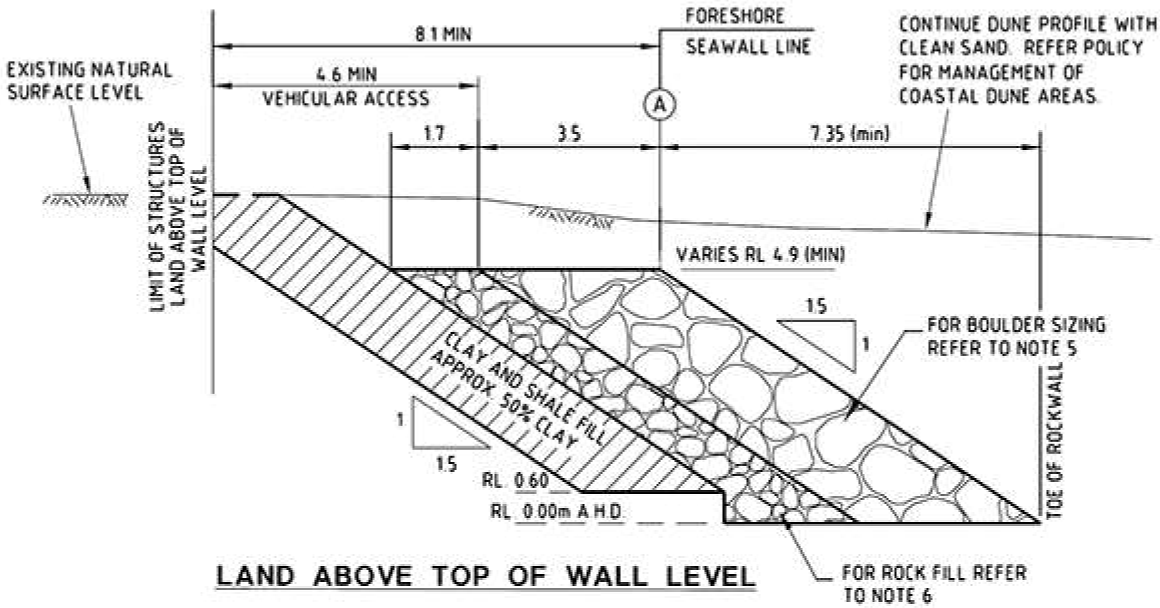


Figure 1e: Diagrammatic Expression of Seawalls Shoreline Protection Technique

2) **Non-structural measures**: Includes modifications in public policy, management practices, regulatory policy and pricing policy (e.g., structure acquisitions or relocations, flood proofing of structures, implementing flood warning systems, flood preparedness planning, establishment of land use regulations, emergency response plans).:

Benassai (2006) and UNITED NATIONS COMMISSION ON SUSTAINABLE DEVELOPMENT (1992)

highlighted the benefits of adopting the structural and non-structural approached to shoreline protection.

Benefits of Adopting the Proposed Shoreline Protection

i. Erosion control and shore stabilization.
ii. Restored and enhanced habitat which supports fish and wildlife populations.

iii. Increased property values.
iv. Enhanced community enjoyment.
v. Opportunities for education.
vi. Improved public access to waterfront through recreational activities such as fishing, boating and birding can be used to satisfy zoning and permitting requirements for waterfront development projects.
vii. Complemented natural shoreline dynamics and movement; increased resilience and absorption of wave energy, storm surge and floodwaters; and an adaptive tool for preparation of sea level rise.
viii. Improved water quality from settling or trapping sediment (e.g. once established, a marsh can filter surface water runoff or oysters can provide coastal water filtration).
ix. Stabilizing the shoreline and reducing current rates of shoreline erosion and storm damage
x. Providing ecosystem services, such as habitat for fish and other aquatic species and increasing flood storage capacity
xi. Maintaining connection
xii. Protection from wave forces
xiii. Methods and materials are adaptable
xiv. Can be combined with beach nourishment projects to extend their life
xv. Mitigates wave action
xvi. Low maintenance cost
xvii. Indefinite lifespan
xviii. Minimizes adjacent site impact
xix. Moderates wave action
xx. Manages tide level fluctuation
xxi. Long lifespan

xxii. Simple repair
xxiii. Resists strong wave forces
xxiv. Shoreline stabilization behind structure

The first phase comprises port construction works and port operations of various marine and landside infrastructure and facilities.

The marine infrastructure and facilities include:

i. A breakwater to protect the port from adverse wave conditions.
ii. A quay wall for mooring container vessels and supporting ship-to-shore (STS) cranes.
iii. An approach channel, turning basin and berthing pockets to facilitate navigation and maneuvering and berthing of container vessels.
iv. Service vessel and coastguard vessel berths to accommodate tugs, pilot vessels and patrol vessels, and a coastguard base.
v. Aids to navigation (AtNs) to allow for the safe navigation of all vessels to and from the port.

The landside infrastructure and facilities include:

i. A container yard for the storage of containers being imported and exported via the port.
ii. A truck gate to administer trucks accessing the container terminal by road.
iii. An intermodal rail yard to administer the transfer of containers between trains and the container yard.
iv. Buildings to accommodate the port services and functions essential to the efficient operation of the container terminal.
v. Utilities including power supply, water supplies and drainage systems.

vi. Security provisions including perimeter fencing and access controls.

The second phase of the project includes the construction of a new system which constitutes a port infrastructure for cargo loading and unloading, connected to the mainland.

The planned project consists in the construction of a deep-water, marine container terminal with a throughput capacity of 900,000 million TEU and further work that includes the following:

i. dredging of a shallow part,
ii. construction of the Deep-Sea port in offshore area,
iii. development of the internal fuel station,
iv. development of an administrative building,
v. provision of power supply system,
vi. installation of the lighting system.

The port will be open 24 hours a day, 7 days a week, 365 days a year in the 4-shift system which requires direct employment of approximately 500 employees, and indirectly over 10,000 employees.

As is often the case with port projects of large-scale development, the details of the main equipment enclosures and laydown areas, methods of construction (e.g. the balance of on-site and off-site fabrication) and the precise building programme cannot yet be established. Construction works, electrical equipment etc. will be carried out by specialist companies. The construction of the port will involve several teams that will work in parallel on construction, assembly and installations.

4.3 Dredging works

The planned depth at the quay for Container Terminal will be 17.5 m. The area of the dredging works will amount to approx. 500,000 m^2. Whereas, the volume of the spoil derived from the dredging will be approx. 50,000,000 m^3. According to the initial findings 70% of the spoil volume will constitute silts, and muddy sand requiring transportation via dump barges to a sea dump site specified by the Federal Ministry of Environment, while 30% will be muddy sands suitable for shore re-silting.

The results of tests on sediment purity in the vicinity of the operating Terminal and tests on core samples conducted within the scope of the planned modernization of the approach fairway to the North Port suggest that the spoil from the areas requiring dredging will be pollution free.

In accordance with the applicable regulations, the removal of the dredging spoil requires development of the environmental impact report and obtaining a permit. A proper variant of the spoil storage will be selected depending on the lithology and purity of the sea bottom sediments.

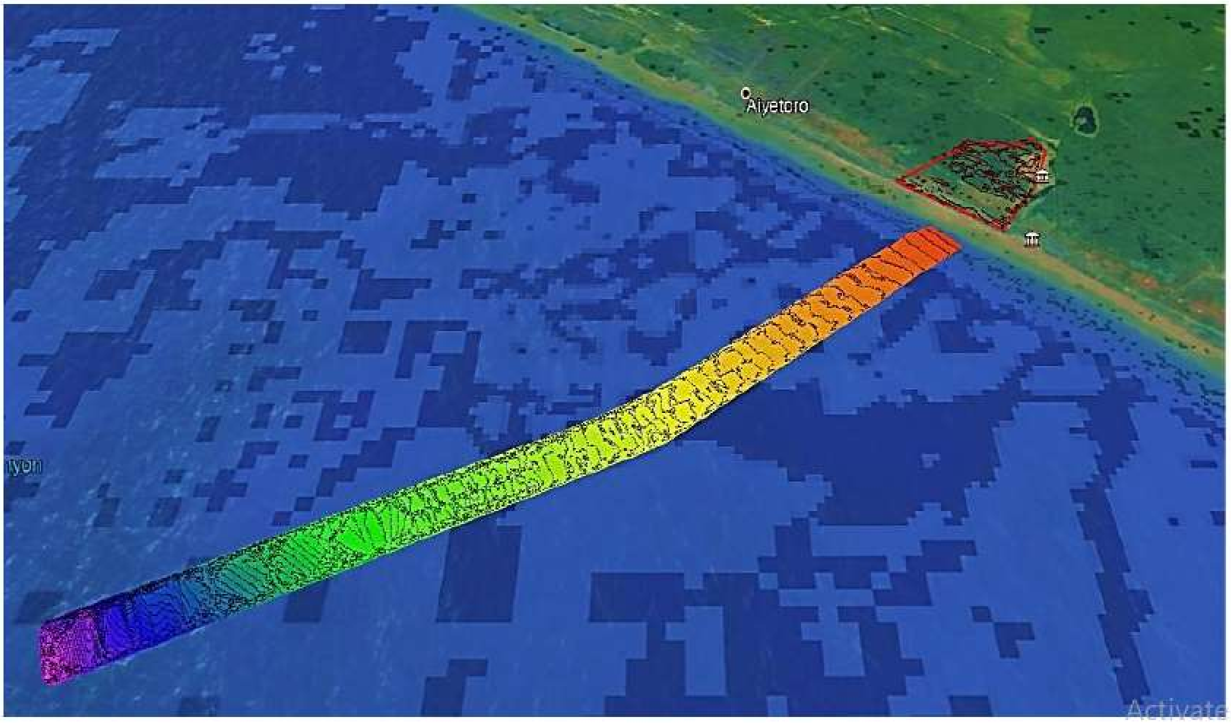


Plate 4.1: **The minimum distance to be established between the project area and the protected area from the shoreline of Aiyetoro**

Projected Volume of Sand from Dredging Activities:

As part of the breakwater construction, intense dredging will be carried out. Within the footprint of the breakwater and rock and stone columns will be placed as a ground improvement technique. Projected dredging of between 30 and 50 million m^3 medium to coarse sand is estimated for the project area.

Dredging for navigation is anticipated to generate dredged material. This volume of the dredged materials is expected to comprise approximately 50 million m^3 of dredged material from the approach channel, turning basin and berthing pockets to achieve the design depths, and another approximately 20 million m^3 to cover over-dredging to achieve the design depths and additional dredging to achieve the natural angle of repose for the side slopes.

Land reclamation works will be undertaken during the Phase 1 of the port development) to create the required land elevation of +2.5 mBZ in advance of the construction of the landside infrastructure and facilities). This elevation is approximate given that there may be some refinement of the preliminary design and reclamation works will use dredged material arising from dredging for navigation and, possibly, the dredging for the breakwater.

Furthermore, surcharging the consolidation of the reclamation material by placing additional material (i.e. surcharge material) on top of the reclamation material and using pre-fabricated vertical drains (PVDs) to expedite consolidation will further be carried out. After consolidation, all options require the removal of the excess surcharge material and stockpiling it in the Phase 2 port area or off site.

After consolidation, approximately the remaining surcharge material will be removed to create the land level of approximately +2.5mBZ. It is anticipated that the excess surcharge material will be transported and stockpiled in the Phase 2 port area. However, it is possible that the excess surcharge material may need to be taken off site and stored for re-use for future development of the port.

Construction equipment will be used within the reclamation area to place and move the dredged material and to direct the flow of dewatering effluent (e.g. bulldozers, excavators reclamation pipelines and loaders. A weir box will be constructed to regulate the discharge of the dewatering effluent into the sea.

Impacts Caused by Dredging

The World Bank Technical Paper 126 on the environmental considerations for Port and Harbor development highlighted the following impacts that would be caused by dredging. These are adopted in this report as being relevant to the proposed Deep-Sea port of Ondo State.

Dispersal and Settlement of Re-suspended Sediments

Disruption of bottom sediments can cause a variety of environmental impacts. Problems arise in particular where sediments have been contaminated by chemicals, petroleum hydrocarbons and domestic wastes. Taxies or contaminants released from the disturbed soils can go into solution or suspension and contaminate or cause severe mortalities among important marine and estuarine fishery resources.

Particles re-suspended may be re-deposited on bottom life either smothering it or forcing it to move elsewhere (if sufficiently mobile). Organics in the suspended material can deplete available oxygen from the surrounding waters and temporarily create stressed conditions for many aquatic animals.

If suspended sediments are sufficiently concentrated and persist through extended operations, light penetration into the water column may be reduced causing damage to light- requiring photosynthetic algae, corals and other aquatic organisms.

Sediments become re-suspended during initial excavation and during transfer to nearby land depositories or barges if clam-shell or dragline equipment is being used.

Hydraulic dredging may introduce less suspended material at the dredging site, but the required settling ponds and ultimate release of partially clarified water at a point distant from the dredging may cause impacts at that location.

Sediment dispersal in the water column can be reduced by surrounding the site with silt curtains (if currents are not too strong) and by not permitting barge or land site overflow. Knowledge of the area's hydrography (tidal and river flows)prior to starting work is essential in identifying areas most likely to be affected by the work.

Excavation of soft bottom by dredging also removes the habitat of those forms living in the bottom sediments. If there is appreciable sedimentation in the area, new bottom sediments will form and restore the habitat after the work is finished.

Effects of Blasting

Explosive charges used to break up rock formations destroy bottom habitats. Compression effects of the blasting often injure or temporarily disable marine life some distance from the blasting site. In addition, the more general but less damaging disturbance of a blasting program will be to force mobile aquatic forms from the area until the work is completed. This last effect is important, and plans (seasonal scheduling) therefore should ensure that blasting does not disrupt migratory pathways of important fisheries.

Careful attention should be paid to the proximity and condition of nearby shore zones, bulkheads, and other structures to ensure that use of explosives poses no threat to their integrity.

Results of Altered Bathymetry

Deepening of channels, anchorages and berth construction can alter patterns of tidal and river flow. Should these patterns evidence high flows, eddies, etc., hydrographic studies and modeling may be advisable to find ways to avoid creating undesirable situations. These situations can range from unsafe vessel maneuvering to requirements for frequent dredging or to disturbance of valuable fisheries resources. Deepening of channels can also cause undesirable changes in the penetration of salt wedge conditions.

Effects of Changing Shoreline Configuration

Bathymetric changes brought about by dredging (deepening or widen- ing of waterways, etc.) can alter flow velocities and directions. This possibility should be examined carefully to assure that planned changes will not alter existing shore zone configurations through erosion, accretion or shoaling. Increased water depths can result in intensified wave activity on the shoreline with consequent increased littoral sediment transport resulting in accelerated erosion or accretion.

Loss of Bottom Habitat, Shellfisheries, Fisheries, Fishery Food Sources

Dredging excavation of soft bottom can remove important bottom- living aquatic life. However, the bottom will readily be recolonized by replacement benthic organisms within a few seasons. As the original habitat will probably have changed due to the dredging operations (e.g., sediment type, topography, water depth, current pattern etc.), the new population might differ from the original one. It is advisable to determine whether possible current pattern changes will jeopardize or encourage resettlement of the original bottom life and associated fishery resources.

Altered Groundwater Flows

Subsurface groundwater flows near the land-sea interface can be altered by dredging or blasting as part of harbor/port improvement. Should there be extensive freshwater flow toward the estuary, the dredging could accelerate the flow and lower water table levels in the adjacent upland. If freshwater flows are minimal or slow, dredging and blasting could increase saltwater intrusion into nearby water supply aquifers. If these impacts seem possible, it may be advisable to locate alternate freshwater sources.

Impacts of Dredged Material Disposal

The problems associated with the disposal of dredged materials have become major issues in many parts of both the industrialized and developing world.

Filling or Excavation that Covers/Removes Bottom Biota or Habitat

Excavation for or filling on the bottom to support a breakwater, pier or other waterside structure will cause loss of the displaced or covered bottom habitat and its associated animal and plant life.

New Habitats Formed by Structures (Especially Pilings and Breakwaters)

Erection of piers and breakwaters usually provides an abundant supply of new attachment surfaces, i.e., habitats for marine/estuarine organisms. Breakwaters or other structures possessing quarried rock or rip-rap surfaces also supply much shelter for mobile aquatic animals. Organisms occupying these habitats (both attached and sheltered) may be desirable or undesirable. It may be advisable to know what undesirable species are common to the area, note the characteristics making them undesirable, and determine their desired habitats. If the effects of their presence pose a significant problem, alternate construction plans may be preferable.

Filled Structures (Including Breakwaters)

Such structures constitute sizable masses of artificial shoreline often projected into a bay, harbor or estuary. If tidal flows are substantial, these obstructions may create major disturbances in existing tidal flows, increasing scour in some areas and accelerating sediment deposition in others. If there are indications that sediment deposition may be markedly increased, provisions for more frequent maintenance dredging or additional structures may be required. If there is indication that sediment deposition may be a very serious problem, opting for a piling-supported structure permitting some measure of unobstructed flow may be preferable.

If filled structures are selected, care must be taken to determine the effects on maintenance routines for channels and other dredged areas. Revised navigation patterns could be required. Somewhat different in structure and configuration but presenting similar environmental concerns are submerged pipelines running across shore zones (well platforms, Single Buoy Moorings (SBM) or storm/sewage outfalls). Disturbances of the shoreline have inherent risks of initiating serious erosion, particularly if the shoreline is subject to extensive wave action. Protection of the pipeline(s), once in place even though buried, may require a breakwater-like structure. Intertidal areas can be disturbed and/or lost as a result, and extension of the protective structures into the near shore waters may change shore zone currents, introducing altered areas of scour and shoaling.

Disturbances from Pile Driving, Other Construction Activities

Pile driving and other waterfront construction activities cause considerable noise and vibration easily transmitted to the adjacent waters. This disturbance may temporarily cause displacement of fisheries and other mobile marine animals. All other things being equal, these animals will usually return to the area once the disturbance ceases.

Dispersal of Suspended Sediments

Construction of piers, bulkheads, breakwaters, etc., even when not requiring dredging, can disturb bottom sediments, increasing turbidity adjacent to the work site. Should examination of bottom conditions and hydrographic patterns indicate this might be a matter of concern, preventative measures to minimize impacts should be considered. Otherwise, bottom organisms may be smothered by sediment deposition, light penetration in the water column may be reduced, and fisheries can be temporarily displaced during the construction period.

Piling-Supported Structures--Effects

Structures extending into harbor waters and supported by pilings driven into the bottom can impose several impacts on the site and vicinity. Piling Installation will disturb the bottom beneath the proposed structure, destroying some of the bottom habitat and temporarily displacing the mobile bottom animals and local fisheries. In addition, the structure, when completed with decking, will shade the area underneath and possibly diminish survival by attached algae and other aquatic plants. Presence of piling clusters will alter the habitat to some extent and may encourage the presence of either desirable or undesirable species. Pilings will also slow existing tidal or river flows, thus increasing sediment deposition at some locations beneath the area.

4.4 Project Area and Protected Area

According to Wikipedia (2020), Ilaje land has an area of 1,318 km² and a population of 290,615 as at the 2006 census although the population can be said to have been under enumerated due to the riverine nature of the area, and lack of accessibility by road/land. Towards the western reaches, the Aheri and Etikan share border with the Ijebus. The Ikales to the north and bound the Mahins, the Itsekiri people who the Ilajes consider their cousins, share the eastern border with the Ugbos, the Yoruba speaking Apoi and Arogbo Ijaws are located to the north east in Ese Odo LGA, and the Atlantic Ocean is situated on the southern boundary. The Ilajes are one of the most dynamic and enterprising people in Nigeria. Their aquatic skill, coupled with their ability to adapt enabled them to conquer their harsh geographical environment and turn it to their advantage. Consequently, they were able to build large communities like Ugbonla, Aiyetoro, Zion Pepe and Orioke Iwamimo. Aiyetoro for example in its hey-days had the highest per capita income in the whole of Africa due to its early discovery of crude petroleum, and attracted visitors, tourists and researchers from all over the world

Apart from petroleum found in the area, other mineral raw materials available in Ilajeland include glass sand, salt, Tar sand/Bitumen, quartz and clay. Agricultural products include: Fish, Poultry, piggery, Maize, Palm oil, Vegetables, Timber, Raffia, Poultry, Copra, Cocoyam, Bananas and Cassava. The natural environment of Ilajeland is particularly suitable for the development of large-scale rice plantations and the salt industry. The occupational activities of the Ilajes include fishing, canoe making, lumbering, net making, mat making, launch building, farming and trading. Fishing however remains the major agricultural preoccupation of the Ilajes. This is underscored by the fact that the Ilaje's geographical sphere has one of the longest coastlines in Nigeria.

The towns and villages under Ilaje is divided into five distinct kingdoms with each kingdom having various towns, villages and harmlets: UGBO KIGDOM, MAHIN KINGDOM, ETIKAN KINGDOM, AHERI KINGDOM and IGBOTU,

UGBO KINGDOM

- Abetobo zion
- Abokiti
- Amehin
- Apata ilaje
- Asumaga
- Awoye
- Ayetoro
- Bijimi
- Bowoto
- Eke atiye
- Eke baale
- Eke didi
- Eke ilutitun
- Eke itiola
- Eke maha
- Eke moki
- Ago Alufa
- Ago nati
- Ajegunle
- Eke nla
- Eke ofolajetan
- Eke yonren
- Ernna ogbeni
- Erunna
- Erunna lagbe
- Gbagara
- Idi-ogba
- Idogun
- Idogun ayadi
- Idogun ehinmore
- Ikorigho
- Ilepete
- Alagbom zion
- Alagbon
- Ilowo
- Ilowo ayetoro
- Ilowo Nla
- Ilowo ogunsemore
- Iluabo
- Imoluwa
- Jirinwo
- Lepe
- Molutehin
- Obe Adun
- Obe akingboye
- Obe apata
- Obe Arenewo

- Obe Dapo
- Obe Enikanselu
- Obe ifenla
- Obe Iji
- Obe Jedo
- Obe Magbe
- Obe Nla
- Obe Ogbaro
- Obe Olomore
- Obe Orisabinone
- Obe Rebimino
- Obe Rewoye
- Obe Sedara
- Odofado
- Odonla
- Odonla meduoye
- Odun Ogungbeje
- Odun ojabireni
- Odun oriretan
- Odun Oyinbo
- Odun Yonren
- Ogbongboro
- Ogboti
- Oghoye
- Ojumole
- Okun ipin
- Olotu
- Olotu kuwo
- Olotu niye
- Olotu yara
- Orioke Harama
- Oroto
- Otumara
- Otumare se- side
- Owoleba
- Saheyi
- Uba Korigho
- Ubale
- Ubale kekere
- Ubale nla
- Ugbage
- Ugbo
- Ugbonla
- Womitenren
- Yaye
- Zion Ikerigho
- Zion Iluabo

MAHIN KINGDOM

- Abealala
- Abereke
- Aboto
- Ago Doroh
- Ago Ikuebolati
- Ago Lulu
- Ago Olomidegun
- Akata
- Alagbede
- Aruwayo
- Asisa
- Atijere
- Betiegbofo
- Broke Camp
- Ebute Ipare
- Ehin - Osa
- Elegboro
- Ereke
- Ereke Majofodun
- Ereke Makuleyi
- Etigho
- Gbabijo
- Ibila
- Idigho
- Igbegunrin
- Igbo - Okuta
- Igbobi
- Igbokoda
- Igbolomi
- Ikale Camp
- Iloro
- Ilu Sosi
- Imoluwa
- Ita - Age
- Italita Camp
- Itebukunmi
- Job Camp
- Korolo
- Kugbonre
- Kurugbene
- Legha
- Lerenren
- Logede Camp
- Madagbayi
- Magbehinwa
- Magbojuri
- Mahin
- Mahintedo
- Maran
- Moferere
- Mogunyanje
- Motiala
- Motoro
- Odun Oloja
- Odun Oluma
- Odun Oroyo
- Odunmogun
- Ogorogo

- Ohaketa Camp
- Ojan
- Oke Etigho
- Okishilo
- Okoga
- Okunniyi
- Olosunmeta
- Opolo
- Orere - Ara
- Oribero
- Orimoloye
- Orioke Iwamimo
- Oriranyin
- Orofin Camp
- Oropo Zion
- Oroyomi
- Pete-Inu
- Piawo
- Ramasilo
- Seja Odo
- Seja Oke
- Seluwa
- Tedo Camp
- Tomoloju
- Tomoloju Camp
- Ugbaha
- Zion Gbabijo
- Zion Igbokoda
- Zion Mahintedo
- Zion Ogogoro

ETIKAN KINGDOM

- Agba Gana
- Ago Apeja
- Ago Buli
- Ago Egun
- Ago Festus
- Ago Gbobaniyi
- Ago Ijebu
- Ago Ikumapayi
- Ago Iwabi
- Ago Lubi
- Ago Oluji
- Aiyetitun
- Araromi Etikan
- Igbobi
- Ikaji Etikan
- Moborode
- Obalende Etikan
- Ode Etikan
- Oja Igo Etikan
- Oja oje
- Oja Osho
- Oja Temidire
- Oke Harama
- Okonla
- Okun Eikan
- Ramasilo Etikan
- Uba Agba
- Uba Akobi
- Uba Domi
- Uba Etikan
- Uba Kalebari
- Uba Oke Kelian
- Uba Ropeda
- Uba Yellow

AHERI KINGDOM

- Agbala Obi
- Agbala Olope Meji
- Agerige Town
- Agerige Zion
- Aheri Camp
- Ajebamidele
- Akata
- Ako Ira-Oba
- Alape Junction
- Araromi Sea-side
- Enu-Ama
- Ideghele
- Idigbengbin
- Igogun
- Ihapen
- Ilefunfun
- Ipare
- Ipepe
- Mofehintokun
- Okesiri
- Olopo
- Ramasilo
- Temidire
- Ubalogun
- Zion pepe

IGBOTU

- Aboromeji
- Aboto Camp
- Ago
- Ago-Ogele
- Ago-Yellow
- Amayetigba
- Araromi
- Arigbe Camp
- Baale Camp
- Bisewe Golote
- Ebidlo
- Ekohebo Camp
- Enikorogha
- Epewe

- Eredase Camp
- Esenoko Camp
- Gbabijo
- Gunmagun Camp
- Hamidifa
- Idigba Camp
- Igbebomi Iyara
- Igbobini
- Igbolani-Arubenghan
- Igbotu
- Igbotu-Atijo
- Igbotu-Gbaluwe
- Igbotu-Zion
- Igirikile
- Imobi
- Itebetabe Camp
- Iyara
- Kafawe
- Kitikoro
- Kolodi Camp
- Kurugbene
- Lagereke
- Laporen Camp
- Lobele Camp
- Logede
- Lumoko Camp
- Moboro Village
- Odi
- Ogbeni Camp
- Ogunmade
- Okoro
- Okorogbene
- Okuru Camp
- Olorunsola Camp
- Olowo Camp
- Oluagbo
- Omukoro Camp
- Onipanu Ago Bagi
- Onisosi
- Otarogbene Camp
- Pee Camp
- Pghono Camp
- Piria
- Shabomi Babomi
- Sogbo Camp
- Surulere
- Yogha
- Zion

The following communities and suspected pipeline areas that were identified as protected area that cannot be occupied by the port and its access channel are shown in **Plates 4.3 and 4.5, whilst the project area is shown in Plate 4.4**.

If the protected areas are to be occupied, it would involve a resettlement plan for the communities.

A) UPLAND:
Ugbo and Ugbonla
B) SEA SIDE:

Eruna Ado, Eruna Asuku, Eruna Ero, Abe Okun Ipin, Olotu Temuhi, Olotu Kwo, Olotu – Yara, Olutu Niyi, Yaye, Ojabineni, Womitere. Ogboti, Lepe, Ayadi, Idiogun, Zion - Ehimoren, Ehimoren, Aiyetoro (**Plates 4.3 and 4.4**).

Plate 4.2: Google Earth Image of Project Location

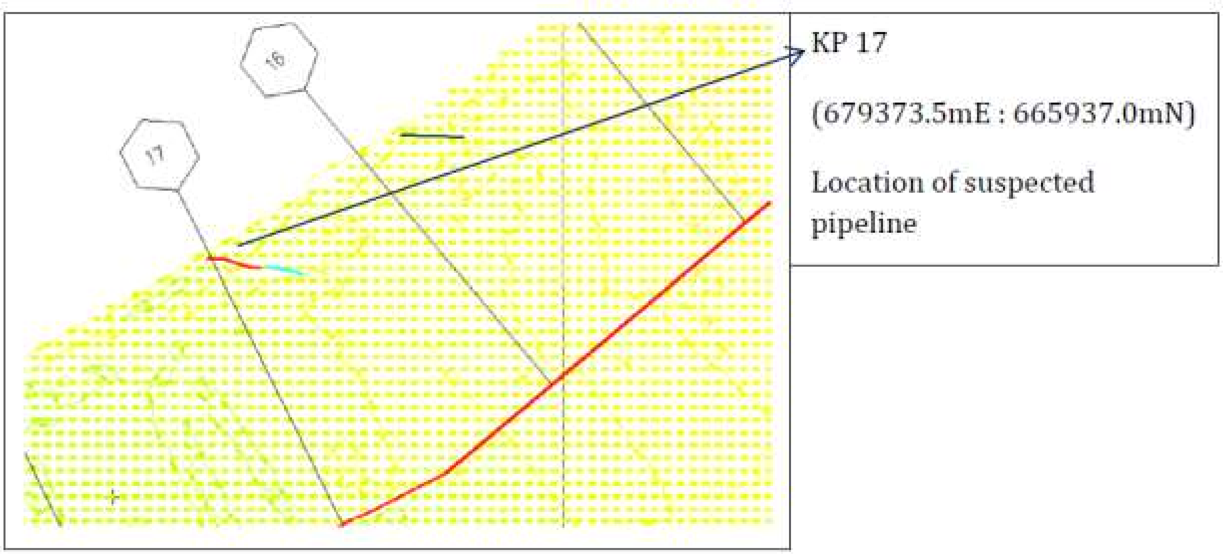


Plate 4.3: Part of the Protected Area Where Pipelines are Located in the Project Location

The project area is broken into sections A – F. The Different Sections of the project can be located with center coordinate as listed below:

SECTION A	E4°46'39.19"	N6°09 55.48"
SECTION B	E4°45'00.10"	N6° 08 51.93"
SECTION C	E4°44'56.160"	N6°08 51.93"
SECTION D	E4°46'17.00"	N6°07 18.00"
SECTION E	E4°46'51.49"	N6°08 02.29"
SECTION F	E4°43'51.00"	N6°08 44 .17"

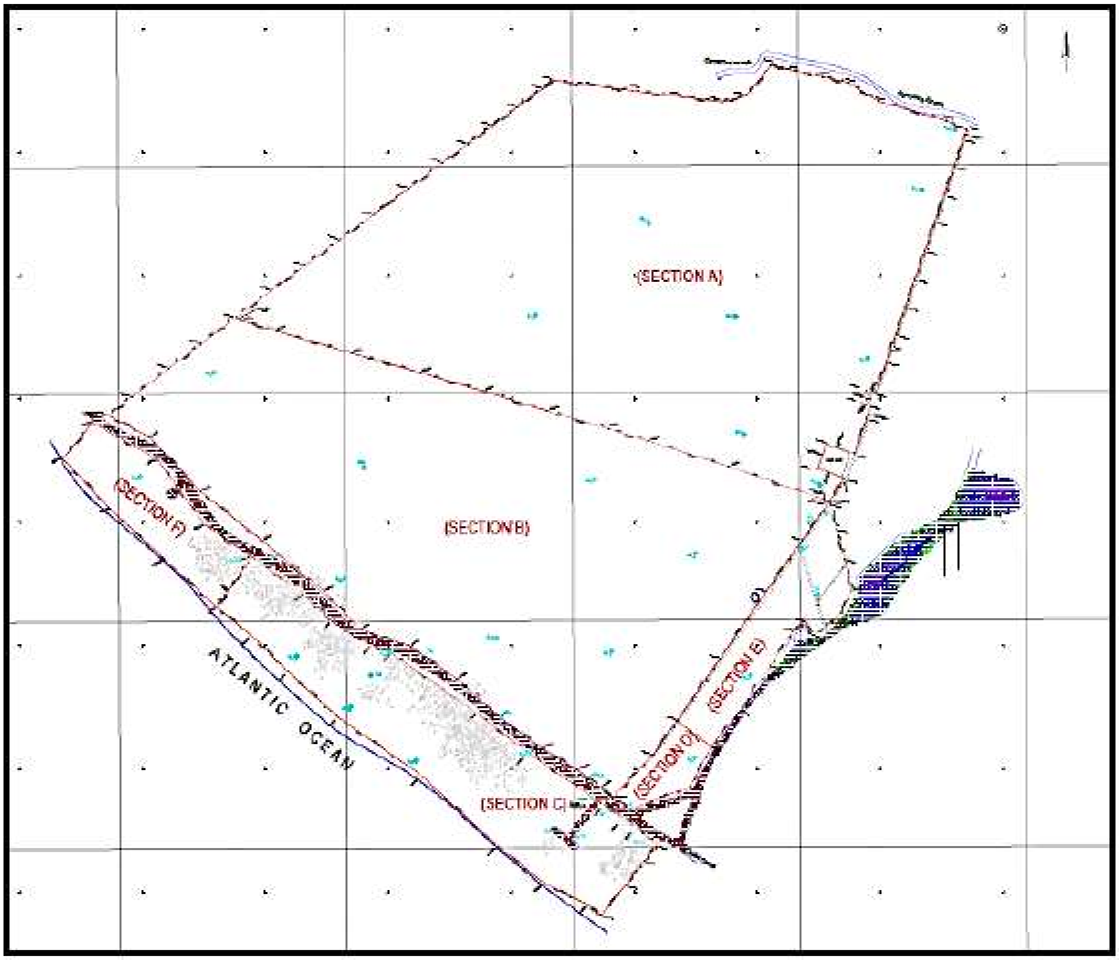


Plate 4.4: Map showing the location of project area

Plate 4.5: Google Earth Image of the Protect Areas

Minimum Distances to be Established between the Project Area and Protected Areas

The minimum distance to be established between the project area and the protected area is 1km from the shoreline of Aiyetoro (**See Plate 4.1**).

beneath the structure.

4.5 Ecosystem of the Project Area

Historical satellite imageries spanning a period of 17 years were used to assess the ecosystem degradation in the communities that would be affected by the proposed Deep-Sea area.

For the study, the total land area covered by the ecosystem is 146682 ha. The area covered by each ecosystem used in this study is shown in **Table 4.1**. A land area of 2169 ha was attributed to no data, that is about 1.48% of the total ecosystem area of 146682 ha contained no specific ecosystem.

The largest part of the ecosystem is occupied by the swamp forest with a land area of 101193 ha (68.99% of the total ecosystem area). The Woodland and Grassland covers about 101 ha (0.07% of the total ecosystem area). Water as an ecosystem occupies a land area of 2237 ha (1.52% of the total ecosystem area). The existence of these ecosystems in the study area shows that it is a rich coastal environment that serves a lot of benefits to man and his well-being.

Presented below is the existing ecosystem classes contained in the communities where the Deep-Sea port would be situated, and the land area loss by each of the identified ecosystem class. The results suggested that both swamp forest and mangrove degradation is manifested by a high level of dependence on the ecosystem classes as a means of livelihood.

From the analysis of historical remote sensing data collected to the establishment of the Deep-Sea port, Olajide ***et al***. (2020), show that hectares of ecosystem land area coverage and biodiversity depletion was already taking place in year 2000, 2006, 2008, 2011, 2016 and 2018 respectively. The remote sensing method adopted in reliability of the method for temporal monitoring of ecosystem depletion (**Plate 4.6**).

We observed that, there has been significant loss in the biodiversity-rich zones' area and in species composition over the past ten years in the study area (**See Plates 4.7 to 4.11**), and this loss could continue for the next ten years (2028) if appropriate policies and strategies are not adopted. By 2028, there could either be a drastic decrease or increase in the rate of biodiversity depletion depending on policies and/or practices adopted. There is a direct relationship between biodiversity and means of livelihood, as the study has shown that biodiversity loss has impacted the means of livelihoods of the residents negatively. The principal direct drivers of the changes in aquatic and terrestrial biodiversity-rich zones were sea incursion and pollution respectively, while economic and market factors were the principal indirect drivers of change (**Table 4.2**).

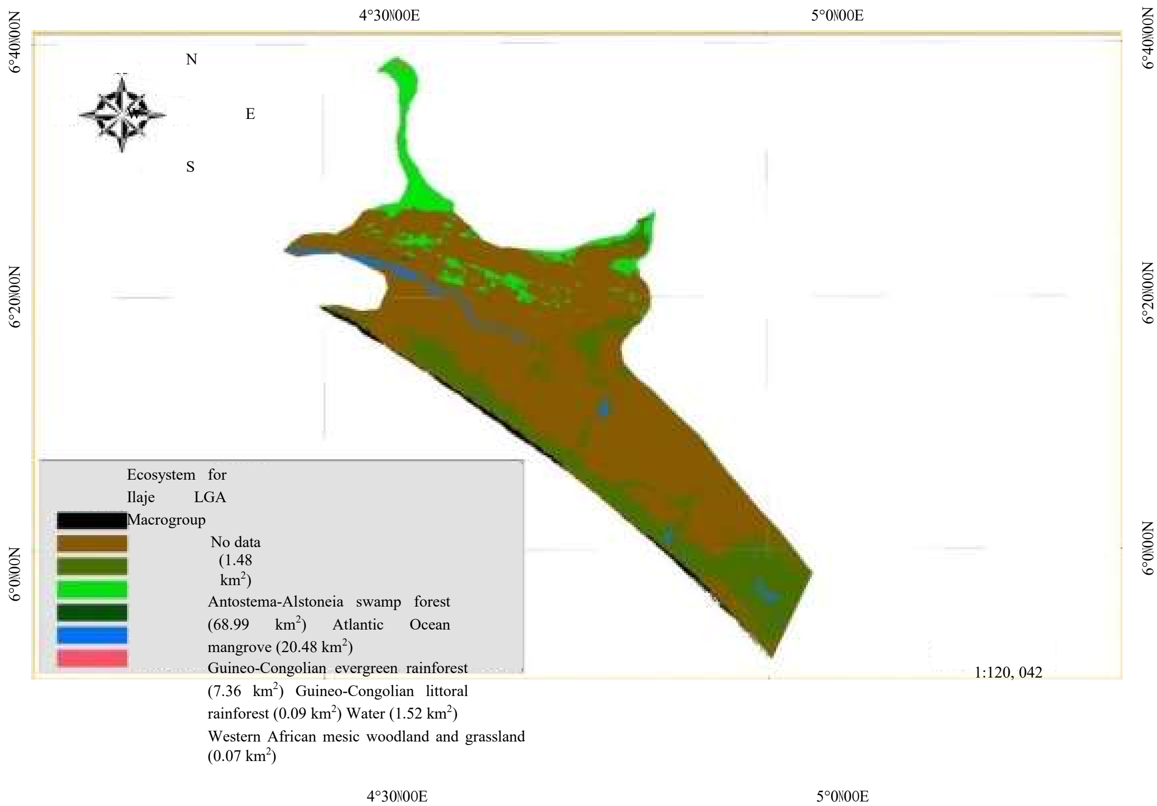


Plate 4.6: Map showing land area covered by ecosystems (1990)

Table 4.1: Ecosystem land area

Ecosystems	Count	Ecosystem land area (ha)	Ecosystem land area
No data	2546	21	1.
Guineo-Congolian evergreen rainforest	12677	10	7.
Guineo-Congolian littoral rainforest	160	1	0.
Antostema-Alstonia swamp forest	118760	101	69.
Western African mesic woodland and grassland	118	1	0.
Atlantic Ocean mangrove	35259	30	20.
Water	2625	22	1.
Total	172145	146	100.

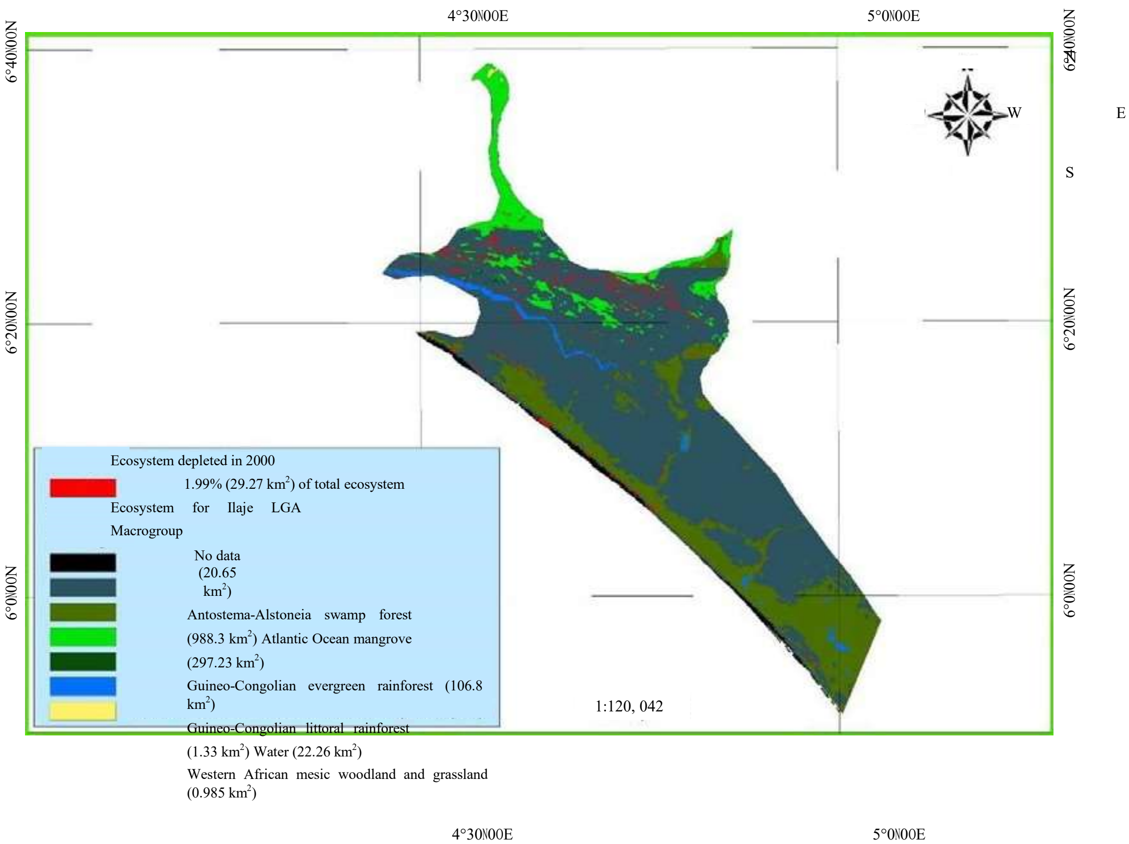


Plate 4.6b: Map showing ecosystem depleted in 2000

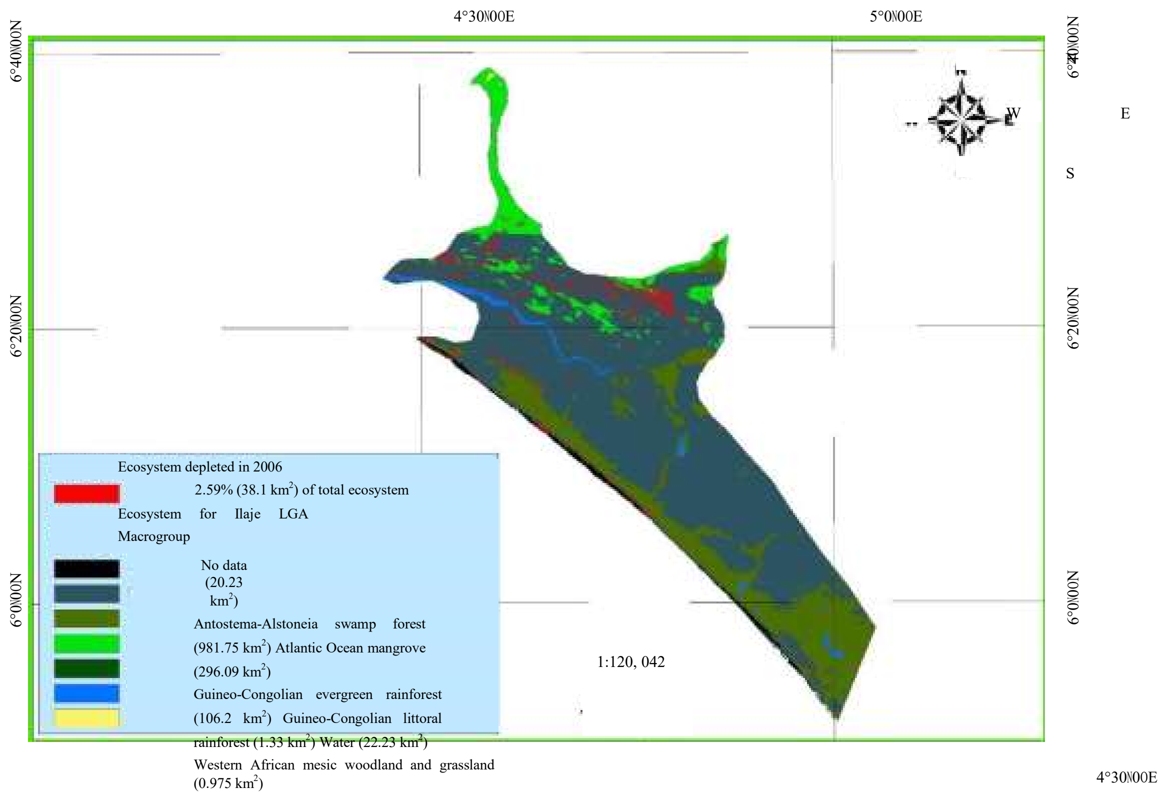


Plate 4.6c: Map showing ecosystem depleted in 2006

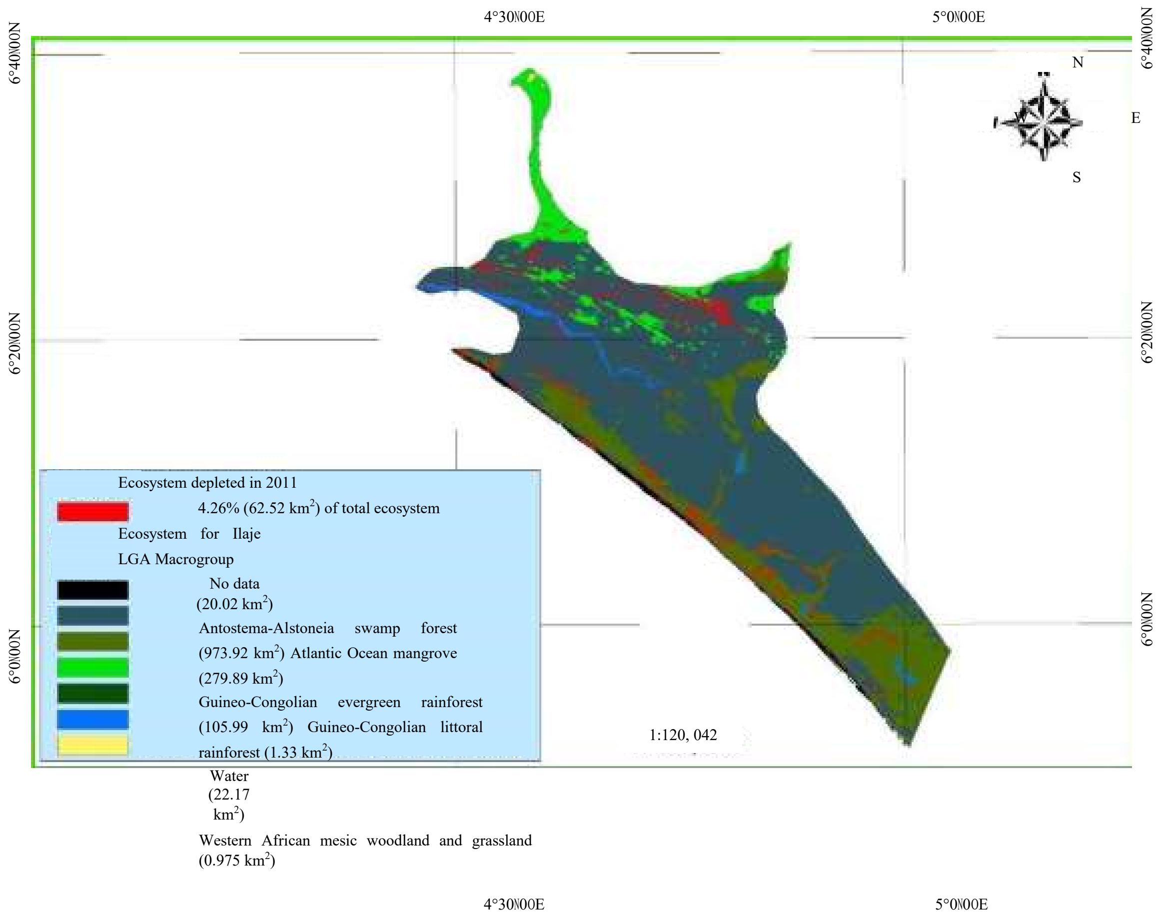


Plate 4.6d: Map showing ecosystem depleted in 2011

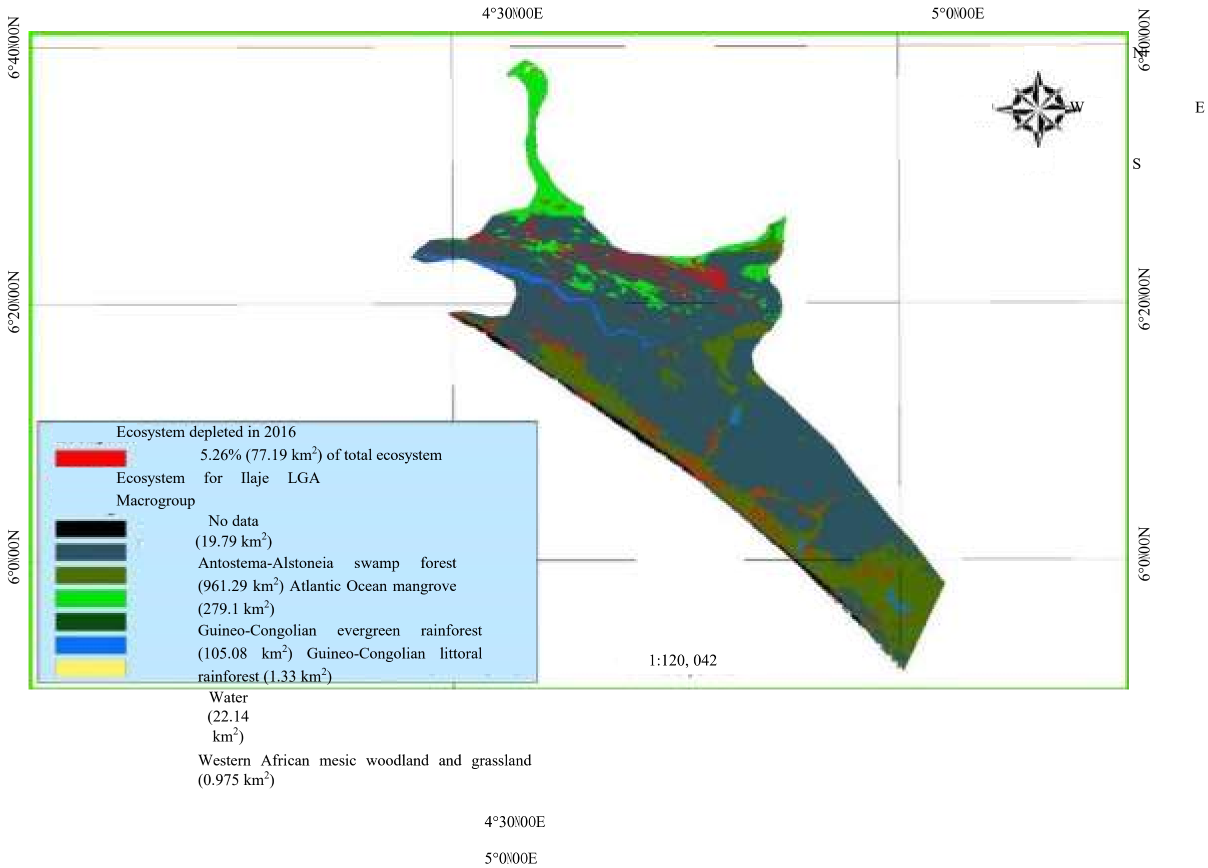


Plate 4.6e: Map showing ecosystem depleted in 2016

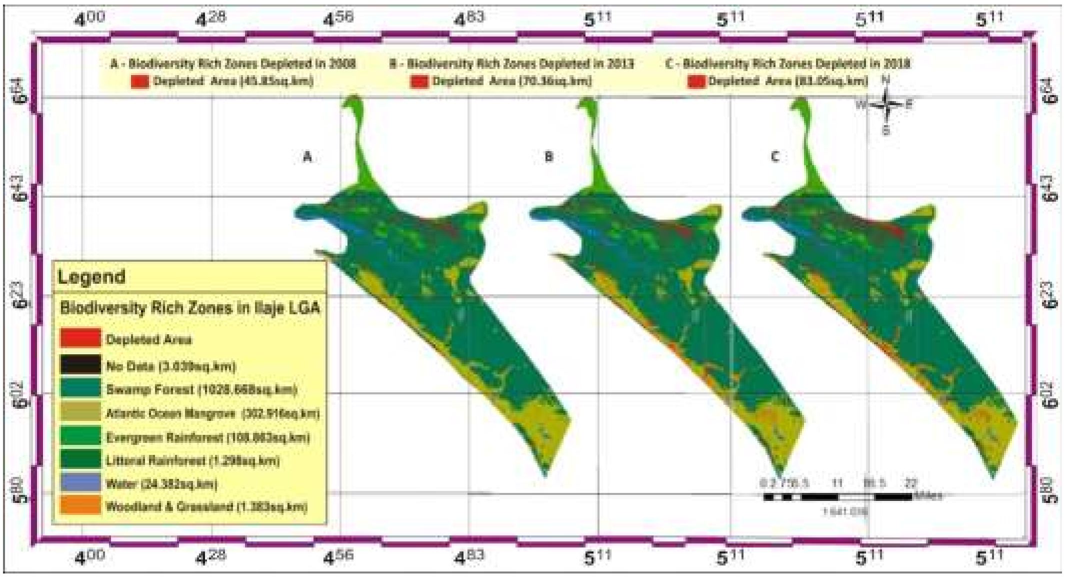


Plate 4.7: Biodiversity-rich zones Depleted in 2008, 2013 and 2018

Table 4.2: Biodiversity Hotspots depleted consequent on human activities

Year	Total Biodiversity	Biodiversity loss in	Biodiversit y loss in	Biodiversity Loss in	Residual/ Remaining Biodiversity Area
	Area (km^2)	(km^2)	(Hectares)	(%)	(km^2)
The base	1467.51	-	-	-	1467.51
Year					
2000					
2008	1467.51	45.85	4585	3.12	1421.66
2013	1467.51	70.36	7036	4.79	1397.15
2018	1467.51	83.05	8305	5.66	1384.46

4.6 Coastal erosion in the Project Area

Coastal erosion has become a challenging phenomenon to coastal settlements all over the world. The consequences of this reality have been overwhelming to the affected. Coastal areas are generally regarded as the land and sea areas bordering the shoreline.

Earlier study has appraised coastal erosion processes and its impact on the people of Aiyetoro community. It is observed that coastal erosion is affecting community livelihoods and threatening a sustainable development of the study area. In line with the above, the study found ~~out~~ that coastal erosion has led to shifting fishing grounds hence relatively lower yield of fish and other marine (**See Plates 4.8 to 4.10b**).

Plate 4.8: Wooden planks are the predominant construction materials in Aiyetoro

Plate 4.9: Retreated houses due to action of coastal erosion in Aiyetoro

Plate 4.10a&b: Aiyetoro Community threatened by sea incursion and wave actions

4.7 Characteristics of Coastal Housing in the Project Area

The existing socio-economic and physical characteristics of the communities in the proposed Deep-Sea area of Ondo State are examined with a view to providing a framework for effective implementation of rehabilitation and relocation in the study area.

Thomas (2017) showed the diversity and commonality of coastal towns found in the proposed Deep-Sea port area of Ondo State vary considerably. The housing units characterizing the area are huts, hamlets, and small village settlements. One obvious feature of all coastal towns is that they are next to the sea (**Table 4.3 and 4.4 respectively**).

Table 4.3: Building Construction material types in Aiyetoro Community

S/N	MATERIAL TYPE	NUMBER	PERCENTAGE %
1	Concrete Blocks	---	0
2	Hollow Blocks	76	11.875
3	Wooden Planks	564	88.125
	TOTAL	**640**	**100.00**

Primary and secondary data were obtained for the study by Thomas (2017) and corroborated with our dry season and rainy season sampling between November 2019 and March, 2020). Primary data were obtained through the administration of questionnaire on residents in the selected communities. There were 169 settlements in the area; and this is made up of 66 huts, 51 hamlets and 52 small towns. Using stratified sampling technique, one out of every 10 settlements (10%) was selected; which gave seven huts, six hamlets and six small towns. A total of 2,123 houses were identified in the selected settlements. Simple random sampling was used to select 10% of these houses. A household head was selected per building using random sampling. In all, 213 copies of questionnaire were administered, thereafter 211 of which were successfully retrieved for analysis. Data collected were analyzed using descriptive and inferential statistics.

The study found that 72.9% of the respondents were between 31 and 60 years old with an average age of 41 years old. Also, 82.5% of the coastal dwellers had one form of formal education or the other. It was also discovered in the study that 33.2% of the respondent's major means of livelihood was fishing and that 55.9% of the study population comprised low-income earners (**Table 4.3**).

Finding also revealed that 81.9% of the respondents in the study resided in rooms of apartment (building type), while (56.0%) of the study population used local building materials for walls in the study area. Moreover, finding revealed that respondents in the study defecate majorly (42.7%) in stream/river, while 50.7% of the respondents in the study make used of same river/stream for their domestic use (**Plates 4.11 to 4.14**).

Table 4.4: Coastal dwellers' socio-economic background in the Study (After Thomas, 2017)

Socio-economic variable	Small towns	Hamlets	Huts	Study area
Age				
1-30	32 (25.8%)	10 (19.2%)	6 (17.1%)	48 (22.7%)
31-60	87 (70.2%)	39 (75%)	28 (80%)	154 (72.9%)
Above 60	5 (4%)	3 (5.8%)	1 (2.9%)	9 (4.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Educational status				
No formal Primary	21 (17.5%)	6 (11.5%)	10 (28.6%)	37 (17.5%)
Secondary Tertiary	17 (13.7%)	10 (19.2%)	6 (17.1%)	33 (15.6%)
Total	28 (22.6%)	10 (19.2%)	8 (22.9%)	46 (21.8%)
	58 (46.8%)	26 (50%)	11 (31.4%)	95 (45%)
	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Occupation				
Fishing	31 (25%)	26 (50%)	13 (37.1%)	70 (33.2%)
Artisan	14 (11.3%)	4 (7.6%)	2 (5.7%)	20 (9.3%)
Farming	11 (8.9%)	7 (13.4%)	6 (17.2%)	24 (11.4%)
Civil servant	27 (21.8%)	2 (3.8%)	1 (2.8%)	30 (14.2%)
Trading	26 (20.9%)	8 (15.8%)	7 (20%)	41 (19.5%)
Unemployed	15 (12.2%)	5 (9.4%)	6 (17.2%)	26 (12.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Income				
<24500	72 (58.1%)	22 (42.3%)	24 (68.6%)	118 (55.9%)
24501-54000	27 (21.7%)	16 (30.8%)	7 (20%)	50 (23.7%)
Above 54000	25 (20.2%)	14 (26.9%)	4 (11.4%)	43 (20.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)

Plate 4.11: Building built with raffia palm pole in the Study Area

Plate 4.12: Dwelling Unit Built with Wooden Plank in the Study Area

Plate 4.13: Typical toilet used by coastal dwellers in the study area

Plate 4.14: Raised building foundation in Araromi seaside

Table 4.5: Coastal dwellers' housing characteristic in the Study Area (After Thomas, 2 017)

Housing feature	Small towns	Hamlets	Huts	Study area
Dwelling type				
Rooms of apartment	32 (25.8%)	10 (19.2%)	6 (17.1%)	48 (22.7%)
Flat system	87 (70.2%)	39 (75%)	28 (80%)	154 (72.9%)
Duplex	5 (4%)	3 (5.8%)	1 (2.9%)	9 (4.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Wall material				
Cement block	32 (25.8%)	12 (23.1%)	3 (8.6%)	47 (22.3%)
Mud block	8 (6.5%)	3 (3.8%)	6 (17.1%)	16 (7.6%)
Raffia palm	44 (35.5%)	18 (34.6%)	16 (45.7%)	78 (37%)
Woodcraft	22 (17.7%)	8 (15.4%)	10 (28.6%)	40 (19%)
Corrugated	18 (14.5%)	2 (3.8%)	0 (0%)	30 (14.2%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Toilet type				
Water closet	28 (22.6%)	6 (11.5%)	0 (0%)	34 (16.1%)
Pit latrine	56 (45.2%)	26 (50%)	5 (14.3%)	87 (41.2%)
River/stream	40 (32.2%)	20 (38.5%)	30 (85.7%)	90 (42.7%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Source of water				
Borehole Well	49 (39.5%)	14 (26.9%)	8 (22.9%)	71 (33.6%)
Rivers/stream	21 (16.9%)	9 (17.3%)	3 (8.6%)	33 (15.7%)
Total	54 (43.6%)	29 (55.8%)	24 (68.5%)	107 (50.7%)
	124 (100%)	52 (100%)	35 (100%)	211 (100%)

4.8 Muddy Coastal Water of the Project Area

According to Oyedotun (2015), of the four distinct geomorphic zones along the 800 km of Nigeria's coastline, Ondo State coastline is along the 75 km eastern boundary mud beaches which terminate at the Molume at the boundary with Delta State of the western flank of the Niger Delta. The coastline is of predominantly medium to coarse, poorly sorted, finely skewed and platykurtic to leptokurtic silt beach. It is also a mesotidal (2 – 4 m tidal range) beach with largely fine grained (0.18 – 0.34 mm) sediments and are of low gradient (< 80).

Due to the low mean tidal range, the coast has a relatively high and consistent intensity of wave action. Large swell waves are, therefore, common in the area, which are generated by the prevailing south-westerly winds and the flooding driven by high tides. This low-lying mud coastline has an elevation varying between 0.5 to 2 m above mean sea level and persistent significant wave height (hs) of the order of 1.4 m – 2.5 m with the prevalence of longshore currents at the near shore zone. The continental shelf in the study area is narrow, relatively gently sloping with bathymetric lines running generally in parallel to the coastlines.

Oyedotun (2015) investigated the decadal shoreline changes in the muddy coastline of Ondo State between 1972 and 2014. Movements of High Water (HW) shoreline were investigated using the Digital Shoreline Analysis System (DSAS), an ArcGIS extension developed by the USGS. Datasets includes multiple photograph editions from Landsat and Nigeria Satellite Imageries. Shoreline features delineated from each year images included the positions of HW, from which were calculated the Net Shoreline Movement (NSM) and End Point Rate (EPR, the yearly rate of movement). The preliminary results show that the shorelines of Ondo State coastline have experienced a consistent landward movement over the four decades. These changes are attributed to the wave attacks, increasing tide levels in the Atlantic Gulf of Benin, the recent sea-level rise, river canalization which reduce sediment transportation to coastal zone, the probable historical sand mining and other anthropogenic activities at the coastal zone.

The datasets used in the study are predominantly the remotely sensed images from Landsat (1972, 1999, 2002, 2004 and 2014) and Nigeria Sat 1 (2007) images. The positions of HW were identified and digitised from each of the images before being analysed for their movement and changes in a DSAS.

The spatial distribution for the rates-of-change (NSM and EPR) for the Ondo State HW coastline is presented in **Plate 4.15a**. The spatial assessment of the change pattern shows the dynamic landward movement of HW shorelines in the study site. HW Shoreline change analysis (1972 to date) shows large-scale and consistent patterns of retreat. This muddy coastline has experienced recession over the last four decades (**Plate 4.15b**) and the average net shoreline movements across all DSAS transect is – 25 m. The total erosion is not almost the same all over the coastline. The retreat of a little less than 20 m is observed in Awoye. Broad yearly rates of change in the position of HW are in the range of -2 to -5 m yr-1 before Aiyetoro and after Awoye (and towards the boundary of the Ondo State with Delta State) while around -2 to ±0.5 m yr-1 are observed in Awoye area (**Plate 4.15c**). He proposed that the High-Water erosion at the study is thought to be as a result of combination of many factors.

In order to quantitatively examine the cumulative rate of change at some locations along the HW in the coastline, two transects are selected from Aiyetoro and Awoye areas for examination. The cumulative change in the shoreline positions along the same transects are plotted in graphs with 'year' plotted along the X-axis and the corresponding cumulative change in shoreline positions with respect to 1972 shoreline plotted on the Y-axis. In the graphs, presented in **Plate 4.16**, the positive values indicate accretion trend whereas the negative trends as erosion. From the cumulative graph time series, it is observed that there is a period of no stability in the early and later parts of the series, with interval of severe erosion in the 1970s and 1980s. The cumulative HW shoreline movements indicate the landward migration of the HW to ~ 20 km from their original position in 1972. The findings from this study have shown that the persistent scale of erosion which has been reported in the past literatures.

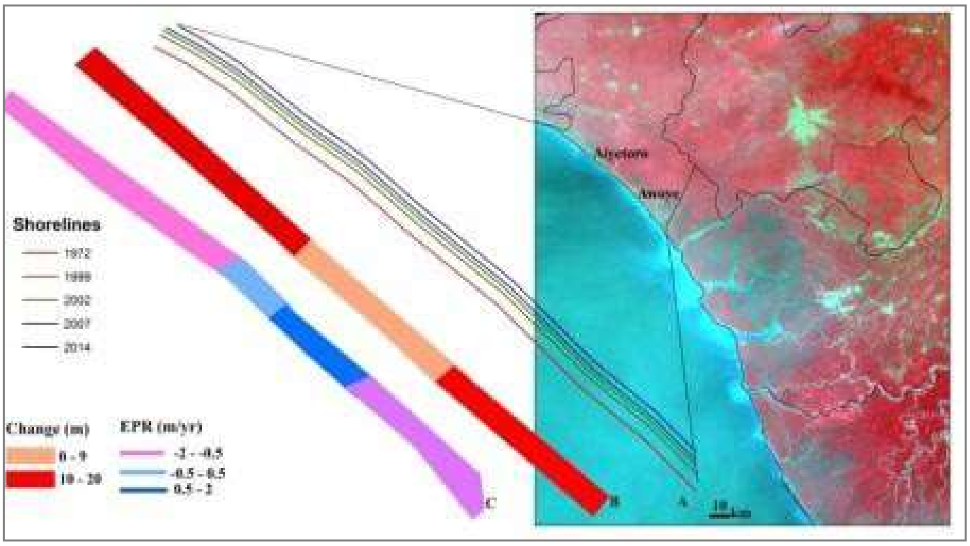


Plate 4.15a-c: Shoreline change analysis of Ondo State coastline showing (A) the digitized shoreline positions, (B) Net Shoreline Movement, and (C) decadal yearly rate of change (End Point Rate)

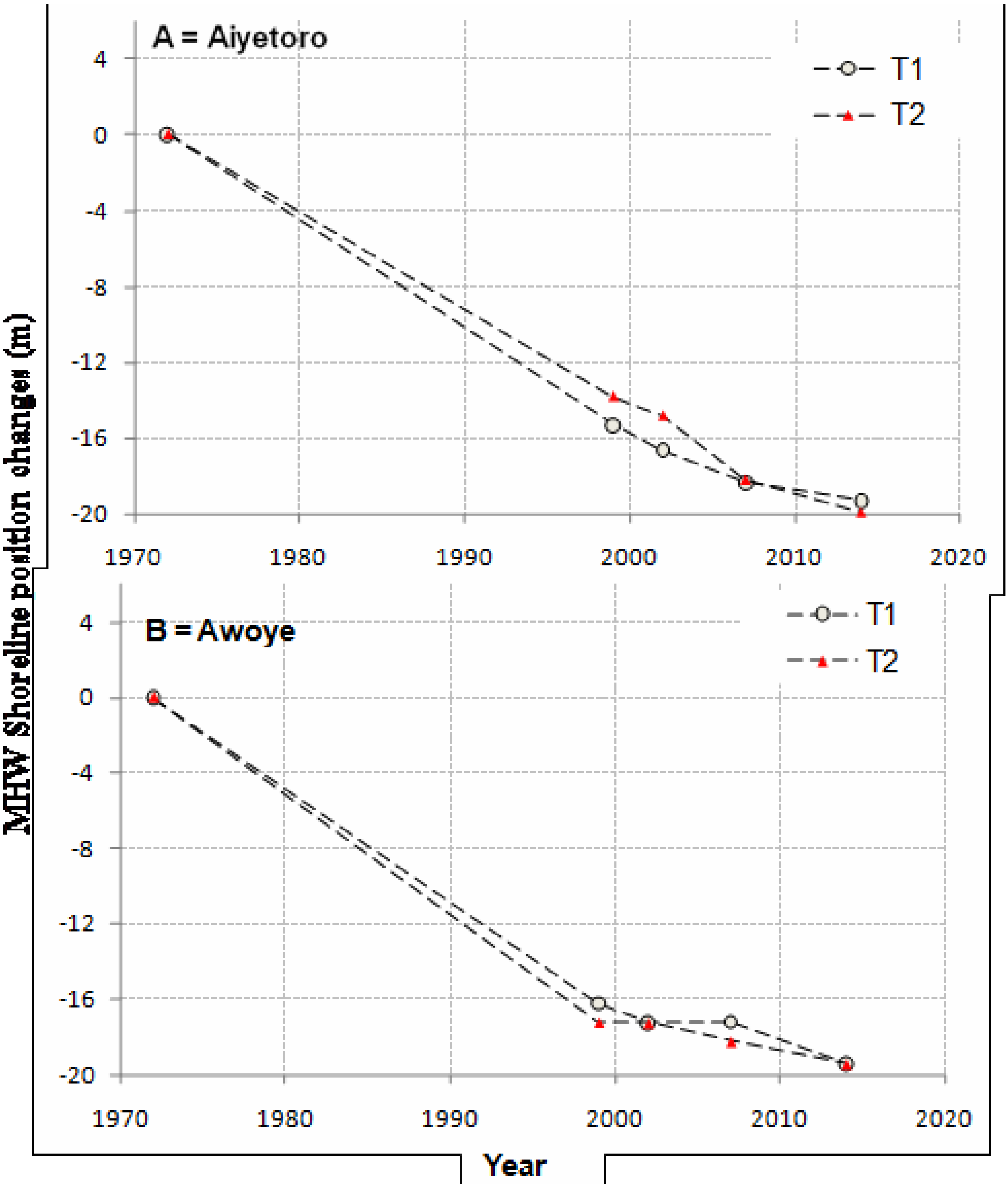


Plate 4.16: Cumulative volume of change of two transects in two sample locations, Aiyetoro and Awoye

4.9 Physico-Chemical and Rainfall Properties of the Project Area

Environmental pollution and degradation affect sustainability through loss of fish breeding grounds and habitats in the study of the coastal waters of Ondo State. Density and diversity of flora and fauna depends on chemical regime of water (Adebowale *et. al*, 2008).

The results of the in-situ physicochemical analysis of the coastal waters of Ondo State conducted for 18 months (June 2011-December 2012) retrieved from the archive and produced by Bolarinwa *et al.* (2016) revealed that the mean values of dissolved oxygen, pH, temperature and water transparency were 7.35 ± 0.104 mg/l, 6.35±0.036 mg/l, 28.15±0.19 ^{O}C and 0.67±0.015 m respectively. There was no significant difference in these parameters at $P>0.05$ across both the dry and wet seasons. Conductivity ranged from 80.8±1.56 µhoms/cm in December to 93.6 ± 1.35µhoms/cm in the rainy month of July. Phosphate ranged from 1.17 mg/l ±0.15 in December to 5.67±0.13 mg/l in July and differs significantly at $P<0.05$ across the seasons. They suggested that the higher values of conductivity and phosphate in the wet season might be due to large water flooding, runoffs or bioturbation by bottom-dwelling fishes.

Secchi-disc Water transparency of the coastal waters was observed to be highest in the month of February at 0.83 ±0.03m and lowest in the wet month of June with mean value of 0.45 ± 0.06m. The annual mean value for the sampling sites was 0.67±0.015m.

Rainfall ranged from 1.5mm in November and December to 647.3 mm in July and 1099 mm in September. They observed that a high positive correlation ‘r’ existed between rainfall and phosphate level (0.69) and conductivity (0.76). Silicates ranged from1.68±0.035mg/l to 18.43±0.21 mg/l. The higher silicate level recorded in the wet season might be due to leaching out of silicates from bottom soil due to large runoffs. Mean values of nitrate, Nitrite, alkalinity of 1.34± 0.074 mg/l ,0.27 ±0.005 and 56.31±0.368 mg/l differ significantly at $P<0.05$ probably due to high bacterial decomposition and mineralization through evaporation of the water hyacinth-infested coastal waters.

Rainfall and temperature data of Ondo State were also collected from the archives of the Meteorological Agency of Nigeria, Oshodi, Lagos and used for Okitipupa since the areas are under the same climatic coverage. The data were modelled into three and half ($3^{1/2}$) decade partitions namely; 1971-1980, 1981-1990, 1991-2000 and 2001-2007 respectively and subjected to trend analysis statistical method. This method is used to ascertain if the variability positive or negative of rainfall and temperature have an influence on the susceptibility of the soil to erosion and flooding.

Annual Rainfall of the study area (1901-2011)

Plate 4.17 shows the time series plot of annual rainfall receipt extracted in the study area. The annual values were calculated from the monthly rainfall amounts. Other computations were done for the mean annual rainfall amount observed in the study area was 1579.283mm and a standard deviation of 246.0073mm. This was employed in the computation of the Normalized Anomaly of annual rainfall. A 4percentile moving average anomaly was superimposed on the time series of the anomaly plot in order to show the flow of rainfall received and the cycle of rainfall distribution in the study area. There was a noticeable cycle of annual rainfall amount but the steepness of such cycles increased beginning from 1979. Positive anomaly shows years of above longtime average rainfall received while negative anomaly describes years of below average rainfall receipt.

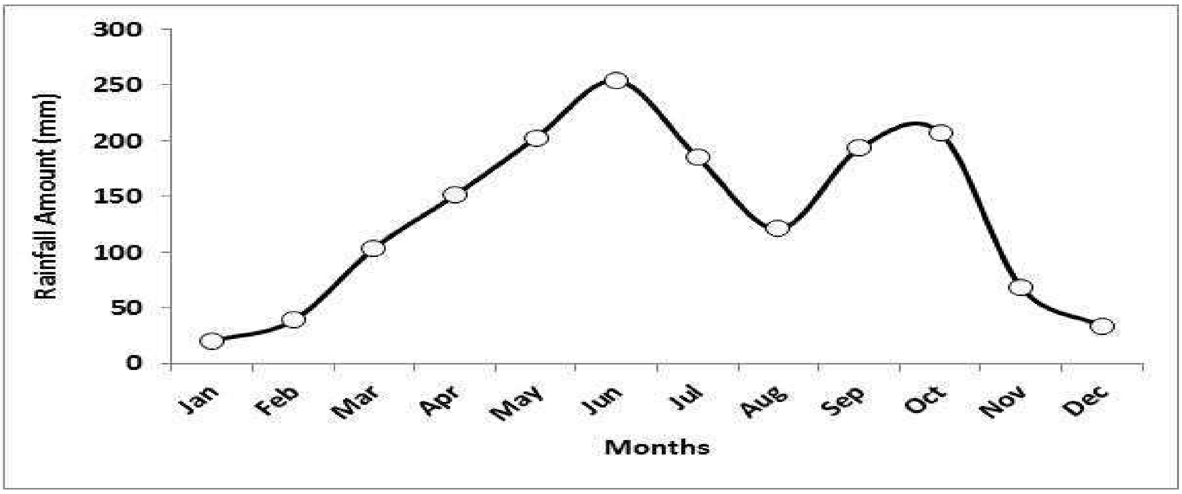


Plate 4.17: Average monthly distributions of rainfall in the study area. Source: Computed from ensemble satellite products (November, 2012).

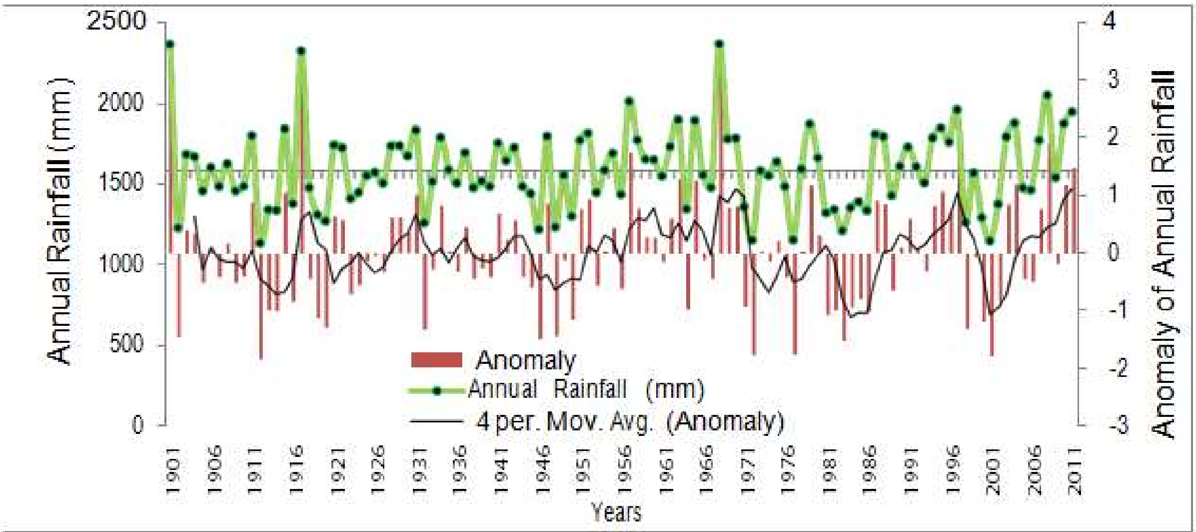


Plate 4.18: Annual rainfall distributions in the study area

Okitipupa occupies a flat terrain and most likely to experience flash floods and prone to widespread flooding in form of water logging. Flash floods are local events which are produced by intensive rainfall over a small area. Okitipupa has a land area of about 63 square kilometre with a population of 233,565 by the 2006 census. **Tables 4.6 and 4.7** shows the annual mean rainfall for the 1st decade (1971-1980) which increases from 1971 (281.40mm) reaching a peak in 1975 (464.00mm) and fluctuating from (243.60mm) in 1976 to (404.90mm) in 1980 giving an indication of rainfall changes over the years. An analysis of the monthly mean rainfall in **Plate 4.18** indicates that the rains were generally high in July, and sharply dropping in August in what is known locally as 'August break'. The rainfall distribution in September is not uniform an indication of a shift in the rainfall pattern around the area showing by extension a change in the climatic condition (**See Plate 4.19**).

Table 4.6: Annual mean rainfall for the 1st decade (1971-1980)

				RAINFAL		ONDO					
	1971	**1972**	**1973**	1974	1975	1976	1977	1978	1979	1980	1981
JAN	3.30	31.60	0.00	0.00	0.00	13.50	18.80	0.00	9.00	0.00	0.00
FEB	62.50	63.90	31.80	44.40	61.00	79.40	33.10	62.70	12.50	50.50	5.10
MAR	93.00	106.50	55.90	111.50	96.60	106.10	56.10	126.10	96.10	127.00	98.50
APRIL	127.30	80.70	120.90	191.50	221.70	137.30	138.10	288.20	115.40	188.50	140.20
MAY	146.90	151.40	189.90	182.80	301.50	172.20	164.90	203.50	140.00	133.70	165.90
JUNE	133.00	203.40	178.30	229.10	104.90	184.10	275.10	233.00	169.00	278.20	253.20
JULY	281.40	134.50	271.80	265.40	464.00	72.40	210.20	425.70	297.30	186.00	209.90
AUG	80.10	105.90	276.10	153.30	110.10	89.70	106.20	72.10	290.70	404.90	150.30
SEP	0.00	205.90	177.50	330.10	130.70	89.40	104.90	296.40	364.20	348.60	183.00
OCT	109.50	120.00	154.40	133.00	206.20	243.60	188.40	168.40	173.90	303.80	132.60
NOV	60.50	2.30	2.80	16.30	82.10	81.00	3.40	8.40	100.70	52.00	49.70
DEC	25.20	38.60	16.00	0.00	36.10	0.00	39.80	1.80	4.70	21.90	0.00
ONDO	93.56	103.73	122.95	138.12	151.24	105.73	111.58	157.19	147.79	174.59	115.70

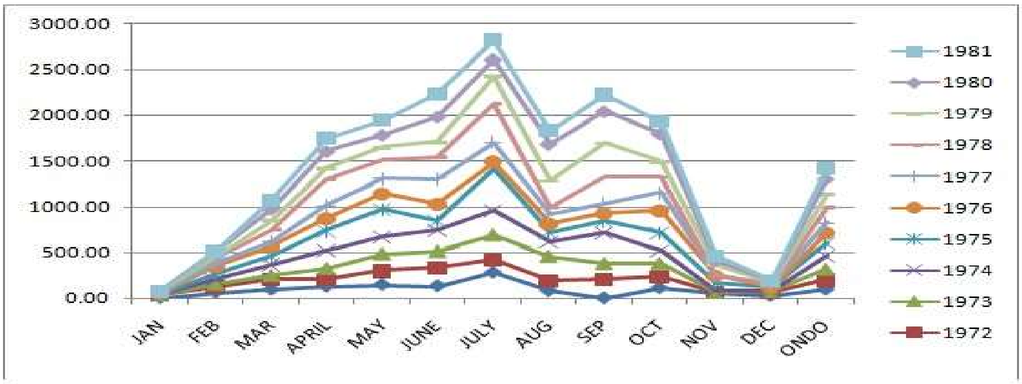


Plate 4.19: Annual mean rainfall distribution in 1971-1980 decade

In the second decade (1981-1890) Table 4.7, the annual mean rainfall was least in 1984 (24.48mm) and maximal in 1985 (174.24mm). Many months were without rainfall in this decade.

Table 4.7: Annual mean rainfall (mm) for 2nd decade (1981-1990)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Jan	00.0	9.60	0.00	0.00	0.00	4.60	0.00	3.70	0.00	12.10
Feb	5.10	101.40	17.80	1.40	41.90	125.40	32.10	92.30	0.00	1.20
Mar	98.50	60.50	34.70	171.20	212.80	190.70	145.40	93.90	115.00	0.00
April	140.20	208.50	0.00	121.20	513.30	41.60	91.20	193.80	200.70	140.90
May	165.90	165.40	158.50	0.00	410.70	211.10	86.60	240.40	245.10	121.00
June	253.20	158.90	282.60	0.00	259.80	271.90	140.80	223.40	230.00	197.20
July	209.90	156.10	129.40	0.00	335.40	170.60	244.40	141.70	300.30	210.40
Aug	150.30	44.70	45.30	0.00	285.00	102.20	355.10	101.40	210.50	115.50
Sept	183.00	185.60	312.10	0.00	0.00	256.90	230.70	301.70	158.90	277.30
Oct	132.60	186.40	80.20	0.00	0.00	132.30	263.20	244.80	124.20	150.00
Nov	49.70	14.50	46.90	0.00	32.00	23.40	0.80	27.70	23.60	76.00
Dec	0.00	0.00	22.00	0.00	0.00	0.00	6.60	29.70	0.00	55.80

Mean 115.70 107.63 94.13 24.48 174.24 127.56 133.08 141.21 134.03
113.12

Plate 4.20 gives a picture of the variations which conform with the usual rainfall pattern of the studied area or any other area within the climatic region. The rainfall scenario indicates a clear reversal of rainfall distribution pattern ever known as rain was highest in April (513.30mm) of 1985 and there was the usual 'August break' which showed decreased amount of rainfall. Generally, the rainfall distribution in this decade conform with the usual trend of wet and dry seasons known in the region except the unusual heavy downpour in April. The unusual heavy rainfall in April is significant for it suggests a shift in the seasonal rainfall pattern and this agrees with the opinion of that in many places the hydrologic impact of climate change on floods may not primarily be due to the increased annual rain depth but to the shift in the seasonal rainfall pattern. The June and September peaks of rainfall in **Plate 4.20**.

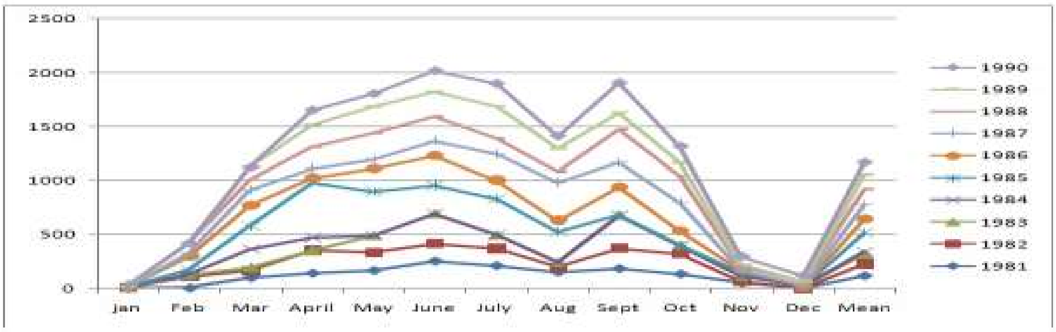


Plate 4.20: Annual mean rainfall distribution in 1981-1990 decade

Table 4.8 shows that the total mean annual rainfall for the decade (1991-2000) ranges between 101,93mm in 1994 and 192.52mm in 1991 respectively.

Table 4.8: Rainfall distribution in the 3rd decade (1991-2000)

	1991`	1992	1993	1994	1995	1996	1997	1998	1999	2000
Jan	0.00	0.00	0.00	31.30	0.00	5.40	27.60	0.00	3.20	0.00
Feb	55.30	4.90	34.60	50.90	49.80	93.20	0.00	23.20	21.20	0.00
Mar	171.20	74.90	121.00	74.50	101.00	141.30	0.00	0.20	69.20	87.20
April	295.30	96.70	100.10	186.20	130.70	187.20	219.40	108.90	132.00	187.60
May	204.20	196.10	152.40	192.70	124.60	187.40	219.50	228.50	120.50	124.80
June	281.30	223.90	195.30	263.30	407.50	236.00	276.40	254.60	236.10	384.70
July	552.20	185.00	91.70	0.00	251.30	236.80	71.90	210.90	335.10	169.40
Aug	223.60	52.00	219.40	0.00	319.40	190.90	76.20	40.80	170.70	198.00
Sep	309.60	488.20	351.20	219.10	348.80	302.20	230.10	241.40	253.60	216.30
Oct	204.90	131.40	88.30	165.90	244.30	175.00	187.70	332.30	259.30	176.30
Nov	0.00	67.10	90.30	39.20	36.60	1.60	23.70	63.80	63.80	23.40
Dec	12.60	0.00	5.60	0.00	0.00	0.00	32.70	0.00	0.00	0.00
Mean	192.52	126.68	120.83	101.93	167.83	101.93	120.68	113.77	125.38	138.73

Plate 4.21 shows a general rainfall distribution for the decade with two distinct rainfall maxima in June and September and a noticeable variance

(552.20 mm) occurring in July of 1991.The spatial distribution of rainfall in this area indicates regularity in time and space. When rain falls regularly there is the tendency for the soil/ground to get fully saturated and under this condition the soil/ground capacity to store water may be exceeded thus forming runoffs that may escape to cover the surface of land as flood.

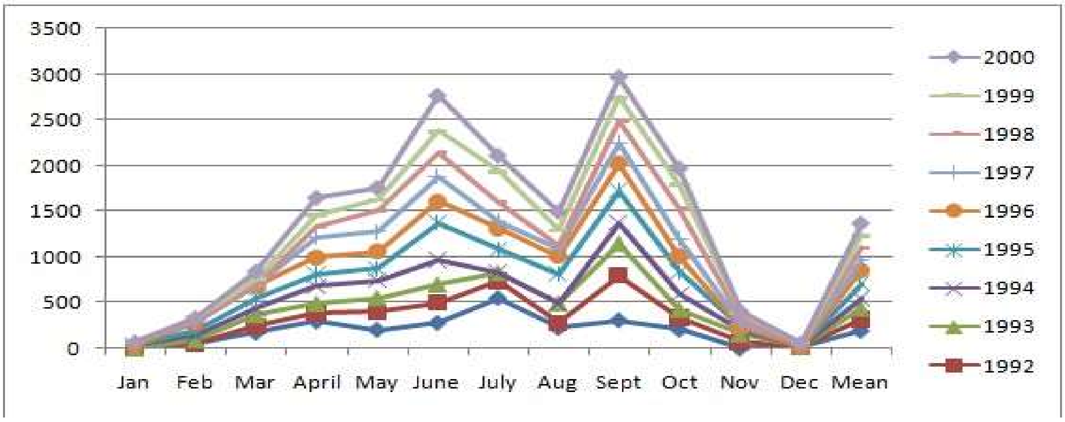


Plate 4.21: Annual mean rainfall distribution in 1992-2000 decade

Plate 4.22 gives the total annual mean rainfall for 2001-2007. The distribution of rainfall indicates that the values vary from 112.96 mm in 2001 to 140.90 mm in 2003. The dry and wet seasons are clearly defined above. The distribution of rainfall is consistent with the pattern in the region showing a single rainfall maximum in September. Rainfall consistency and intensity give rise to runoffs which cumulates to flooding. A general trend analysis of the rainfall for the decades is shown in **Plate 4.22**.

Table 4.9: Rainfall distribution in 2001-2007

	2001	2002	2003	2004	2005	2006	2007
Jan	11.1	0	16.3	4.8	0	7.7	0
Feb	0	11.7	12.7	78.2	12.1	49.1	57
Mar	84.7	124.3	53.8	49.2	161.4	101.1	19.3
April	253.3	175.4	297.5	173.1	108.6	62	113
May	219.4	98.8	111.1	171.6	248.2	189.9	220
Jun	199	264.9	193.2	207.9	298.3	269.3	154
Jul	333.2	294.4	61	171.9	314.6	155.4	77.5
Aug	91.1	237.6	81.4	170.4	30.1	358.9	383.1
Sept	274.8	148.4	556.6	354.1	278.2	183.8	291.1
Oct	66.4	0	184	197.5	142.4	103.9	137
Nov	56.6	0	123.2	37.4	38.4	23	19.9
Dec	1.1	0	0	0	17	4.5	5.4
Mean	132.56	112.96	140.9	134.68	137.44	125.72	123.11

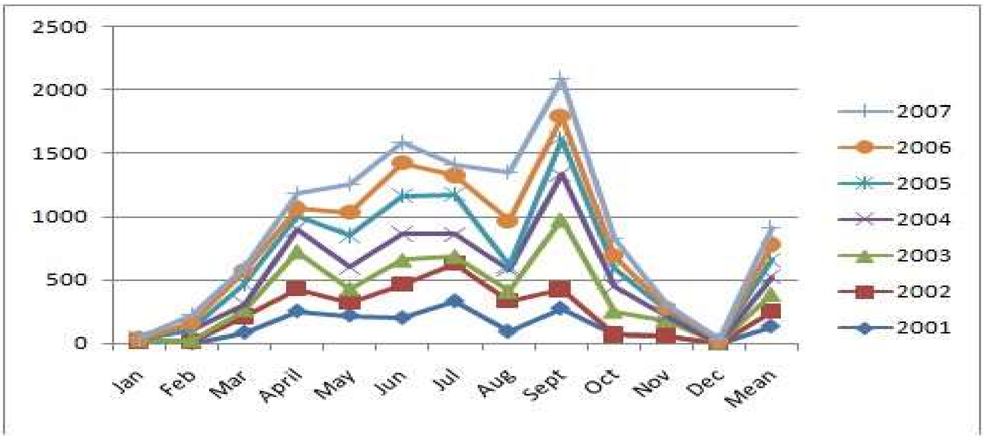


Plate 4.23: Annual mean rainfall distribution in 2001-2007 decade

The trend analysis suggests that in the last few decades (1971-2007) the rainfall has been on the increase, an indication that climate is positively changing over the years. The increase ranges from y=1.684 to y=3.716 (**Plate 4.23**). It has been stated that in the Nigerian context, an unusual increase in the rainfall and temperature over time can cause massive erosion and flooding which are attributable to climate change. However, while the rainfall increases in the studied area the temperature slightly decreases from -0.25 to -0.1 (**Plate 4.24**).

They generally observed that the coastal waters of Ondo State of Nigeria were conducive to fish production since most of the physicochemical parameters still fell within W.H.O tolerable limits.

The mean pH of the coastal waters was 6.35± 0.036 ppm. The highest pH of 7.83 ±0.16 mg/l was observed in the month of February and lowest at 5.60 ±0.29 mg/l in September. High turbidity in the rains coupled with decomposing organic matter like *Eichornia Crassipes* which infestation was massive in the study area at the period of study.

There was no significant difference in the value of pH across the seasons ($P<0.05$). Temperature ranged from 27^{O}C – 30^{O}C. The highest value of 30^{O}C was observed in the dry month of December and lowest at 27.33 ±1.161^{O}C in July and September, the rainiest months of the years (**Plate 4.24**).

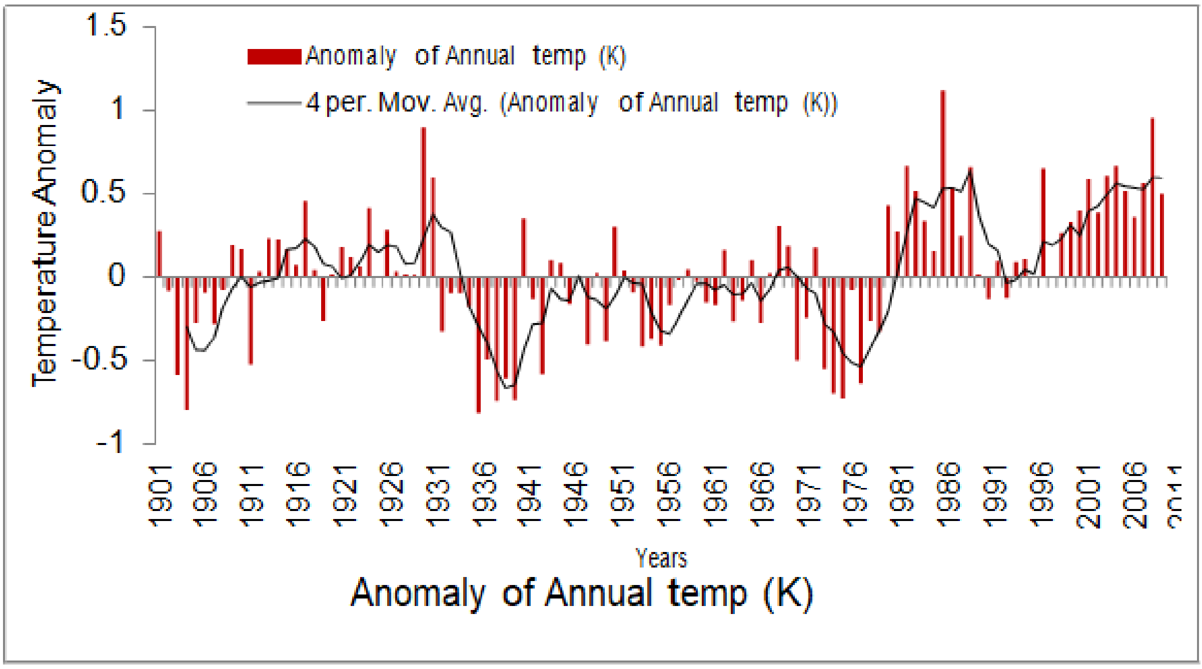


Plate 4.24: Annual temperature distributions in the study area

Salinity ranged from the lowest at 1.36 ±0.13ppt observed in the rainy month of September to 5.27 ±0.21 ppt in January, the driest month. The mean value was 2.55±0.109.

Conductivity ranged from the lowest at 80.8 ± 1.56 µhomscm-1 in December to highest at 93.6±1.35 µhomscm-1 in the month of July. The mean value of the coastal waters was 85.81 ± 0.597 µhomscm-1.

The mean value of phosphate of the coastal water ranged from the lowest at 1.17 ± 0.15ppm in December to the highest in July at 5.67±0.13ppm. There were seasonal variations in the phosphate level. There was significant difference in phosphate level across the seasons at $P<0.05$. There was no significant difference among the three sampling sites in the coastal waters at $P > 0.05$. Higher phosphate value was observed during the rainy season than the dry season.

Nitrate value was lowest in July, the rainiest month at 0.26±0.015mg/l and highest at 4.15±0.127mg/l in the dry month of February. The mean value was 1.34±0.074mg/l. The mean Nitrite concentration of the coastal waters was 0.27 ±0.005mg/l. The lowest value of 0.14 ± 0.006mg/l was recorded at the onset of the rainy season and highest at 0.46± 0.12mg/l in January, the peak of the dry season (**See Table 4.9a**).

Table 4.9a: **Physico-chemical Parameters of the Coastal waters of Ondo State, Nigeria (As reported by Bolarinwa et al. (2016)**

	Dissolved oxygen (mg/l)	Water transparency (m)	pH (mg/l)	Salinity (ppt)	Conductivity(uhoms/cm)	Phosphate (ppm)	Nitrate (ppm)	Alkalinity (ppm)	Nitrite (ppm))	Silicate (ppm)	Water depth (m)
Mahin	7.27	0.65	6.41	2.47	85.45	3.55	1.36	56.41	0.28	11.68	2.48[b]
Ugbo	7.47	0.68	6.29	2.64	86.18	3.61	1.33	56.21	0.26	11.92	2.73[b]
Ugbonla	7.63	0.70	6.33	2.84	87.49	3.80	1.12	55.22	0.27	12.37	3.41[a]
Mean	7.37	0.67	6.35	2.55	85.81	3.58	1.34	56.31	0.27	11.80	2.73
SEM	0.104	0.015	0.036	0.109	0.597	0.075	0.074	0.368	0.005	0.201	0.279

Mahin	Rainfall(mm)	Temperature(°C)
Ugbo	244.61	28.29
Ugbonla	244.61	28.01
Mean	244.61	28.67
SEM	0.000	0.190

Akegbejo-Samsons (1995) also observed higher secchi disc transparency in Ondo coastal waters in the months of April, May and June which was characterized by scanty rains attributing the differences in the secchi disc reading to more light penetration or greater angle of incidence due to speed of river flowing. Furthermore, *Akegbejo-Samsons (1995)* found the water transparency of the coastal waters of Ondo State to range from 0.82-1.10m during the wet season and mean value 1.07 ±0.33m in the dry season. Mean annual temperature value of 26.23±1.68 ^{O}C in December and highest value of 28.7^{O}C in March in the study of the coastal waters of Ondo State was also reported by Akegbejo-Samsons (1995).

From the studies *(Ajibare 2014),* it is obvious from the results of the physico-chemical parameters of the water samples (**See Table 4.9b**) from the communities that will be affected by the proposed Deep-Sea area indicate that the water samples fall within the stipulated range of acceptability hence the water can be classified as a good, stable and healthy aquatic ecosystem.

The quality of water from four coastal towns in the proposed Deep-Sea area of Ondo State were assessed using standard methods with the view of determining the level of pollution through anthropogenic activities and state of the aquatic ecosystem. The result revealed that all the physico-chemical parameters of water determined (except turbidity and hardness) showed no significant difference across the sampling locations. The result obtained is within the permissible level of aquatic biodiversity, set by United State Environmental Protection Agency and World Health Organization thus, the water can be classified as brackish and a good, stable and healthy aquatic ecosystem.

It is pertinent to note that, the results of our investigations during the dry season and rainy season sampling (November 2009 to March, 2020) correlate significantly with previous works by earlier workers.

Table 4.9b: Monthly Variation of Physico-chemical parameters of water in coastal waters of Ondo State, between September and December, 2011

		Location				
Parameters	**Month**	**Asumogha**	**Ayetoro**	**Bijimi**	**Idiogba**	
DO	September	7.53	7.76	7.70	7.54	
(mg/l)	October	7.64	7.48	7.43	7.61	
	November	7.54	7.78	7.39	7.39	
	December	7.67	7.63	7.58	7.63	
	Mean	**7.60** ^{a}	**7.66** ^{a}	**7.53** ^{a}	**7.54** ^{a}	**7.58**
Temperature	September	29.67	29.00	29.33	29.00	
(°C)	October	30.00	29.67	29.67	29.33	
	November	29.67	29.67	29.33	29.67	
	December	29.67	29.67	29.33	29.67	
	Mean	**29.75** ^{a}	**29.50** ^{a}	**29.42** ^{a}	**29.42** ^{a}	**29.52**
pH	September	6.67	6.53	6.53	6.63	
	October	6.68	6.71	6.70	6.74	
	November	6.67	6.77	6.78	6.77	
	December	6.63	6.73	6.75	6.70	
	Mean	**6.66** ^{a}	**6.68** ^{a}	**6.69** ^{a}	**6.71** ^{a}	**6.69**
Turbidity	September	44.23	40.20	35.40	40.93	
(NTU)	October	45.70	46.17	42.13	44.43	
	November	44.87	46.03	43.43	42.63	
	December	46.63	47.07	46.83	47.77	
	Mean	**45.36** ^{b}	**44.87** ^{b}	**41.95** ^{a}	**43.94** ^{ab}	**44.03**
Salinity	September	10.01	10.01	9.89	9.93	
(°/oo)	October	15.03	15.08	14.96	15.03	
	November	17.16	17.34	17.11	17.49	
	December	23.21	23.77	23.49	24.14	
	Mean	**16.35** ^{a}	**16.55** ^{a}	**16.36** ^{a}	**16.65** ^{a}	**16.48**
Hardness	September	83.65	84.00	84.03	83.26	
(mg/l)	October	83.13	85.70	86.33	83.19	
	November	84.77	88.60	87.40	85.57	
	December	86.73	90.33	90.33	87.00	
	Mean	**84.57** ^{a}	**87.16** ^{b}	**87.03** ^{b}	**84.75** ^{a}	**85.88**
Conductivity	September	40.00	40.00	39.67	39.00	
(mS/cm)	October	41.00	40.33	40.67	40.00	
	November	42.00	42.67	42.33	41.33	
	December	43.33	44.33	44.00	43.67	
	Mean	**41.58** ^{a}	**41.83** ^{a}	**41.67** ^{a}	**41.00** ^{a}	**41.52**

CHAPTER FIVE

5.0 STUDY METHODOLOGIES/MEASURED ENVIRONMENTAL CONDITION

5.1 Overall Study Approach

The major aspects of the project environment covered during two seasons (dry and rainy) of fieldwork were as follows; **Table 5.1a**. Standard methods approved by the Nigerian regulators were used for laboratory analyses of water and sediment samples. **Table 5.1b** summarizes the reference methods used.

Table 5.1a: Environmental Components Investigated and Their Impact Indicators

SN	Environmental component	Potential Impact Indicators
1	Climate and Meteorology	Radiation, temperature, wind (speed and direction), pressure, rainfall, relative humidity
2	Air quality	Pollutant gases (NO_x, SO_2, CO, H_2S, NH_3, VOC_s), particulate matter (PM)
3	Soils / sediment / land use	Physico-chemical characteristics (pH, anions, cations, heavy metals, nutrients, THC, Oil and grease etc), erosion tendency, land use characteristics, agriculture
4	Geology and Hydrogeology	Subsidence, landslide, rock type etc.
5	Water quality	Physico-chemical characteristics (pH, conductivity, cations, anions hardness, acidity, heavy metals, oil and grease, BOD, COD, TSS, Colour, Turbidity), microbial quality of surface and groundwater
6	Hydrobiology (phytoplankton, zooplankton, macrobenthos, macrophytes)	Diversity, abundance, productivity, economic importance
7	Wildlife and fisheries	Diversity, abundance, productivity, rare species endangered species
8	Vegetation / forestry	Taxa composition, physiognomy, abundance nuisance species
9	Socio-economic / community health	Population, income, settlement pattern, health, safety and security, infrastructure, social problem, housing, employment etc

The two main sources of information for all these specific studies were through literature review and the field investigations. Information on the general features of the environment such as geology, land form and climate was based largely on literature review. The second source was through (fieldwork) to collect site specific data and materials (biological specimens and samples for laboratory / herbarium analysis).

Table 5.1b: Summary of Laboratory analytical methods used for Water / Sediment Analysis

Parameter	Unit	Method
pH (H_2O)		ASTM D4972
Turbidity	(NTU)	APHA 214
Salinity	$^0/_{00}$	API-RP 45
Total Dissolved Solids	(mg/L)	APHA 209C
Total Solids	(mg/L)	APHA 209D
TSS	(mg/L)	APHA 209D
Electrical Conductivity	(µS/cm)	APHA 209
Bicarbonate	(mg/L)	API-RP 45
Alkalinity	(mg/L)	APHA 2320-ALKALINITY-B
Acidity	(mg/L)	APHA 2310 B
Ammoniac Nitrogen	(mg/L)	EPA 350.2
THC	(mg/L)	APR – RP 45
Nitrite	(mg/L)	EPA 354.1
Chloride	(mg/L)	APHA 4500 Cl-
Sulphate	(mg/L)	EPA 375.4
Total Phosphorous	Ppm	APHA 4500
P0 43- Calcium	Ppm	APHA 3111
Magnesium	Ppm	APHA 3111/ASTM D3561
Potassium	Ppm	APHA 3111/ASTM D3561
Cadmium	Ppm	APHA 3111
Chromium	Ppm	APHA 3111
Lead	Ppm	APHA 3111
Manganese	Ppm	APHA 3111
Iron	Ppm	APHA 3111
Copper	Ppm	APHA 3111
Zinc	Ppm	APHA 3111
PCB	ppb	EPA 625

The site verification and scoping exercise was carried out on 22nd November, 2019. Before the site verification, a courtesy visit was paid to Oba Fredrick Akinrutan, the Olu of Ugboland to intimate him about the Deep-Sea Port project and our activities. The officials of ONDIPA, State Federal Ministry of Environments accompanied the consultants and technical personnel of Jabridep Nigeria Limited to the field for the site verification exercise.

The Dry Season EIA Sampling was carried out between 22nd and 26th November, 2019, whilst the Rainy EIA sampling was conducted between 1st and 7th March, 2020. The period coincided with late part of the dry session, and early rainy season in the study area. All field investigations and protocols were according to standard methods. The grid co-ordinates (latitude, longitude and altitude) of all selected sampling stations were recorded using a portable Global Positioning System (GPS) set (**Table 5.2**). The highlight of field procedures and protocols for each study are presented as follows.

Table 5.2 **Sampling Location for Environmental Parameters Investigated**

S/No	Sampling Location	Longitude	Latitude	Elevation (Metres)
1	S1	4.506558	6.324816	12.32
2	S2	4.635049	6.234159	10.46
3	S3	4.746408	6.146357	11.08
4	S4	4.855625	6.04699	13.26
5	S5	4.985187	5.925923	12.76
6	S6	4.537253	6.293193	4.3
7	S7	4.668599	6.1904	1.56
8	S8	4.771392	6.109737	3.22
9	S9	4.879182	6.010585	1.4
10	S10	4.940572	5.949194	4.24
11	S11	4.497635	6.295335	-4.62
12	S12	4.593289	6.231089	-2.23
13	S13	4.701079	6.152567	3.45
14	S14	4.818149	6.050774	-2.59
15	S15	4.905951	5.957546	-3.27
16	S16	4.508343	6.259429	-10.54
17	S17	4.616132	6.180906	-9.86
18	S18	4.717497	6.090249	-10.11
19	S19	4.817435	5.998949	-11.03
20	S20	4.908092	5.904008	-6.46

The *In situ* water quality parameters of samples for both the dry (November, 2019) and rainy season (March, 2020) sampling are shown in Table 5.3a and Table 5.3b.

Table 5.3: ***In situ*** **water quality parameters of samples from (November, 2019)**

SN	Sample Location	Total depth (m)	Air temp (^0C)	Water temp (^0C)	FV (cm/s)	Cond. (μScm^{-1})	pH	Secchi Transp. (m)	DO (mgl^{-1})	DOsat (%)
1	S1	12.32	35.0	28.0	47	16	6.01	1.75	4.0	51.61
2	S8	10.46	33.5	28.5	43	23	6.10	1.79	3.2	41.61
3	S12	11.08	32.1	32.3	40	159	6.01	1.83	3.5	52.00
4	S17	13.26	34.7	33.8	38	105	5.84	1.77	2.8	48.65
5	S20	12.76	30.6	33.4	44	42	5.42	1.80	3.0	47.45

Table 5.3b: ***In situ*** **water quality parameters of samples from (March, 2020)**

SN	Sample Location	Total depth (m)	Air temp (^0C)	Water temp (^0C)	FV (cm/s)	Cond. (μScm^{-1})	pH	Secchi Transp. (m)	DO (mgl^{-1})	DOsat (%)
1	S1	12.32	33.0	24.0	43	20	6.51	1.78	4.7	58.13
2	S8	10.46	31.7	24.5	39	27	6.60	1.83	3.9	47.25
3	S12	11.08	30.0	28.1	36	165	6.65	1.87	4.2	58.19
4	S17	13.26	32.5	29.6	34	110	6.72	1.81	3.5	55.73
5	S20	12.76	28.1	29.4	39	46	6.11	1.85	3.8	54.00

5.1.1 Air Quality and Noise

During the field campaign, climate and meteorological parameters collected were: wind speed and direction, ambient air temperature, pressure and relative humidity. Weather Tracker Kestrel 4500 was used for the measurements of meteorological parameters. This Weather Tracker is a sophisticated, multi-function environmental monitoring instrument used to measure major environmental condition including Barometric Pressure, Altitude, Density, Temperature, Humidity, Wind Speed, Wind Chill, Dew Point, Wet Bulb, and Heat Index. It has a chart mode that allows users to recall and graph up to 250 measurements, along with the date and time of storage with a PC interface that allows data uploading for long-term storage, in-depth analysis and detailed charting. This was used to monitor the wind speed, wind direction, relative humidity, pressure and temperature during the study period.

The dry season and rainy sampling took place in twenty (20) locations. **Table 5.2** and **Figure 5.3** summarizes the designations of each of these locations with their coordinates.

Ammonia (NH_3), carbon monoxide (CO), hydrogen sulphide (H_2S), oxides of nitrogen (NO_X), sulphur dioxide (SO_2), and volatile organic compounds (VOCs) gaseous air pollutants were measured during the field study in the ambient environment of the proposed project site using various methods of sampling described below:

5.1.1.1 Ammonia (NH_3) Measurements

Ammonia (NH_3) measurements were taken using an *in situ* non-integrated single gas ammonia monitor (ToxiRAE Model PGM-1150). The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current ammonia concentrations can be continuously monitored in ppm (parts per million). It has facility for Short Term Exposure Limit (STEL) from which the ammonia concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. It has detection range of 0 – 20 ppm with 0.1 ppm resolution.

5.1.1.2 Carbon Monoxide (CO) Measurements:

Carbon monoxide (CO) measurements were taken using an *in situ* non-integrated single gas carbon monoxide monitor (ToxiRAE Model PGM-1150). The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current carbon monoxide concentrations can be continuously monitored in ppm (parts per million). It has facility for Short Term Exposure Limit (STEL) from which the carbon monoxide concentration

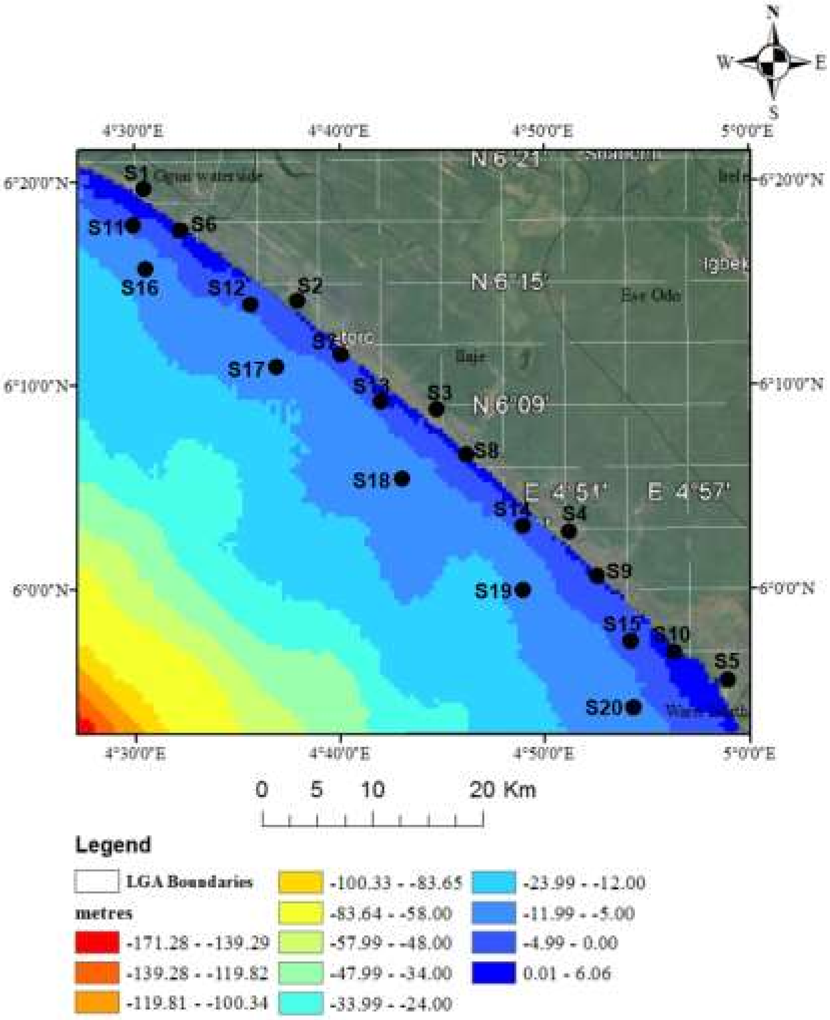


Figure 5.1.1: Sampling Station for Air Quality in the Proposed Deep-Sea Port Area (November, 2019and March, 2020 Sampling)

For the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. It has detection range of 0 – 500 ppm with 1 ppm resolution.

5.1.1.3 Oxides of Nitrogen (NO_X) Measurements:

Nitrogen oxides (NO_X) concentrations were measured as NO_2 using an *in situ* single gas NO_X monitor (ToxiRAE Model PGM-1110). The monitor is a 9.3cm x 4.9cm x 2.2cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current NO_2 concentrations can be continuously monitored in ppm (parts per million) with a detection range of 0 – 20 ppm and 0.1 ppm resolution. It has facility for Short Term Exposure Limit (STEL) from which the NO_2 concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. The monitor was calibrated on 12th July, 2019 with Calibration and Test Certificate S/N 021-905130 from RAE Systems, 3775 North First Street, San Jose, California 95134, USA. For every field measurement, the "Auto-Zero at Start-up" calibration was carried out as required in the study.

5.1.1.4 Sulphur Dioxide (SO_2) Measurements:

To measure the SO_2 concentrations during the field study, an *in situ* single gas SO_2 monitor (ToxiRAE Model PGM-1130) was used. The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current SO_2 concentrations can be continuously monitored in ppm (parts per million) with a detection range of 0 – 20 ppm and 0.1 ppm resolution. It has facility for Short Term Exposure Limit (STEL) from which the SO_2 concentration for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest reading since the monitor was turned on. The monitor was calibrated on 12th July, 2019 with Calibration and Test Certificate S/N 023-900636 from RAE Systems, 3775 North First Street, San Jose, California 95134, USA.

5.1.1.5 Hydrogen Sulphide (H_2S) and Volatile Organic Compounds (VOCs):

These compounds were measured using an *insitu* MultiRAE gas monitor (Model PGM50-5P). The monitor is a 9.3 cm x 4.9 cm x 2.2 cm measuring instrument weighing about 0.1 kg with an instantaneous direct readout displays through which current VOCs concentrations can be continuously monitored in ppm (parts per million). It has facility for Short Term Exposure Limit (STEL) from which the H_2S and VOCs concentrations for the last 15 minutes can be determined; the Time Weighted Average (TWA) from which the accumulated reading of the gas concentration since the monitor was turned on is divided by 8 hours; and the Peak Reading, which is the highest since the monitor was turned on. It has detection range of 0 – 200 ppm with 0.1 ppm resolution.

5.1.1.6 Noise Measurements

Noise measurements were taken with a digital, battery-powered, sound pressure level meter (EXTEC Instruments, US Model 407735). It has both A and C weighting and 0.1 dB resolution with fast/slow responses. Its high- and low-metering ranges were 35 – 100 dB and 65 – 130 dB, respectively. The meter is also equipped with a build-in calibration check (94 dB), tripod mount, and analogue DC/AC conditioned outputs of 10mV/dB and utilized a 0.49 " (12.3 mm) condenser microphone. To measure the noise levels at any of the sampling locations, the sound level meter was placed at a distance of at least 3 m from any barrier or other sound reflecting sources and at about 1.2 – 1.5 m above ground level. Measurements were taken by setting the sound level meter to the "A" weighting network.

5.1.1.7 Air Sampling for Particulates

Particulate matter (PM) was measured with GT-321 Particle Counter/Dust Monitor, an equipment from Met One Instruments. It is handheld, battery operated and completely portable unit measuring five mass ranges of TSP: PM_1, $PM_{2.5}$, PM_7, PM_{10}, and TSP. It has a concentration range of 0 – 1 mg/m^3 (with a resolution of 0.1 µg/m^3), a sampling time of 2 minutes and a flow rate of 2.83 l/min. To measure, it is placed at 1 m above the ground level, switched on in the environment of interest and the measured concentration read directly on the screen after particle capturing.

All these methods are as recommended by the Federal Ministry of Environment (FEPA, 1991), and the Department of Petroleum Resources (EGASPIN, 2002).

5.2 Geophysical and Hydrogeological Studies

During each field survey of the Deep-Sea Port Area, an initial reconnaissance survey was carried out by using compass and Garmin Global Positioning System (GPS) set to confirm some of the selected locations of five traverses. Bathymetry seabed depth and morphology was carried out using the Ground Penetrating radar (GPR) and seabed Sonar scanner. For this study, GPR data was acquired across the river. The GPR data used was collected using a Geophysical Survey System Incorporated SIR system-3000 equipment. The survey was carried out using a 200MHz monostatic antenna with the antenna oriented parallel to the survey direction (Parallel-Broadside). The orientation of the traverses was approximately north–south with survey direction of 182^o. Traces were recorded with a stack of 16-fold enough to improve the signal to noise ratio. 33 scans per meter were collected (0.03m station spacing) with a sampling window of 2000ns with an offset of +200ns. The GPR data positioning was calibrated using a survey wheel. Each radar traces contains 512 points per trace. The river line data was acquired with the antennae mounted on a wooden boat with the survey wheel manually rolled as the boat moves.

The terrain is flat with gently undulating topography. The geomorphologic units in the area include sand ridges, lagoons, swamp flats and creeks. Numerous rivers flowing southwards to the Atlantic Ocean drain the basin. These rivers include the Owena, Oluwa, Oni, Ogbese, Ose, Ominla, Akeun and Ufara (**Fig. 5.1.2**). The major rivers flow through the sedimentary rocks in deeply incised valleys aligned in a north-south direction, into the coastal lagoons. The mean monthly temperature is 27˚C, with a mean monthly range of 2˚C. The mean annual total rainfall exceeds 2000 millimeters (Iloeje, 1981).

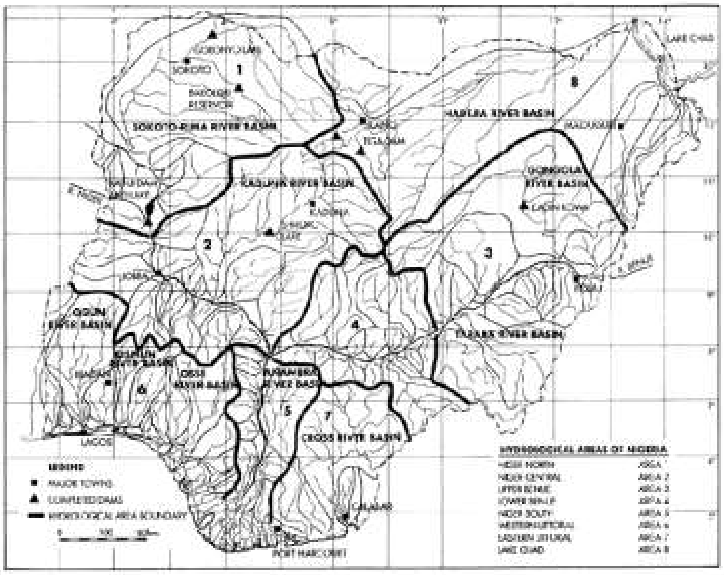


Figure 5.1.2: Hydrological map of Nigeria showing the major inland waters (http://www.fao.org/3/T1230E/T1230E02.htm).

The hydrological information, flow, water levels, velocities etc were obtained from the Nigeria Hydrological Services Agency (NIHSA): http://nihsa.gov.ng/

i. Flows: change of flow channel, cutting off channels and forming new channels.

ii. Water levels and discharge.

iii. Flow velocities. Information about the following parameters were obtained:

- ✓ Variability of flow velocity within (selected) cross-sections;
- ✓ Distribution of low flows between the braiding channels;
- ✓ Mean annual flow;
- ✓ Mean (annual) low flow;
- ✓ Mean (annual) high flow.

In the proposed Deep-Sea Port area, the coast has a relatively high and consistent intensity of wave action due to the low mean tidal range. Large swell waves are common in the area, which are generated by the prevailing south-westerly winds and the flooding driven by high tides. This low-lying mud coastline has an elevation varying between 0.5 to 2 m above mean sea level and persistent significant wave height (hs) of the order of 1.4 m – 2.5 m with the prevalence of longshore currents at the near shore zone. The continental shelf in the study area is narrow, relatively gently sloping with bathymetric lines running generally in parallel to the coastlines (**Fig. 5.1.3**). Evolution of the present-day physiography of the study sites are attributed to the separation of South America from the African plate, especially from the Upper Jurassic to the Lower Cretaceous.

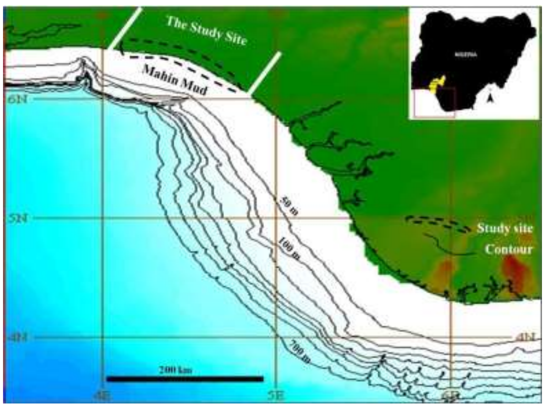


Figure 5.1.3: Nigeria's Atlantic Gulf of Benin showing Ondo State coastline
(***Sources:*** *The Port of Ondo Report*)

Major geological formations include general alluvium, lagoonal marshes, abandoned beach ridges and coastal plains sand. The exposures on the general alluvium reveal coarse, clayey, unsorted sands with clay lenses and occasional pebble beds which are lithologically indistinguishable from typical coastal plains sand strata (Jones and Hockey, 1964). These Formations produce generally swampy soils on the nearly level coastal plains sand on alluvium, and very deep, well-drained soil, with very dark brown to dark brown surface sands from the nearly level coastal plains on coastal plain sand. Elevation rises from about 1 m along the coastline to between 35 and 55 m in the upland (Iyun and Oke, 2000). Although the firm upland area in the north is dissected by some seasonal rivers of the western littorals, surface drainage is sparse around the coast (**Fig. 5.1.4**).

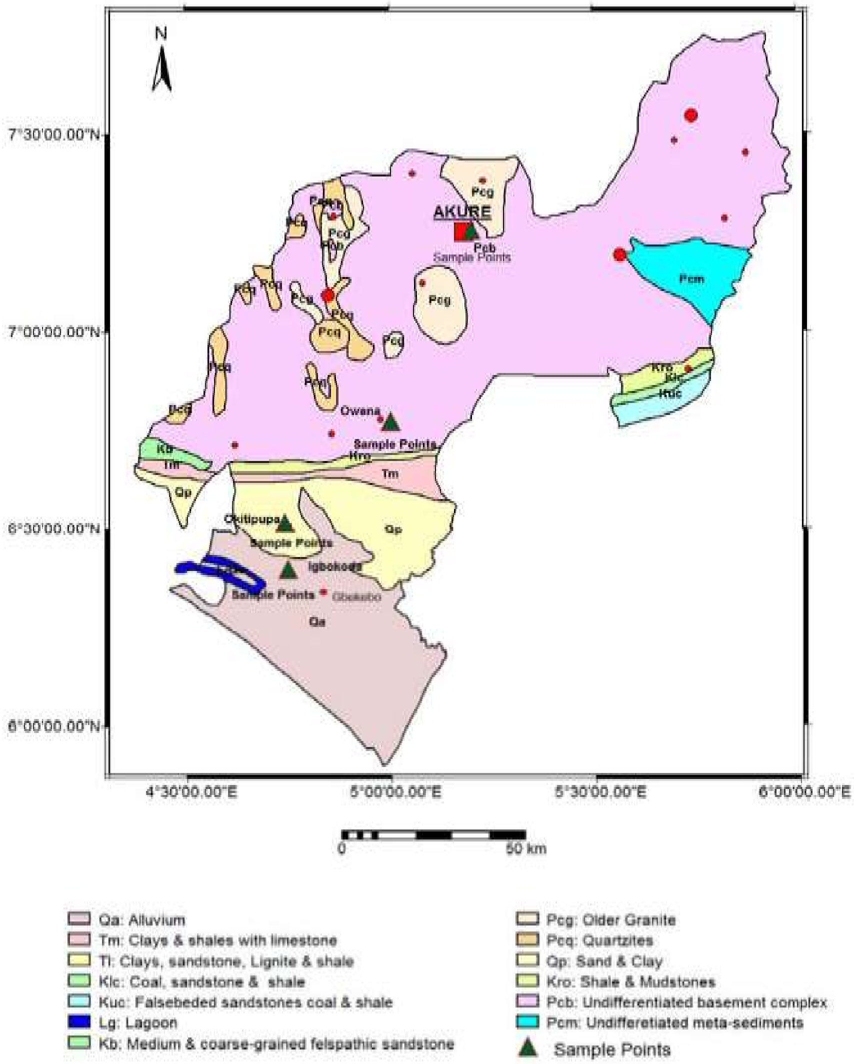


Figure 5.1.4: Geological map of the study area (After Akure sheet 62)

Borehole logs and ditch cutting data of the studied boreholes obtained from NIHSA and NGSA are presented in **Figures 5.1.5a to 5.1.5e**. Generally, the NGAM log and ditch cutting samples revealed that the subsurface lithology of the study area in all the boreholes consists of alternating layers of sand, clay, clayey sand, and sandy clay. The thickness of the various units varies across the area, and the major water-bearing sand-(aquifer) units mostly consist of thin lenses of interlayered impermeable clays (aquiclude or aquitard). In our interpretations, thick sand units that are separated by thin clay/clayey sand/sandy clay layers are merged and considered as a single uniform and continuous sand unit. In addition, in few of the boreholes, where thick continuous sand layer is rare, clayey sands and/or sandy clay constitute the major water-bearing units.

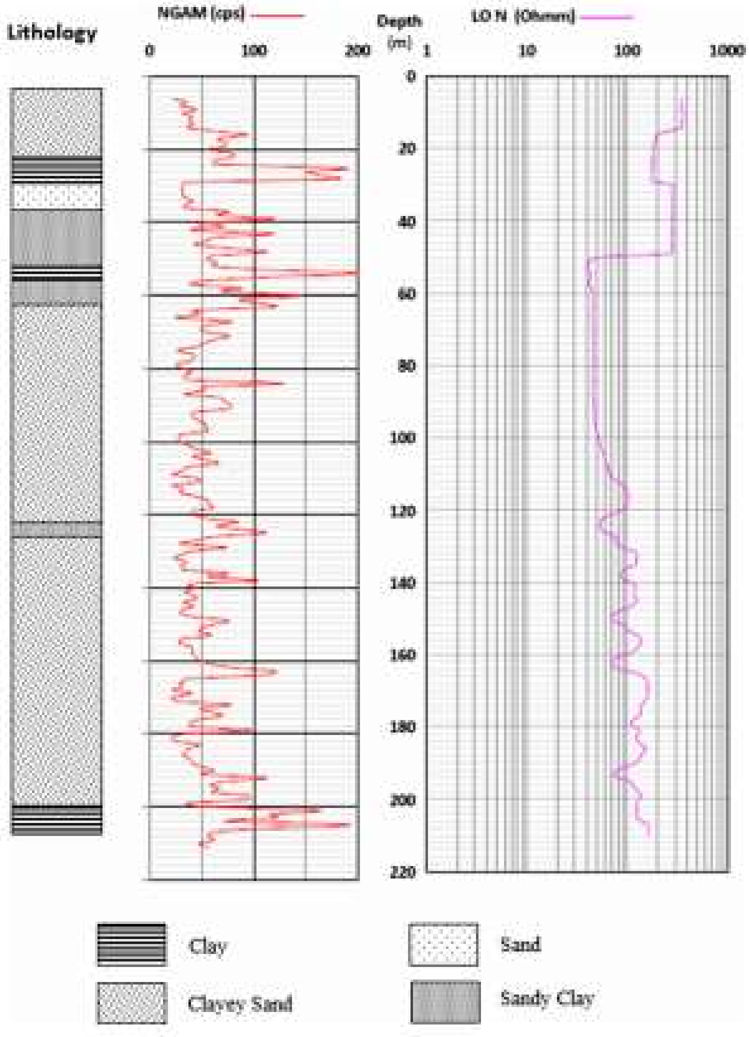


Figure 5.1.5a: Borehole Log from the Coastal Area of Ondo State (Sources: The Port of Ondo Report)

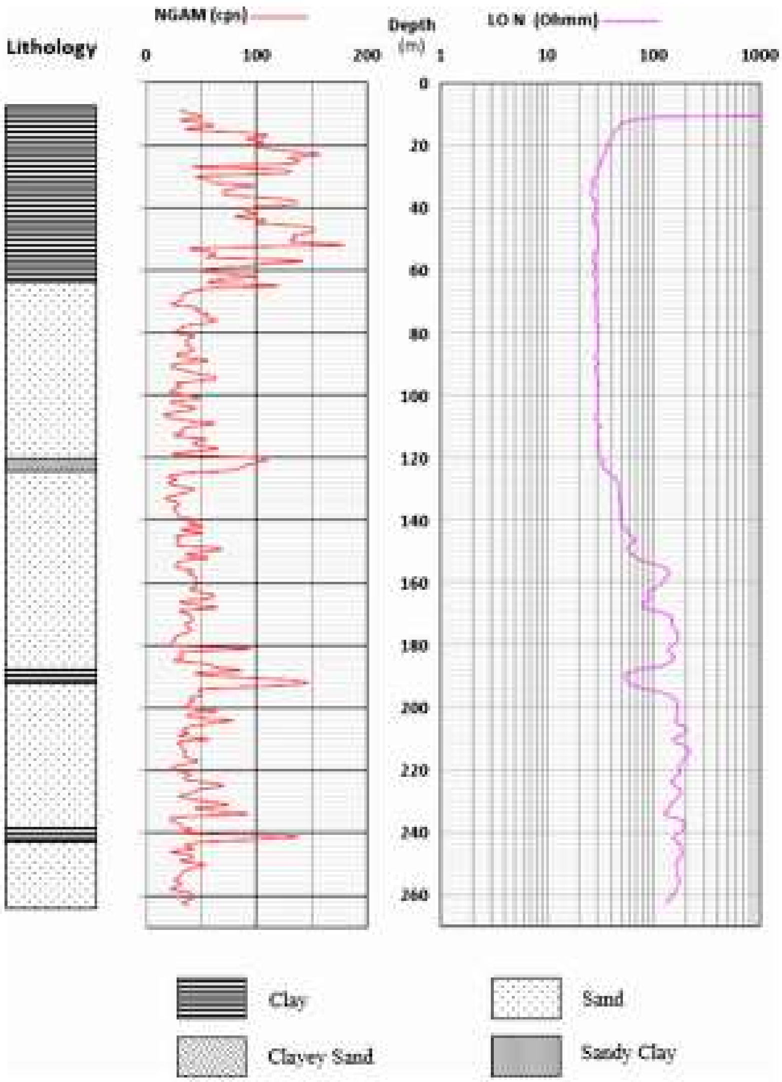


Figure 5.1.5b: Borehole Log from the Coastal Area of Ondo State (*Sources: The Port of Ondo Report*)

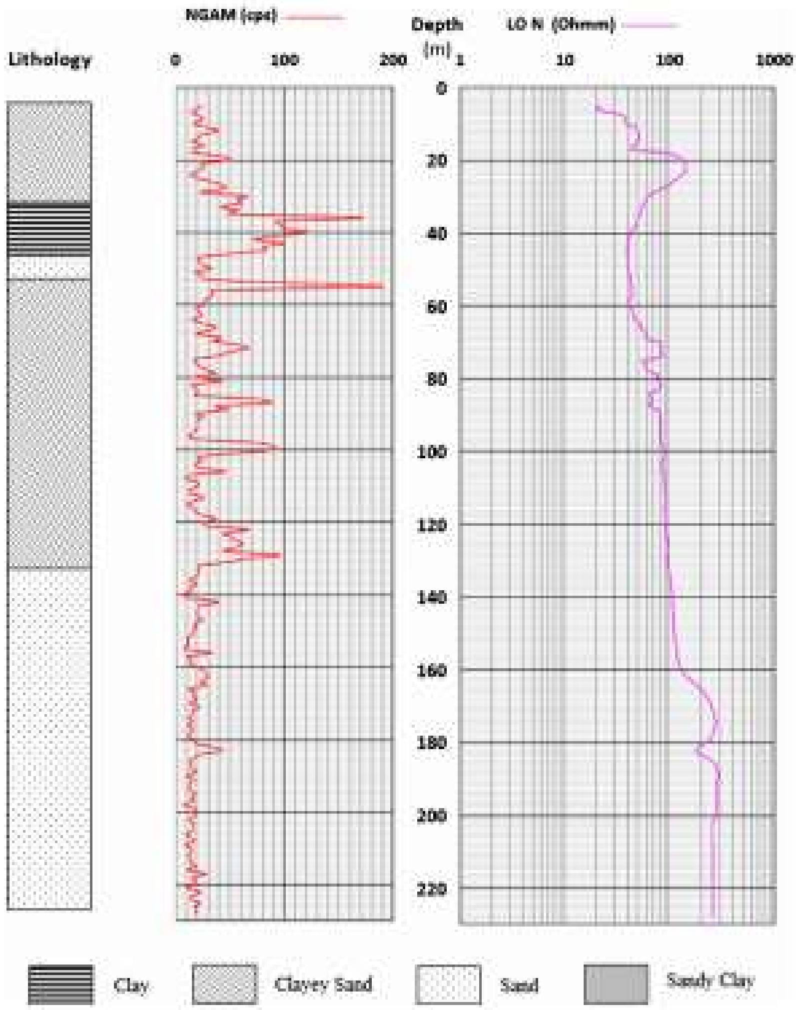


Figure 5.1.5c: Borehole Log from the Coastal Area of Ondo State (Sources: The Port of Ondo Report)

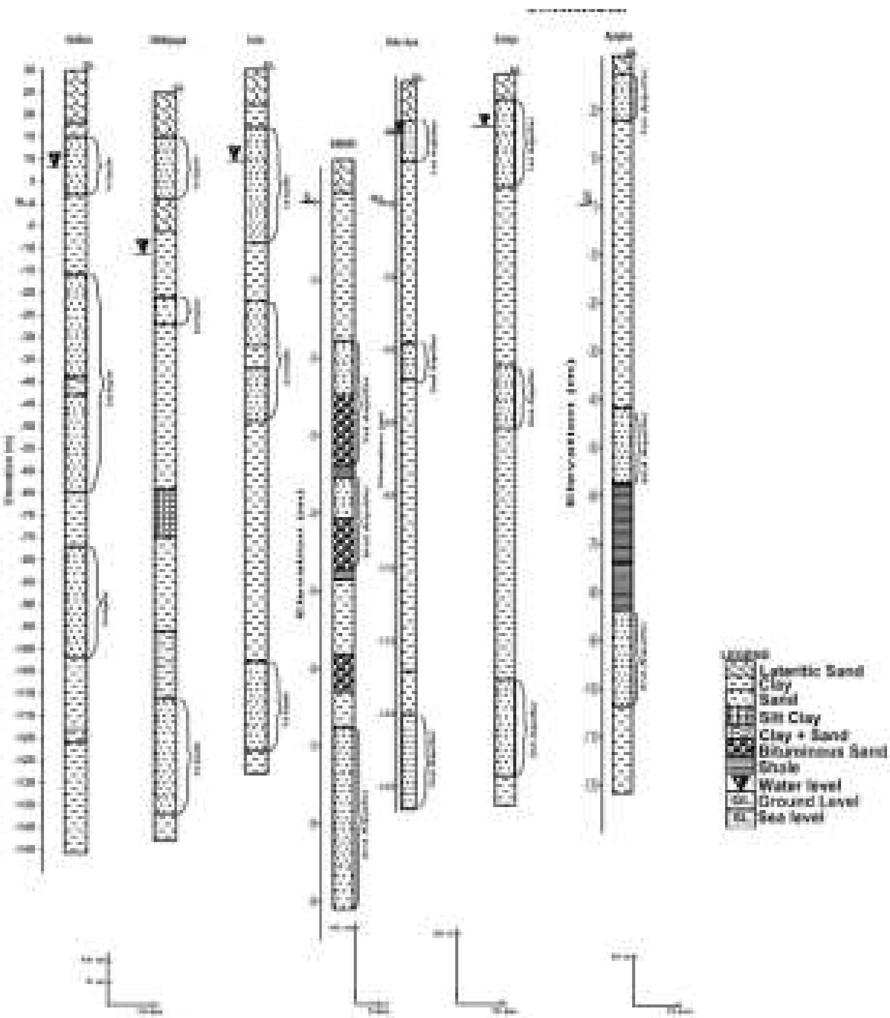


Figure 5.1.5d: Borehole Log from the Coastal Area of Ondo State Covering Ilutitun, Okitipupa, Irele, Agbabu, Ode-A ye, Erinje and Ajagba
(Sources: The Port of Ondo Report)

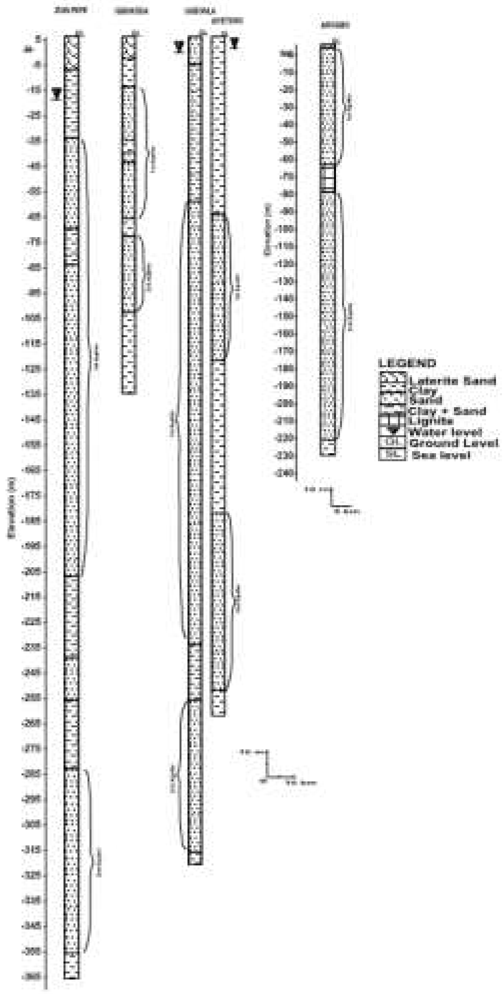


Figure 5.1.5e: Borehole Log from Ugbonla, Ondo State (Sources: The Port of Ondo Report)

5.3 Coastal Morphology and Sediment Processes

5.3.1 Coastal geology

The Nigerian continental shelf is located on a relatively localized protrusion into the Gulf of Guinea basin and is underlain by Tertiary sediments that thicken seaward to a maximum of about 12,000 m. According to *Allen (1965)*, the Tertiary sediments are overlain by two series of Quaternary sediments. The older series comprises sheet-like sand bodies which can be traced over most of the continental shelf, deposited during late Pleistocene to early Holocene sea-level rise (transgression of the sea). The surface of the sand sheet is formed into terraces and ridges parallel to the shore and crossed locally by shallow valleys. The ridges have been interpreted as drowned barrier beaches and island complexes.

The younger series locally buries the older sands across the continental shelf. They comprise sands near shore, silts in moderate depths and clays in deep water, and have been deposited during the seaward growth of the modern Niger Delta. River mouth bars and inshore terraces are the principal morphological features of the modern continental shelf underlain by the younger series. *Allen and Wells (1962) and Awosika (1990)* described a system of relict Holocene coral banks in some parts of the middle and outer continental shelf. The coral banks are aligned parallel to the coastline in 80 - 100 meters of water and attain heights of about 7 m in some places, especially along the western shelf.

5.3.2 Coastal bathymetry

The Nigerian continental shelf is narrow in the west and ranges in width from 28 - 33 km (**Fig. 5.1.6**). The width increases to 63 km off Cape Formoso at the nose of the Niger Delta, increasing eastwards to about 75 km off the coast of Calabar.

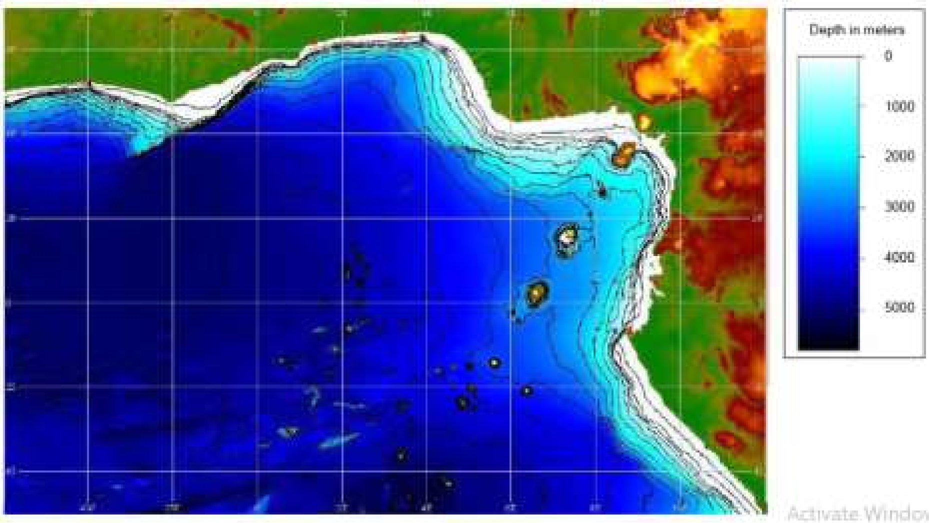


Figure 5.1.6: Nigerian Continental shelf (Sources: The Port of Ondo Report)

Three major submarine canyons; Avon, Mahin and Calabar deeply groove the Nigerian continental shelf and slope. The Avon Canyon (approx. 06°10'N, 03°55'E) is about 15 km wide and 730 m deep with its head at about 3 - 5 km off the Lagos coast in water depths less than 18 m. The Mahin Canyon is located off the Mahin Mud Coast. It is smaller than Avon Canyon and begins further from the coast in 55 m of water. This canyon is approximately 1.6 km wide and 180 - 900 m deep. The Calabar Canyon is located eastwards off the coast of Calabar. This canyon cuts the shelf for a length of about 8 km; the width is about 3 km and the depth vary from 180 - 450 m.

These canyons serve as conduits for channeling sand into offshore submarine fans located on the continental slope. The overall nature of the Nigerian continental shelf is mainly depositional as compared to adjacent parts of the continental shelf along the Gulf of Guinea where rocks appear close to the coast.

5.3.2.1 Marine Gravity signatures of the Mahin Canyon in the Ondo State Deep-Sea Port

- **Satellite Gravity**

For the identification of the Mahin Canyon in the Ondo State Deep-Sea Port area, three different techniques were employed for the investigation: Satellite Gravity, Spectral analysis and Quasi-3D modeling. Ten profiles were selected from the coast to 10 km into the offshore areas of Ondo State. One hundred satellite-gravity data were processed by applying latitude, free-air and Bouguer corrections. The resulting Bouguer gravity anomaly were modelled using quasi-3D gravity models constrained by ***a priori*** information derived from available well-log data. Forward modelling approach was adopted in calculating the gravity anomalies over a model of assumed mass distribution. The models that represent the geology of the basin were obtained when satisfactory approximation between the calculated and observed gravity fields for the basin was achieved.

Furthermore, spectral analyses method was applied to the Bouguer anomaly. The anomaly depth was obtained by computing least-squares fit to the lowest frequency segment for the azimuthally averaged log power spectrum.

- **Spectral Analysis**

Spectral Analysis has been widely used by several authors (Spector and Grant, 1970, Gerard and Debeglia, 1975; Bhattacharyya, 1978) for estimation of depths. Energy spectral analysis provides techniques for quantitative studies of large and complex aero-magnetic or gravity data sets. The logarithm of the radial average of the energy spectrum (the square of the Fourier amplitude spectrum) is plotted against the radial frequency. The slopes of the linear segments of the spectrum correspond to separate depth ensembles and provide parameters used for the design of numerous filters. The slope of each segment provides information about the depth to the top of an ensemble of magnetic or gravity bodies (Kivior and Boyd, 1998)

Methods for estimating the depth extent of gravity sources are classified into two categories; those that examine the shape of isolated gravity anomalies (Bhattacharyya and Leu, 1975) and those that examine statistical properties of patterns of gravity Anomalies (Spector and Grant, 1970). However, both methods provide the relationship between spectrum of gravity anomalies and the depth of a gravity source by transforming the spatial data into frequency domain. The method adopted in this project is the latter in which the top boundary and the Centroid of a gravity source Z_t and Z_0 , respectively, were calculated from the power spectrum of gravity anomalies and are used to estimate the basal depth of a gravity source Z_b Using the relation existing between the parameter, i.e. ($Z_b = 2Z_0 - Z_t$) . The obtained basal depth of the gravity source is assumed to be the Curie Depth Point (CDP). The relationship used is given as:

$$\text{In} = \left[\frac{p(S)^{1/2}}{|S|}\right] = InA - 2\lambda |S| Z_0 \quad (1)$$

Where P (S) is the radically averaged power spectrum of the anomaly, |S| is the wave number, and A is a constant.

The second step is the estimation of the depth to the top boundary (Z_t) of that distribution from the slope of the second longest wavelength spectral segment (Okubo et al, 1985).

$$\text{In}\left[P(S)^{1/2}\right] = \text{In B} - 2\lambda |S| Z_t \quad (2)$$

Where B is a sum of constant independent of |S|. The basal depth (Z_b) of the gravity source is calculated from equation (3).

$$Z_b = 2 Z_0 - Z_t \quad (3)$$

The approach used above is as follows:

First, the radially averaged power spectra (Equations 1 and 2) were computed for each traverse using the Signproc software of G.R.J. Cooper (2000). Next, the slope of the longest wave length parts yield the Centroid depth, Z_0, of the deepest layer of gravity sources, while the slope of the second longest wave length spectral segment yielded the depth to the top, Z_t of that layer. Using equation (3), the curie depth estimate was derived.

- **Quasi-3D Modelling**

The Quasi-3D modelling program of Chouteau and Bouchard (1993) was used to carry out the models of the subsurface. The program is based on several algorithms (Talwani et al, 1959; Talwani and Heirtzler, 1964; Broom, 1986). It has constraints concerning the depth of investigation, the strike of the model and the density contrast between the anomaly which is responsible for the observed anomaly and the basement.

- **Residual Bouguer Gravity Result**

Qualitative interpretation of the residual gravity map was carried out using visual inspection of patterns, trends and features of interest. Plate 10 shows the Residual Bouguer gravity map of the study area while **Plate 11** shows the location of traverses 1 – 10 on the Residual Bouguer gravity map. The residual map has a contour interval of -5 mgals.

Plates 10 and 11 shows oblate shaped gravity anomalies. It has dominant trends of N-S, NNE-SSW, NNW-SSE and E-W. These trends are consistent with trends that were observed in the study area by Ako et al., (2004).

The gravity intensity in the area ranges from -20 mgals (Red) to -100 mgals (Violet). The minimum intensity value of -100 mgals is observed in the central region. Thus, the gravity relief of 120 mgals in the area is attributed to the differences in the densities of the underlying materials.

The area is also characterised by alternation of gravity highs and lows going from west to east. This can be interpreted as juxtaposition of materials of high- and low-density values i.e. alternation of sediment-filled submarine canyons and mobile shale (shale diapirs) respectively.

The portion of the map with the lowest gravity value (in Violet) is rimmed by the -100 mgals contour, this occurs twice on the map; at the central portion and towards the eastern portion while the portion with the highest gravity value (in Red) is rimmed by the -20 mgals contour. A major gravity high trending approximately NNE-SSW (with a ridge-like physiographic feature) separates the two major gravity lows (of -100 mgals and below) discussed above which occurs in the area.

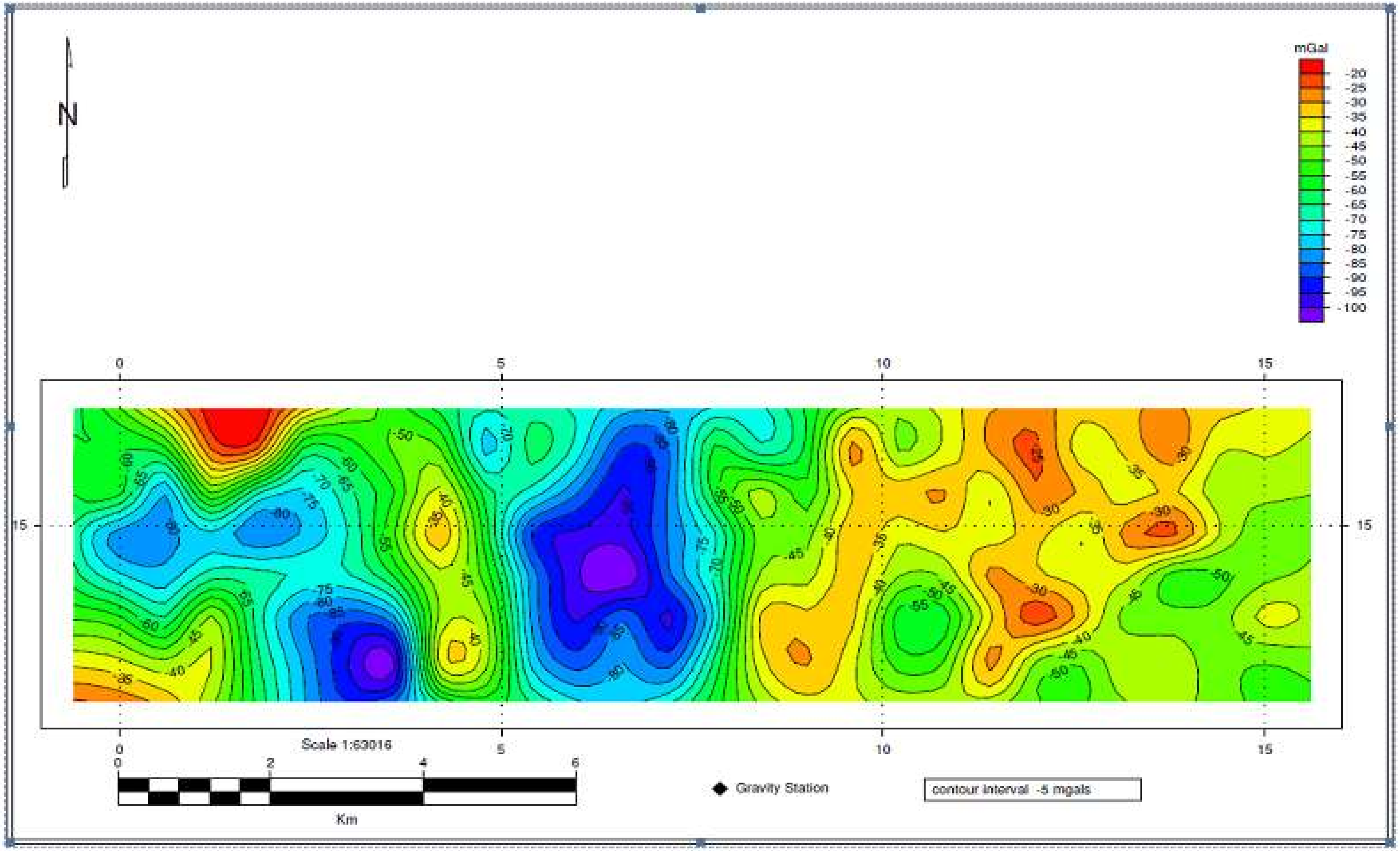


Plate 10: Residual Bouguer Anomaly Map of the Ondo State Deep-Sea Port Area

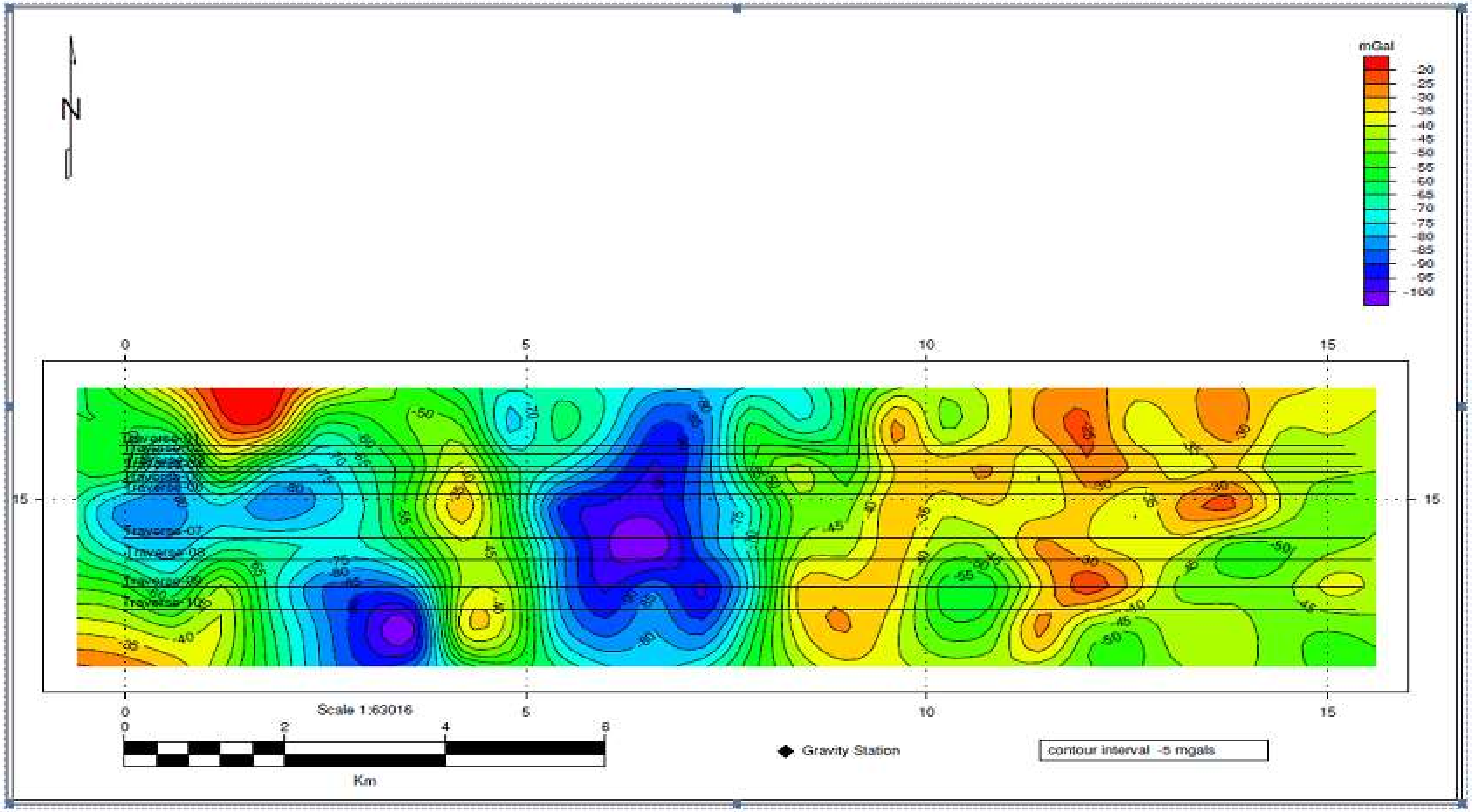


Plate 11: Residual Bouguer Anomaly Map of the Ondo State Deep-Sea Port Area with the Overlay of Traverses 1 – 10 used for the Quasi-3D modelling

This gravity high is rimmed by the -35 mgals contour at its peak. The somewhat circular/oblate gravity lows of the bouguer map are therefore interpreted as sediment-filled submarine canyons which has a lower density than the surrounding shale diapirs.

At the centre of the map is a major gravity low with a minimum amplitude of -100 mgals that trends approximately N-S. **The width of the anomaly ranges from 1.8 to 2.0 km** and it is bounded by high gradient zones. This anomaly may be interpreted as a major sub-basin in the area.

- **Spectral analysis Result**

The plots of the averaged power spectra for traverses 1-10 using the approach earlier described in this chapter are shown in **Plates 12** respectively. All the traverses trend in an East-West direction. It is generally observed that, each plot is dominated by two straight line segments. The first segment is the low wave number (< 10 Radian/km) except for traverse 5 which has a wave number that is less than 30 Radian/km. The calculated depths for the low wave number segment vary from 0.86 to 2.63 Radian/km. The second line segment represent the high wave number having a distinct intercept with the wave number axis and a value ranging from 5.0 to 50.5 Radian/km with exception of traverses 6, 9 and 10 which vary from 5.0 – 60.4 Radian/km, 5.0 – 48.0 Radian/km and 2.5 – 48.0 Radian/km respectively.

The two-line segments determined from averaged Power Spectrum in reverse order gives; first, the 0 - 10 km depth range which correlate with short wavelength gravity anomaly having their sources in the uppermost part of the basin. The 10 - 70 km depth range which corresponds to long wavelength gravity anomaly and/or the base of the uppermost part of the basin in this region.

The calculated depth estimates for each traverse are shown in **Table 5:4**. The top boundary of the gravity sources was found to be at about 0.42, 0.25, 0.25, 0.25, 0.36, 0.22, 0.33, 0.30, 0.29, 0.33 km below sea level (B.S.L) for traverses 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 respectively (**Table 5:4**).

On the other hand, the Centroid of the gravity sources varies from 0.86 to 2.63 km (B.S.L) and equivalent Curie depth point ranges from 1.36 to 4.93 km (B.S.L). The obtained Curie depth points reflect the average local CDP value beneath each of traverses 1 – 10 respectively.

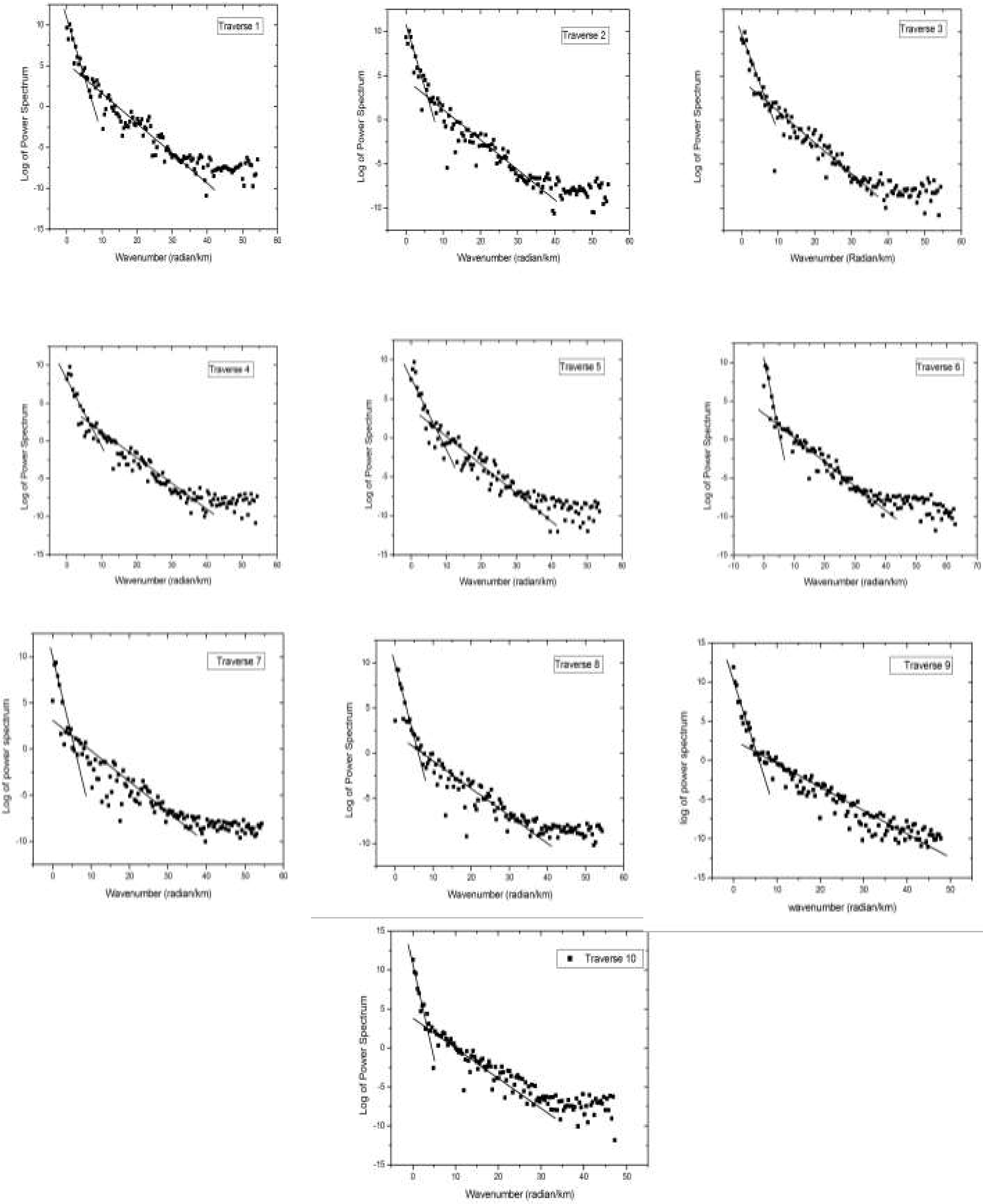


Plate 12: The Derived Energy Spectra of Traverses 1 to 10

Table 5.4: Calculated Depth estimates for Traverses 1 – 10 using Spectral Analysis

Traverse	Centroid Depth Z_o (Km)	Depth to Top Z_t (Km)	Curie Depth Z_b (Km)
1	1.25	0.42	2.08
2	1.30	0.35	2.25
3	1.08	0.25	1.91
4	0.90	0.25	1.55
5	0.86	0.36	1.36
6	1.90	0.22	3.58
7	2.00	0.33	3.67
8	2.50	0.30	4.70
9	1.67	0.29	3.05
10	2.63	0.33	4.93

- **Model Interpretation of Subsurface Geology Beneath Traverse 1**

Plate 13 depict the model of the subsurface image beneath Traverse 1. It is about 15.263 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of eight (8) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons have a depth range of 0.8 - 2.6 km and a width range of 0.6 - 2.0 km. A major Submarine Canyon occurs at the central portion (distance 6.0 – 8.0 km) of this subsurface image. Its depth of occurrence is 2.6 km and its width is 2 km. It corresponds to the major gravity low with a minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (**Plate 11**).

Towards the Eastern portion of this model (distance 1.5 – 3.0 km), there is another major Submarine Canyon with approximately same depth as the canyon earlier mentioned which occur at distance 6.0 – 8.0 km but this canyon is very narrow about 0.5 km at the middle and broadens out at the base (to about 1.5 km).

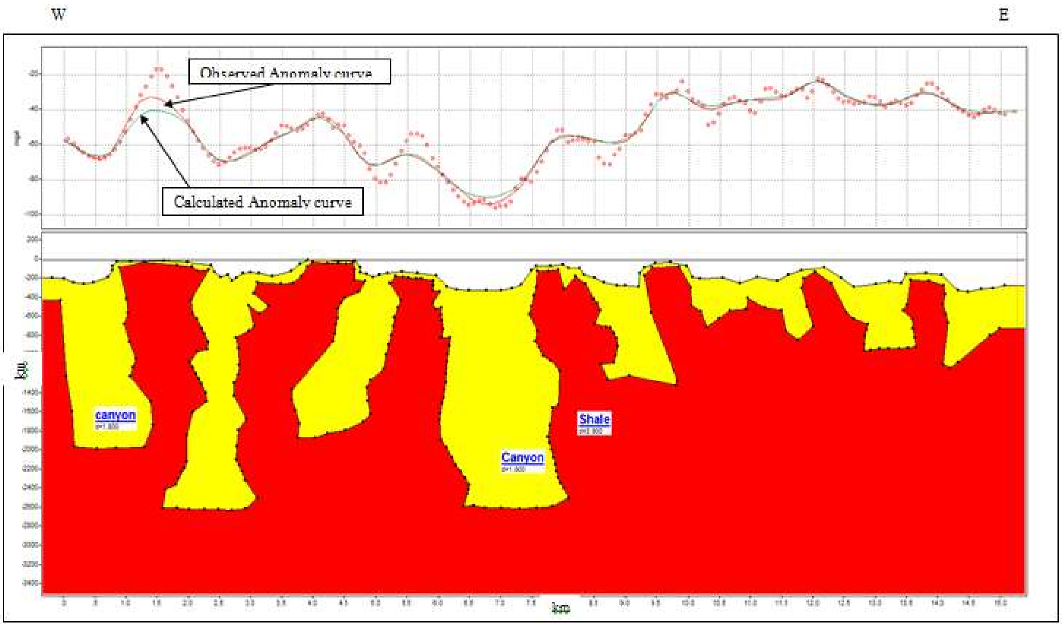


Plate 13: Model of Subsurface Geology Beneath Traverse 1

- **Model Interpretation of Subsurface Geology Beneath Traverse 2**

Plate 14 displays the model of the subsurface image beneath Traverse 2. It is about 15.367 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of nine (9) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 0.8 - 2.6 km and a width range of 0.7 – 2.3 km. A major Submarine Canyon occurs at the central portion (distance 5.5 – 8.0 km) of this subsurface image. Its depth of occurrence is 2.6 km and its width is 2.3 km. It corresponds to the major gravity low with a minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (**Plate 11**). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion. Towards the Eastern portion of this model (distance

1.8 – 3.5 km), there is another major Submarine Canyon with a depth of 1.7 km and a width of 1.6 km.

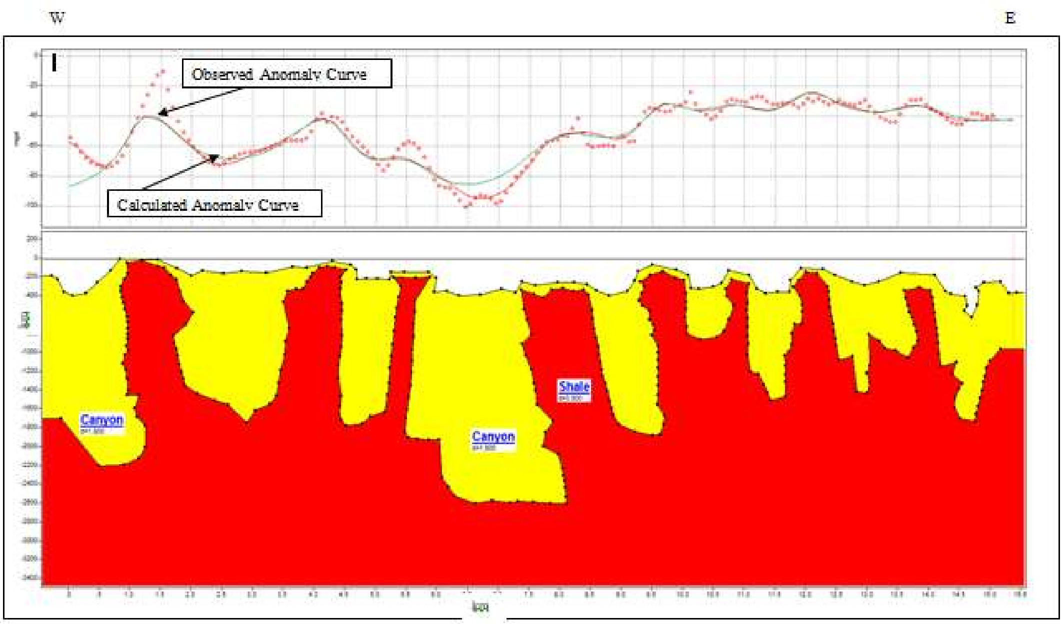


Plate 14: Model of Subsurface Geology Beneath Traverse 2

- **Model Interpretation of Subsurface Geology Beneath Traverse 3**

Plate 15 shows the model of the subsurface image beneath Traverse 3. It is about 15.427 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of seven (7) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 1.3 - 2.7 km and a width range of 0.7 – 2.9 km. A major Submarine Canyon occurs at the central portion (distance 4.6 – 7.7 km) of this subsurface image. Its depth of occurrence is 2.7 km and its width is 2.9 km. It corresponds to the major gravity low with a minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map

(Plate 11)). From a distance of 5.0 – 6.0 km, it is intruded by a shale diapir which overhangs within it and imposes some restriction on obtaining a perfect exact fit between the calculated (green) and Observed (red) anomaly curves (Plate 15). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion.

Towards the Eastern portion of this model (distance 1.7 – 3.1 km), there is another major Submarine Canyon with a depth of 1.1 km and a width of 1.4 km.

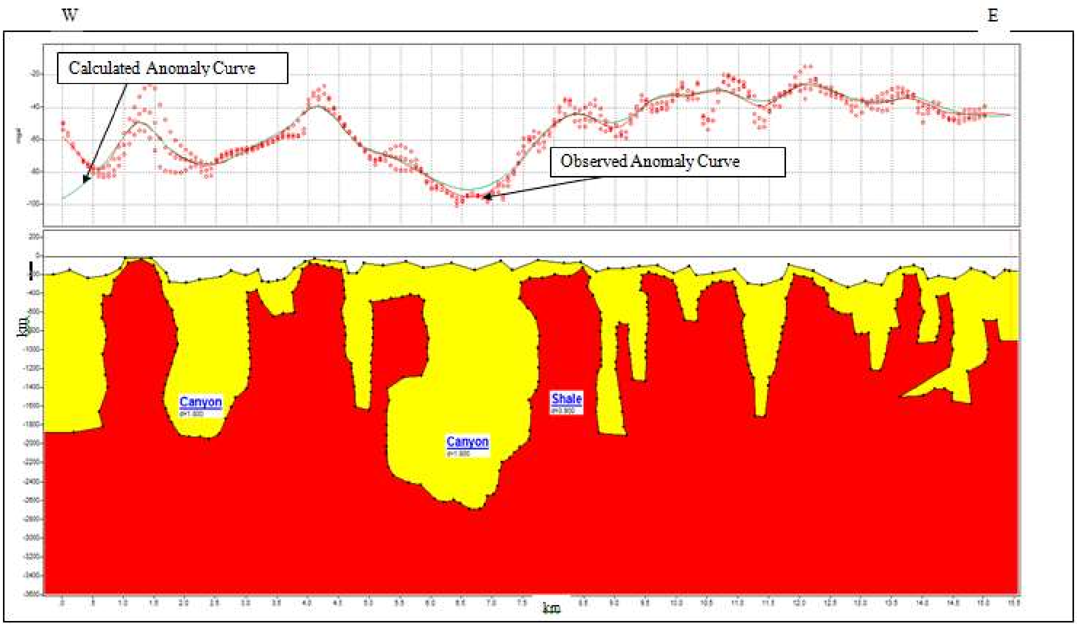


Plate 15: Model of Subsurface Geology Beneath Traverse 3

Model Interpretation of Subsurface Geology Beneath Traverse 4

Plate 16 is the model of the subsurface image beneath Traverse 4. It is about 15.278 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of seven (7) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 0.8 - 2.1 km and a width range of 0.6 – 3.1 km. A major Submarine Canyon occurs at the central portion (distance 4.6 – 7.7 km) of this subsurface image. Its depth of occurrence is 2.1 km and its width is 3.1 km. It corresponds to the major gravity low with a minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (Plate 11). From a distance of 5.0 – 5.8 km, it is intruded by a shale diapir which overhangs within it and imposes some restriction on obtaining a perfect exact fit between the calculated (green) and Observed (red) anomaly curves (**Plate 16**). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion.

Towards the Eastern portion of this model (distance 1.5 – 3.5 km), there is another major Submarine Canyon with a depth of 2.1 km and a width of 2.0 km approximately. Though this Canyon has the same depth with the central Canyon its width and sediment thickness are considerably lesser than that of the central Canyon.

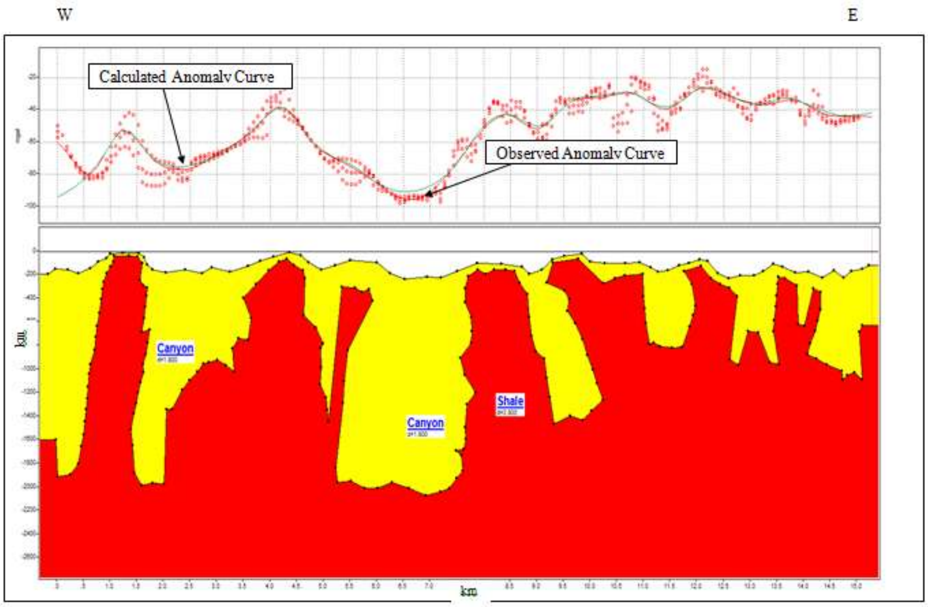


Plate 16: Model of Subsurface Geology Beneath Traverse 4

- **Model Interpretation of Subsurface Geology for Traverse 5**

Plate 17 is the model of the subsurface image beneath Traverse 5. It is about 15.338 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of eight (8) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 0.9 - 2.0 km and a width range of 0.6 – 3.0 km. A major Submarine Canyon occurs at the central portion (distance 4.7 – 7.7 km) of this subsurface image. Its depth of occurrence is 2.6 km and its width is 3.0 km. It corresponds to the major gravity low with a minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (Plate 11). From a distance of 5.3 – 5.7 km, it is intruded by a shale diapir which is almost vertical and dips at a very steep angle and imposes some restriction on obtaining a perfect exact fit between the calculated (green) and Observed (red) anomaly curves (**Plate 17**). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion. Towards the Eastern portion of this model (distance 1.5 – 3.7 km), there is another major Submarine Canyon with a depth of 2.0 km and a width of 2.2 km approximately. Its width and depth are smaller than that of the Canyon at the central portion of the subsurface geology for **traverse 5**.

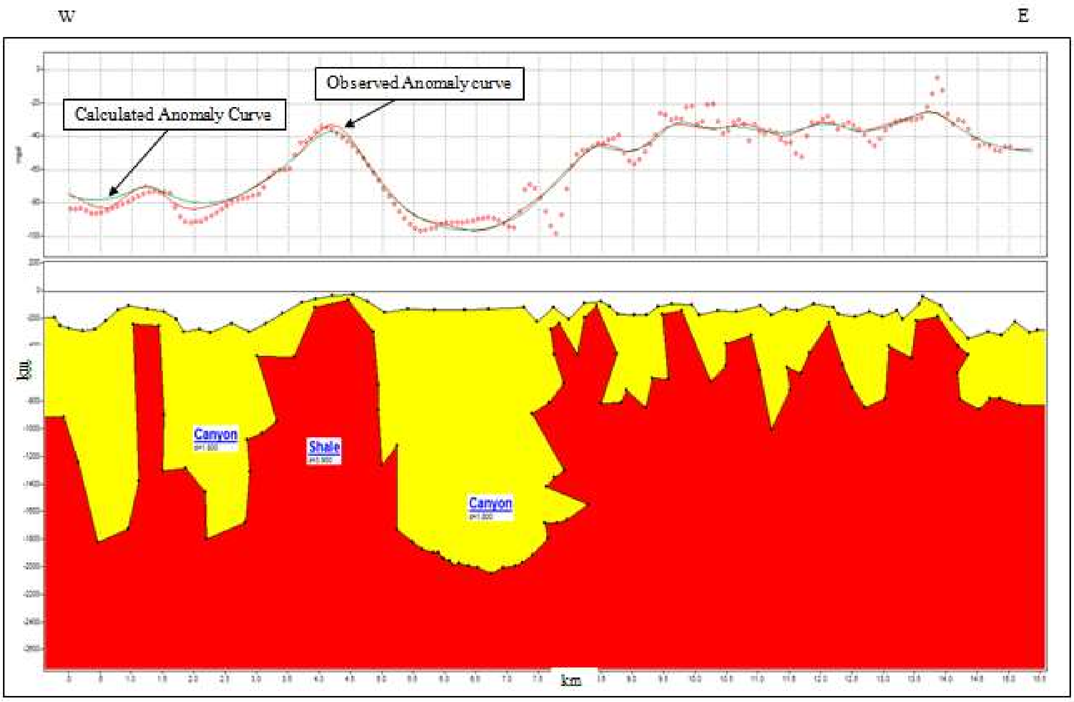


Plate 17: Model of Subsurface Geology Beneath Traverse 5

- **Model Interpretation of Subsurface Geology for Traverse 6**

Plate 18 displays the derived model of the subsurface image beneath Traverse 6. It is about 15.367 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of seven (7) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 0.9 - 2.1 km and a width range of 1.0 – 2.7 km. A major Submarine Canyon occurs at the central portion (distance 5.0 – 7.7 km) of this subsurface image. Its depth of occurrence is 2.1 km and its width is 2.7 km. It corresponds to the major gravity low with a minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (Plate 11). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion. Towards the Eastern portion of this model (distance 1.5 – 3.8 km), there is another major Submarine Canyon with a depth of 1.8 km and a width of 2.3 km approximately. Its width and depth are smaller than that of the Canyon at the central portion of the subsurface geology for **traverse 6**.

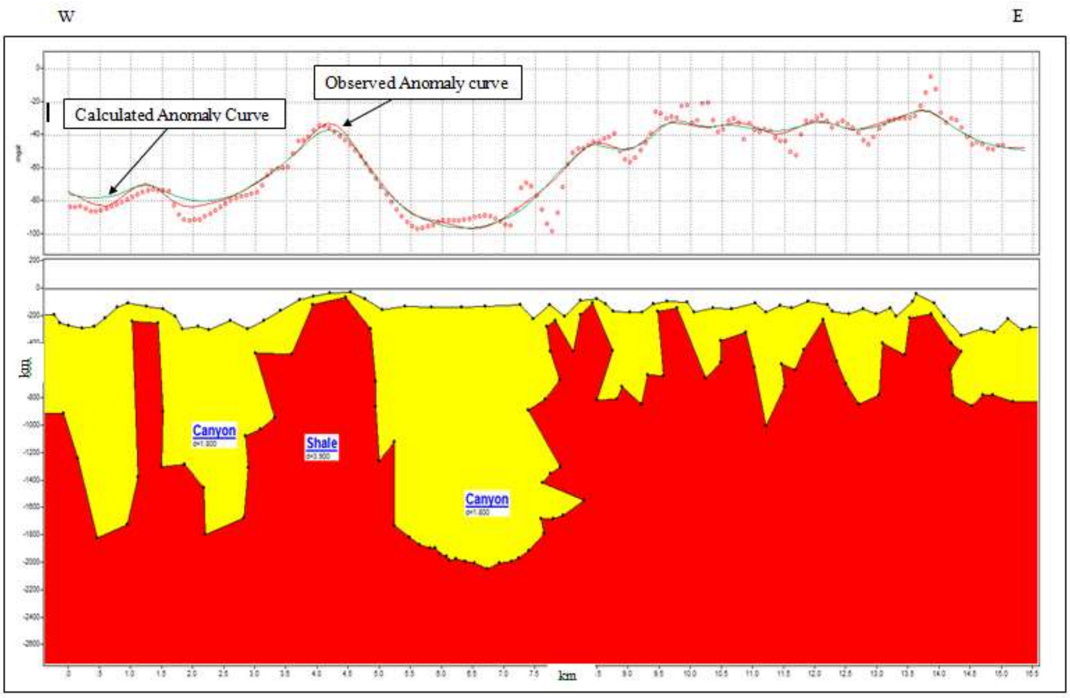


Plate 18: Model of Subsurface Geology Beneath Traverse 6

- **Model Interpretation of Subsurface Geology for Traverse 7**

Plate 19 shows the derived model of the subsurface image beneath Traverse 7. It is about 15.472 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of seven (7) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 1.3 - 2.4 km and a width range of 1.3 – 4.1 km. A major Submarine Canyon occurs at the central portion (distance 4.3 – 8.4 km) of this subsurface image. Its depth of occurrence is 2.4 km and its width is 4.1 km. It corresponds to the major gravity low with minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual

Bouguer gravity map along traverse 7 (Plate 11). It is the core of the anomalous zone. Its deepest portion occurs from a distance of 6.0 – 6.7 km, it is not intruded by any shale diapir though a perfect exact fit between the calculated (green) and Observed (red) anomaly curves (**Plate 19**) was not obtained probably due to the steeply dipping attitude of the adjacent diapirs. The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion. Towards the Eastern portion of this model (distance 1.5 – 3.8 km), there is another major Submarine Canyon with a depth of 1.8 km and a width of 2.3 km approximately. Its width and depth are smaller than that of the Canyon at the central portion of the subsurface geology for **traverse 7**.

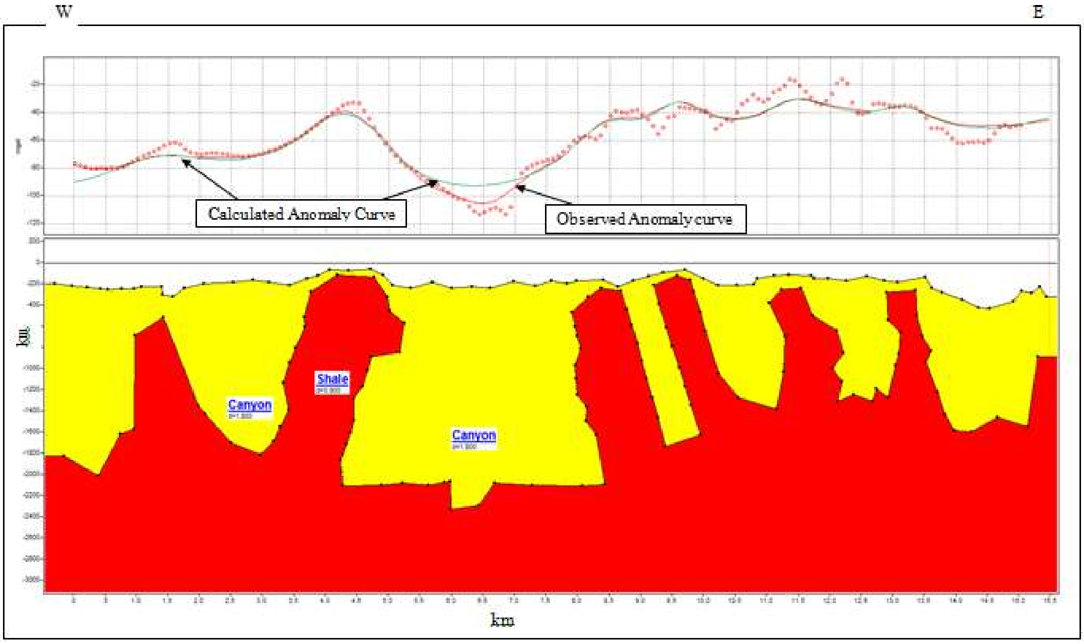


Plate 19: Model of Subsurface Geology Beneath Traverse 7

- **Model Interpretation of Subsurface Geology for Traverse 8**

Plate 20 is the derived model of the subsurface image beneath Traverse 8. It is about 15.561km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of six (6) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 0.5 - 2.1km and a width range of 0.9 – 2.7km. A major Submarine Canyon occurs at the central portion (distance 5.0 – 7.7 km) of this subsurface image. Its depth of occurrence is 2.1 km and its width is 2.7km. It corresponds to the major gravity low with minimum amplitude of -100mgals which trends approximately N-S as shown on the Residual Bouguer gravity map along traverse 8 (Plate 11). It has an almost regular geometry which is U-shaped but it is not intruded by any shale diapir and the adjacent Shale diapirs are not steeply dipping, hence, a good fit between the calculated (green) and Observed (red) anomaly curves (**Plate 20**) was obtained. The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion. Towards the Eastern portion of this model (distance 1.6 – 3.9 km), there is another major Submarine Canyon with a depth of 1.3 km and a width of 2.3 km approximately. Its width and depth are smaller than that of the Canyon at the central portion of the subsurface geology for **traverse 8**.

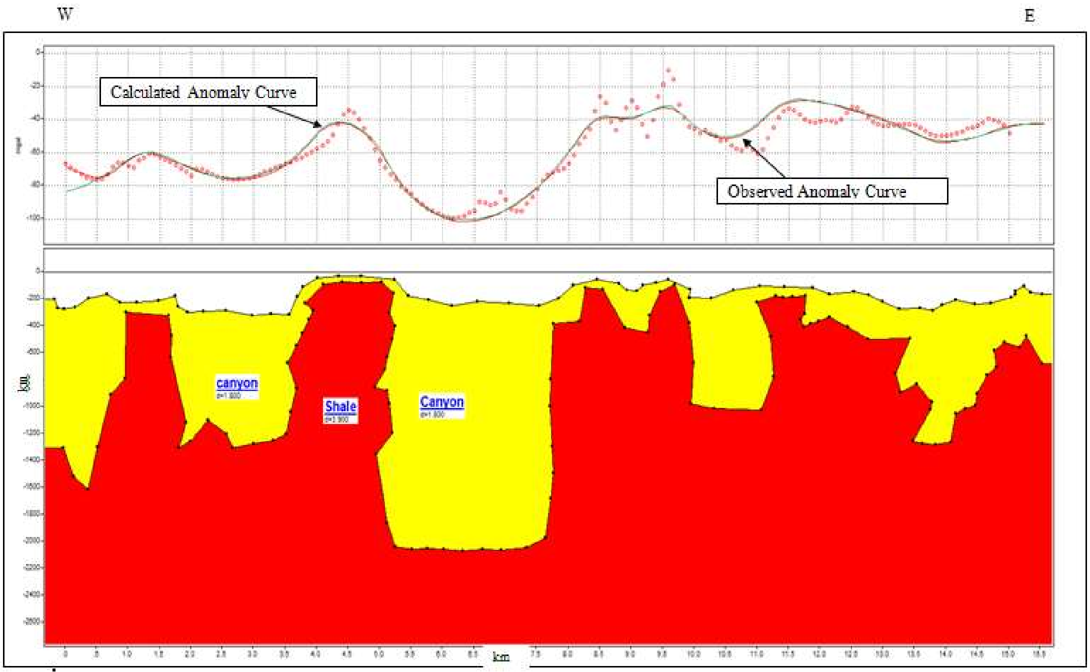


Plate 20: Model of Subsurface Geology Beneath Traverse 8

- **Model Interpretation of Subsurface geology for Traverse 9**

Plate 21 depicts the derived model of the subsurface image beneath Traverse 9. It is about 15.472 km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of five (5) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 1.1 - 2.4 km and a width range of 1.5 – 3.0 km.A major Submarine Canyon occurs at the central portion (distance 5.0 – 8.0 km) of this subsurface image. Its depth of occurrence is 2.4 km and its width is 3.0 km. It corresponds to the major gravity low with minimum amplitude of -

100mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (Plate 11). From a distance of 6.0 – 7.0 km, it is intruded by an irregular shale diapir which imposes some restriction on obtaining a perfect exact fit between the calculated (green) and Observed (red) anomaly curves (**Plate 21**). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion. Towards the Eastern portion of this model (distance 1.5 – 4.2 km), there is another major Submarine Canyon with a depth of 2.0 km and a width of 2.7 km approximately. Its width and depth are very close to that of the Canyon at the central portion of the subsurface geology for **traverse 9**.

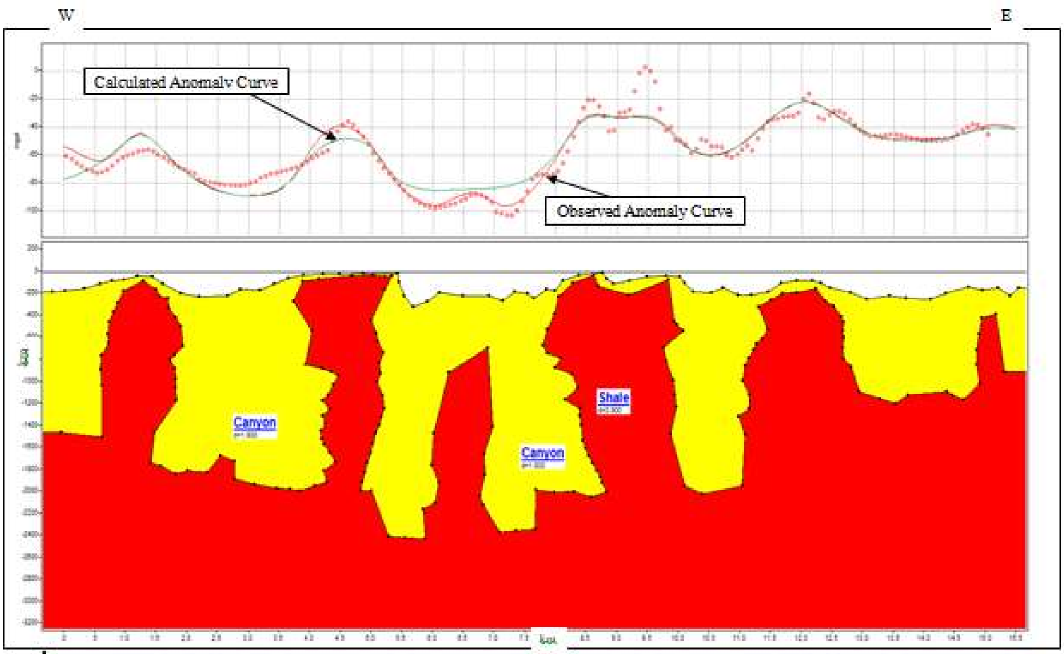


Plate 21: Model of Subsurface Geology Beneath Traverse 9

- **Model Interpretation of Subsurface Geology for Traverse 10**

Plate 22 displays the model of the subsurface image beneath Traverse 10. It is about 15.382km long and consists of two basic morphologies i.e. the sub-basins or sediment-filled submarine canyons juxtaposed by mobile shale structures or shale diapirs that intrude into the sediments. The model consists of five (5) Submarine Canyons juxtaposed by Shale diapirs. The Submarine Canyons occur have a depth range of 1.1 - 2.1km and a width range of 1.5 – 3.0 km. A major Submarine Canyon occurs at the central portion (distance 5.3 – 8.0 km) of this subsurface image. Its depth of occurrence is 2.1 km and its width is 2.7km. It corresponds to the major gravity low with minimum amplitude of -100 mgals which trends approximately N-S as shown on the Residual Bouguer gravity map (Plate 11)). From a distance of 5.0 – 5.8 km, it is intruded by an almost regular shale diapir with nearly straight edges which is covered by a thin layer of sediment directly above it and imposes some restriction on obtaining a perfect exact fit between the calculated (green) and Observed (red) anomaly curves (**Plate 22**). The Canyons towards the Eastern portion of this model are generally wider and deeper than those seen on the western portion.

Towards the Eastern portion of this model (distance 1.6 – 4.0 km), there is another major Submarine Canyon with a depth of 2.1 km and a width of 2.4 km approximately. It has the same depth but its width is very close to that of the Canyon at the central portion of the subsurface geology for traverse 10.

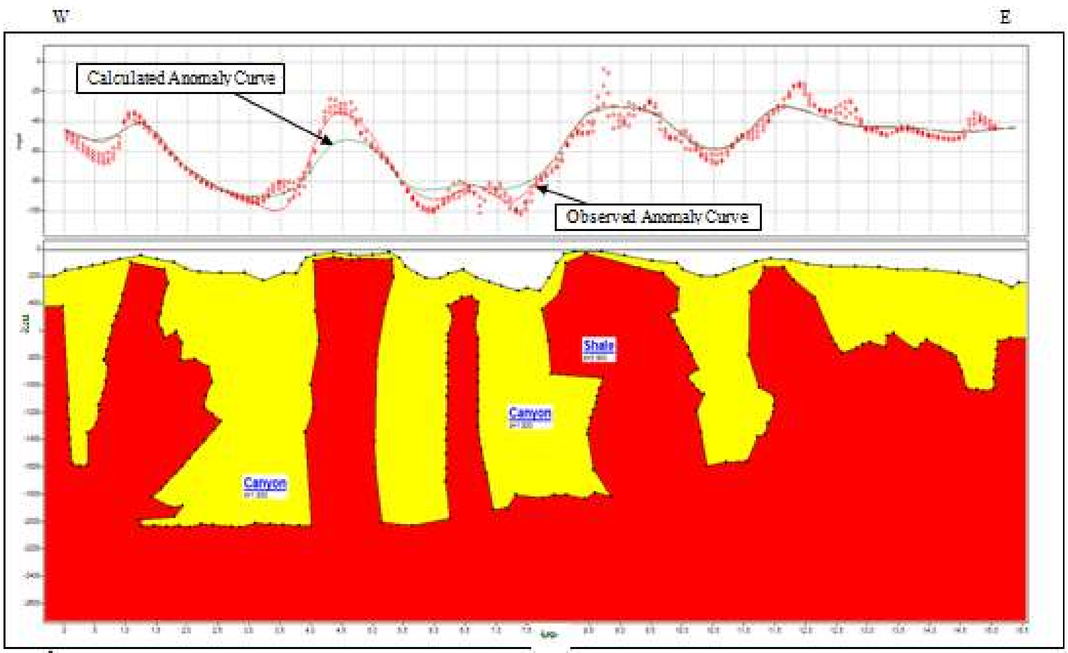


Plate 22: Model of Subsurface Geology Beneath Traverse 10

It is inferred that the canyons that we mapped in the proposed Ondo State Deep-Sea Port area contains stacked erosionally confined channel sands and shales. These canyon systems delineated from these models has a large size**.** The identified Mahin Canyon in the Ondo State Deep-Sea Port is at approximately 15 km (9.3 nautical miles) from the coastline into the Atlantic Ocean. The width of these anomaly ranges from 1.8 to 2.0 km, whilst its depths varies between 2 to 3.3 km.. We adjudge that the canyon would not be obstructive to the safety of navigation since its exact location and size are known, thus it route can be completely avoided during navigation.

We thus infer that the canyons possibly served as feeder channels for the turbidities found in the area. Also, basin-wards fine-grained gravity sediments form the basal part of the sedimentary fill of the canyons as earlier suggested by Deptuck et al., (2003).

It is observed that the seafloor of the outer Shelf and upper slope appears highly eroded with deeply incised canyons that were generated in response to lower sea level stands and high sediment. The deepest part of the canyon system incised several hundred meters into the pre-existing substrate, into the aggrading deltaic complex. The canyons become shallower landward. These shallow natures of the canyons landwards possibly suggest partially or complete erosion during the sea-level low stand phase. The canyons might have provided conduits for off-shelf sediment transport, slope by-pass and deposition on the continental rise. From the morphology of the Canyon systems delineated, it is evident that the Canyons might have evolved through multiple phases of cut-and-fill followed by the formation of new Canyons systems re-occupying old ones.

The canyon walls are relatively steep with apparent slopes ranging from 4 ^{o} to 7^{o}. Generally, the canyon has a U-shaped cross-sectional morphology as revealed by the modeling. Based on the proposition of Morris and Busby-Spera (1988) which suggest that U-shaped canyons are extremely rare in the upper reaches of submarine canyons, rather they occur in 20% of the lower reaches of submarine canyons. We thus infer that the canyon fill in the proposed Ondo State Deep-Sea Port area were deposited in the lower reaches of the submarine canyons. As seen from these plate figures 12 to 21 respectively, the canyon walls have irregular surfaces which suggest a possible slump features. Further, these slump features are indicative of down-cutting and lateral widening of the canyons. From all these gravity derived models, it is obvious that the shale diapir uplifted the slope sediments and protruded through the overlying strata, producing a bathymetric ridge rising from the adjacent sea floor. It is observed that the steep flanks of the rising shale diapir serve as the walls of its steep-sided canyons.

Sediments deposited in the Avon canyon are interpreted as being sourced from the land, brought down by rivers, and transported predominantly by longshore currents into the canyon. Recent erosion of beach sediments also contributes to sediments which are transported eastwards and into the canyon through the narrow head. The main current regimes controlling sedimentary processes around the Mahin canyon include: a wind - and wave-driven regime in the nearshore, and a tidal regime that predominates offshore. Normal circulation in the shelf and prevailing westerly winds combine to set up an eastward longshore littoral drift. Along the western Nigerian continental shelf, surf zone longshore current direction are west - east (Ibe and Awosika, 1984).

5.3.3 Coastal geomorphology

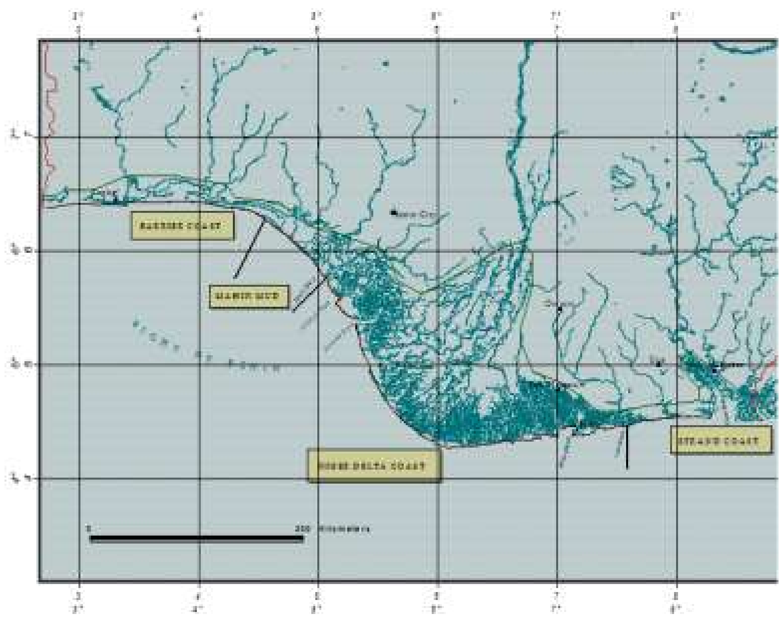


Figure 5.1.7: Map showing the different geomorphological zones along the Nigerian coast (Sources: The Port of Ondo Report)

The Nigerian coastline is relatively straight, with few natural indentations. Nigeria is located along the Atlantic Ocean of West Africa, i.e., the Gulf of Guinea. She has a coastline of about 830 km between the western and eastern boarders of the country with the Republic of Benin in the West and Cameroon to the East respectively. It has a maritime area of 46,300 km sq. between 0-200m depth with the Exclusive Economic Zone of 210,900 km sq. which lies between 4 10’ and 6 20’ North latitude and 2 45’ and 8 32’ East longitude to the Gulf of Guinea, (World Resources, 1990).

The Nigerian coastal zone is washed by two currents; the cool guinea current and the warm equatorial current with vegetation comprising mainly mangrove swamps. the zone is characterised generally by low-lying sandy beaches throughout its entire length, indented with lagoon systems in the west as well as the delta complex which is the Niger delta. the continental shelf is characterised by more or less uniform gentle slopes broken at specific points by submarine canyons (Avon, Mahin and Calabar canyons). A canyon is a deep valley, or narrow chasm with steep cliff walls which has been carved out of the earth crust by running water. It is a gorge. of the three canyons, Avon is V-shaped and it is the largest located in the Nigerian part of the Atlantic Ocean. The shape of the Avon canyon is like a large amphitheater with “steep rims” and there are several gullies along the shelf located in the east and west part of the Avon canyon. The canyon is located along longitude 3”55’ 00” E and latitude 60 10’ 00” N. It is the first to be seen under the sea in the Lagos area followed by Mahin which is U-shaped and Calabar in the extreme eastern area of the Atlantic shelf width ranges from 15 km in the west to about 67 km in the Niger Delta and about 87 km off the cross-river estuary in the east, (Awosika 1993). Studies of the canyon at the Nigerian Institute of Oceanography and Marine Research (NIOMR) show that waves are larger at the flanks of the canyon but smaller at the head of the canyon.

Geomorphologically, the Nigerian coastline can be divided into four main zones. From west to east, the following coastal types can be distinguished; the Barrier-

Lagoon Complex, the Transgressive Mud beach or the Mahin Mud coast, the Niger Delta and the Strand Coast (Okada) (*Ibe, 1988*) (**Fig. 5.1.7**).

i. The barrier-lagoon system in the west stretching for almost 250 km from the Nigeria/Benin boarder to the village of Ajum where the coastline starts to inflect southwards about 100 km east of Lagos. The narrow barrier bar fronting the ocean is backed by the Lagos Lekki and Yelwa lagoons and many meandering creeks.

   Holiday resorts with recreational facilities are located close to these lagoons. The city of Lagos, which is the centre of economic activities in the Country is backed by the lagoon. There are local settlers at this frontier who engage predominantly in fishing as a means of livelihood. A simple pollution incident could conceivably ruin this regional way of life.

ii. The Mahin transgressive mud coast stretching for almost 75 km and consisting predominantly of mud starts from Ajumo and terminates at the Benin river estuary in the north western flank of the Niger Delta. This is a very low-lying coast with wide subtidal platform of about 1 to 2 km

iii. The Niger Delta covering almost 20,000 sq. km, spans a coastline of about 450km and terminates at the Imo river entrance. About 2,370 sq.km of this delta consist of rivers, creeks and estuaries and about 8600 sq. km of stagnant swamps. The mangrove swamp in Niger Delta covers an area of about 9,000 sq.km, km and has about twenty barrier islands. The subtidal platform and the delta swamps comprise a high-density fish-breed breeding ground.

   Artisanal fishing is also carried out by the local settlers especially along the barrier island coast. Crabs, shellfish, lobsters etc., which are rich in protein are dominant in this region. Off-shore oil exploration platforms are also located in this region thereby exposing the delta to risk of oil pollution. Port

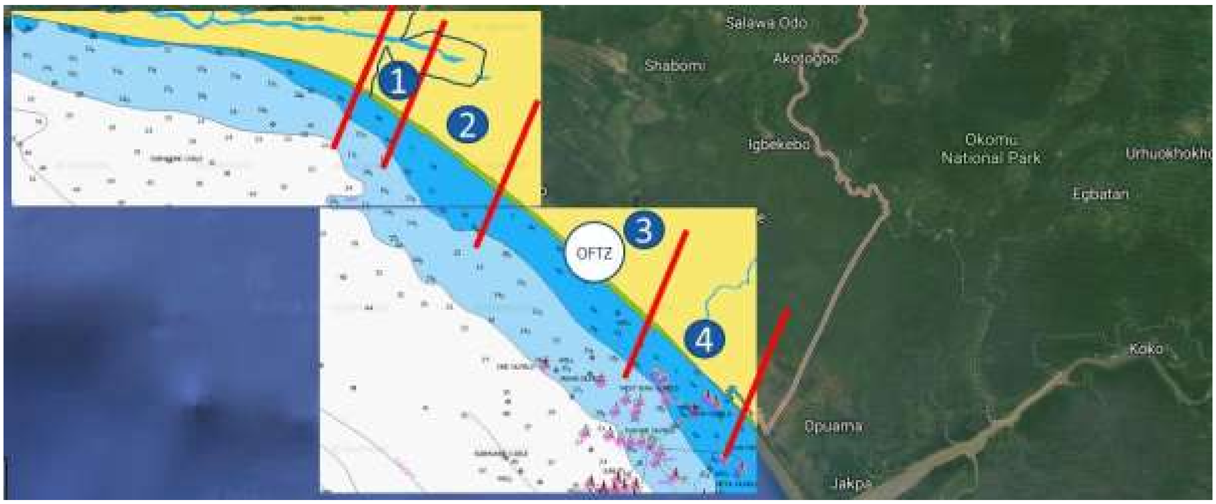
Harcourt and Warri are the major port cities in this region with high maritime activities.

iv. The Strand coast east of the Niger Delta stretches for about 85 km from the Imo river eastwards to the Nigeria/ Cameroon boundary. It is fronted by flat sandy beaches. The Cross-River estuary which is the largest in Nigeria is the most prominent feature in this area. These flat sandy beaches provide recreation grounds for visitors. However, the local dwellers who solely engage in fishing also use this 'points' as spots for marketing their daily catch. They have no other means of livelihood.

SAFETY OF THE ONDO DEEP-SEA PORT FOR NAVIGATION

Despite the presence of the three canyons, from the above sections, Avon canyon is in Lagos axis while the Mahin canyon is about 15km away into the offshore area of Ondo state while the deep -sea port is 3km away on the Atlantic Ocean. Definitely, the presence of Mahin canyon would not impede navigational safety and movement of vessel. For example, the Avon canyon has not affected navigational movement in any form. This is further confirmed by the recent bathymetrical survey which clearly indicated that there are no marine hazards wrecks or metal obstacles at the proposed approach channel or port site. The design opted for has also taken cognizance of all the prevailing natural hazards .The breakwater breakwater will raise seabed level above water surface while dredging will deepen the sea bed in the approach channel and the turning basin including the berthing pockets and this change is permanent throughout the life of the port, consequently, the breakwater will directly change sediment transport, erosion and accretion which in turn changes the bathymetry. In conclusion the canyons do not obstruct safety of navigation for they are outside the navigational path. The location has been carefully selected based on the following multi analysis criteria which are listed below; and the selected location is recommended.

Figure xx The four location options for developing the Port of Ondo



Source: MTBS, Navionics, Google Earth

- **Nautical access**: The water depth and the ease of nautical access;
- **Natural shelter**: The protection for ships by natural landmass;
- **Land accessibility**: The hinterland connectivity and access by roads, rail or waterways;
- **Structure of the land**: This relates to the soil structure of the land and land heights;
- **Available space**: This is the space available for land-based developments and ability to develop;
- **Ease of implementation**: This is the rating for a port development project in this region;
- **Environmental impact**: The rating for issues with environment; and,

- **Encroachment**: This is the level of encroachment.

The main project site conditions are characterised by mud sedimentation near the coastline, a marine seabed clear of any hazards with a gradual slope to deeper waters (>16.5 m at a distance of 13.5 km), wetlands and a river between the free trade zone and the beach. The site has calm wind conditions (<8 knots) and one dominant wave direction from SSW.

The maximum significant wave height in the port area from available data is in the range of approximately 1.5 m to occasionally 3.0 m. Significantly large wave would not be possible due to the depth limitation. The waves mainly come from the SSW with peak periods up to 14s.The conclusions in ” A bathymetric study on the site was concluded by December 2018. The study named Bathymetric*, Hydrographic and wreck survey of the shipping channel for the development of deep-sea port and industrial city with free trade zone status at Erunna/Ogboti in ILAJE LGA, ONDO STATE* was prepared by Humber Marine Werks Co. Ltd” reported that a wide area of 2.5 km wide and over 21 nautical miles (Nm) seawards was investigated to survey the proposed shipping channel (from about CD -4.5 m water depth line to CD – 93.5 m water depth). It investigated the seabed depth profile, seabed soil, existence of wrecks and other obstacles through magnetic survey, side-scan sonar, and seismic recording. The study was carried out in line with the international Hydrographic Organisation (IHO) SP-44 Standards.

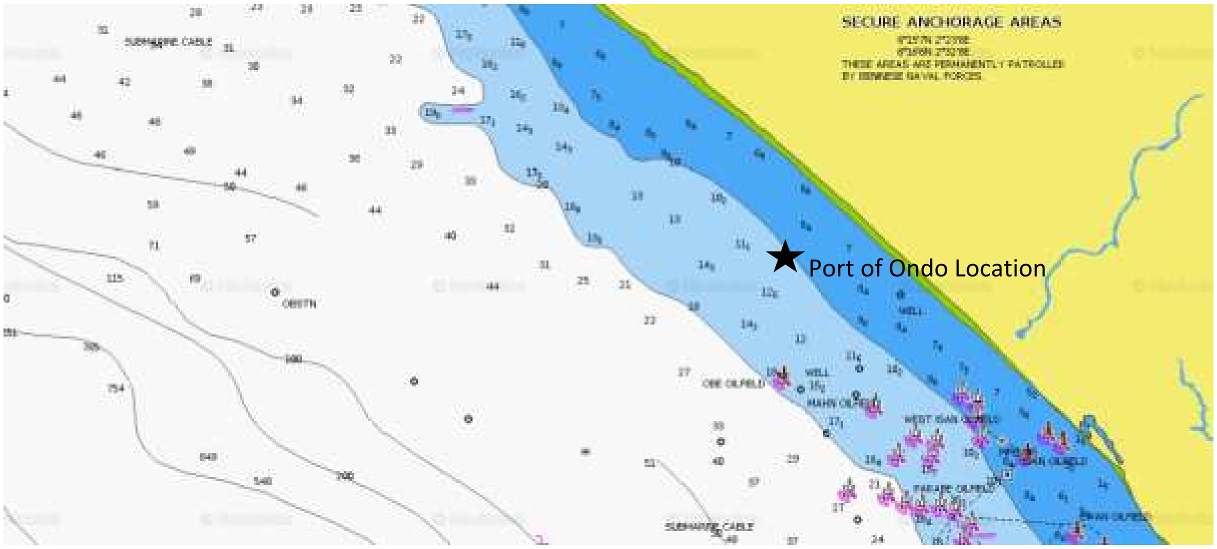
The main conclusions[1] of the study is as follows:

The conclusion from the report is that no wreck or marine hazards or any metallic debris were found along the seabed of the area surveyed. The seismic record of the survey on sub-bottom profiling indicated the presence of “Silty sand” in a gradual sloped depth profile. The port location and access channel are a little wider than the surveyed channel, but the majority of the port and access channel is within the strip surveyed and is sufficient fur future design steps.

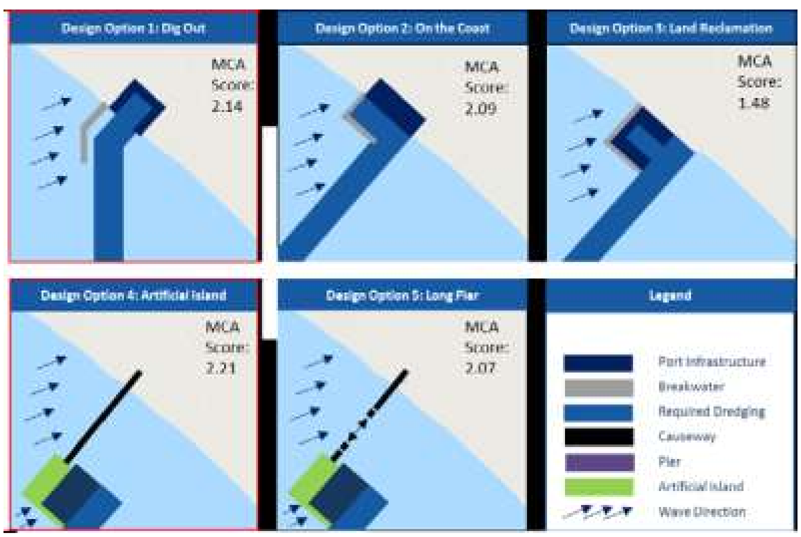
For this report it has been concluded that:

- The survey does not object against any of the engineering recommendations in this report; • The survey area does cover most of our current proposed location and access channel; and,
- The depths of the survey are in close agreement to the ones used in this report.
- Our geophysical investigation also confirms that the selected site and all its parameters are suitable for the safety of navigation in the area despite the canyons in our coastal waters

Figure 3-12 Broader Project area bathymetry



Source: webapp.navionics.com



Furthermore, the artificial island has advantages from a security perspective. The dig-out port has its challenges with a river deviation, local encroachment and clay layers in the development site and requires a long approach channel in difficult sea areas where mud transportation will increase maintenance dredging.

Figure 3-1 Morphological zones along the Nigeria coastline

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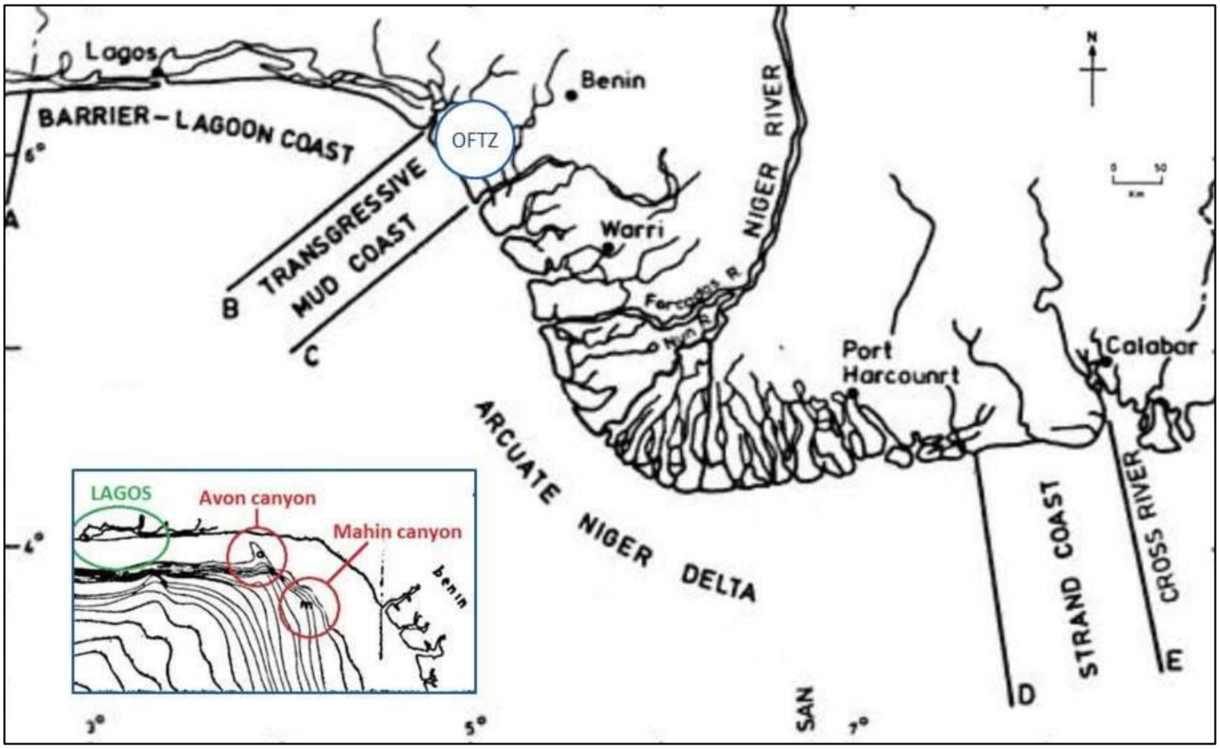
Lagos
Benin
BARRIER-LAGOON COAST
OFTZ
TRANSGRESSIVE
MUD COAST
NIGER RIVER
Warri
Forcados R
Port
Harcounrt
Calabar
ARCUATE NIGER DELTA
STRAND COAST
CROSS RIVER
LAGOS
Avon canyon
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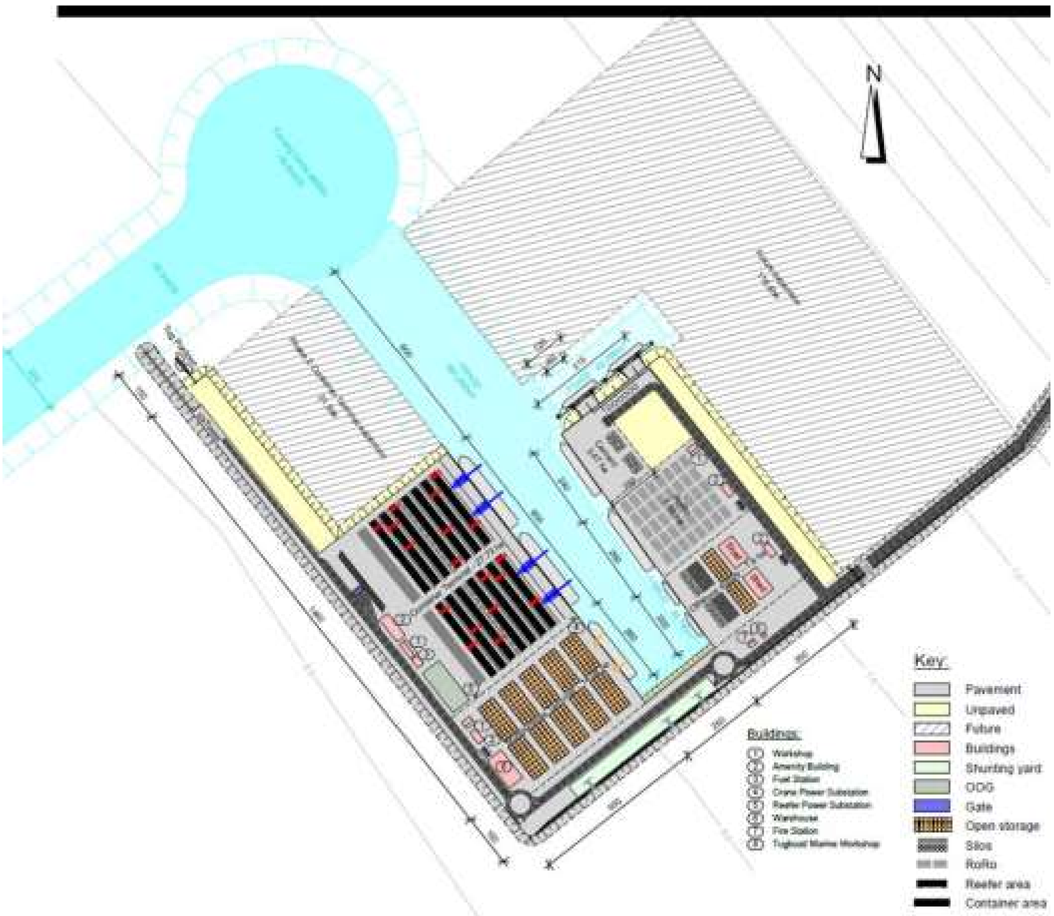

The figure above shows the final design. The distance to the shoreline was optimised through a sand balance calculation. It is recommended to develop the artificial island 2.8 km from shore. The reasons include:

- To stay away from the main mud sedimentation along the shoreline (impacts to about 2.5-3.0 km);
- To balance the dredging and reclamation volumes;
- To balance the costs between the approach channel and the cost of a causeway/trestle bridge.;
- Reduce the impact of the port construction on the coast;
- Reduce the social impact of the port on settlements on the coast;

- Increased security for the port compared to an onshore port;
- Fishery activities are maintained as fishery boats can pass the trestle bridge; and,
- Sufficient space is reserved for future expansion up to 116.6 ha (as the future expansion shall be faced northeast along the causeway in the lee side of the main island.

Other key characteristics of the port infrastructure are the following.

- Single-lane access channel with width of 200 m, a length of 10.8 km and depth of CD -16.5 m;
- Turning circle with a diameter of 600 m and depth of CD -16.5 m;
- Main basin with a depth of CD -15.0 m / CD -11.0 m and a minimum width of 250 m in the southeast, widening slightly towards the northwest to reduce potential harbour seiches (standing waves);
- Sub basin at CD -11.0 m with length of 400 m and a width of 120 m for bitumen and bunkering services;
- Reserved area for rail shunting yard with two rail lines at 500 m (future expansion to 600 m and 2 extra rails possible);
- Port services pontoon for pilot boat and tugs; and
- In order to connect the port to the free trade zone (FTZ), a causeway, trestle bridge, dam and bridge have been planned, with the following extents of each:
- Bridge across river – approximately 100 m from the FTZ across the river;
- Dam across beach – approximately 650 m from the river to the shoreline;

- Trestle Bridge – approximately 1,500 m from the shoreline to the causeway. The trestle bridge will allow currently and sediment to move along the coast and small boats to pass underneath;

- Causeway – approximately 1,685 m from the trestle bridge to the port.

Additional expansion maybe required subject to demand growth in the cargo segments. An additional area of 116 ha is available for port expansion. this encompasses a width of about 750 m available along the causeway with options to develop an additional 1,460 m of berthing lengths and beyond.

5 Breakwater and revetment

Construction of the port includes the installation of slope protection structures, i.e., revetment and a breakwater, to protect the boundaries of the reclamation area and to reduce wave disturbance inside the harbour basin. The reclamation area is confined by the quay wall in the harbour basin and embankments around the perimeter of the port. These embankments will have to be protected against wave attack; therefore, it is required to install revetments as slope protection on the embankments of the terminal area. In addition, from initial data of the wave direction and magnitude in the proposed area, a breakwater of 150 m length has also been designed to reduce wave agitation in the harbour basin and turning circle.

Basis for Design

The design of the revetment and breakwater should be based on the following principles:

- Provide sufficient protection against wave attack;
- Allow terminal operation during extreme events;
- Minimum or no maintenance required during design life;

- Economics and ease of construction;
- 50-year design life;
- Designed to withstand a 1 in 100-year storm event; and,
- Factor of safety of 1.5.

5.4 Soil and Land Use Study

5.4.1 Rationale for Soil Sampling Design

The Project location is within the sedimentary belt of Nigeria. The geological materials in the project location which eventually gave rise to soils in the area were reported (SSSN, 1981) to be derived from the Benin Formation, typically ferruginised sandstone. The topographical map of the area indicates that the project location is essentially a low-land plain with very little variation in vegetation types mainly due to micro-variabilities – engendered by human influence. In view of the geologic, physical, physiographic, relief and hydrological pattern in the area, strong relationships are expected between the vegetation and soils.

A reliable, efficient, time-tested and cost effective, habitat approach sampling method was employed. In this approach, vegetation type and boundary were closely related to soil type and distribution. Through detailed field observations and field morphological examination of the soils through auger borings, the soil types, their quality, productivity, capability, suitability, susceptibility to erosion and distribution within and around the project location were documented. The entire field could not be covered during the field investigation because of the sea condition during the survey.

5.4.2 Field Observation and Soil Sampling

Field observations and soil sampling were carried out on the field along the four-cardinal north, south, east and west directions. Field soil morphological description following the procedure in the 'Guideline for Soil Survey and Profile Description' (FAO, 1996) was adopted. Soil sampling was carried out under varying land use types (e.g. fallow; farmland such as under sole cassava, sole maize, maize mixed with cassava) using Dutch Soil Auger with stainless steel tip. Bulk soil samples were collected by bulking at least 10 core samples 2 – 5 m spatially spread around a central sampling location. *(Foth 1997)* indicated that bulk rather than core soil sample gives better representation of an area. Depth of soil sampling was 0 – 15 cm for the topsoil and 15 – 30 cm for the subsoil. In view of the uniform morphology exhibited by soils in the study area, and for purposes of soil classification, a Soil Profile pit was established, described and sampled on basis of its genetic horizons. All the soil observation and sampling points were geo-referenced using hand-held GPS. Soil sampling locations were the same for both (dry and rainy) seasons. The various locations for soil observation and sampling during the dry and rainy seasons' field study are presented in **Table 5.1.1** Land use types were studied and documented along each cardinal direction of the project area at each of the soil observation and sampling points.

5.4.3 Field QA/QC Measures

To ensure that representative soil samples were collected on the field, several core soil samples were bulked to give one composite/bulk soil sample per sampling location. Collection of composite soil samples eliminates micro-variabilities on the field (*Thien and Graveel, 1997).*

Dutch Soil Auger with Stainless Steel at the Tip was used for soil sampling to prevent contamination of the samples with the sampling equipment. Furthermore, the soil sampling equipment was thoroughly cleaned and rinsed with tissue paper after the completion of soil sampling at every soil sampling location so as to prevent cross-contamination of the soil samples. Bulking of soil samples was carried out in a plastic bucket lined with aluminum foil sheet, and the homogenization of the core samples was achieved using stainless steel spatula. Soil samples meant for physico-chemical properties and heavy metals were kept in polyethylene bags, while those meant for microbiological analysis were kept in sterilized bottles. Soil samples to be used for THC determinations were stored in glass bottles. All the soil samples collected for various laboratory analyses were properly labelled to indicate sampling location, soil depth, sample number and date of sampling.

5.4.4 Laboratory Analyses of the Soil Samples

Table 5.1.2 gives the summary of the analytical methods employed while detailed analytical procedures are provided in the Appendix. All the soil samples meant for the various determinations were analyzed within the withholding period as specified in the relevant sections of Methods of Soil Analysis, Parts II & III (Page *et al*., 1996; and EGASPIN (DPR, 2002).

Table 5.5: Summary of the methods employed for the Soil samples analyses.

Parameter	Method
Grain Size Distribution	Hydrometer (Bouyoucos, 1951)
Total Hydrocarbon Content (THC)	Xylene extraction followed by the use of Spectrophotometer
Total Organic Carbon (TOC)	Dichromatic Wet Oxidation (Walkley and Black, 1934) as reviewed by Spark *et al.*, 1996
Alkali Metals (K, Na, Ca)	Digestion, Flame Photometry (Jones, 1988)
Heavy metals (Cd, Cr, Cu, Fe, Pb, Zn, Co, Ni, V)	Digestion followed by the use of Atomic Absorption Spectrophotometry (AAS) (Jones, 1998, Allen, 1974)
Ph	Glass electrode meter
Total Nitrogen	Macro kjedahl (Jackson, 1962)
Available phosphorus	Colorimetric (Jones, 1998; Murphy and Riley, 1962)
Sulphate	Turbidimetric (Tabatabi, 1974)
Chloride	Titrimetric method (Jones, 1998)
Exchangeable acidity	Spark *et al.* (1996)

5.4.5 Laboratory Quality Control (QC) and Quality Assurance (QA)

Soil sample handling, preservation and analysis in the laboratory were in accordance with the provisions in the Environmental Guideline and as in other internationally acclaimed publications such as the "Methods of Soil Analysis by *Page et al. (1996).* Analytical methods used were those that are specified by Federal Ministry of Environment and some other Internationally Published Methods and Procedure.

5.5 Vegetation Methodology

Prior to field sampling, a reconnaissance visit was undertaken to all parts of the study area with a view to selecting sites for the assessment. The field survey involved sampling and observation of the attributes of vegetation in the study area that are likely to be affected by the project activities and subsequent development. During the reconnaissance survey, the vegetation types in the study area were identified. For the two-season sampling (November, 2019 and March, 2020). All observations and sampling points (**Table 5.2**) were geo-referenced using hand held Global Positioning System (GPS) receivers while photographs of the major vegetation types were taken. Vegetation observation and samplings were carried out within each vegetation type i.e. each habitat type (by habitat-type is meant a vegetation type/subtype that can be conveniently mapped together as a homogenous unit on the field on the basis of flora composition/land use type). The lengths of transects varied depending on the extent of the vegetation type/subtype being studied. Species composition and density along each transect were studied in detail using the Quadrat and Belt Transect methods *(Greig-Smith, 1983)*. A 5 m x 5m quadrat was used at every 100-metre interval to provide the maximum chance of encountering most of the occurring species. All plants within each quadrat were systematically identified, evaluated and the number of individuals of each species enumerated.

Their height and girth were measured with Haga altimeter and tape respectively. Specimens of plant species that could not be readily identified on the field were collected and pressed in a plant press and taken to Ife Herbarium (at Obafemi Awolowo University, Ile-Ife) for proper identification and/or authentication. The number of strata/layers/storey in each vegetation type was noted and the dominant species recorded. Where counting of individuals was not possible as in situations where there are creeping plants, cover was measured according to Greig-Smith (1983).

Plant and crop pathological studies were carried out by observing levels of vegetation death (if any), leaf damage (if any), insect pests, fungal, bacteria, and viral diseases of crops and wild plants and collecting and culturing infested plants for pathogen identification. The species nomenclature used was in accordance with *Hutchinson and Dalziel (1954-1972)* Flora of West Tropical Africa.

5.6 Methodology for Water Quality and Hydrobiology

At each sampling point, separate water samples were collected for the following water quality parameters or set of parameters:

- (i) Dissolved Oxygen (DO)
- (ii) Biological Oxygen Demand after five days incubation (BOD_5)
- (iii) Heavy metals (As, Cd, Co, Cr, Cu, Mn, Zn, Pb, Fe Ni)
- (iv) Water microbiology
- (v) Total hydrocarbon (THC)
- (vi) General physico-chemical characteristics

In situ determinations were carried out for ambient air and water temperatures (using a mercury in glass bulb thermometer), pH (using a Lovibond pH comparator), water depth and transparency (using a secchi disc with a graduated line). River water was collected directly from just below the surface level using a 2.5L capacity plastic bottle while samples were collected from hand dug wells using the same rubber container used by the local people. Samples for DO were fixed with Winkler's reagents (Mackereth *et al.,* 1978) immediately on collection, and the concentration determined titrimetrically later on reaching the field base. The conductivity of samples was also determined (using a conductivity meter) at the hotel base, usually within six hours of sample collection.

Water samples for microbiological analyses were collected in pre-sterilized plastic bottles and refrigerated at the hotel base pending departure for laboratory base. Samples for heavy metals were collected in glass bottles and acidified to a pH approximately 2 with the addition of appropriate amount of concentrated sulphuric acid (s.Hg = 1.84). Qualitative plankton sample was collected at each river station by filtering a known volume of water sample (50 liters) through a phytoplankton net to a concentrate volume of about 25±5ml. The concentrate plankton sample was preserved in 5% formalin solution by the addition of appropriate amount of 40% formaldehyde. Sediment samples were collected from the rivers (using a van veen grab) for their physico-chemical characteristics and for the occurrence of benthic macro invertebrate animals. The samples for benthic macro invertebrate fauna were sieved through a 1mm mesh size sieve using the river water. The observed animals were carefully picked out (using a fine brush) and preserved in 10% formalin solution. All samples were adequately labeled with regard to sampling site, time of sampling and code/ reference number using an indelible pen or marker.

Laboratory analyses were carried out on all samples within the withholding of each determination. Except for true colour and Total Dissolved solids (TDS) which were carried out on filtered samples (using O.45µ pore size Millipore filter paper) all other determinations of chemical analysis were based on unfiltered samples. Standard analytical methods with precision in the range of 0.1 – 10% were employed (**Table 5.5**). Manufacturers' manuals for the operation of equipment were duly followed.

Table 5.6: Summary of Analytical methods used for Water Quality Determinations

Parameter	Methodology	Reference
Alkalinity/Acidity	Acid-base Titration	APHA et at., 1980
Sulphate ($SO^2{}_4$)	Turbidimetric tritration	Golterman et al., 1978
Chloride ($Cl^=$)	Argentometric titration	Golterman et al., 1978
Anions (PO_4, NO_3, HC)	Colorimetric/Spectrophotometer	APHA et al, 1980
Na^t, K^t	Flame Analyser	Manufacturer Manual
Heavy metals	AAFS	Manufacturer Manual

NOTE:

The sediment/soil, water, chemical and microbial tests were carried out in three accredited Federal Ministry of Environment laboratories namely: Tudaka Environmental Consultants Limited, Ekpan, Delta State; Automated Geotechnics Limited, Lagos, and the Central science laboratory, Obafemi Awolowo University, Ile-Ife.

The certificates of analysis from the three laboratories are contained in annexure 1; while the photographs of the equipment used for the analysis are shown in annexure 2.

5.7 Methodology for wildlife and Fisheries

The presence of wildlife was investigated mainly by visual observations within the areas. In addition, oral interviews were conducted with hunters and inhabitants in the area. Visual estimates of bird population were made where the bird colonies were sighted. Additional information on the wildlife fauna, was obtained from literature. The species list of wildlife obtained was subjected to further authentication using the keys provided by Happold *(1978), Nason (1992), Serle and Morel (1984) and Sikes (1974)*.

Information on the fish fauna on the field was obtained from fisher-folks in the vicinity. The fish species obtained or reported were identified and classified using the keys provided by *Daget (1991)*.

5.8 Socio-economics and Health Survey

During both the two-season sampling (dry and rainy seasons), a comprehensive census of all the communities within the project areas and the areas of potential project influence (APPI) was carried out with the assistance of some youth leaders (Mr. Awolowo and the Chief Security Officer of Ugbo-land) who acted as local guides. All of them are resident within the study area and are also indigenes of the area. The communities were visited for physical examination of the available infrastructural facilities, their functional status and detailed study of the people. The two approaches used to collect the relevant information include:

(i) **Rapid Rural Appraisal (RRA)** – This was used to collect information on issues general to the communities. These were obtained from key informants.

(ii) **Structured Questionnaire** – This was used to collect detailed information from individual respondents with respect to their socio-economic activities and living conditions, (Appendix A)

Some of the information collected include: settlement patterns, available infrastructures, gender issues, migration and cultural ties, major occupation, cropping systems, crops grown, sources of water, religious activities, marketing activities, public health, transportation, amenity and recreation, household food consumption patterns, land use conflicts between crop farmers and cattle herders (if any) and the disposition of the local people and the communities towards the project.

The data collected were analyzed by the use of descriptive and inferential statistics. The Impact identification and analysis were carried out on the data acquired using the Leopold *et al* (1971) technique. By the techniques, specific parameters of each attribute that could manifest potential impacts were identified and the cause effect relationships established.

5.9 MEASURED EXISTING ENVIRONMENTAL CONDITION

5.9.1 Hydrology

The upper courses of the rivers and Creeks drains the areas which are characterized by steeply incised valleys. The Creeks and rivers flow in a South-West, and southern direction drain into the Atlantic Ocean.

5.9.2 Seabed Bathymetry Depth

Bathymetry seabed depth and morphology was carried out using the Ground Penetrating radar (GPR) and seabed Sonar scanner (**Figs. 5.18a and 5.1.8b**). The obtained bathymetrical data show relatively short distance to deep water. The coastline has a gentle slope from beach to the deeper depth with silty-sand on the sea bed. Generally, mud transportation flows in the northeast direction.

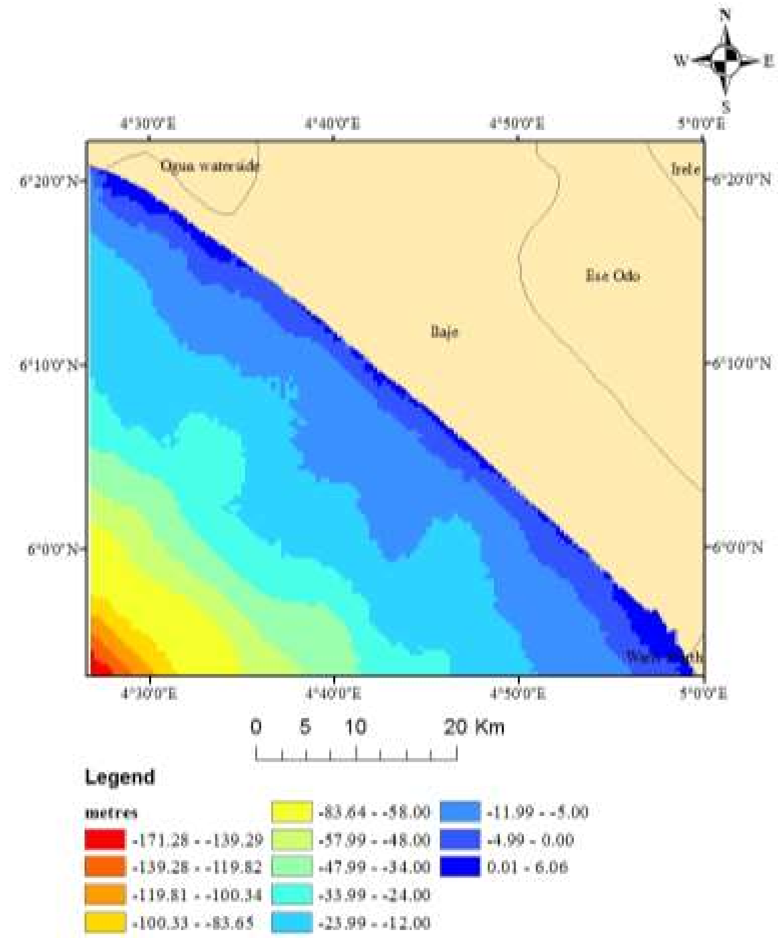

Figure 5.1.8a: Seabed Bathymetry Depth of the Project Area at the Deep-Sea Port

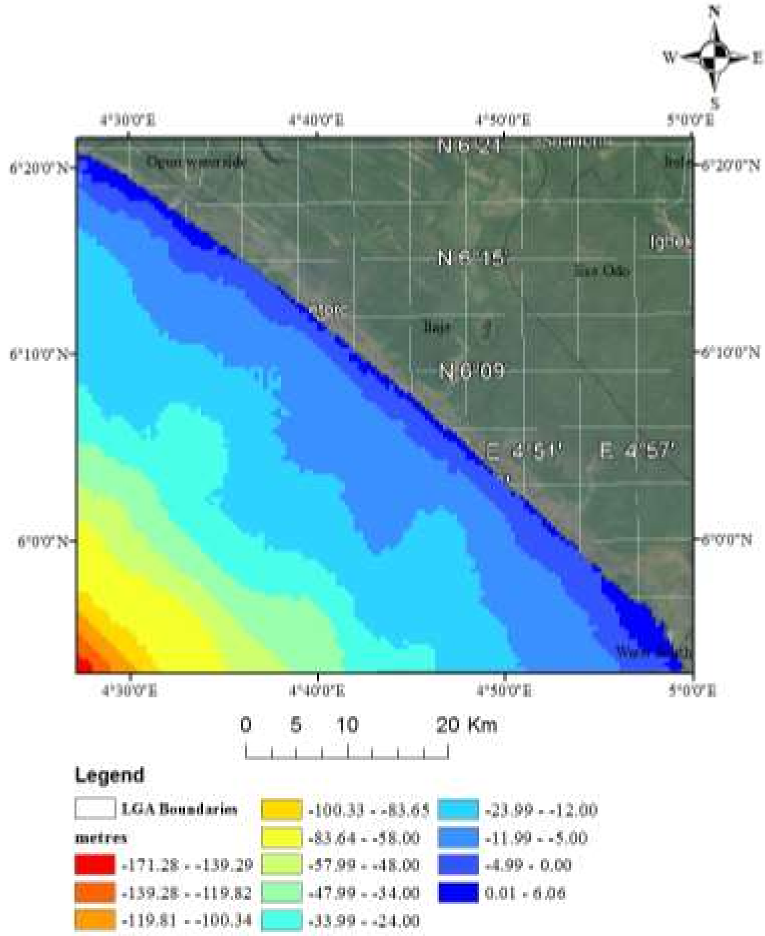

Figure 5.1.8b: Seabed Bathymetry Depth of the Project Area at the Deep-Sea Port Overlaid on the Google Earth Image

5.9.3 Seabed Topography

Figures 5.1.9a to 5.1.9e revealed the flat lying undulate reflectors, thin layers and curved reflectors beneath the ocean and river bed. The major rivers flow into the coastal lagoons. This is observed as region of high amplitude, with thick band of dark color. From this section, a distinct 2D image of the river (geometry in purple colour) and the bathymetric water level (in white colour) with depth ranging between 0 m and 0.5 m is revealed.

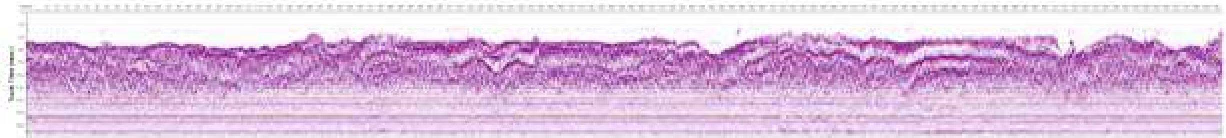

Figure 5.1.9a: Seabed Topography beneath Traverse one

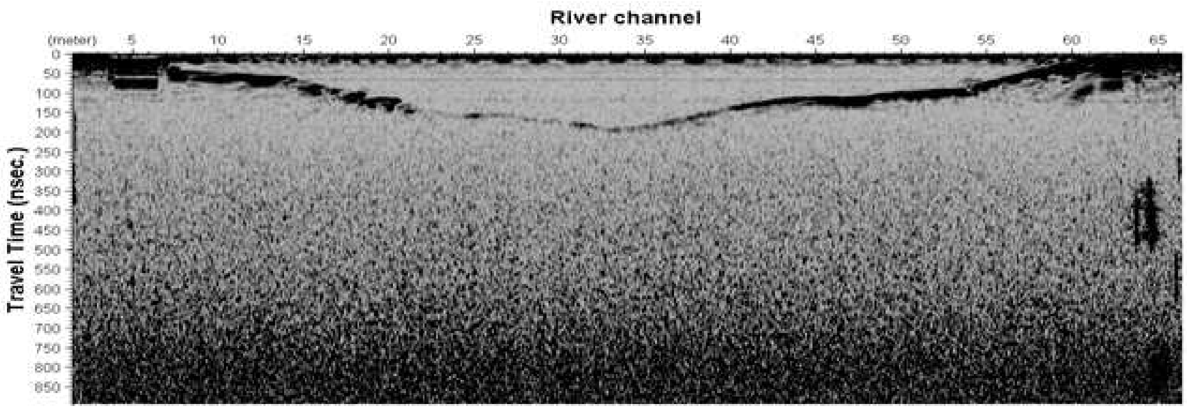

Figure 5.1.9b: Seabed Topography beneath Traverse Two

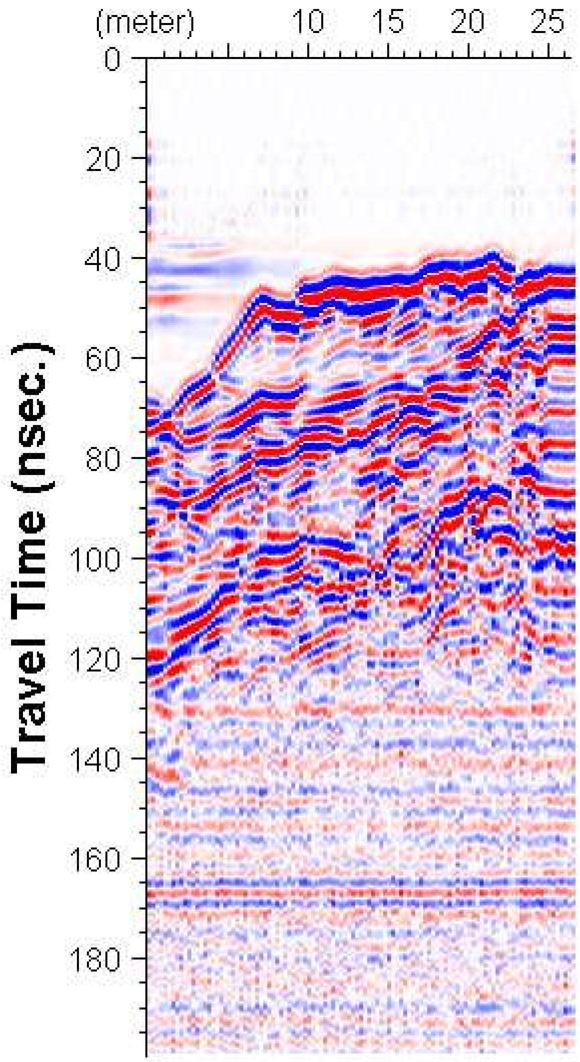

Figure 5.1.9c: Seabed Topography beneath Traverse Three (Obtained from this investigation through GPR Ocean Bottom Scanning)

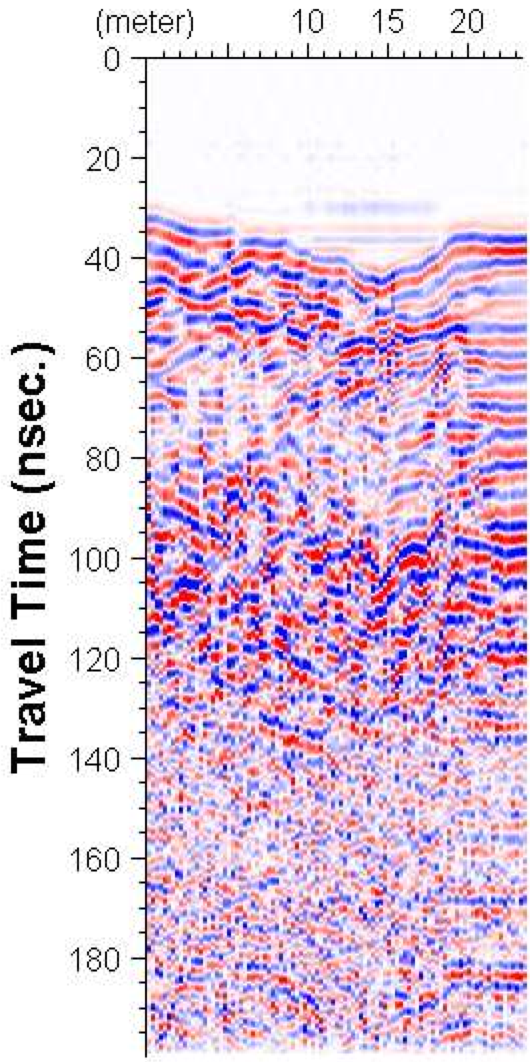

Figure 5.1.9d: Seabed Topography beneath Traverse Four (Obtained from this investigation through GPR Ocean Bottom Scanning)

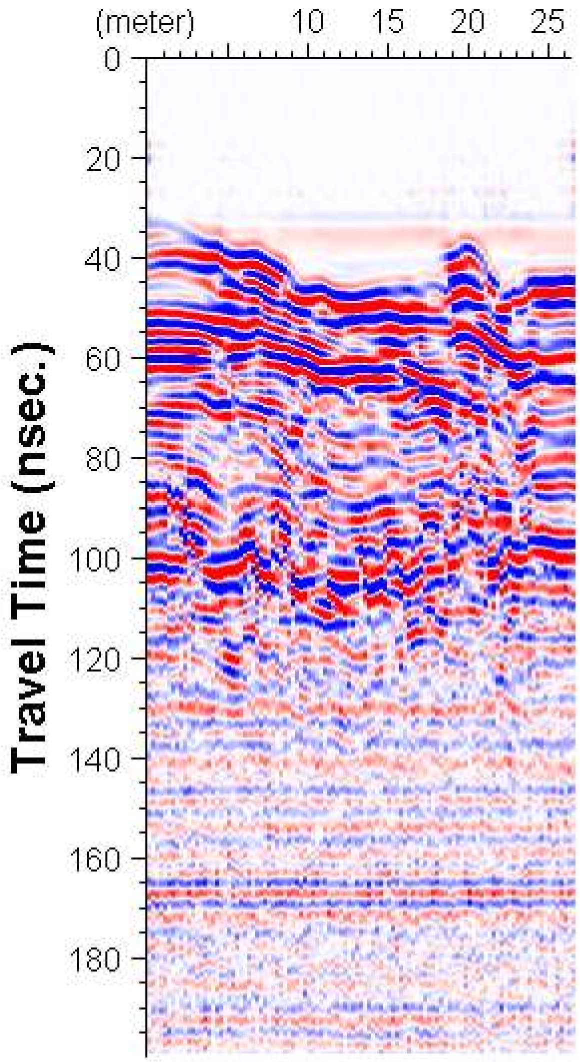

Figure 5.1.9e: Seabed Topography beneath Traverse Five (Obtained from this investigation through GPR Ocean Bottom Scanning)

5.9.4 Topography and Elevation Survey

Topography survey was carried using the Real Time Kinematic where the base station was placed on PBT 600 which are also denoted as PT1 as control an base point for the project, and antenna station beside it for the smooth communication between the stations, while Rova RTK mode was used to carry out locational points of the project area covered upland and seaside of the communities. The upland and seaside covered include:

Ugbo, Ugbonla communities, Eruna, Ado, Eruna Asuku, Eruna Ero, Abe Okun Ipin, Olotu Temuhi, Olotu Kwo, Olotu Yara, Olotu Niyi, Yaye, Ojabineni, Womitere, Lepe, Ayadi, Idiogun, Zion Ehmoren and Ehimoren (**Figure 5.2)**.

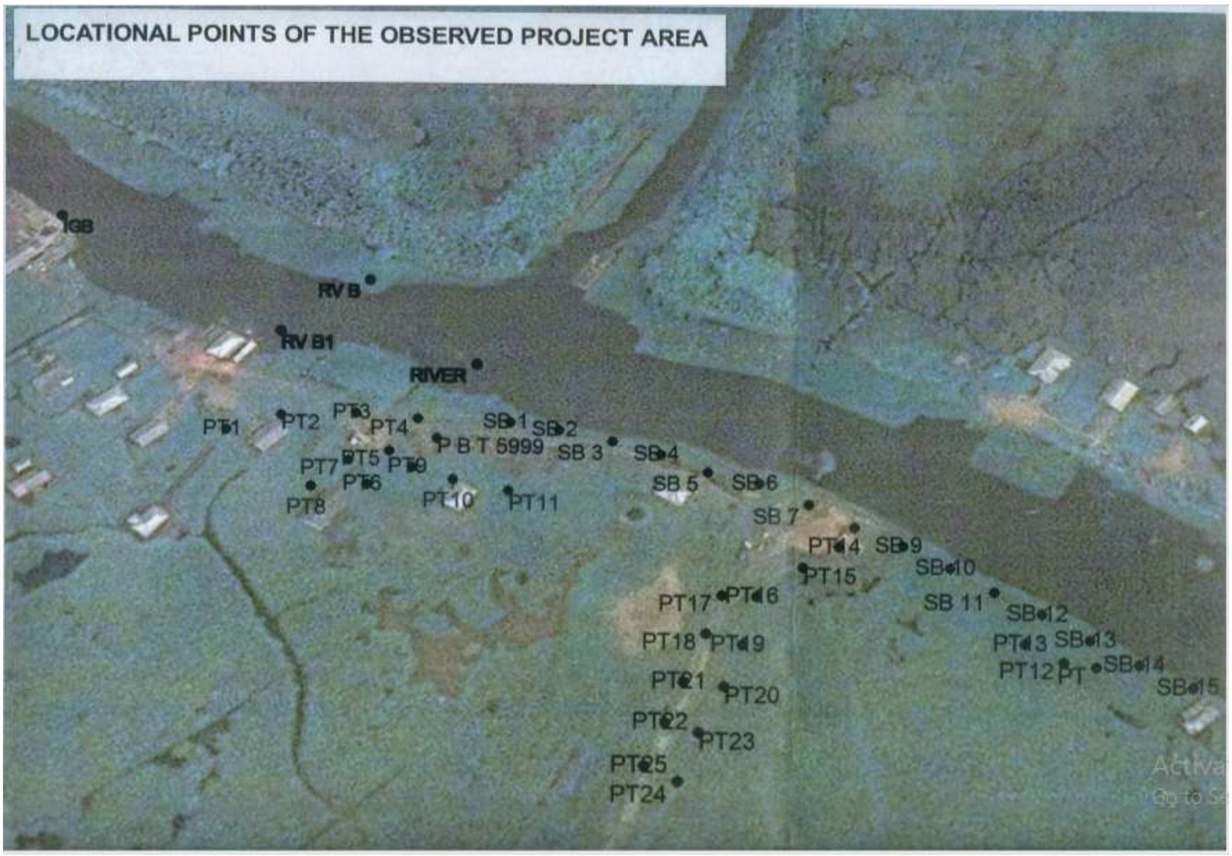

Figure 5.2: Locational Survey Points

The instrumentation used includes:

1) Tarsus Dual Frequency Differential GPS which contains Base, Rova, Radio and Antenna with Cables and other accessories.
2) Hand held GPS
3) Two Laptops with modem connection

Seabed elevations showing the four profiles A-B, C-D, E-F and G-H respectively (**See Figures 5.3 to 5.7**).

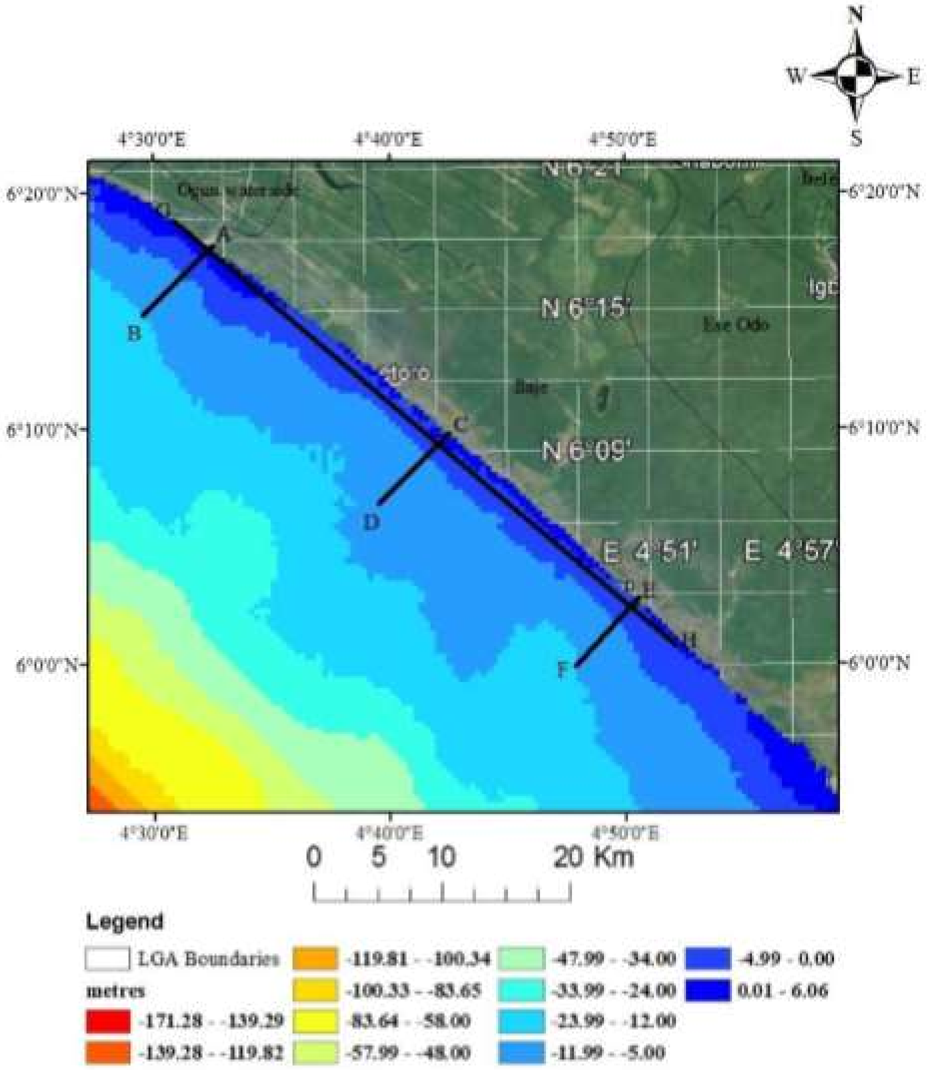

Figure 5.3: Seabed elevations Map showing the location of the A-B, C-D and E-F profiles

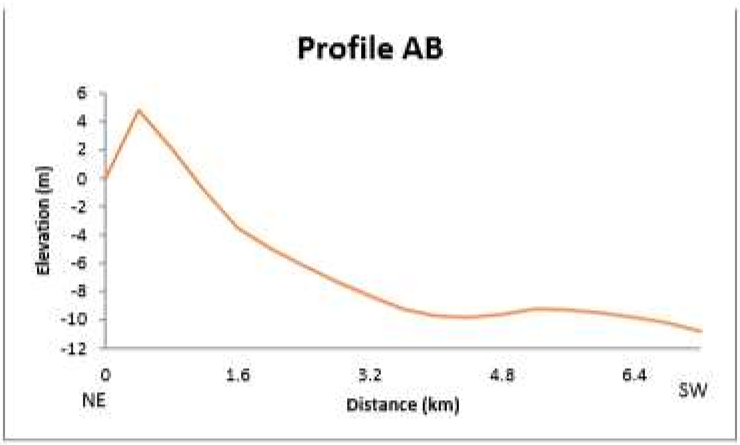

Figure 5.4: Seabed elevations Along Profile A-B

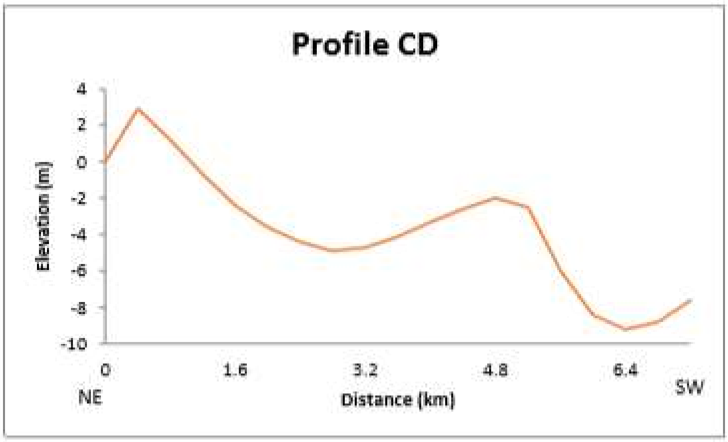

Figure 5.5: Seabed elevations Along Profile C-D

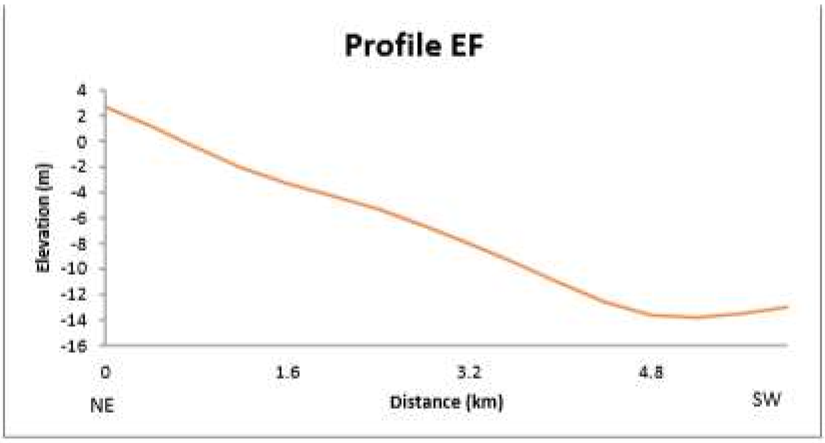

Figure 5.6: Seabed elevations Along Profile E-F

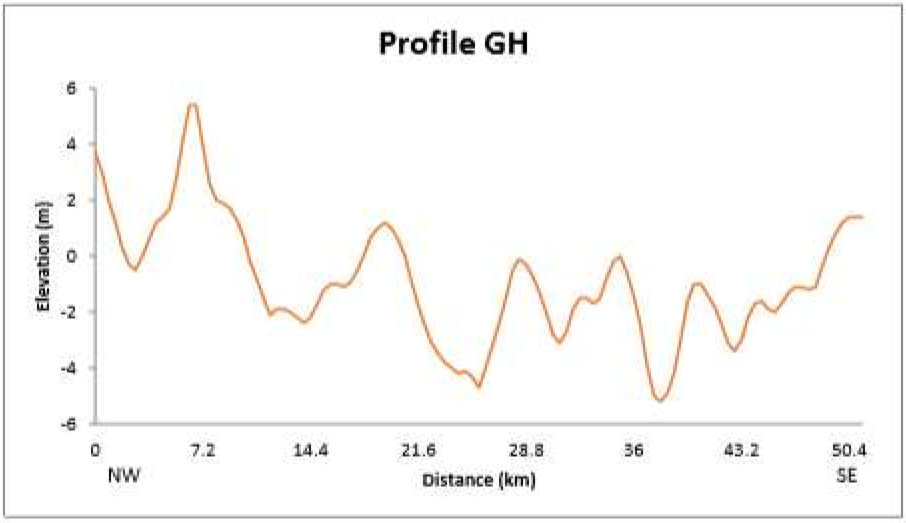

Figure 5.7: Seabed elevations Along Profile G-H

5.9.5 Magnetic Survey

The ENVI Cs Cesium Vapour magnetometer was employed for the magnetic survey in the project area. The ENVI Cs is a continuous reading magnetometer with high sensitivity with integrated navigational GPS and a versatile design that offers the user the ability to maximize productivity.

The residual Magnetic Map for the Deep-Sea Port Area is shown in **Figure 5.8**, while the SPI magnetic map is shown in **Figure 5.9.** Magnetic profiles based on the residual and SPI anomalies were taken along A-B, C-D, E-F and G-H respectively (**See Figures 5.91 to 5.94**).

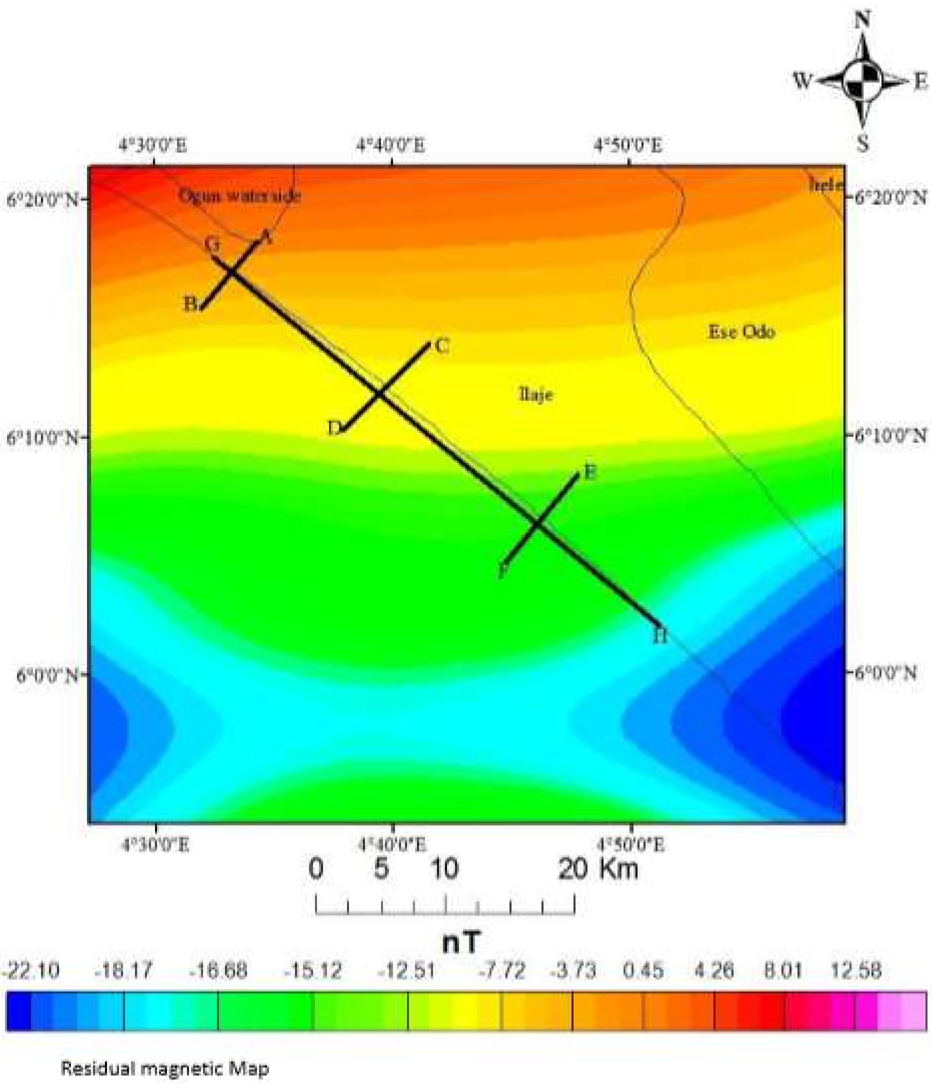

Figure 5.8: The Residual Magnetic Map for the Deep-Sea Port Area

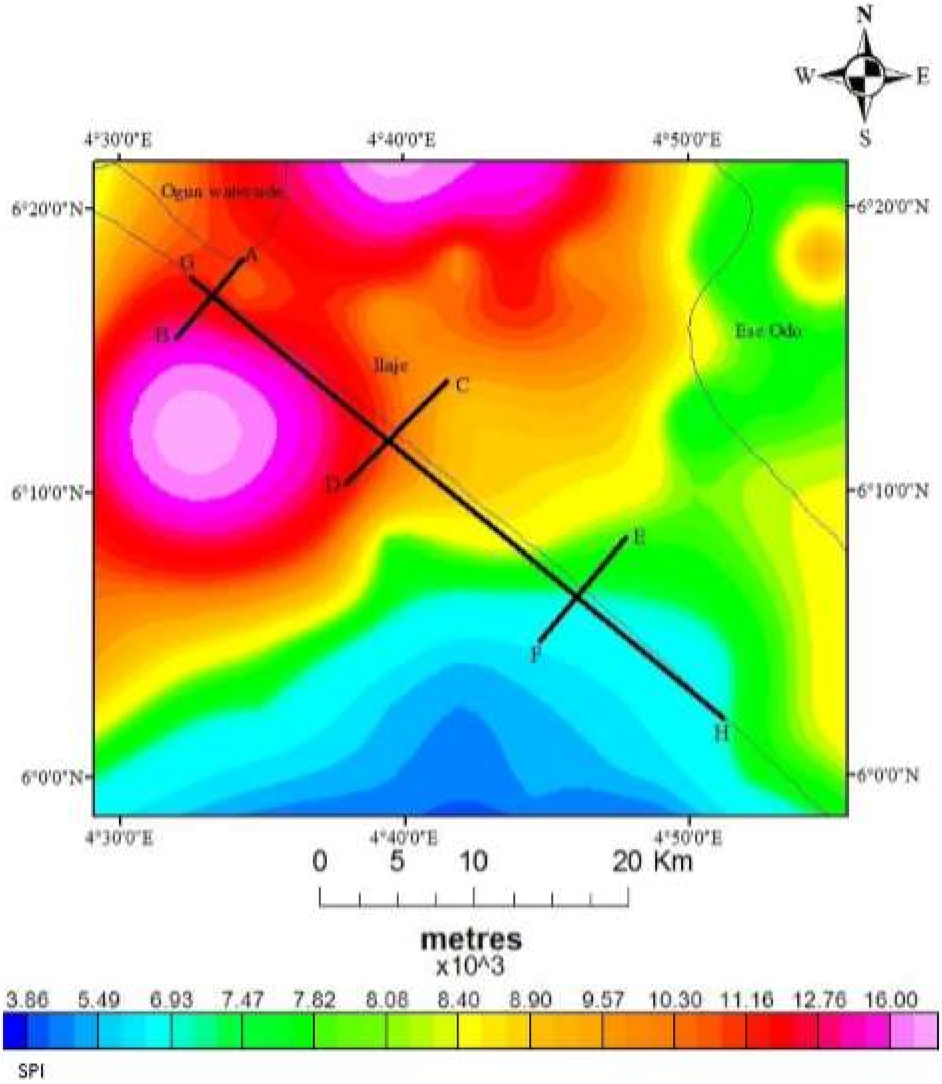

Figure 5.9: The SPI Magnetic Map for the Deep-Sea Port Area

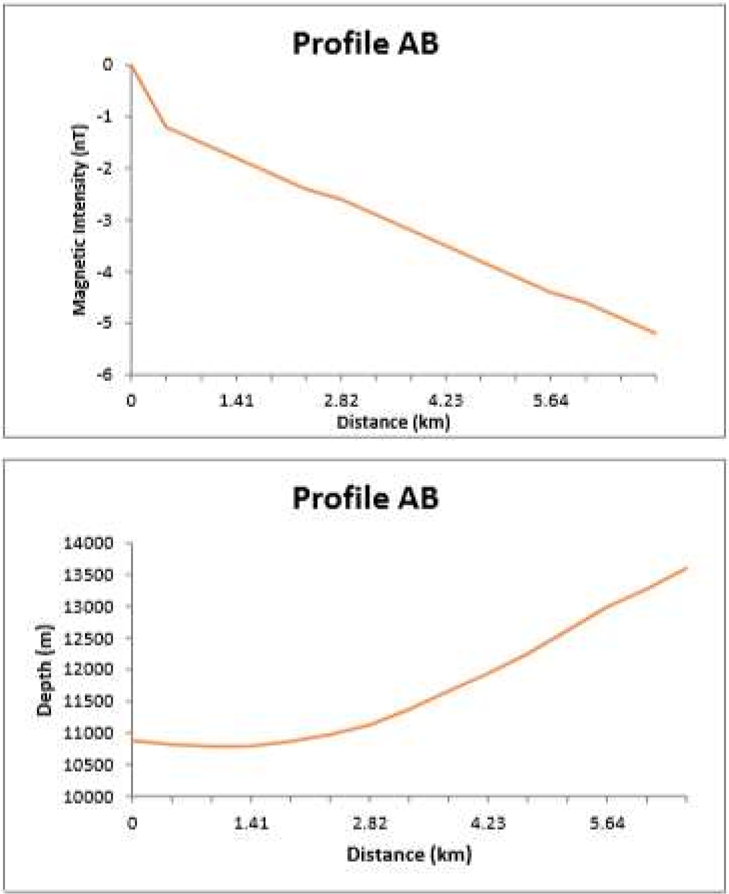

Figure 5.9.1: The Magnetic Intensity along Profile A-B

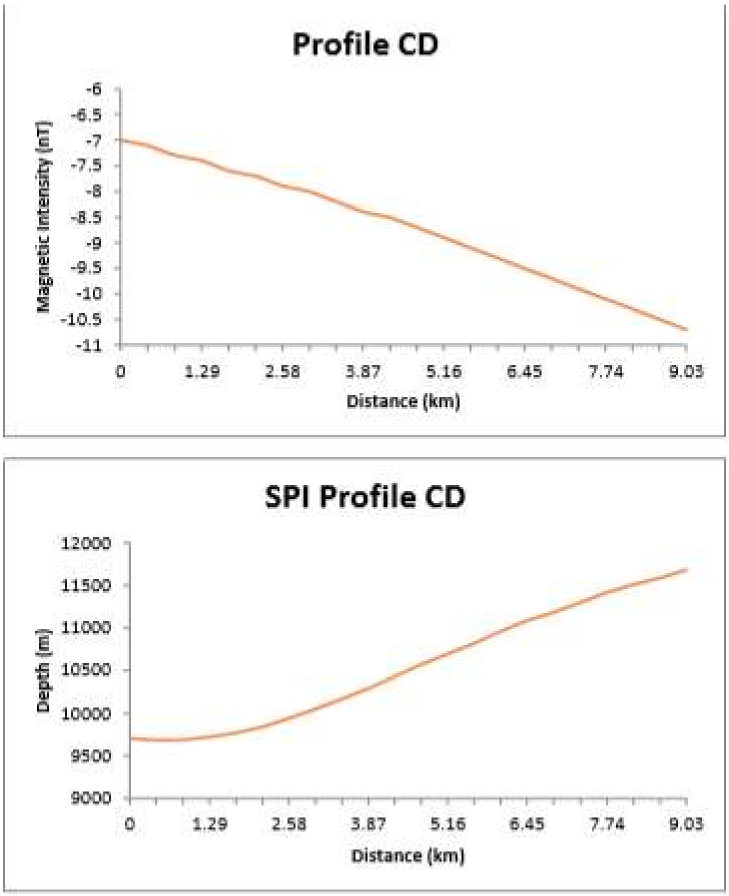

Figure 5.9.2: The Magnetic Intensity along Profile C-D

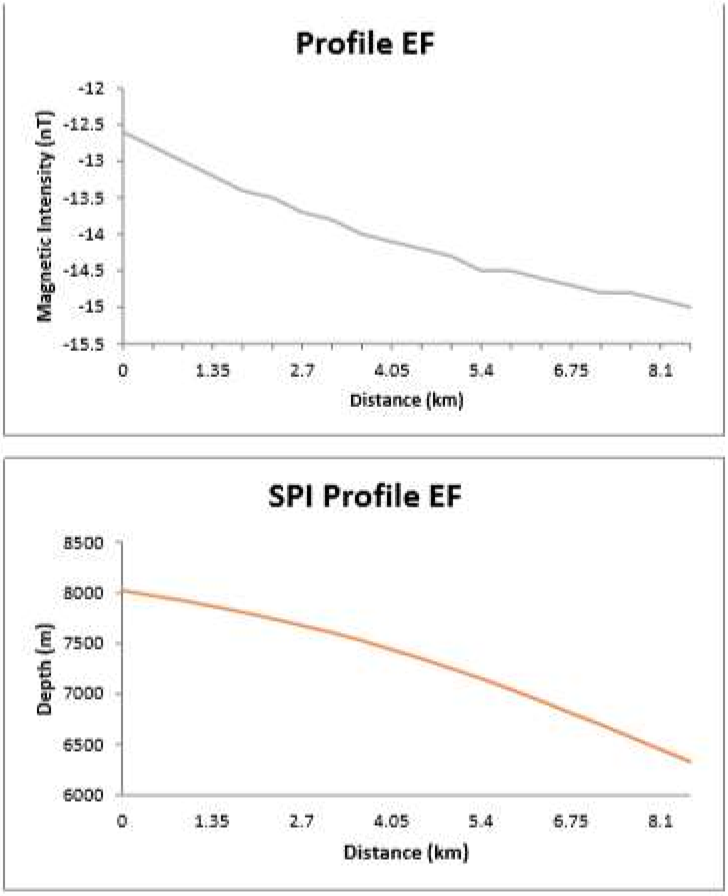

Figure 5.9.3: The Magnetic Intensity along Profile E-F

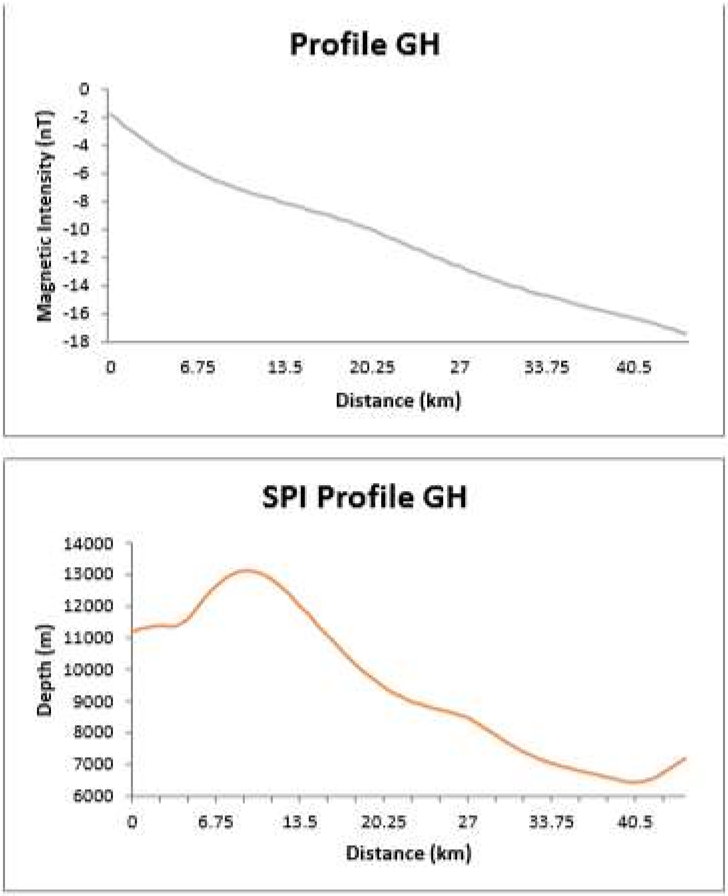

Figure 5.9.4: The Magnetic Intensity along Profile G-H

5.9.6 Climate and Meteorology

The climate of the study area is similar to other parts of southern Nigeria. Following the classification scheme of Papadakis (1965), the survey area is of the moist monsoon Humid semi-hot equatorial climate. The climate is characterized by a humid season stretching from March to October and rainfall surplus over 1000mm per annum. Mean annual rainfall is about 2400 mm (96 inches).

5.9.6.1 Rainfall

Based on NIMET, the study area has a total annual rainfall in excess of 2,400 mm (Figure 4.9.5) with over 95% of the total rainfalls occurring between April and September (rainy season). The region experiences double peak rainfall pattern with peaks in July and September which coincide with the period when the influence of south-westerly monsoon wind is at its peak. It rains throughout the year in the area (**Figure 5.9.5**).

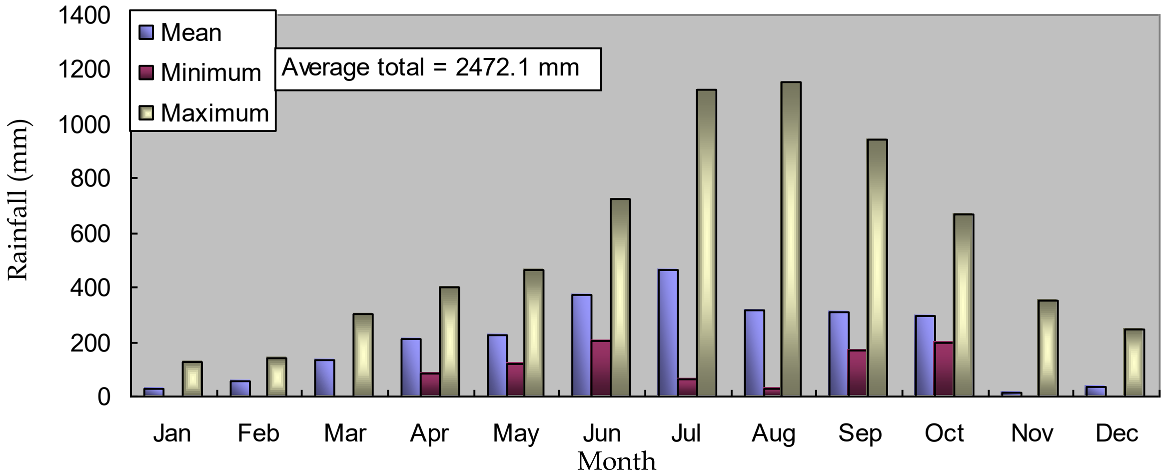

Figure 5.9.5a: Eight Decades Monthly Rainfall Distribution in the Area (NIMET, 2019)

5.9.6.2 Relative Humidity

The relative humidity in the study area ranges between 80 and 90 % using a 15-year historical data (**Figure 5.9.6**) with the mean monthly level indicating the months of June through September as wettest (85% – 90%) and December through February as driest. The relative humidity range of 42.3% – 68.7% with an average of 59.0% was obtained in the study area during the rainy season field survey while the range of 44.4 % - 83.9 % with an average of 69.0% was obtained during the dry season study (**Figure 5.9.7**). These agree with the historical data.

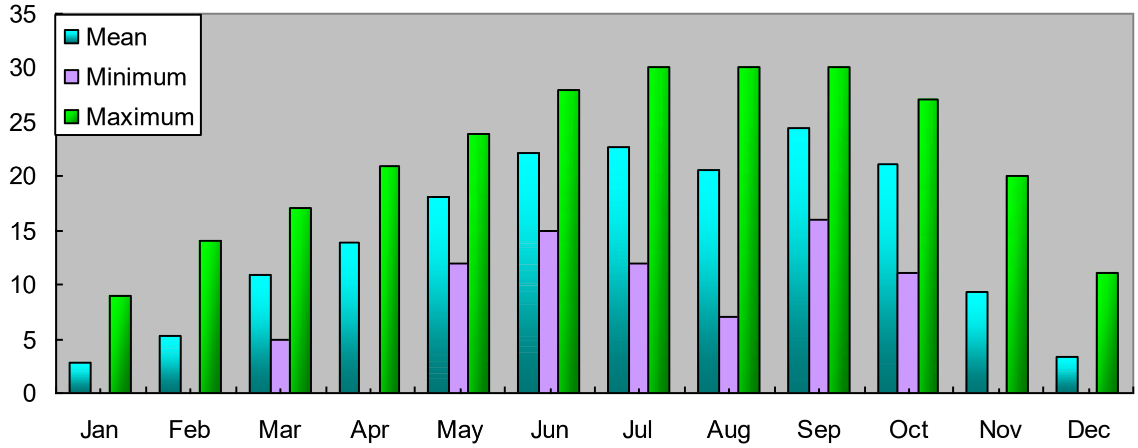

Figure 5.9.5b: Eight Decades Number of Rain Days in the Study Area (NIMET, 2019)

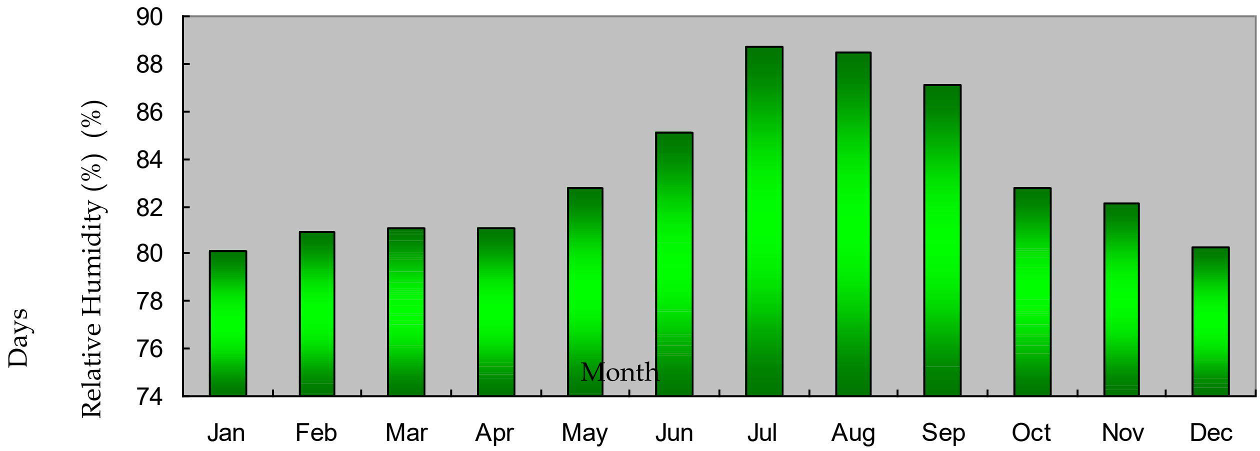

Figure 5.9.6: Historical Monthly Relative Humidity Distribution in the Study Area

(NIMET, 2019)

5.9.6.3 Air Temperature

Being in the coastal zone of the tropics, the proposed Deep-Sea Port area experiences uniformly high temperatures throughout the year with a mean annual maximum temperature of 31.3°C. The highest mean monthly maximum temperature occurs in February and the lowest in July, during the peak period of the wet season. The lowest temperature during the wet season is attributed to the depletion of incoming solar radiation by greater cloud cover. During the field study, the measured ambient air temperature was 31.3 – 39.5 °C with an average of 34.7 °C in the wet seasons and 35.0 – 41.0 °C with an average of 37.6 °C in the dry season. These agree with the historical temperature variations of the study area.

5.9.6.4 Wind Pattern

Surface wind speed in the area is characterized by small diurnal variation and influenced by both land and sea breezes resulting from the alternate warming of the land and sea. It reaches maximum level during the night due to radiation cooling leading to instability in the surface layer. The two major wind regimes are the North-East and the South-West Trade Winds (**Figure 5.9.7**) which are similar to the measured wind pattern during the field study (**Tables 5.1.4a and 5.1.4b**). The wind speed during the wet season is usually a gentle breeze (3.4 - 5.4 m/sec) followed by light breeze (1.6 - 3.3 m/sec), and moderate breeze (5.5 - 7.9 m/sec). Winds above 10 m/sec occur but only during thunderstorms. During this study, the dry season wind speed ranged between 1.2 and 2.6 m/s with an average of 2.0 m/s (**Tables 5.7a and 5.7b**, dry season and rainy season) which fall within the historical wind data for the area.

Table 5.7a: Measured Wind Speed and Direction during the Study

Sampling Location	Dry Season	
	Mean Wind Speed	Prevailing Direction
S1	1.20	SW
S2	2.40	SW
S3	1.20	SW
S4	0.00	Calm
S5	2.40	SW
S6	2.60	NE
S7	0.00	Calm
S8	2.10	SW
S9	0.00	SW
S10	2.10	SW
S11	1.80	SW
S12	1.00	Calm
S13	2.00	SW
S14	1.90	NE
S15	1.20	Calm
S16	1.10	SW
S17	0.90	SW
S18	0.80	SW
S19	2.40	NE
S20	0.10	Calm

Table 5.7b: Measured Wind Speed and Direction during the Study

Sampling Location	Rainy Season	
	Mean Wind Speed	Prevailing Direction
S1	0.85	SW
S2	2.00	SW
S3	1.00	SW
S4	0.10	Calm
S5	2.10	SW
S6	2.30	NE
S7	0.10	Calm
S8	1.80	SW
S9	0.80	SW
S10	1.70	SW
S11	1.60	SW
S12	0.30	Calm
S13	1.80	SW
S14	1.60	NE
S15	0.2	Calm
S16	1.00	SW
S17	1.00	SW
S18	1.00	SW
S19	2.10	NE
S20	0.10	Calm

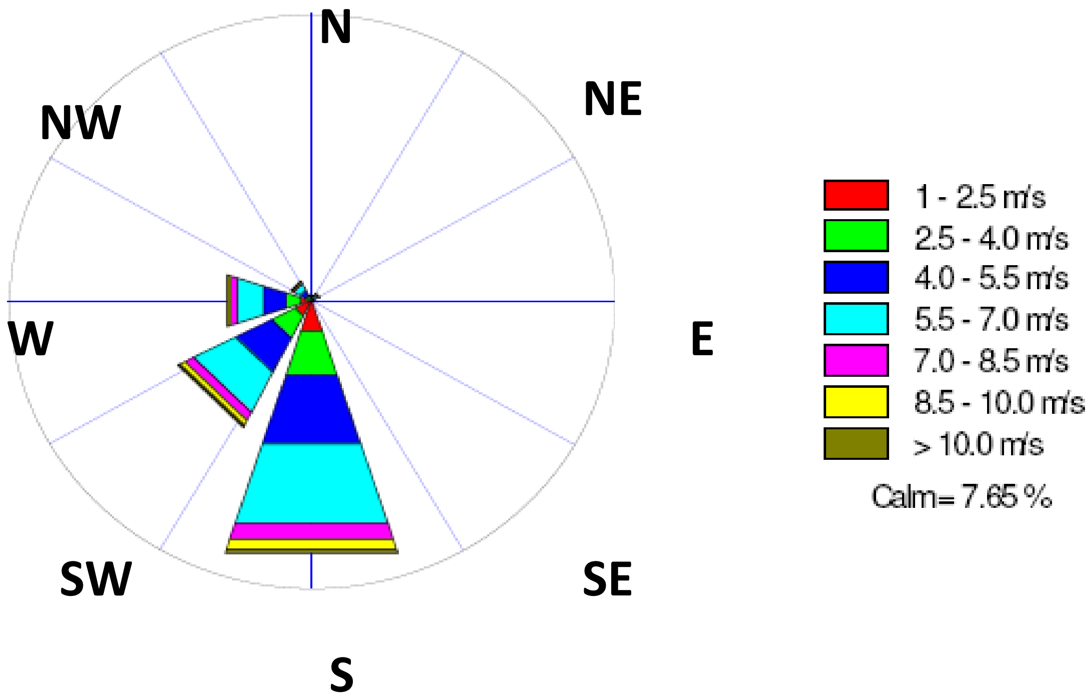

Figure 5.9.7: Wind Direction in the Study Area, 2009 – 2019 (Source: NIMET, 2019)

5.9.6.5 Sunshine Pattern

As shown in Figure 5.9.8, the mean monthly sunshine duration in the study area is about 21.4 % which varies between 14 % and 27 % with the minimum and maximum in the months of July and December respectively. The generally short sunshine rate in July could be attributed to the greater amount of cloudiness and rainfall characteristic of the period. Conversely, the higher sunshine rate in December is due to the prevalent clear skies when the ITCZ has once more started its Northward migration.

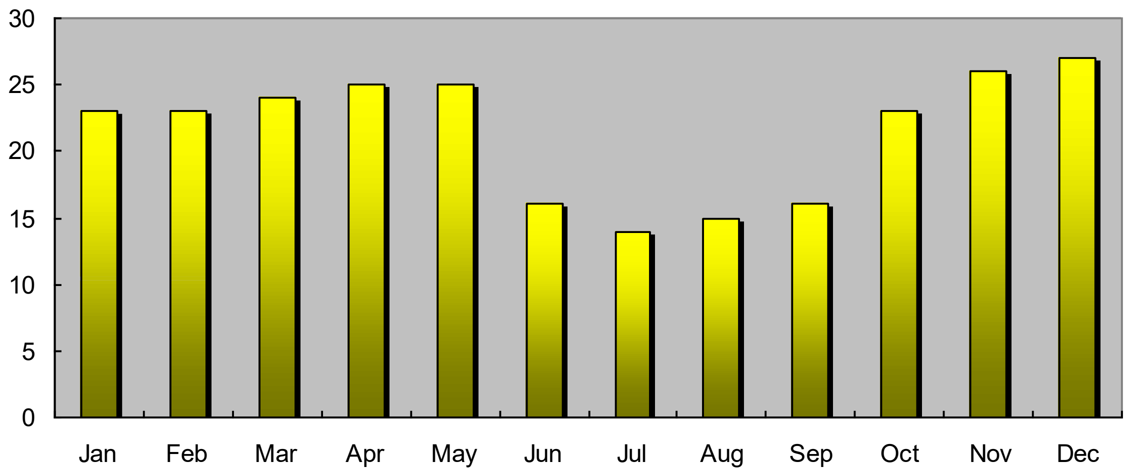

Figure 5.9.8: Monthly Sunshine Rate in the Study Area (Weather Underground, 2019)

5.9.6.6 Pressure

Atmospheric pressure in the study area in the past has been reported to be 1002 - 1012 mb. During the study, the measured atmospheric pressure ranged between 1005.0 and 1007.6 mb in the dry season and 1005.7 – 1007.3 mb in the wet season with respective averages of 1006.3 mb and 1006.6 mb which are all within these historical data.

5.10 Air Quality and Noise

5.10.1 Air Quality

The average measured 1 – hour concentrations of ambient gaseous pollutants in the area as obtained during the field study are summarized in **Table 5.8**. In all the sampling locations, the 1-hour levels of NO_X, CO, SO_2, and H_2S were below the measuring instruments detection limit both in the dry and wet seasons. In the dry season, NH_3 was detected in one of the sampling locations at 1.0 ppm level but in the wet season, it was not detected in any station. In the dry season, VOCs were detected in four (4) of the sampling locations over the range of 0.1 – 0.3 ppm in the dry season while in the wet season, they were not detected in any of the sampling locations in the study area. When compared with the 1-hour limit of 0.1 ppm as set by the Federal Ministry of Environment (FMEnv.), the ambient level of SO_2 in the study area was in compliance during the field measurement exercise of this study.

Table 5.8a: 1-Hour Measured Gaseous and Particulate Concentrations in the Proposed Deep-Sea Port Area (November, 2019)

Sampling Location	Mean Concentration (ppm)					
	NO_X	CO	SO_2	NH_3	H_2S	VOCs
	Dry	Dry	Dry	Dry	Dry	Dry
S1	<0.1	<1.0	<0.1	<1.0	<1.0	0.4
S2	<0.1	<1.0	<0.1	<1.0	<1.0	<0.1
S3	<0.1	<1.0	<0.1	<1.0	<1.0	<0.1
S4	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
S5	<0.1	<1.0	<0.1	<1.0	<1.0	0.2
S6	<0.1	<1.0	<0.1	<1.0	<1.0	<0.1
S7	<0.1	<1.0	<0.1	1.0	<1.0	<0.1
S8	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
S9	<0.1	<0.1	<0.1	<1.0	<1.0	0.3
S10	<0.1	<0.1	<0.1	<1.0	<1.0	<0.1
S11	<0.1	<0.1	<0.1	<1.0	<1.0	<0.1
S12	<0.1	<0.1	<0.1	<1.0	<1.0	0.1
S13	<0.1	<0.1	<0.1	<1.0	<1.0	0.2
S14	<0.1	<0.1	<0.1	<1.0	<1.0	<0.1
S15	<0.1	<0.1	<0.1	1.0	<1.0	<0.1
S16	<0.1	<0.1	<0.1	<1.0	<1.0	0.1
S17	<0.1	<0.1	<0.1	<1.0	<1.0	0.2
S18	<0.1	<0.1	<0.1	<1.0	<1.0	<0.1
S19	<0.1	<0.1	<0.1	1.0	<1.0	<0.1
S20	<0.1	<0.1	<0.1	<1.0	<1.0	0.1
FMEnv Limit	0.04 – 0.06	10	0.01	1.0	10	1.9
World Bank	0.08	26	-	-	-	-

Table 5.8b: 1-Hour Measured Gaseous and Particulate Concentrations in the Proposed Deep-Sea Port Area (March, 2020)

Sampling Location	Mean Concentration (ppm)					
	NO_X	CO	SO_2	NH_3	H_2S	VOCs
	Dry	Dry	Dry	Dry	Dry	Dry
S1	<0.1	<1.0	<0.1	<1.0	<1.0	0.4
S2	<0.1	<1.0	<0.1	<1.0	<1.0	<0.1
S3	<0.1	<1.0	<0.1	<1.0	<1.0	<0.1
S4	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
S5	<0.1	<1.0	<0.1	<1.0	<1.0	0.2
S6	<0.1	<1.0	<0.1	<1.0	<1.0	<0.1
S7	<0.1	<1.0	<0.1	1.0	<1.0	<0.1
S8	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
S9	<0.2	0	<0.2	<0.2	<0.2	0.5
S10	<0.2	0	<0.2	<0.2	<0.2	0.2
S11	<0.2	0	<0.2	<0.2	<0.2	0.2
S12	<0.2	0	<0.2	<0.2	<0.2	0.1
S13	<0.2	0	<0.2	<0.2	<0.2	0.2
S14	<0.2	0	<0.2	<0.2	<0.2	0.1
S15	<0.2	0	<0.2	<0.2	<0.2	0.1
S16	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
S17	<0.1	<1.0	<0.1	<1.0	<1.0	0.2
S18	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
S19	<0.1	<1.0	<0.1	1.0	<1.0	<0.1
S20	<0.1	<1.0	<0.1	<1.0	<1.0	0.1
FMEnv Limit	0.04 – 0.06	10	0.01	1.0	10	1.9
World Bank	0.08	26	-	-	-	-

On extrapolation, the dry season 24-hour concentrations of NO_X, CO, SO_2 and H_2S were insignificant in the study area while both NH_3 and VOCs were of 0.5 ppm and 0.1 - 0.2 ppm respectively in the same season. During the dry season and rainy season sampling, all the measured parameters with 24-hour averaging period concentrations of 0.0 ppm can be considered to be within the recommended limit of the Federal Ministry of Environment for these parameters during the dry season. Although VOCs were detected during the dry season, the

24-hour equivalent levels of these measured concentrations were far below the 1.9 ppm limit of the Federal Ministry of Environment (**Table 5.8**).

The measured particulate concentrations during the field study were of the range 5.0 – 31.1 μg/m^3, 11.1 – 38.0 μg/m^3, 11.4 – 17.0 μg/m^3, 6.0 – 7.3 μg/m^3, and 33.9 – 46.3 μg/m^3 for PM_{10}, PM_7, $PM_{2.5}$, PM_1, and TSP respectively in the dry season (Table 4.1.6). The 1-hour measured TSP concentrations are all within the FMEnv set limit of 600 μg/m^3 in all the sampling locations.

Extrapolation of the measured 1-hour concentrations to 24-hour averaging period levels gives ambient particulate concentrations to become 2.6 – 16.0 μg/m^3, 5.7 – 19.5 μg/m^3, 5.8 – 8.7 μg/m^3, 3.1 – 3.7 μg/m^3, and 17.4 – 23.8 μg/m^3 for PM_{10}, PM_7, $PM_{2.5}$, PM_1, and TSP respectively (**Table 5.9**). These 24-hour extrapolated concentrations of TSP are also far below both the FMEnv limit of 250 μg/m^3 and the World Bank limit of 80 μg/m^3. Though Nigeria has no standard for PM_{10}, these calculated 24-hour concentrations are below the World Bank limit of 80 μg/m^3 for both the dry season and rainy sampling (Tables 5.9a and 5.9b).

Table 5.9a: Measured Particulate Concentrations in the Study Area

S/No	PM_{10}	PM_7	$PM_{2.5}$	PM_1	TSP
	Dry	Dry	Dry	Dry	Dry
S1	31.1	29.9	14.0	6.6	33.9
S2	12.5	12.0	12.1	6.3	38.7
S3	10.1	11.1	13.4	6.3	38.5
S4	13.1	38.0	17.0	7.3	45.9
S5	12.1	12.1	13.2	7.1	41.1
S6	10.2	13.2	14.5	6.0	38.2
S7	14.5	34.4	14.5	7.3	46.3
S8	5.0	23.7	11.4	6.3	44.4
S9	20.7	17.5	6.2	0.9	20.4
S10	13.1	19.3	5.8	1.1	22.7
S11	15.2	20.5	7.2	1.3	26.5
S12	16.8	23.3	8.3	1.4	28.9
S13	4.1	7.8	7.5	1.4	28.9
S14	0.2	1.4	6.9	1.4	29.0
S15	15.9	11.9	6.5	1.4	29.2
S16	20.4	16.2	4.3	0.7	27.9
S17	17.7	21.7	3.7	0.6	17.0
S18	15.1	20.6	3.8	0.7	21.2
S19	14.9	19.9	3.4	0.9	20.5
S20	8.2	19.4	3.1	1.1	20.0
FMEnv Limit	-	-	-	-	250
World Bank Limit	-	-	-	-	80

Table 5.9b: Measured Particulate Concentrations in the Study Area

S/No	PM_{10}	PM_7	$PM_{2.5}$	PM_1	TSP
	Rainy	Rainy	Rainy	Rainy	Rainy
S1	36	32	16	11	38
S2	17	15	14	10	43
S3	15	14	15	10	44
S4	18	42	19	11	50
S5	17	16	15	11	44
S6	15	15	16	10	42
S7	19	39	16	11	50
S8	11	28	13	10	48
S9	23	23	9	5	25
S10	16	24	8	6	27
S11	18	25	10	6	31
S12	21	28	10	6	33
S13	10	13	9	6	32
S14	6	7	9	6	33
S15	22	16	9	6	33
S16	27	20	7	4	31
S17	23	25	6	4	21
S18	21	24	6	4	24
S19	19	22	6	3	25
S20	13	23	5	5	25
FMEnv Limit	-	-	-	-	250
World Bank Limit	-	-	-	-	80

5.10.2 Ambient Noise Status

During the field measurements for this study, the measured minimum noise levels in the proposed project site was of the range 0.0 – 45.3 dB(A) during both the dry and rainy season sampling. In this same study area and maximum measured noise levels were 42.7 – 60.5 dB(A). The minimum measured noise levels during the study were far below both the sleep disturbance limit (Berglund *et al*, 1999) of 45 dB(A) and the WHO's limit of 55 dB(A) for ambient environment. However, the WHO's limit was breached by the measured maximum noise levels in the study area in only 20% of the sampling locations in both seasons. We found out that, in the both the dry and rainy season sampling considered, the 8-hour shop floor limit (Tables 5.1.7a and 5.17b) of the Federal Ministry of Environment was not breached in the proposed Deep-Sea Port area.

Table 5:10a: The Standard Noise Level as set by the Federal Ministry of Environment (Dry Season Sampling, November, 2019)

Duration per Day, hour	Permissible Exposure Limit db (A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

*Source: FEPA (1991).

Table 5.10b: The Standard Noise Level as set by the Federal Ministry of Environment (Rainy Season Sampling, March, 2020)

Duration per Day, hour	Permissible Exposure Limit db (A)
12	90
9	92
7	95
5	97
4	100
6	102
6	105
1	110
0.5	115

*Source: FEPA (1991).

In this study, the measured meteorological parameters agree with the historical data in the study area. All the measured and extrapolated air quality parameters (NO_X, CO, SO_2 NH_3, H_2S, VOCs, PM_{10}, PM_7, $PM_{2.5}$, PM_1, and TSP) were within the known limits of both the Federal Ministry of Environment and that of the World Bank during the dry season sampling. Similarly, the minimum measured noise levels were far below both the sleep disturbance limit of 45 dB(A) and the WHO's limit of 55 dB(A) for ambient environment except at 10% of the sampling locations. The sleep disturbance limit was breached by the measured maximum noise levels in all but three locations. The WHO's limit was breached by the measured maximum noise levels in the study area in 20% of the sampling locations in the dry season. However, the 8-hour shop floor limit of the Federal Ministry of Environment was not breached in any of the sampling locations in the study area during the field measurements.

5.11 Soil and Land use

5.11.1 Land Use

In view of the physical and social setting of the study area, peasant farming, involving mostly arable crop production and lumbering (i.e. logging) is very prevalent. It was also observed that some women were into cassava tubers' processing into garri, while some of the men and women take to hunting and trading respectively. Forms of land use patterns within the study area include crop farming, and other agronomic practices.

Crop Farming: The cultivated arable crops include cassava, maize, fruit and leaf vegetables. Plantain/Banana is cultivated as home garden. Of these, cassava is by far more commonly cultivated in the study area. Average cost of cassava and maize per hectare depends on their stage of growth, the level of agronomic husbandry and season of the year. Thus, no attempt was made to estimate the average yield of the arable crops per hectare and the expected revenue.

Land preparation & other Agronomic practices in the study area

Agricultural land preparation is mainly by slash and burn, using mostly hand tools with or without heaping/moulding/ridging. On the average, planting is done on the heap.

A number of farmers in the study area were interviewed, and they all indicated that the use of agricultural inputs such as fertilizers (whether organic, inorganics or organo-minerals), and pesticides such as insecticides, herbicides, rodenticides, etc. for farming activities is not very common in the area. Thus, soil contamination from these farm inputs in the study area is not envisaged.

5.11.2 Fish Farming and Livestock

Fish farming is the predominant occupation of the people living in the area. Livestock observed within the various communities during the field work include dogs, sheep and goat. Domestic animals' cats, duck, hen, and water fowl. Generally, the animals scavenge and roam the surroundings, and no record of vaccination of any of the domestic animals could be obtained. Similarly, no game reserve was reported to be located anywhere within the study area.

5.12 Geomorphology and Soil Physico-Chemical characteristics

Geo-morphologically, the study area is very gently sloping to plain with slopes not steeper than 2 – 3%. However, the low content of soil organic matter, the sandy nature of the soils predisposes the soils to water erosion that could lead to siltation downstream in the area.

To further elucidate these facts through laboratory analysis, soil samples were collected from the study area.

5.12.1 Physical Characteristics of the Soils in Deep-Sea Port Area Field

In general, the soils are devoid of surface stones, boulders and or ironstone. The soils have potential for low water holding capacity, are generally very porous and well aerated. Incidence of ponding/water-logging condition is not envisaged except in exceptionally wet years.

Soils in the study area are highly weathered, well sorted, well drained, and high in sand content, with low content of clay and silt. **Table 5.11a** show the grain size distribution for the dry and rainy seasons respectively as recorded from the representative soil profile established sampled and analyzed in the Field. From the data obtained, the soils are sandy loam on the surface and sandy clay loam (scl) to sandy loam (sl) in the subsoil horizons. Table 6.1b indicates the spatial distribution of grain size in soils of the Field. From the various soil samples collected at various locations, the sand particles ranged from a minimum of 77% sand to 82% sand (dry season) – **see Tables 5.11b**. The implication of this high sand content is that the soils in all parts of the Field are sandy, porous and hence would be readily permeable to aqueous materials and or contaminants.

Similarly, the subsoils (i.e. 15 – 30-cm soil depths) too are predominantly sandy in texture (**see Table 5.11c**). The pattern of distribution of the various soil particles (i.e. sand, silt and clay) within the subsoil horizons in soils of the Field was not significantly different from those of the surface soil horizons. This implies that infiltration into the soils and transmission within the soils of aqueous materials in the area will be rapid and unhindered. Therefore, aqueous materials such as oil, paints and related materials (fresh or spent/used) would have to be carefully handled and hygienically disposed of in the field during the construction and maintenance phases of the proposed project. In general, issues concerning environmental hygiene would have to be carefully planned and executed in the field.

Table 5.11a: Physical Characteristics of Representative Soil Profile (Dry and Rainy Season, November, 2019 and March, 2020)

Soil Sampling Depth (cm)	Genetic Horizon	Soil Physical Properties			
		Grain Size Analysis			
		Sand	Silt	Clay	Texture
0 – 2 0	A	78	3	19	SL
20 – 60	AB	76	3	21	SCL
60 – 120	B	74	3	23	SCL

SL = Sandy loam; SCL = Sandy clay loam

Table 5.11b: Average Composition of the Physical Characteristics of Topsoils (0 – 15cm) (Dry and Rainy Season, November, 2019 and March, 2020)

Statistics (n = 8)	Soil Physical Properties			
	Grain Size Analysis (%)			
	Sand	Silt	Clay	Texture
Min	77	3	13	-
Max	82	5	18	-
Mean.	80.75	3.25	16.00	SL
Sd	1.75	1.28	2.27	-

Table 5.11c: Average Composition of the Physical Characteristics of Subsoils (15 - 30cm) (Dry and Rainy Season, November, 2019 and March, 2020)

Statistics (n = 8)	Soil Physical Properties			
	Grain Size Analysis (%)			
	Sand	Silt	Clay	Texture
Min	76	5	9	-
Max	80	12	15	-
Mean.	78.4	10.6	10.7	SL
Sd	1.3	1.6	1.4	-

5.12.2 Chemical Properties of the Soils

Chemically, the fertility constraints in these soils include the low soil organic matter content, low available-P and the very low content of the exchangeable bases (i.e. low exchangeable Na^+, K^+, Mg^{2+} and Ca^{2+}). In addition, the exchangeable acidity (H^+ and Al^{3+}) is considerably high (see Tables 4.1.9a). For instance, optimum soil pH for good arable soils in southern Nigeria is 6.5 while 2.5% is considered adequate for soil organic matter. Organic matter is generally regarded as the store house for plant nutrients. However, values recorded in these soils were well below the average hence the soils are considered to be low to very low in the essential plant nutrients such as N, P and K. This is because the average values of percentage Nitrogen recorded in soils of the study area were considerably below 1.00%N, and P values were well below 20-ppm which are critical values for soils in the southern part of Nigeria (Adepetu *et al*., 1979). **Tables 5.12a & 5.12b** show the chemical characteristics of the soils for the dry season period.

Table 5.12a: Chemical Characteristics of the Representative Soil Profile

(Dry Season, November, 2019)

Soil Sampling Depth (cm)	Genetic Horizon	Soil Chemical Properties												
		pH		OM	Avail-P	SO_4^{2-}	Cl^-	Exch. Acidity		Total-N	Exchangeable Bases			
								Al^{3+}	H^+		K^+	Na^+	Mg^{2+}	Ca^{2+}
		H_2O	$CaCl_2$	(%)	(µg/g)			(cmol(+)/kg		(%)	(cmol(+)/kg –soil)			
0 – 2 0	A	3.3	3.1	1.46	9.45	48.1	706	0.5	7.8	0.0759	0.02	0.43	0.30	0.22
20 – 60	AB	3.4	3.0	0.54	8.34	47.9	558	0.4	5.1	0.0632	0.02	0.38	0.20	0.20
60 – 120	B	3.3	3.1	0.13	6.91	57.2	348	0.3	4.3	0.0047	0.10	0.13	0.20	0.30

Table 5.12b: Chemical Characteristics of the Representative Soil Profile

(Rainy Season, March, 2020)

Soil Sampling Depth (cm)	Genetic Horizon	Soil Chemical Properties												
		pH		OM	Avail-P	SO_4^{2-}	Cl^-	Exch. Acidity		Total-N	Exchangeable Bases			
								Al^{3+}	H^+		K^+	Na^+	Mg^{2+}	Ca^{2+}
		H_2O	$CaCl_2$	(%)	(µg/g)			(cmol(+)/kg		(%)	(cmol(+)/kg –soil)			
0 – 2 0	A	3.5	3.3	1.35	9.15	45.00	774	0.7	7.9	0.08000	0.05	0.52	0.39	0.24
20 – 60	AB	3.6	3.2	0.48	8.00	43.00	602	0.5	5.3	0.07000	0.04	0.43	0.26	0.22
60 – 120	B	3.45	3.3	0.11	7.00	55.25	390	0.4	4.5	0.00500	0.30	0.25	0.24	0.41

Table 6.2c: Average Chemical Characteristics of the Topsoils (0 – 15cm)
(Dry and Rainy Season, November 2019 and March, 2020)

Statistics (n = 8)	Soil Chemical Properties												
	Ph		OM	Avail-P	SO_4^{2-}	Cl^-	Exch. Acidity		Total-N	Exchangeable Bases			
							Al^{3+}	H^+		K^+	Na^+	Mg^{2+}	Ca^{2+}
	H_2O	$CaCl_2$	(%)	(µg/g)			(cmol(+)/kg		(%)	(cmol(+)/kg –soil)			
Min	3.3	3.2	0.47	4.61	49.15	1581	0.50	1.2	0.025	0.03	0.3	0.3	0.28
Max	4.4	4.15	2.98	10.00	63.15	4985	0.80	5.4	0.27	0.05	0.7	0.7	1.45
Mean.	3.91	3.84	1.92	7.25	57.28	3267	0.40	3.9	0.12	0.04	0.5	0.35	0.35
Sd	0.37	0.41	1.63	1.33	13.61	872	0.35	1.8	0.09	0.02	0.03	0.22	0.25

For the dry and rainy season samplings, the soils in the proposed Deep-Sea area have low to very low in soil organic matter, N, P, K, Mg and Ca, and have considerable amount of exchangeable acidity. Furthermore, the soils were strongly acid and remained porous, permeable, well aerated without any evidence of encrustation. In general, the soils are poor in inherent fertility and have the potential capability of supporting mostly acid tolerant arable crops.

A consideration of the subsoil horizons showed that the highly weathered soils showed evidence of thorough mixing occasioned by the long period of weathering or pedogenesis (**Table 5.12c**). On the field, the subsoil horizon boundaries were diffuse and the morphology of the subsoil horizons was essentially uniform. Consequently, the soil chemical parameters recorded for the various subsoil horizons were not significantly different from those of the epipedons (i.e. surface horizons).

Table 5.12c: Average Chemical Characteristics of the Subsoil (15 - 30cm)
(Dry Season, November 2019)

Statistics (n = 8)	Soil Chemical Properties												
	pH		OM	Avail-P	SO_4^{2-}	Cl^-	Exch. Acidity		Total-N	Exchangeable Bases			
							Al^{3+}	H^+		K^+	Na^+	Mg^{2+}	Ca^{2+}
	H_2O	$CaCl_2$	(%)	(µg/g)			(cmol(+)/kg		(%)	(cmol(+)/kg –soil)			
Min	3.1	3.1	0.2	4.24	40	2111	0.1	0.4	0.018	0.01	0.22	0.12	0.14
Max	4.0	3.8	1.14	6.33	56	3110	0.5	2.1	0.124	0.03	0.32	0.43	0.87
Mean.	3.8	3.4	0.78	5.02	47	2210	0.3	1.8	0.071	0.03	0.24	0.32	0.43
Sd	0.4	0.3	0.5	1.2	9	52	0.2	0.7	0.05	0.01	0.03	0.11	0.22

Table 5.12.c: Average Chemical Characteristics of the Subsoil (15 - 30cm)
(Rainy Season, March, 2020)

Statistics (n = 8)	Soil Chemical Properties												
	Ph		OM	Avail-P	SO_4^{2-}	Cl^-	Exch. Acidity		Total-N	Exchangeable Bases			
							Al^{3+}	H^+		K^+	Na^+	Mg^{2+}	Ca^{2+}
	H_2O	$CaCl_2$	(%)	(µg/g)			(cmol(+)/kg		(%)	(cmol(+)/kg –soil)			
Min	3.3	3.2	0.32	4.38	44	2327	0.2	0.5	0.020	0.02	0.25	0.14	0.16
Max	4.2	3.9	1.19	6.41	61	3284	0.6	2.3	0.135	0.04	0.37	0.49	0.92
Mean.	3.9	3.6	0.84	5.26	49	2267	0.4	1.9	0.072	0.04	0.24	0.37	0.46
Sd	0.6	0.6	0.55	1.29	11	78	0.3	0.8	0.095	0.02	0.08	0.15	0.29

5.12.3 Soil and Sediment Survey

Parts of the continental shelf and slope off shore Ondo State have been investigated to a maximum depth of about 50 m.

100 stations were occupied during the survey, and grab samples were obtained for further studies. The sampling interval used to obtain the grab sediment samples from the coast to 10 km outwards into the Atlantic Ocean is 100 m. The sea bed morphology was recorded over long traverses using a non-precision, navigational echo-sounder (**See Plate 25**).

During the surveys, sounding lines were established either perpendicular to, diagonal or parallel to the coastline. Ship's speed was maintained at about 6 km per hour, for all the bathymetric surveys. Positioning of the vessel was carried out using satellite navigation (SATNAV) and radar techniques.

Echo sounder (Furuno type) on board the vessel was used to collect continuous water depth records on echo sounder paper. A 10 minutes event mark was used throughout all the surveys. A plotter on board was used to plot all the ship's courses, throughout the survey.

Resulting from the combined study of echograms and bottom samples, supplemented with data from British Admiralty hydrographers and Nigerian Institute of Marine and Oceanographic Research (NIOMR) and seismic sections from the Department of Petroleum Resources (DPR) provided detailed information of the investigated area.

The most important earlier surveys of this region were made by the British Admiralty, giving its results as discrete soundings and bottom sediment notations on charts. This work established the general character of the higher continental margin, revealing at least one submarine canyon and the existence on the continental shelf of large patches of sand separated from shore by mud.

It is observed that, in terms of grain size, bottom sediments were classified as sand (coarser than 60 (μ), clayey silt or silty clay. The sand facies extend from shore for distances of 2 km and downward into maximum depths from 3-50 metres. The shallower deposits of this facies comprise clean to slightly muddy sands which coarsen toward the beaches. The beach sands are typically fine grained, clean and well sorted, but a little offshore very fine sand is encountered. In places the deeper part of the facies consists of interbedded layers of very fine sand, clean coarse silt and clayey silt, the latter increasing in importance seaward. The area of the sea floor occupied by the silt facies varies from 3 to 7-20 km in width and from 40 to 80 m maximum depth.

Core samples obtained in the area earlier by Allen (1964) and Ibe and Awosika (1984) show thick layers of silty clay and clayey silt in close alternation with thin bands and laminae of clean coarse silt. These layers die out in depths from 10 to 15 km, giving place to uniform clayey silts forming the deeper part of the facies. The clay facies is represented by uniform silty clays devoid of stratification which cover the remainder of the continental shelf. Thus the zones characterised by sand, silt and clay conform closely to the classical idea of grain size changes away from actively building coasts.

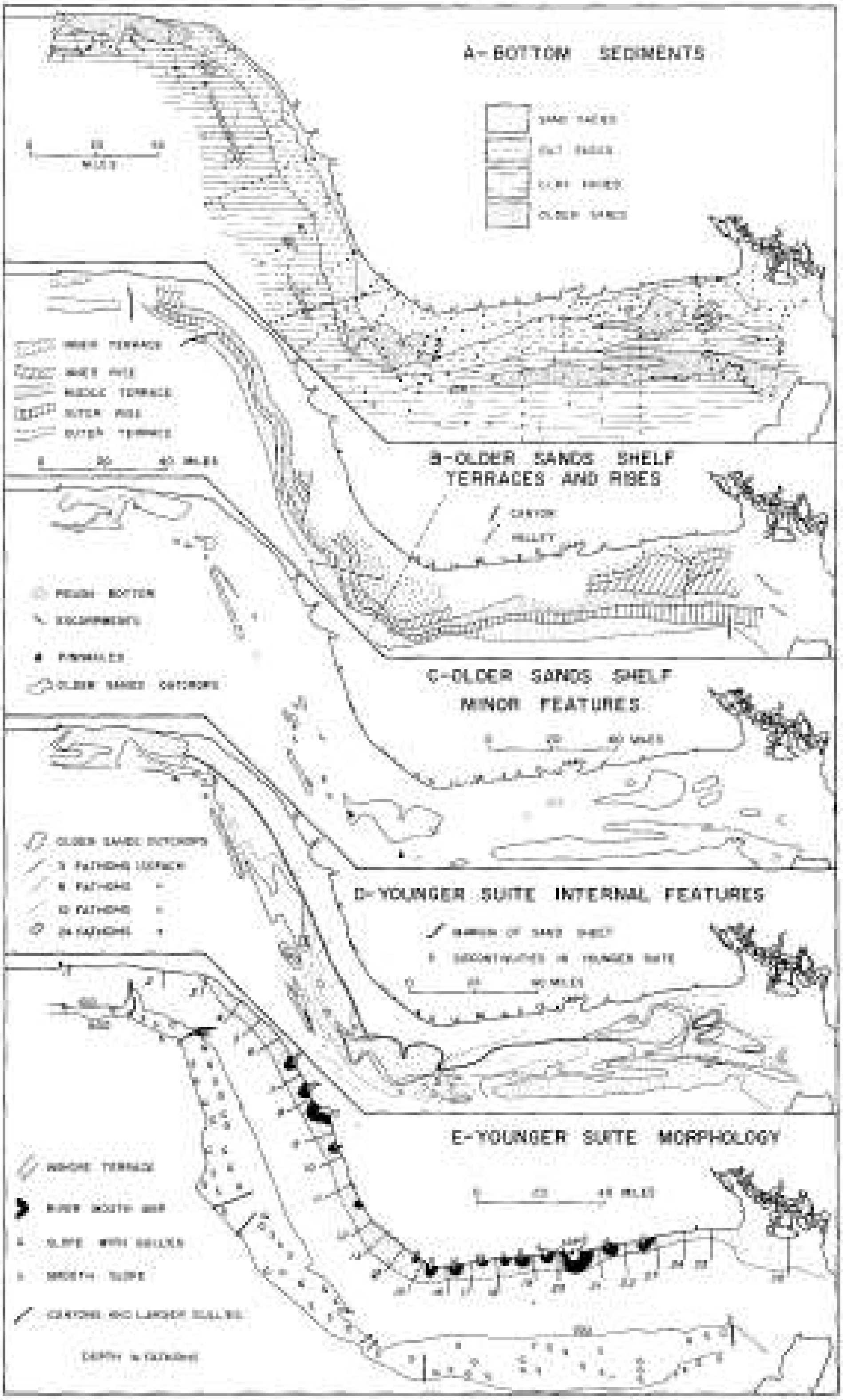

Plate 25: Sediment distribution along the entire Nigerian continental Shelf. Note the Grab sample locations are shown in black dots (After Allen, 1964)

Distribution in depth: Stratigraphical Succession

The evidence obtained from the combined analysis of echograms and bottom samples data obtained from Allen (1964), Allen (1968) and Ibe and Awosika (1984) suggest that the sand patches observed are the unburied portions of a sheet-like sand body extending over the whole shelf. In most areas this sheet underlies the sand, silt and clay facies seen at the surface and itself overlies deposits of other character.

A strong and persistent sub-bottom reflection marking a major physical discontinuity in the bottom sediments was observed on all echograms and was found to vary in depth below the sea bed (See Plates 26, 27, 28 and 29 respectively).

Sedimentary Distribution and Movement

Allen (1964) was the first to study the sediment distribution along the entire Nigerian continental shelf, discussing the sediments as 'younger' and 'older' suites. The investigated parts of Ondo State, in the proposed Deep-Sea Port area was found to consist mainly of the older sands, but with the younger suites (QS) cropping out farther out to sea. The older suites were discussed as convex upward, extending and growing steeper towards the shelf edge. These older suites are composed of shelly or glauconite sands, which occur in gently sloping terraces and in, water depths down to 25 to 30m. The sand facies grade into silt and mud farther out to sea, from a depth of about 35m to the shelf edge. The geological map of the Nigeria also shows the sand facies offshore the western continental shelf.

Studies by Allen and Wells (1962); Burke (1972) and Ibe et al., (1984) indicated that the net direction of sediment movement is west-east transported mainly by longshore currents. The Guinea current, which flows west-east with some reversals (Longurst, 1961) and a current speed of not more than 0.3m/s is not known to transport bottom sediments. However, it may be transporting suspended material along its course.

Geologically, they form the innermost part of continental margins, which are divided usually into the shelf, continental slope and rise and abyssal plain (**See Plate 30**). The United Nations Law of the Sea Convention (UNCLOS) of 1982 however, has a legal definition (Fig. 2.11). Article 76 of the Convention sets out the definition of Continental Shelf and the requirements by Coastal States wishing to make a submission to the United Nation Commission on the Limits of the Continental Shelf (CLCS). Article 76 of the UNCLOS 1982 defines the continental shelf in two scenarios (United Nations, 1997):

i. “the breadth of the continental shelf is limited to a distance of 200 nautical miles (M) from the baselines from which the breadth of the territorial sea is measured. This also occurs where the outer edge of the continental margin does not extend beyond 200M (Art. 76)”;

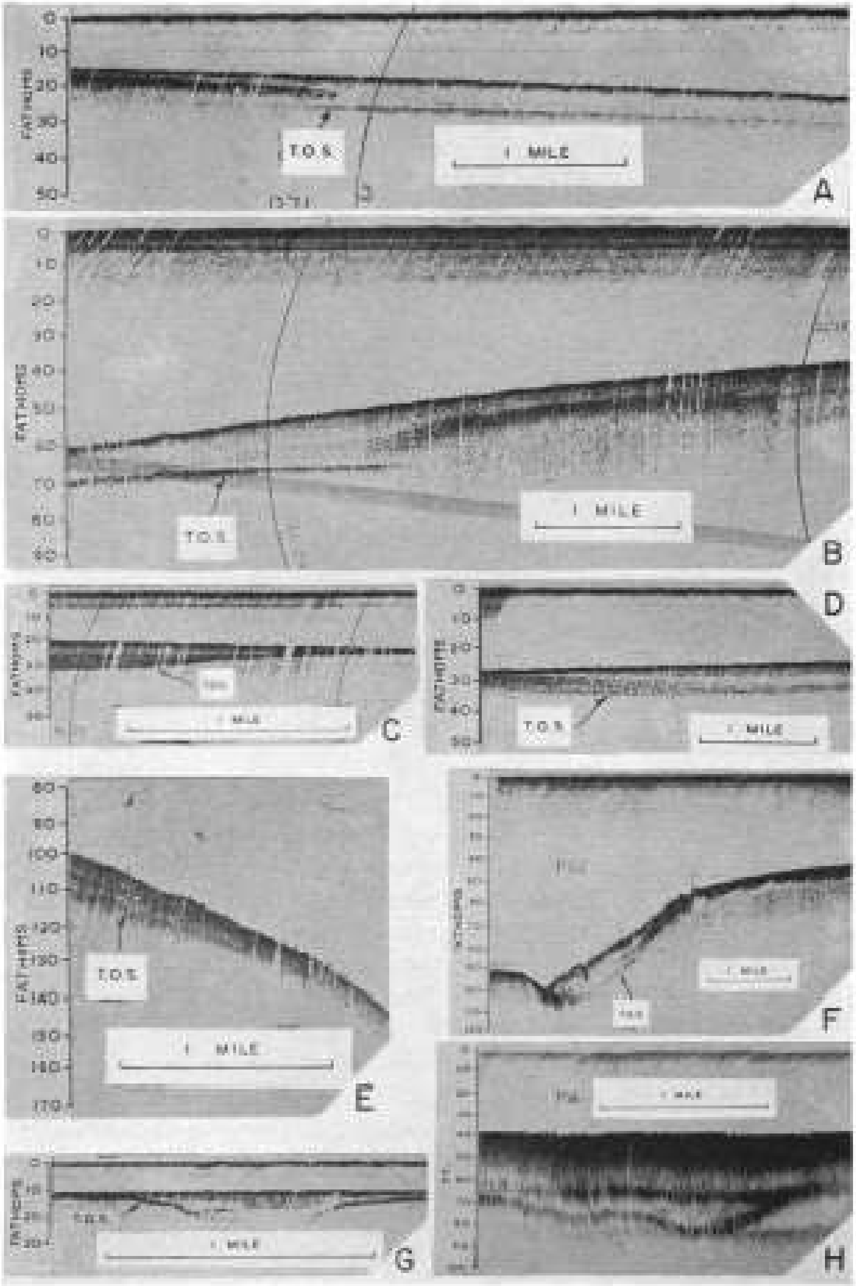

Plate 26: Internal Features of Younger Suite obtained through Echogram along the Continental Shelf of Nigeria (After Allen 1964, and NIOMR, 1984). The location of the Ondo State Deep-Sea Port Area is towards the right hand corner

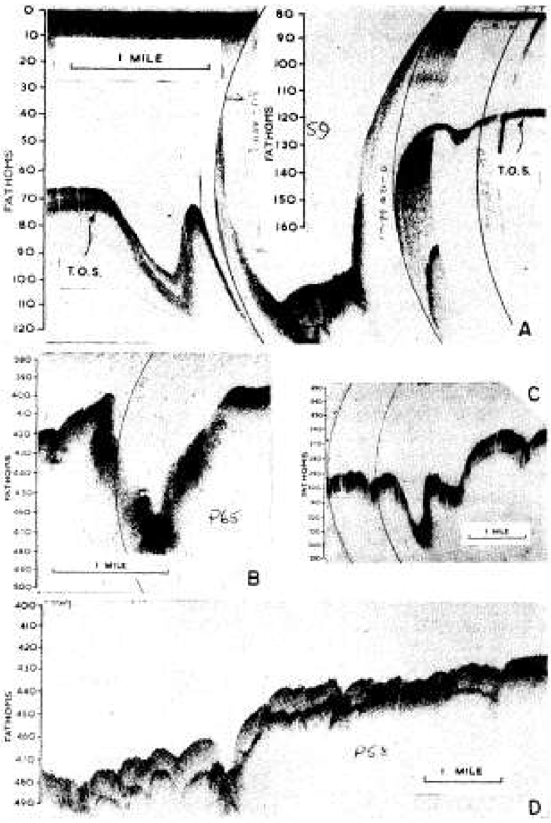

Plate 27: Internal Features of the Older Suite obtained through Echogram along the Continental Shelf of Nigeria (After Allen 1964, and NIOMR, 1984). The location of the Ondo State Deep-Sea Port Area is towards the right-hand corner.

The interpretation of the 2D seismic sections (**Plates 28 and 29**) reveal prominent reflectors which mark the boundaries of six seismic layers or units labeled 1, 2, 3, 4, 5 and 6 on the seismic sections. These major reflectors have been marked by lines coloured green (G) yellow (Y), blue (B), and red (R). A major erosional surface marking the base of the Avon canyon paleo-channel is recognised on the seismic sections and coloured purple (P). Onlap surfaces within the canyon fill are coloured dashed purple. These major seimic reflectors (colour coded) act as seismic layer boundaries of the six (1-6) different seismic units identified in the seismic sections. Deep-Seated faults within the basement complex are mapped on the seismic sections by black (BL) lines. These faults which dip mostly to the east are very well shown by the offsetting of the G reflector. Furthermore, the 2D seismic sections revealed the general geometry and architecture, sedimentary units and patterns, unconformities in the investigated area. Individual sequences vary in thickness in relation to location of sources of sediments. Within seismic units demarcated by prominent reflectors (coloured), the lowstand wedge thins considerably along strike and is interpreted to record variable paleobathymetry along strike.

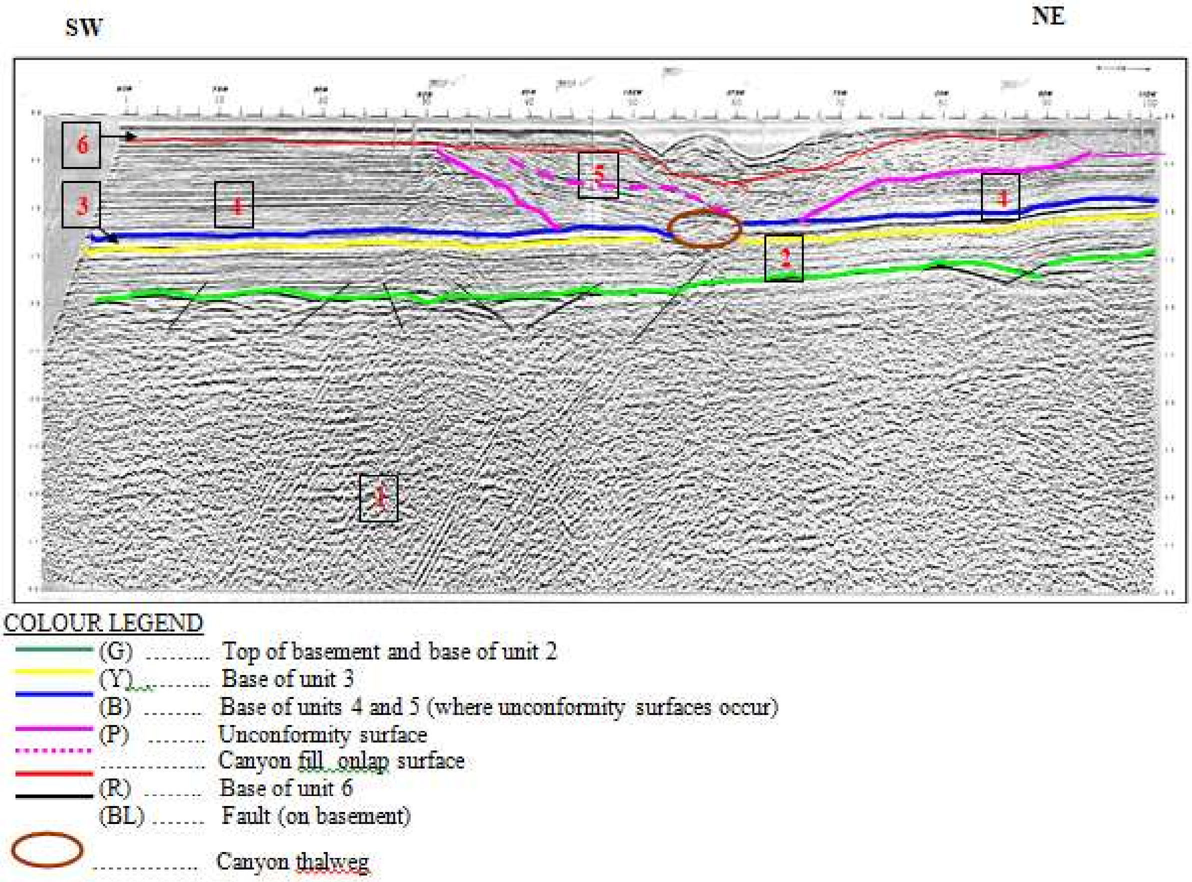

Plate 28: Seismic Section Showing the Canyon and Bottom Reflection Sediments in the Proposed Ondo Deep-Sea Port Area

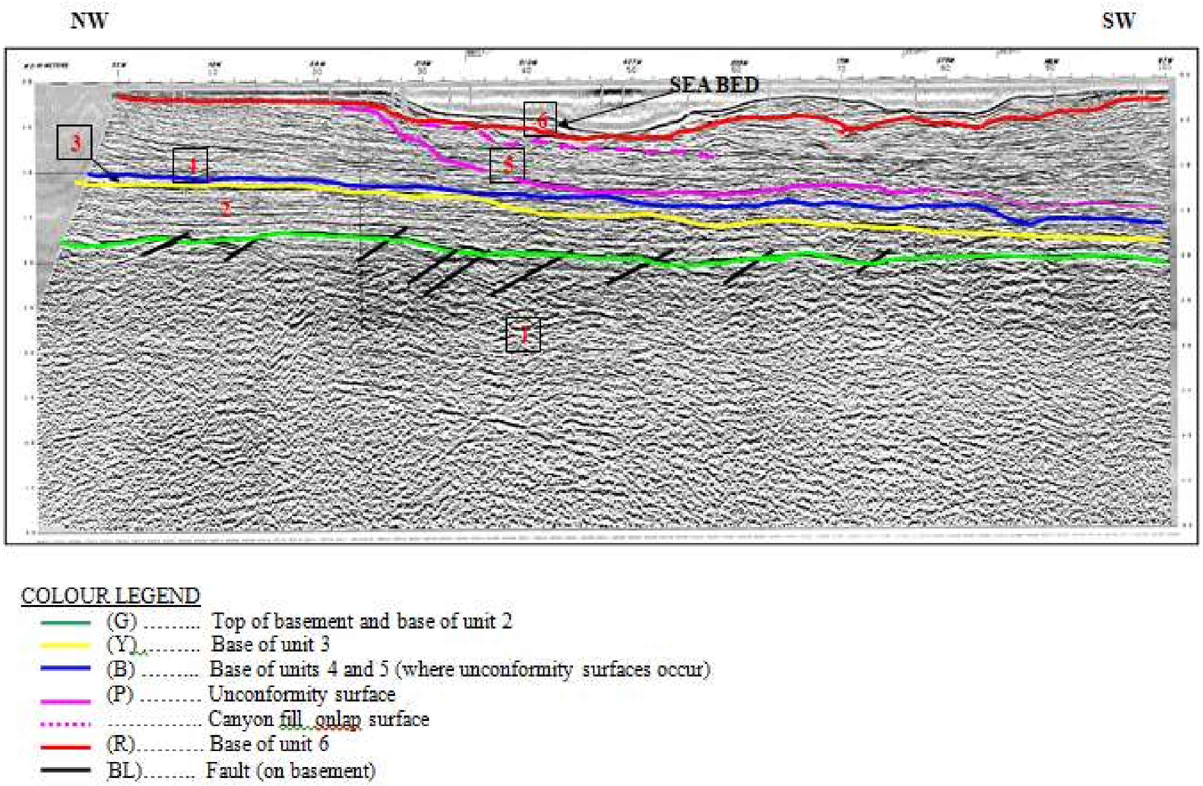

Plate 29: Seismic Section Showing the Sea Bed Morphology and the Bottom Reflection Sediments in the Proposed Ondo Deep-Sea Port Area

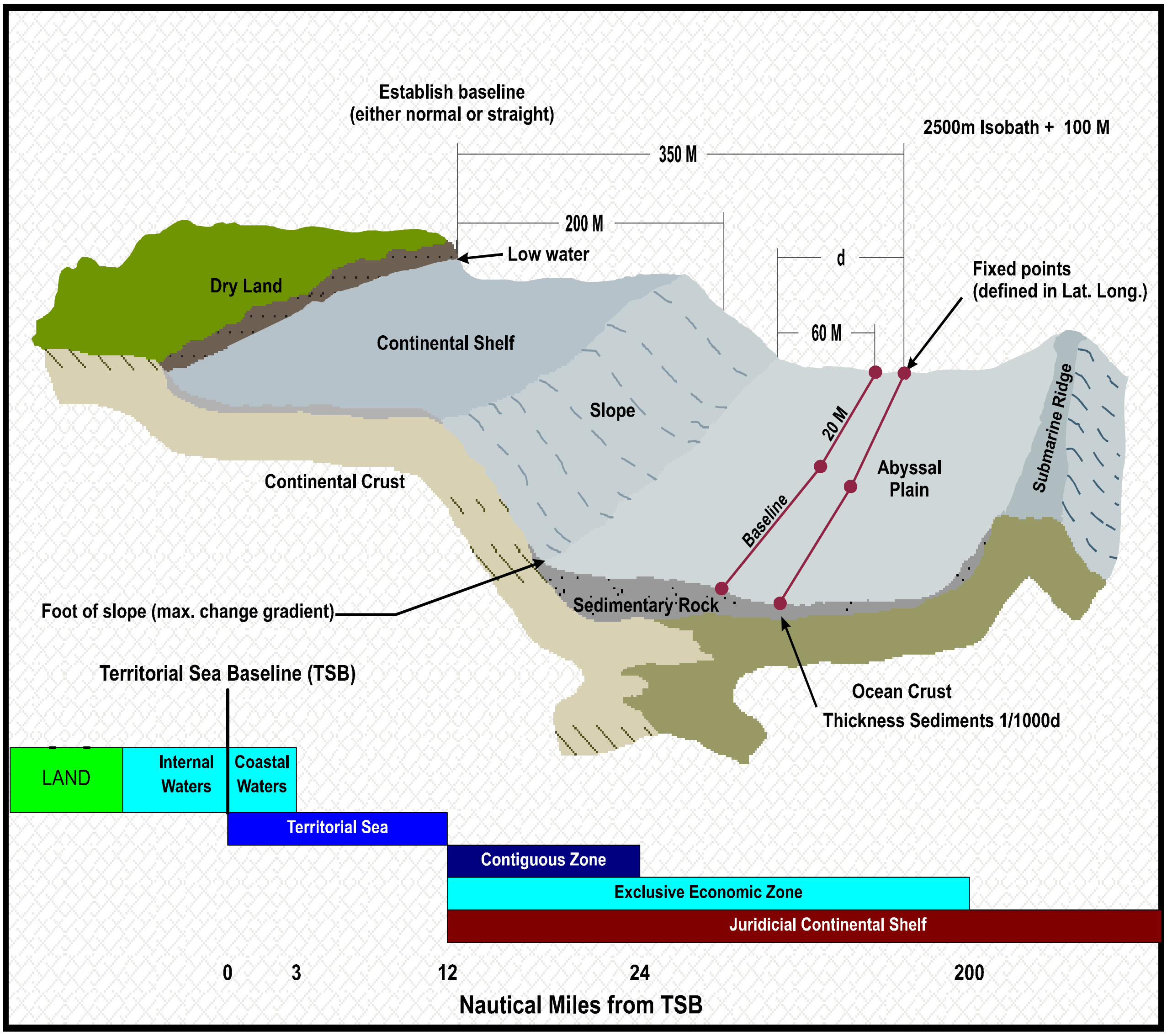

Plate 30: **Legal (UNCLOS II of 1982) definition of the continental shelf (After Kapoor and Adam, 1986).**

5.12.4 Classification of the Soils

Soils similar to the proposed Deep-Sea area were classified (Amusan *et al.*, 2005) as Ultisol, i.e. low base status acid forest soils (USDA Soil Taxonomy, 2002) and as Lixisol (FAO/UNESCO, 1996) i.e. moderately to highly weathered, acid forest soils with low activity clay and commonly low to moderate in inherent fertility. These soils are highly to very highly susceptible to water erosion on account of low soil organic matter, loose or incoherent and or weak soil structure and heavy annual regional rainfall.

5.12.5 Total hydrocarbon content of the Soils

The soil samples were all extracted with xylene. However, using the Spectrophotometer to determine the total hydrocarbon content (THC) of the extract, no THC was detected in any of the soil extracts. The detection limit for the Spec used was 0.01-ppm. Thus, it was concluded that none of the soil samples collected in during the dry season had THC concentration of 0.01 ppm and above. It was therefore concluded that the THC concentrations in the soil samples were below the detection limit (< 0.01-ppm) of the equipment employed.

5.12.6 Heavy Metal Content of the Soils

The heavy metal concentrations in the soil samples collected from the Soil Profile pit both during the dry and rainy season sampling are presented in Tables 5.2.0a and 5.2.0aa.

Table 5.13a: Heavy Metal Content of Representative Soil Profile (Dry Season, November 2019)

Soil Sampling Depth (cm)	Genetic Horizon	Heavy Metals								
		Fe	Cu	Zn	Pb	Cr	Co	Ni	V	Cd
		(ppm)								
0 – 2 0	A	45	10	4	12	4	BDL	9	2	1.0
20 – 60	AB	38	8	3	8	2	BDL	7	1	0.6
60 – 120	B	38	8	2	7	2	BDL	7	0	0.3

BDL = Below detection limit (i.e. < 0.001-ppm) of the equipment employed

Table 5.13b: Heavy Metal Content of Representative Soil Profile (Rainy Season, March, 2020)

Soil Sampling Depth (cm)	Genetic Horizon	Heavy Metals								
		Fe	Cu	Zn	Pb	Cr	Co	Ni	V	Cd
		(ppm)								
0 – 2 0	A	48	11	4.5	15	6	BDL	7	1	0.6
20 – 60	AB	40	9	3.7	10	4	BDL	5	1	0.4
60 – 120	B	40	8.6	2.5	8	4.2	BDL	5	0	0.1

BDL = Below detection limit (i.e. < 0.001-ppm) of the equipment employed

The cobalt's (Co) concentrations in the profile pit samples were below the detection limit (i.e. < 0.001-ppm) of the equipment employed. All the other forms of heavy metals were present in relatively low concentrations and no unusually high concentration of any of the other heavy metals was detected in the profile pit soil samples. In terms of quantity and distribution of these metals, there were no significant differences for both seasons judging by the values obtained as recorded in **Table 5.13a and 5.13b**.

Tables 5.14a show the quantity and pattern of distribution of these heavy metals in the various soil samples collected from different locations within the Deep-Sea Port Area Field. It would be observed that throughout the entire field, there was no evidence of bio-accumulation of any of these heavy metals in the soils. Data for both seasons were similar in concentration and distribution, thus, it was inferred that there were no significant seasonal variations during the two season sampling (**see Table 5.14a**).

Table 5.14a: Average Concentration of the Heavy Metal Content of Top soils (0 – 15cm) (Dry Season, November 2019)

Statistics (n = 20)	Heavy Metals								
	Fe	Cu	Zn	Pb	Cr	Co	Ni	V	Cd
	(ppm)								
Min	40	3	3	4	1	-	1	0.8	0.05
Max	60	10	6	9	3	-	6	3	2
Mean.	48	7	4	6	2.4	BDL	4	2	1
Sd	6	2	1	2	1	-	3	1	0.6

Table 5.14b: Average Concentration of the Heavy Metal Content of Top soils (0 – 15cm) (Rainy Season, November 2019)

Statistics (n = 20)	Heavy Metals								
	Fe	Cu	Zn	Pb	Cr	Co	Ni	V	Cd
	(ppm)								
Min	49	5	5	6	2	-	2	1	0.9
Max	77	13	8	13	4	-	8	5	4
Mean.	54	9	5	8	3	BDL	6	3	2
Sd	9	3	2	5	2	-	4	2	1

Table 5.14c and **Table 5.14d** present the spatial distribution of heavy metals in the subsoil during the two-season sampling. It was also noted that values obtained were similar in quantity and pattern of distribution to those of the surface soil samples for both the dry and rainy season sampling.

Table 5.14c: Average Concentration of the Heavy Metal Content of Subsoils (15 - 30cm) (Dry Season, November 2019)

Statistics (n = 8)	Heavy Metals								
	Fe	Cu	Zn	Pb	Cr	Co	Ni	V	Cd
	(ppm)								
Min	41	2	1	4	1	-	0.8	0.5	0.03
Max	60	9	4	7	2	-	2	1.1	0.8
Mean.	47	6	3	5	1.2	BDL	1.4	1	0.5
Sd	6	3	0.5	0.6	0.4	-	0.5	0.2	0.3

Table 5.14d: Average Concentration of the Heavy Metal Content of Subsoils (15 - 30cm) (Rainy Season, November 2019)

Statistics (n = 8)	Heavy Metals								
	Fe	Cu	Zn	Pb	Cr	Co	Ni	V	Cd
	(ppm)								
Min	45	4	2	6	2	-	1	1	0.2
Max	63	11	5	9	3	-	4	1.8	1
Mean.	55	8	7	6	2	BDL	2	3	1
Sd	11	5	2	1	1	-	1	0.8	0.7

Generally, the concentrations of the heavy metals are very low when compared to corresponding concentrations in naturally occurring unpolluted soils as reported by *Alloway (1991)* and *Allen et al. (1974)*. To make sound, scientific judgement about the extent of heavy metal contamination or otherwise of the soils studied, adequate references were made to heavy metal content in unpolluted soils as reported for different countries of the world and also indicated the normal range in unpolluted soils (**Table 5.15**).

From the heavy metal concentration data reported for soils in the study area, there was no evidence of heavy metal accumulation/bioaccumulation in the soils as at the time of field investigations. This is because the heavy metal concentrations reported for soils in the study area were significantly lower ($P < 0.05$) than the concentrations that were reported as the trigger levels (**Table 5.15**).

Table 5.15: Background Levels of Heavy Metals (mg/kg) in Soils of different countries of the world.

Metal	Countries of the World			Normal range in unpolluted Soils
	Netherlands	UK (Former GLC)[1]	FRG (NOEL)[2]	
Fe	-	-	-	-
Cr	100	0 – 100	100	5 – 1500
Ni	50	0 – 20*	50	2 – 750
Pb	50	0 – 500	100	2 – 300
Zn	200	0 – 250*	300	1 – 900
Cu	50	0 – 100*	100	2 – 250
Cd	1	0 – 1	3	0.01 – 2.0
V	-	-	-	3 – 500

[1]GLC = Greater London Council; [2]FRG/NOEL = Federal Republic of Germany; No Effect Limit.
Source: Alloway (1991).

5.12.7 Soil Microbiology

The microbial flora of soil samples from the proposed Deep-Sea area comprised of five bacteria species and twelve species isolates of fungi which are all moulds (**Table 5.16**) The most occurring bacterial isolates were *Psedumonas aeruginosa* (Pseudomonades: *Pseudomonadaceae*) which occurred in all the soil samples and *Klebsiella edwardsii* (Eubacteriales: *Enterabacteriaceae)* with 84% occurrence. The occurrence frequency of bacteria isolates was higher in surface soil than in subsoil. In general, the number of isolates per sample varied from 2 to 4. The fungal flora was dominated by common moulds, notably *Mucor, Penicilium, Rhizopus and Aspergillus* species. On the whole the most occurring fugal isolates were *Cephalosporium sp* (84%), *Fusarium sp* and *Mucor mucedo* (67% each) and *Phialophora sp* (50%). The number of fungal isolates per soil sample was in the range of 1-8 (median = 5spp). Again species richness and frequency of occurrence were higher in surface soil than in subsoil (**Table 5.16a and Table 5.16b**).

Table 5.16a: Occurrence and distribution of microbial flora in soil samples from the proposed Deep-Sea Area (Dry Season, November, 2019)

SN	Taxon	Occurrence in sampling station						%Occurrence frequency		
		1	2	3	4	5	6			
Bacteria								SS	SSS	TS
1	*Acinectobacter calcoucerticus*			+	+			33	33	33
4	*Klebsiella edwardsii*	+	+		+	+	+	67	100	84
5	*Klebsiella ozoenae*			+				33		17
7	*Kl. Rhinoclenomatis*	+		+	+	+		100	33	67
8	*Pseudomonas aeruginosa*	+	+	+	+	+	+	100	100	100
Fungi										
1	*Aspergillus fumigatus*				+				33	17
2	*Aspergillus glaucus*	+		+	+			67	33	50
3	*Cephalosporium sp*	+	+	+	+	+		100	66	84
4	*Fusarium sp*	+	+		+	+		67	67	67
5	*Microsporium audounii*		+						33	17
6	*Mucor hiemalis*				+				33	17
7	*Mucor mucedo*		+	+	+	+		67	67	67
8	*Penicillium digitatum*				+				33	17
9	*Phialophora sp*		+	+			+	33	67	50
10	*Pullularia pullulans*					+		33		17
11	*Rhizopus oryzae*			+				33		17
12	*Rhizopus stolonifera*				+	+		33	33	33
Total bacteria		3	2	4	4	4	2			
Total fungal		3	5	5	8	5	1			
Total microbial isolates		6	7	9	12	9	3			

SS = Surface Soil, SSS = Subsurface soil, TS = Total samples

Table 5.16b: Occurrence and distribution of microbial flora in soil samples from the proposed Deep-Sea Area (Rainy Season, March, 2020)

SN	Taxon	Occurrence in sampling station						%Occurrence frequency		
		1	2	3	4	5	6			
Bacteria								SS	SSS	TS
1	*Acinectobacter calcoucerticus*			+	+			39	39	39
4	*Klebsiella edwardsii*	+	+		+	+	+	70	106	96
5	*Klebsiella ozoenae*			+				39		21
7	*Kl. Rhinoclenomatis*	+		+	+	+		103	37	72
8	*Pseudomonas aeruginosa*	+	+	+	+	+	+	105	107	109
Fungi										
1	*Aspergillus fumigatus*				+				36	21
2	*Aspergillus glaucus*	+		+	+			69	36	55
3	*Cephalosporium sp*	+	+	+	+	+		103	69	88
4	*Fusarium sp*	+	+		+	+		69	70	70
5	*Microsporium audounii*		+						36	19
6	*Mucor hiemalis*				+				35	20
7	*Mucor mucedo*		+	+	+	+		71	71	71
8	*Penicillium digitatum*				+				37	19
9	*Phialophora sp*		+	+			+	35	69	55
10	*Pullularia pullulans*					+		38		19
11	*Rhizopus oryzae*			+				35		20
12	*Rhizopus stolonifera*				+	+		39	39	39
Total bacteria		3	2	4	4	4	2			
Total fungal		3	5	5	8	5	1			
Total microbial isolates		6	7	9	12	9	3			

SS = Surface Soil, SSS = Subsurface soil, TS = Total samples

Information in microbial abundance in soil sample is presented in **Table 5.17a and Table 5.17b** (Dry and Rainy Season Sampling). The total heterotrophic bacteria (THB) occurred over a wide range of 4.0×10^3 cfu/g (mean = 2.7×10^6 cfu/g) while hydrocarbon degrading bacteria (HDB) occurred in the range of 0-10×10^3 cfu/g (median = Nil). Thus, on the average the ratio of HDB: THB was less 0.01%. The abundance of Total heterotrophic fungi (THF) were generally less than that of THB, occurring over the range of 7.0×10^2 – 5.0×10^5 cfu/g (median = 2.1×10^3 cfu/g) the value of HDF / THF occurred in the range of 0.5 – 65.9% (median = 12.5%) suggesting the some of the fungi are hydrocarbon degraders. Mean abundant tended to decrease from surface soil through mid-subsurface soil to bottom subsurface levels (**Tables 5.2.3 and 5.2.3b**). On the whole, microbial abundance occurred within the known levels in unpolluted soils.

Table 5.17a: Descriptive statistics of microbial abundance in Soil Samples (Dry Season, November 2019)

SN	Sample code	Depth (cm)	THB@35^{0}C (cfu/g)	HDB@30^{0}C (cfu/g)	THF@30^{0}C (cfu/g)	HDF@30^{0}C (cfu/g)	HDF/ THF (%)
1	OS-25R (5)	15-30	6.0x10^7	1.0 x10^3	2.1 x10^4	1.0 x10^3	4.8
2	OS-CONT (7)	15-30	4.0 x10^7	0.04 x10^3	2.0 x10^5	1.0 x10^3	0.5
3	OS-1R(a)	0-15	2.7 x10^6	Nil	4.0 x10^3	3.0 x10^3	75
4	OS-1R (13)	15-30	4.0 x10^5	Nil	4.1 x10^4	2.7 x10^4	65.9
5	OS-6R (14)	0-15	1.2 x10^6	Nil	7.0 x10^2	1.0 x10^3	14.3
6	OS-Cont (36)	0-15	7.0 x10^7	0.08 x10^3	5.0 x10^5	3.0 x10^3	0.6
7	OS-6R (41)	60-153	4.0 x10^3	Nil	8.0 x10^3	1.0 x10^3	12.5

Table 5.17b: Descriptive statistics of microbial abundance in Soil Samples (Rainy Season, November 2019)

SN	Sample code	Depth (cm)	THB@35^{0}C (cfu/g)	HDB@30^{0}C (cfu/g)	THF@30^{0}C (cfu/g)	HDF@30^{0}C (cfu/g)	HDF/ THF (%)
1	OS-25R (5)	15-30	8.0x10^7	1.5 x10^3	2.8 x10^4	1.3 x10^3	5.1
2	OS-CONT (7)	15-30	45.0 x10^7	0.08 x10^3	2.4 x10^5	1.3 x10^3	0.77
3	OS-1R(a)	0-15	2.9 x10^6	Nil	4.4 x10^3	3.6 x10^3	89
4	OS-1R (13)	15-30	4.3 x10^5	Nil	4.6 x10^4	3.0 x10^4	68.15
5	OS-6R (14)	0-15	1.5 x10^6	Nil	7.9 x10^2	1.6 x10^3	17.55
6	OS-Cont (36)	0-15	7.8 x10^7	0.10 x10^3	5.6 x10^5	3.7 x10^3	0.95
7	OS-6R (41)	60-153	4.5 x10^3	Nil	8.5 x10^3	1.9 x10^3	15.35

5.12.8 Vegetation

The vegetation of the area is characterized by Fallow land vegetation with big stands of *Mangifera indica* and other few woody species*; Musanga cecropoides, Gmelina arboreus and* Fallow land vegetation dominated by mixture *Alstonia boonei* and woody species ,shrubs and herbs.

5.12.9 Fallow land vegetation

The fallow land communities include fallow of less than five years of age. The rotational fallow systems of cultivation accounts for much of the structural and floristic variations as well as the micropattern of the present cover at the study site. This vegetation has no significant nature conservation and occupies about 48% of the area.

The vegetation of this fallow land is more of herbaceous and the soft stem plants. There is considerable variation in the composition of woody fallow land vegetation and this can be related to environmental factors and age. Some shade-loving forest floor species have been eliminated and species adapted to open conditions such as *Chromolaena odorata and Panicum maximum* were found in abundance with few scattered stands of woody species. They were more luxuriant during the rainy season.The *Elaeis guineensis and Alstonia boonei* form the upper stratum while *Chromolaena and Panicum maximum* form the ground layer in most of the study area. Species such as *Alchornea cordifolia, Rauvolfia vomitoria, Psidium guajava, Tremia orientalis and Albizia zygia* form the middle layer. *Rauvolfia vomitoria* were in fruit during the rainy season. No unique and endanger species was encountered in any of the identified vegetation communities. Pathologically, the plants were generally healthy except some few scattered problems like rust on oil palm (*Elaeis guineensis*) caused by *Curvularia* spp

Fallow land vegetation of the following distinct physiognomy was encountered at the study site:

(i) Fallow land vegetation with big stands of *Mangifera indica* and few other woody species.

(ii) Fallow land vegetation with stands of *Musanga cecropoides, Gmelina arboreus* and other woody species.

(iii) Fallow land vegetation with stands of *Alstonia boneei* and other woody species.

(iv) Fallow land vegetation dominated *Hevea brasilensis* (Rubber) with other few woody species, shrubs and herbs

5.12.10 Farmland Vegetation

The farmlands which constituted the larger portion (52%) of the study site are covered mainly by *Zea mays* (maize) and *Manihot esculenta* (Cassava). The following farmlands were encountered in the study site (**See Table 6.8**):

i. Farmland of *Manihot esculenta* (Casava) with *Musa spp (Bannana)*.

ii. Farmland of mixture of *Manihot esculenta* (Cassava) and few stands of *Zea mays* (Maize) during the dry season Farmland of mature *Zea mays* (Maize) with cobs and tassels and Cassava during the rainy season sampling.

iii. Farmland of mature *Zea mays* (Maize) with cobs and tassels (**See Table 5.18**).

Table 5.18: Checklist of Common Economic Trees/Plants found in the Study Area (Dry Season and Rainy Season Sampling)

S/N	Scientific Name	Common Names	Uses/Economic importance
1.	*Zea mays*	Maize	Edible grains
2.	*Alstonia boonei*	Alstonia	**Medicinal**
3.	*Elaeis gineensis*	Oil palm	**Oil, broom**
4,	*Alchornea* cord*ifolia*	Christmass bush	Medicinal
5.	*Pycnanthus angolensis*		Medicinal
6	*Thaumatococcus daniellii*		Wrapper
7	*Manihot esculenta*	Cassava	Food

Table 5.19: Comparative Features of the Vegetation Type/Subtype found in the Study Area (Dry Season and Rainy Season Sampling)

S/N	Vegetation types/communities	Dominant Plant Species	Other Species	Density of woody species	Species Diversity
A (i)	Fallow land vegetation with big stands of *Mangifera indica* and other few woody species.	*Alstonia boonei Alchornea cordifolia Costus afer*	*Chromolaena odorata Panicum maximum Rauvolvia vomitoria Psidium guajava*	Medium	Low
(ii)	Fallow land vegetation with stands of Musanga *cecropoides,Gmelina arboreus*	*Musanga cecropoides Gmelina arboreus*	*.Panicum maximum* *Chromolaena odorata*	Medium	Low
(iii)	Fallow land vegetation dominated by stands of *Hevea brasilensis (Rubber).*	*Hevea brasilensis Panicum maximum*	*Chromolaena odorata*	Medium	Low
(v)	Fallow land vegetation dominated by mixture *Alstonia boonei* and woody species ,shrubs and herbs.	*Elaeis guineensis Albizia zygia Chromolaena odorata Panicum maximum*	*Pycnanthus angolensis Ageratum conyzoides Tridax procumbens Euphorbia heterophyla Andropogon gayanus*	Medium	Medium
B (i)	Farmland of Cassava (*Manihot esculenta)*with *Musa spp*	*Manihot esculenta Spondias mombim Chromolaena odorata Panicum maximum*	*Andropogon gayanus Calapogonium spp Trema orientalis Combretum spp Ageratum conyzoides*	Few	Very low
(ii)	Farmland of of *Manihot esculenta (Cassava)* with a few stands of *Zea mays* (Maize)	*Manihot esculenta Zea mays (*Maize) *Panicum maximum*	*Alstonia boonei Chromolaena odorata*	Very low	Very low
(iii)	Farmland of Maize (*Zea mays)* in tassels and cobs	*Zea mays*	*Alstonia boonei Albizia zygia (Sapplings)*	Very Low	Low
(iv)	Farmland of *Zea mays* (Maize) and *Cassava*	*Zea mays, Cassava*	*Calapagonium spp,*	Very low	Low

5.13 Water Quality and Hydrobiology

Information on the site description and grid-co-ordinates of the selected sampling stations for water studies is presented in **Table 7.0**. Whereas the surface water source was investigated for both water quality (physico-chemical and microbial) and hydrobiology parameters, the ground water sources (tapped from the newly established monitoring boreholes) were analyzed only for water quality.

5.13.1 In Situ Water Quality Parameter

The records of the *in-situ* water quality parameters during the study period are presented in **Table 7.0**. The water was characterized by deep green colouration. During the rainy season a flow velocity of 47cm/s was recorded. The water was characterized by very low electrical conductivity (16 – 19uScm^{-1}) suggesting a very dilute fresh water. The water pH was generally acidic (5.65 – 6.10). Water temperature (26.6 – 28.5^{0}C) was cold compared to ambient air temperature (31.0 – 35.0^{0}C). This was probably due to the fact that the river course was heavily shaded by vegetal cover reducing light penetration. The river was characterized by moderate levels of dissolved oxygen concentrations (3.2 – 6.3mgl^{-1}) and saturation (41.6 – 80.7%). Groundwater sources were shallow (about 1.5 m) for hand dug well and relatively deep for the monitoring boreholes with total depth over 40m, and depth to static level of over 20 m giving a water column of about 20 m. The groundwater sources were also acidic (pH = 5.1 – 6.01) but with higher conductivity values (36 – 159uScm^{-1}) than that the river.

5.13.2 General Physico-Chemical Water Quality

The general physico-chemical quality of the river is compared with those of ground water sources from the Deep-Sea Port Area. The water sources were characterized by low true colour and turbidity. The levels of electrical conductivity and TDS suggest that the water sources were very dilute freshwater and saline water. The river water was poorly buffered and very soft with evidence of the occurrence of non-carbonate hardness. Total acidity was about eight times more than total alkalinity. The levels of pH, hardness all potent the propensity of the water to corrode carbonate structure. It was however characterized by low oxygen demand (BOD<1.0mgl^{-1}, and COD<10mgl^{-1}). Although much higher in hardness than the river water, the groundwater also shows that it is soft in nature (**See Table 5.20**).

5.13.3 Major Ions and Probable Salts

The concentrations of major ions in water sources are indicated in **Table 5.20** Except for SO_4, the ions were generally higher in the borehole water than in the river. Carbonate salts comprising $CaCO_3$, $MgCO_3$ and Na_2CO_3 were the dominant probable salts. Other salts recorded include $MgSO_4$, Na_2SO_4, NaCl, and KCL (T**able 5.20a, Dry Season sampling, and Table 7.0b (Rainy season sampling)**. The relative contribution of carbonate salts tended to show a negative correlation with increased salinity.

Table 5.20a: *In situ* water quality parameters of surface and ground water samples (Dry Season Sampling, November. 2019)

SN	Total depth (m)	Depth to water (m)	Water column (m)	Cond. (µScm^{-1})	pH	Apparent colour	DO (mgl^{-1})	DO Sat (%)	Air Temp (^{0}C)	Water Temp (^{0}C)
1	3.7	NA	ND	18	5.65	Colourless	6.1	77.1	32.0	26.6
2	4.1	NA	ND	19	5.70	Light green	6.3	80.7	31.0	27.0
3	ND	ND	ND	70	5.55	Turbid reddish	ND	ND	ND	ND
4	42.6	24.4	18.2	36	5.45	Turbid reddish	ND	ND	ND	ND
5	42.6	21.3	21.3	70	5.10	Turbid reddish	ND	ND	ND	ND

NA = Not available
ND = No data

Table 5.20b: *In situ* water quality parameters of surface and ground water samples (Rainy Season Sampling, March, 2020)

SN	Total depth (m)	Depth to water (m)	Water column (m)	Cond. (µScm^{-1})	pH	Apparent colour	DO (mgl^{-1})	DO Sat (%)	Air Temp (^{0}C)	Water Temp (^{0}C)
1	3.7	NA	ND	21	5.68	Colourless	6.6	84.0	35.0	29.2
2	4.1	NA	ND	23	5.75	Light green	6.5	81.0	31.0	27.0
3	ND	ND	ND	75	5.60	Turbid reddish	ND	ND	ND	ND
4	42.6	24.4	18.2	41	5.05	Turbid reddish	ND	ND	ND	ND
5	42.6	21.3	21.3	74	5.30	Turbid reddish	ND	ND	ND	ND

NA = Not available
ND = No data

TABLE 5.21A: THE GENERAL PHYSICO-CHEMICAL QUALITY OF WATER SOURCES

(DRY SEASON SAMPLING, NOVEMBER, 2019)

PARAMETER	SURFACE WATER	GROUND WATER
APPARENT COLOUR (PT-CO)	37.6±5.5	148.2±55.4
TRUE COLOUR (PT-CO)	0.0±0.0	0.0±0.0
TURBIDITY (NTU)	4.6±1.2	15.2±6.8
PH	6.0±0.2	5.76±0.14
CONDUCTIVITY ($uScm^{-1}$)	16.0±1.4	102±28
ALKALINITY ($mgL^{-1}CaCO_3$)	2.0±0.5	39.3±12.3
ACIDITY ($mgL^{-1}CaCO_3$)	18.5±0.5	24.3±4.8
TOTAL HARDNESS ($mgL^{-1}CaCO_3$)	2.8±0.4	34.3±9.1
TDS (mgL^{-1})	9.2±0.5	49.5±13.9
BOD_5 (mgL^{-1})	0.4±0.1	ND
COD (mgL^{-1})	9.5±0.55	9.3±1.5
NO_2(mgL^{-1})	<0.01	0.002±0.002
NO_3(mgL^{-1})	0.01±0.005	0.178±0.016

ND = NO DATA

Table 5.21b: The general physico-chemical quality of water sources

(Rainy Season Sampling, March, 2020)

Parameter	Surface water	Ground water
Apparent colour (Pt-Co)	39.6±1.5	150±50
True colour (Pt-Co)	0.0±0.0	0.0±0.0
Turbidity (NTU)	4.8±1.0	18.0±5.0
pH	5.8±0.2	5.65±0.10
Conductivity (uScm^{-1})	18.0±1.5	105±20
Alkalinity (mgL^{-1}$CaCO_3$)	2.5±0.5	40.5±10
Acidity (mgL^{-1}$CaCO_3$)	20.5±0.5	25±5
Total hardness (mgL^{-1}$CaCO_3$)	3.0±0.5	33± 0.5
TDS (mgL^{-1})	11.5±0.5	55±10
BOD_5 (mgL^{-1})	0.5±0.1	ND
COD (mgL^{-1})	12±0.5	10±1.5
NO_2(mgL^{-1})	<0.01	0.001±0.001
NO_3(mgL^{-1})	0.01±0.005	0.2±0.01

ND = No data

Table 5.21c: Concentrations of major Cations and Anions in water samples

(DRY SEASON SAMPLING, NOVEMBER, 2019)

SN	Parameter (Unit)	Sample			
		S1	S7	S11	S16
1	Ca^{2+} (mgl^{-1})	0.93	17.16	14.21	4.26
2	Mg^{2+} (mgl^{-1})	0.11	1.99	0.83	0.36
3	Na^{+} (mgl^{-1})	1.30	8.40	3.60	0.87
4	K^{+} (mgl^{-1})	0.28	1.28	1.03	0.28
5	Cl^{-} (mgl^{-1})	2.23	9.26	4.57	4.57
6	HCO_3^{-} (mgl^{-1})	2.40	76.80	50.40	14.40
7	SO_4^{2-}(mgl^{-1})	6.22	2.08	0.00	2.08
8	NO_3^{-} (mgl^{-1})	0.20	0.20	0.30	0.00

Table 5.21d: Concentrations of major Cations and Anions in water samples

(RAINY SEASON SAMPLING, MARCH, 2020)

SN	Parameter (Unit)	Sample			
		S1	S7	S11	S16
1	Ca^{2+} (mgl^{-1})	0.96	19.25	16.25	4.55
2	Mg^{2+} (mgl^{-1})	0.15	2.20	0.89	0.62
3	Na^{+} (mgl^{-1})	1.36	8.80	3.72	1.10
4	K^{+} (mgl^{-1})	0.32	1.35	1.16	0.38
5	Cl^{-} (mgl^{-1})	2.28	9.75	4.78	6.37
6	HCO_3^{-} (mgl^{-1})	2.45	79.50	53.50	15.28
7	SO_4^{2-}(mgl^{-1})	6.25	2.25	0.00	2.25
8	NO_3^{-} (mgl^{-1})	0.28	0.24	0.45	0.25

5.13.4 Heavy Metals and THC contents in water

In **Table 7.2** the levels of heavy metals and THC recorded during the present study are compared with values obtained earlier by RPI (1984) for the river body within the same reach of the river course. The concentrations of Chromium, Copper, Mercury and Vanadium were generally below the detection limit of the instrument used (<0.001ppm). On the other hand, Fe and Ni were detected in all the samples (100% detected). Based on median values of the metals they could be ranked as follows: Fe>Zn>Ni>Mn>Cd>Pb suggesting that the ferrous metals were predominant in occurrence and concentrations. Most of the metals (Cd, Fe, Mn) concentrations were higher in the river than in the underground water sources. However, whereas only five metals were detected in the river sample seven of the metals were detected in the groundwater sources. Most of the metals (Cd, Fe, Ni, Pb) occurred in higher concentration than the levels of the corresponding values recorded for the river samples by RPI (1984) suggesting a slight increase in the metals over the past two and a half decades. Total Hydrocarbon (THC) was not detected either in the river samples or the underground water sources. In general, the levels of heavy metals and THC recorded in the study area during both the dry and rainy season sampling all occurred within the levels known for unpolluted environments.

Table 5.22a: Occurrence and distribution of probable salts in Water Samples Dry Season Sampling (November, 2019)

SN	Probable salt	S1		S13		S17	
		Salinity (mgl^{-1})	% Total	salinity (mgl^{-1})	% Total	Salinity (mgl^{-1})	% Total
1	$CaCO_3$	42.9	54.5	35.53	71.43	11.55	57.8
2	$MgCO_3$	6.9	8.76	2.88	5.79	0.38	19.0
3	Na_2CO_3	13.68	17.35	3.23	6.49	0.0	0.0
4	$MgSO_4$	0.0	0.0	0.0	0.0	1.34	6.70
5	Na_2SO_4	3.07	3.89	0.0	0.0	1.49	7.45
6	NaCl	3.76	4.77	5.6	11.26	0.99	5.0
7	KCl	2.44	3.10	1.96	2.45	0.53	2.65
8	Others	5.98	7.64	0.54	2.58	3.72	1.4
9	Total	78.73	100.0	49.74	100.0	19.99	100.0

Table 5.22b: Occurrence and distribution of probable salts in Water Samples Rainy Season Sampling (March, 2020)

SN	Probable salt	S1		S13		S17	
		Salinity (mgl^{-1})	% Total	salinity (mgl^{-1})	% Total	Salinity (mgl^{-1})	% Total
1	$CaCO_3$	44.5	54.0	45.00	71.00	15.00	60.00
2	$MgCO_3$	7.10	8.88	2.90	6.00	0.50	15.0
3	Na_2CO_3	14.00	17.00	3.50	6.50	0.05	0.5
4	$MgSO_4$	0.10	0.01	0.01	0.1	2.5	6.30
5	Na_2SO_4	3.25	3.90	0.01	0.1	1.90	7.25
6	NaCl	3.85	4.80	5.65	11.15	1.50	5.15
7	KCl	2.50	3.15	1.99	2.42	0.75	2.60
8	Others	6.00	7.70	0.59	2.60	3.55	1.45
9	Total	77.45	99.36	59.65	99.87	25.75	98.25

Table 5.23a: The concentration (ppm) of heavy metals and THC in water sources from the Proposed Deep-Sea Area (Dry Season Sampling, November, 2019)

Parameter	S1	S4	S8	S12	S16	S20	RPI (range)
Cd	0.095	0.084	BDL	BDL	40	BDL	0.01-0.035
Cr	BDL	BDL	BDL	BDL	0	BDL	0.030-0.035
Cu	BDL	0.001	BDL	BDL	20	BDL	ND
Fe	0.386	0.152	0.027	0.129	100	0.029	0.00-0.11
Hg	BDL	BDL	BDL	BDL	0	BDL	ND
Mn	0.153	0.062	BDL	BDL	60	0.019	ND
Ni	0.039	0.041	0.041	0.037	100	0.005	0.00-0.01
Pb	BDL	0.014	BDL	BDL	20	BDL	0.00-0.01
V	BDL	BDL	BDL	BDL	0	BDL	ND
Zn	0.045	0.084	BDL	0.113	80	0.014	0.00-0.224
THC	BDL	BDL	BDL	BDL	0	BDL	ND

BDL = <0.01

% det = detection

Table 5.23b: The concentration (ppm) of heavy metals and THC in water sources from the Proposed Deep-Sea Area (Rainy Season Sampling, March, 2020)

Parameter	S1	S4	S8	S12	S16	S20	RPI (range)
Cd	0.10	0.015	BDL	BDL	45	BDL	0.01-0.04
Cr	BDL	BDL	BDL	BDL	2	BDL	0.030-0.035
Cu	BDL	0.002	BDL	BDL	25	BDL	ND
Fe	0.50	0.155	0.030	0.20	107	0.030	0.00-0.15
Hg	BDL	BDL	BDL	BDL	1	BDL	ND
Mn	0.20	0.08	BDL	BDL	64	0.02	ND
Ni	0.050	0.050	0.050	0.05	109	0.01	0.00-0.01
Pb	BDL	0.020	BDL	BDL	28	BDL	0.00-0.01
V	BDL	BDL	BDL	BDL	1	BDL	ND
Zn	0.050	0.090	BDL	0.20	85	0.01	0.00-0.25
THC	BDL	BDL	BDL	BDL	1	BDL	ND

BDL = <0.01

% det = detection

5.13.5 Water Microbiology

The microbial flora of water sources from the project area comprised four bacterial and seven fungal species isolates (**Table 7.4**) that in general the occurrence of heavy is low in water sources in the area. THC was also not detected in any of the samples. The fungal isolates are all common molds (yeasts were not detected). The most widely isolates were the bacteria *Klebsiella edwardsii* (100%) and *Pseudomonas aeruginosa* (100%) and the mold *Rhizopus japonicus* (100%). For both bacteria and fungi the number of species isolates per sample was in the range of 2-4 giving a total microbial species of 5-7 per station (Table 4.2.7.8). the abundance of total heterotrophic bacteria (THB) was in the range of $3.0x10^2 – 1.9x10^7$ cfu/ml while Hydrocarbon degrading bacteria (HDB) were in the range of Nil – $4.0x10^2$ cfu/ml (**Table 7.4**). Thus, based on median values HDB/THB was less 1%. Total heterotrophic fungi (THF) and Hydrocarbon degrading bacteria (HDB) were in the range of $4.0x10^4$ – $8.0x10^4$ cfu/m; and Nil – $2.0x10^3$ cfu/ml respectively. In general, microbial abundance was low in the waterbodies.

5.13.6 *Sediment Physico-Chemical Characteristics*

Information obtained on the physico-chemical characteristics of sediment from the rivers during the study is presented in **Table 5.2.9**. The sediments were essentially sandy (92 – 94%), slightly acidic (pH = 6.1 – 6.4) and characterized by very low organic matter (0.02 – 0.34%). The levels of exchangeable cations varied from very low (K^+ & Ca^{2+}) to low (Na^+, Mg^{2+}). In general, there was no significant seasonal variation in not of the parameters considered, although more parameters were slightly higher in the rainy season than in the dry season.

TABLE 5.24 OUTLINE CLASSIFICATION OF MICROBIAL TAXA IN THE DEEP-SEA AREA

Dry Sea and Rainy Season Sampling, November, 2019 and March, 2020

Dasion:	Protophyta
CLASS:	**SCHIZOMYCETES**
Order:	Pseudomonadales
Family:	Pseudomonodaceae
	Pseudomonas a*eruginosa*
	Pseudomonas stutzeri
ORDER:	**EUBACTERIALES**
Family:	Eneterobacteria
TRIBE:	**ESCHERICHIEAE**
	KLEBSIELLA EDWARDSII
	KLEBSIELLA PNEUMONIAE
DIVISION:	**EUMYCOPHYTA (THE FUNGI)**
CLASS:	**PHYCOMYCETES (ALGAL OR SPORAGIUM FUNGI)**
SUBCLASS:	**ZYGOMYCETES (BLACK MOLDS) FLY FUNGI**
Order:	mucorale
	Mucor mucedo
	Rhizopus japonicus
CLASS:	**ASCOMYCETES (SAC FUNGI)**
SUBCLASS:	**EUACOMYCETES**
SERIES:	**EUROTIALES**
FAMILY:	**EUROTIACEAE**
	ASPERGILLUS GLAUCUS
	PENICILLIUM CAMEMBERTI
Class:	Dueteromycetes (Fungi imperfecti)
Order:	Moniliales
Family:	Dematiaceae
	Cladosporium herbarium
	Microsporium audounii
Others	Botrytis spp

Table 5.25a: The Occurrence and distribution of microbial taxa in water samples from (Dry Season, November 2019)

SN	Taxon	Occurrence in sampling station				% Occurrence frequency
		13	14	15	16	
Bacteria						
8	*Klebsiella edwardsii*	+	+	+	+	100
9	*Klebsiella pneumoniae*		+			25
12	*Pseudomonas aeruginosa*	+	+	+	+	100
13	*Pseudomonas stutzeri*			+	+	50
Fungi						
2	*Aspergillus glaucus*		+			25
5	*Botrytis sp*	+				25
7	*Cladosporium herbarium*			+		25
12	*Microsporium audounii*			+		25
14	*Mucor mucedo*	+		+	+	75
16	*Penicillium camemberti*				+	25
20	*Rhizopus japonicus*	+	+	+	+	100
Total bacteria		2	4	3	2	
Total fungal		3	2	4	3	
Total microbial isolates		5	6	7	5	

Table 2.25b: The Occurrence and distribution of microbial taxa in water samples from (Rainy Season, March, 2020)

SN	Taxon	Occurrence in sampling station				% Occurrence frequency
		13	14	15	16	
Bacteria						
8	*Klebsiella edwardsii*	+	+	+	+	110
9	*Klebsiella pneumoniae*		+			30
12	*Pseudomonas aeruginosa*	+	+	+	+	105
13	*Pseudomonas stutzeri*			+	+	53
Fungi						
2	*Aspergillus glaucus*		+			28
5	*Botrytis sp*	+				27
7	*Cladosporium herbarium*			+		26
12	*Microsporium audounii*			+		26
14	*Mucor mucedo*	+		+	+	78
16	*Penicillium camemberti*				+	30
20	*Rhizopus japonicus*	+	+	+	+	109
Total bacteria		5	7	6	5	
Total fungal		5	4	6	5	
Total microbial isolates		6	8	9	6	

Table 5.25b: Microbial abundance of water samples from the Deep-Sea Area (Dry and Rainy Season, November 2019, and March 2020)

SN	Sample code	THB@35^{0}C (cfu/g)	Coli MPN Presumptive (cells/100ml)	HDB@ 30^{0}C (cfu/g)	THF@ 30^{0}C (cfu/g)	HDF@ 30^{0}C (cfu/g)
1	S4	3.0 x10^2	1.5 x10^2	Nil	8.0 x10^4	Nil
2	S10	1.9 x10^7	1.5 x10^2	4.0 x10^2	8.0 x10^4	43.0
3	S13	1.03 x10^6	2.4 x10^2	1.0 x10^2	6.0 x10^4	2.0 x10^3
4	S16	2.2 x10^5	23.0	Nil	4.0 x10^4	17
Summary						
Mean		5.06 x10^6	1.4 x10^2	1.25 x10^2	6.5 x10^4	5.15 x10^2
±s.e. of mean		4.03 x10^6	0.36 x10^2	1.16 x10^2	0.8 x10^4	4.29 x10^2
Median		6.5 x10^5	86.5	0.5 x10^2	7.0 x10^4	30
±s.e. of median		2.9 x10^5	44.9	0.35 x10^2	0.7 x10^4	9

Table 5.26a: The physico-chemical characteristics of sediment samples from the Ocean (Dry Season, November 2019)

Parameter	1st Sample	2nd Sample
%sand	96	96
% silt	5	5
% clay	3	1
Texture	Sand	Sand
pH, 1:1 water	6.4	6.3
1:2CaCl$_2$	6.2	6.1
Organic carbon (%)	0.20	0.23
Organic matter (%)	0.34	0.40
Total nitrogen (%)	0.02	0.02
PO_4^{3-} (ppm)	7.63	8.96
SO_4^{2-} (ppm)	600	602.6
Cl^- (ppm)	301	297.8
Al^{3+} (cmol/kg)	0.19	0.2
H^+(cmol/kg)	0.78	0.9
K^+ (cmol/kg)	0.03	0.03
Na^+ (cmol/kg)	0.14	0.12
Mg^{2+} (cmol/kg)	0.89	0.92
Ca^{2+} (cmol/kg)	0.29	0.30
CEC (cmol/kg)	2.32	2.47
Basaturation (%)	58.2	55.5

Table 5.26b: The physico-chemical characteristics of sediment samples from the Ocean (Rainy Season, March, 2020)

Parameter	1st Sample	2nd Sample
%sand	105	100
% silt	11	9
% clay	6	4
Texture	Sand	Sand
pH, 1:1 water	6.6	6.5
1:2$CaCl_2$	6.4	6.3
Organic carbon (%)	0.25	0.27
Organic matter (%)	0.41	0.45
Total nitrogen (%)	0.15	0.18
PO_4^{3-} (ppm)	7.75	9.00
SO_4^{2-} (ppm)	620	622
Cl^- (ppm)	307	301
Al^{3+} (cmol/kg)	0.22	0.25
H^+(cmol/kg)	0.82	0.95
K^+ (cmol/kg)	0.05	0.55
Na^+ (cmol/kg)	0.16	0.15
Mg^{2+} (cmol/kg)	0.95	0.93
Ca^{2+} (cmol/kg)	0.35	0.38
CEC (cmol/kg)	2.45	2.50
Basaturation (%)	62.50	60.5

5.14 Phytoplankton Flora and Zooplankton Fauna

As obvious from **Tables 5.27 (a and b),** the phytoplankton flora from the river comprised of 18 species belonging to 14 genera of four algal divisions. The flora was dominated by green algae notably desmids while the other algal groups were poorly represented. The most abundant species were dominated by the desmid *Staurodesmus clepsydra* (2,750 org/m^3), the blue-green *Nemoderma tingitana* (V250 org/m^3) and *Actinotaenium cucurbitum* (1,100 org/m^3). The dominance of desmids in the flora is indicative of a very dilute freshwater. The zooplankton fauna was represented by rotifers and copepods. Typical of most Nigerian waters the rotifer fauna was dominated by a member of the family Brachinodae while the copepods were dominated by Nauphius larvae. *Brachionus dimidiatus* was the most dominant taxon of the zooplankters.

Table 5.27a and **Table 5.27b** provide information on the community structure of the plankton assemblage obtained both during the dry and rainy season sampling. On the whole phytoplankton was characterized by diversity index (*Margelef index)* about two and a half times that of the zooplankton and the calculated Biological index of pollution of 0.75 is suggest the waterbody to be clean.

Table 5.27a: Summary of plankton abundance in the Deep-Sea Port Area (Dry Season Sampling, November, 2019)

Plankton group	Division/ Phylum	Species Number	Abundance (org/m^3)	Margalef index
Phytoplankton	Green algae	13	9000	1.30
	Blue green alage	1	200	0.19
	Brown alage	2	2200	0.260
	Diatoms	2	2000	0.263
	Total	18	13400	1.89
Zooplankton	Rotifers	3	3000	0.375
	Copepods	3	550	0.476
	Total	6	3550	0.851
Total plankton		24	16950	2.46

Table 5.27b: Summary of plankton abundance in the Deep-Sea Port Area (Rainy Season Sampling, March, 2020)

Plankton group	Division/ Phylum	Species Number	Abundance (org/m^3)	Margalef index
Phytoplankton	Green algae	18	9500	1.60
	Blue green alage	3	290	0.25
	Brown alage	5	2600	0.35
	Diatoms	4	2500	0.30
	Total	22	15900	2.20
Zooplankton	Rotifers	7	3700	0.50
	Copepods	5	630	0.76
	Total	9	45900	1.10
Total plankton		30	18000	2.95

5.15 Fisheries and Wildlife

5.15.1 Wildlife

The wildlife fauna reported and observed in the project area and its environs comprises mammalian, avian, reptiles and amphibian fauna. These wildlife species were identified and authenticated from literature. A colony of weaver birds was found on trees surrounding the proposed Deep-Sea Port Area.

5.15.2 Fish and Fisheries

A checklist of the fish fauna that were observed and reported by the fishermen were caught by gillnetting, cast netting, trapping and hook and line. The fishes caught by the fishermen were consumed or sold fresh in the neighbourhood. The common species found in the area are as reported in **Table 5.28.** It comprises ten species belonging to ten (10) genera and eight (8) families.

Table 5.28: Fish Fauna Found in the Proposed Deep-Sea Port Area (Dry Season and Rainy Season Sampling, November, 2019 and March, 2020)

Family	Genus	Species
Mormyridae	Gnathonemus	G. cyprinoides
	Mormyrus	M. macrophelmus
Characidae	Alestes	A. leuciscus
Cyprinidae	Barbus	B. callipterus
Clariidae	Clarias	C. gariepinus
Mochochidae	Synodontis	S. nigrita
Malapteruridae	Malapterurus	M. electricus
Cichlidae	Hemichromis	H. fasciatus
	Tilapia	T. zillii
Ophiocephalidae	Parachanna	P. obscura

5.16 Socio-Economics and Health

5.16.1 Migrati on Pattern, Cultural Ties and Local Administration

Ilaje is a Local Government Area in Ondo State, Nigeria with headquarters in Igbokoda. The origin of the first settlers was traced to Ile-Ife from which they migrated and settled at the outlet to the sea and originally made up of four geo-political entities namely: Ode Ugbo, Ode Mahin, Ode Etikan and Aheri. While most towns and villages in the Mahin kingdom (Ode Mahin) are distributed on arable lands, the towns and villages in the other three geo-polities of Ugbo, Aheri and Etikan kingdoms are spread out along the beaches and swampy terrains of the Atlantic Ocean coast.

It consists of over four hundred towns and villages. {See Annecture for the list of all the communities} It has troughs and undulating low land surfaces. The extreme South is covered by silt, and mud and superficial sedimentary deposits.

Sand underlies most of the Western part of the Local Government extending from the Lekki peninsula in Lagos State to Araromi Sea-side and Zion pepe, Agba to Etugbo and Ipare all, Mahin and Ugbonla. The Eastern part of the Local Government Area can boast of the largest coconut plantation in West Africa. Ilaje Local Government is the largest local Government in Ondo State in terms of its landmass. (277,034 According to the 1991 National Population Census, the Local Government is one of the most populated in Ondo State, with a population figure of two hundred and seventy-seven thousand and thirty-four) land area of 1,318 km^2. It has a shoreline covering about 180 km thereby making Ondo State, a state with the longest coastline in Nigeria. Crude oil, which is the mainstay of the Nigerian economy is also produced in this local government area. Traditionally, it is grouped into 8 kingdoms namely: Mahin land under His Royal Majesty, Amapetu of Mahin, Ugboland which is under His Royal Majesty Olugbo of Ugbo Kingdom. Aheri land under the Maporure and Etikan land under the Onikan of Etikan, Odonla land under the Alagho of Odonla, Obenla land under the Olubo of Obenla, Obe Ogbaro land under the Odoka of Obe Ogbaro, Igbokoda under the Olu of Iggbokoda and Igboegunrin under the Odede of Igboegunrin. (See Appendix for list of communities)

Towards the western reaches, the Aheri and Etikan share border with the Ijebus. The Ikale to the north bound the Mahins, the Itsekiri people who the Ilajes consider their cousins, share the eastern border with the Ugbos, the Yoruba speaking Apoi and Arogbo Ijaws are located to the north east in Ese Odo LGA, and the Atlantic Ocean is situated on the southern boundary. The Ilajes are one of the most dynamic and enterprising people in Nigeria. Their aquatic skill, coupled with their ability to adapt enabled them to conquer their harsh geographical environment and turn it to their advantage. Consequently, they were able to build large communities like Ugbonla, Aiyetoro, Zion PePe and Orioke.

The people of the project area are mainly Ilajes. The techniques of local administration subscribed to is a just and egalitarian society without a hereditary system of leadership around Aiyetoro who choose leadership ~~is~~ based on spiritual leading while the rest of the communities choose their Obas according to the general Yoruba customs and traditions. Other sets of people living in the area include the Ijaws, Urhobos, Ikales, Ibos and Hausas who are in the area to explore the economic opportunities available in the area. No ancestral or cultural site is located on, near or around the project sites.

5.16.2 Settlement Pattern /Community Layout

The coastal area represents the interface or transition zone between land and sea. Coastal area in Ondo State is gradually shifting from poor housing quality status in the major communities especially Igbokoda and deplorable basic facilities courtesy of NDDC. The housing in the hinterland along the coast are highly deteriorated and can be categorized as slums. The situation as observed has posed a number of challenges not on the coastal dwellers alone, but also on the coastal stakeholders. Housing in these areas are characterized by distinctive structural and material features which are mostly single family detached dwelling type, built with planks, bamboo, mud and cement. The deficiency in good quality housing in Ilaje coastal area of Ondo State is compounded by the fact that the area is prone to environmental degradation, common to coastal areas in both developed and developing worlds. However, the effect of the area being relativistic more susceptible to climatic change, environmental degradation due to oil exploration and the existence of coastal features created by the land-sea interaction, such as creeks, deltas and swamps is more.

Ilaje local government area was carved out of the Ilaje/Ese-Odo local government on October 1st, 1996 by the then Military Head of State with headquarter at Igbokoda. The defunct local government area was split with the intention of spreading development to places that has not been impacted on, and to enable a level of autonomy that can enhance the holistic development of the region.

Housing includes not only a physically sound structure for shelter at an affordable price but also at a suitable size and location which meet the needs of the households and a functioning neighborhood environment with an adequate supply of housing related services (Adeleye, 2012). Olotuah (2009) refers to housing as a dwelling unit which caters for man's biological (clean air, water) and psychological needs (satisfaction, contentment, prestige, privacy, choice, freedom, security and social interactions, human development and cultural activities).With this definition in view, very few houses meet this definition i.e. very low Housing Condition Index HCI.

RESEARCH METHODOLOGY: Primary and secondary data were obtained for the study. Primary data were obtained through the administration of questionnaire on residents in the selected coastal area settlements of Ondo State. There were 169 settlements in the coastal area of Ondo State, made up of 66 huts, 51 hamlets and 52 small towns. Using stratified sampling technique, one out of every 10 settlements (10%) was selected; which gave seven huts, six hamlets and six small towns. A total of 2,123 houses were identified in the selected settlements. Simple random sampling was used to select 10% of these houses. A household head was selected per building using random sampling. In all, 213 copies of questionnaire were administered, thereafter 211 of which were successfully retrieved for analysis. Data collected were analysed using descriptive and inferential statistics.

RESULT AND DISCUSSION: This section discusses the results and discussion of the findings obtained from the study. Discuss socio-economic and housing characteristics of coastal dwellers in the study are Socioeconomic Characteristics. The sample population taken from the study area demonstrated the socioeconomic background of the household, which has significant influence on the implementation of rehabilitation and relocation in the study area due to their socio-cultural attachments. The study found that 72.9% of the respondents were between 31 and 60 years old with an average age of 41 years old. Also, 82.5% of the coastal dwellers had one form of formal education or the other. It was also discovered in the study that 33.2% of the respondent's major means of livelihood was fishing and that 55.9% of the study population comprised low-income earners.

Table 5.29: Coastal dwellers' socio-economic background in the Study Area Data

Socio-economic variable	Small towns	Hamlets	Huts	Study area
Age				
1-30	32 (25.8%)	10 (19.2%)	6 (17.1%)	48 (22.7%)
31-60	87 (70.2%)	39 (75%)	28 (80%)	154 (72.9%)
Above 60	5 (4%)	3 (5.8%)	1 (2.9%)	9 (4.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Educational status				
No formal	21 (17.5%)	6 (11.5%)	10 (28.6%)	37 (17.5%)
Primary	17 (13.7%)	10 (19.2%)	6 (17.1%)	33 (15.6%)
Secondary	28 (22.6%)	10 (19.2%)	8 (22.9%)	46 (21.8%)
Tertiary	58 (46.8%)	26 (50%)	11 (31.4%)	95 (45%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Occupation				
Fishing	31 (25%)	26 (50%)	13 (37.1%)	70 (33.2%)
Artisan	14 (11.3%)	4 (7.6%)	2 (5.7%)	20 (9.3%)
Farming	11 (8.9%)	7 (13.4%)	6 (17.2%)	24 (11.4%)
Civil servant	27 (21.8%)	2 (3.8%)	1 (2.8%)	30 (14.2%)
Trading	26 (20.9%)	8 (15.8%)	7 (20%)	41 (19.5%)
Unemployed	15 (12.2%)	5 (9.4%)	6 (17.2%)	26 (12.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)
Income				
<24500	72 (58.1%)	22 (42.3%)	24 (68.6%)	118 (55.9%)
24501-54000	27 (21.7%)	16 (30.8%)	7 (20%)	50 (23.7%)
Above 54000	25 (20.2%)	14 (26.9%)	4 (11.4%)	43 (20.4%)
Total	124 (100%)	52 (100%)	35 (100%)	211 (100%)

5.16.3 Religious Practices

The dominant religion of the people is Christianity. There are also some adherents of traditional religion in the area. In all the communities visited, a high degree of cooperation was found to exist among the adherents of the two religions The Cherubim and Seraphim church plays a significant role in the lives of the people As findings of this study revealed, not only was Cherubim and Seraphim Church of Zion a unifying factor between Arogbo-Ijaw and Ilaje before the 1998/1999 conflict but also and more importantly a weapon of control by the Ilaje over the Arogbo Ijaw.

5.16.4 Presence Of Infrastructures

The level of infrastructure in any community decides the level of development. The high cost of funds needed to provide infrastructure in coastal environment resulted in the neglect of the environment. However, interventions of government through OMPADEC, NDDC and OSOPADEC aside from local government has improved the level of infrastructure in the area. They are important for the communities they serve because in most cases, they not only serve as means by which the local residents are empowered and have access to good quality of life. These facilities include access to good roads, water transportation facilities i.e. number of boats jettied, types of boats, communication, light, energy, water supply, hospitals, schools, colleges, market, day-care centers, museums, libraries, nursing homes and homeless shelters to mention a few. Infrastructural facilities are a key factor in the development of sustainable communities. The quality of life of residents of a community is a function of presence of infrastructures. Available infrastructures designed to enhance the quality of life were found to be thin on the ground.

The Akeredolu led administration is committed to opening up the coastal area of Ondo State because of its vast economic potential. The N9.3 billion Ilaje/Lekki road project was inaugurated in 2019 by Governor Rotimi Akeredolu at Araromi seaside in Ilaje local government area of Ondo State to open up the coastal area to the outside world. The 50 km road is expected to be completed in 36months with 67 culverts, carriage width of 7.3 m, shoulder width of 2.7 m on both sides of the road and a total pavement thickness of 400 mm

The Local Government Area has a total of 117 institutions of learning. This comprises 96 primary schools; 20 secondary schools and Technical College at Ayetoro, established by the community itself and the University of Science and

Technology, Okitipupa established by the governor Olusegun Agagu administration and has recently been renamed after him.

5.16.5 Major Occupations of the People/ Farming Systems of the Area

The major occupational activities of the Ilajes include **fishing, canoe making, lumbering**, net making, mat making, launch building, farming and trading. Fishing however remains the major agricultural preoccupation of the Ilaje. Palm Tree, Timber and raffia are major cash crops in the neigbouring areas, especially Okitipupa and Irele. Other arable crops include cocoyam and maize and banana. Other occupations include trading and processing of cassava into staple food items such as *gaari* and *fufu; popularly known as pupuru in the area.* The women are mostly involved in processing of cassava, as well as marketing of food crops such as cassava products, cocoyam, maize and vegetables (*Telfaria sp. and Cellocia sp.*) in the local markets. Oil palm trees, rubber and plantain are also found in the area.

Farm sizes are very small (about 0.4 – 2.0 hectares). The food crops are mainly for subsistence with only the surplus production sold in the local markets. Land acquisition is not a problem as attested to by our respondents. Some of the methods identified to acquire land include: gift, lease and sale.

5.16.6 Household Food Consumption

The staple food of the people of the study area is cassava based. The cassava is processed into various from such as pupuru, a special delicacy unique to the people of the coastal area of Ondo State, *gaari*, cassava flour, and *fufu*. Other major food preparations consumed by most households are yam (boiled, pounded, fried or roasted) and maize. Household protein are mainly fish, shrimp, crabs, alligator, crocodile and other aquatic species with the popular ororugbo soup.

5.16.7 Sources of Water to the Communities

The major sources of water for drinking for and other domestic uses are the various boreholes in the communities. These bore holes are owned by institutions, communities and individuals. Rain water harvesting is also very common in all the communities while majority still collect water from the streams or go to the streams to wash clothes.

5.16.8 Marketing

Market and marketing facilities exist in the area. The markets are held every day. Representatives from all the communities supervise the market operations and resolve conflicts when such arises. There are some special levies or payments for stall allocation in the market. All the monies collected are used to maintain and run the markets.

The major products sold in the market consist of fish, shrimps, fresh cassava tubers or its products. Other food items sold in the market include palm oil, yams, cocoyam, plantain and vegetables. The market provides employment to a number of people including middlemen/commission agents who operate in the marketing process for the different agricultural products sold.

5.16.9 Transportation

The dominant means of transportation for both human beings and farm produce is by water and road subject to where one is going. For road transportation, motor vehicles and motorcycles (popularly called *okada*) are the only means of transport. However, canoes and boats were used to get to the project site.

5.16.10 Amenity and Recreation

Recreational facilities are poorly developed in the area. The beautiful Aiyetoro beach is unexplored. There is the town hall that serves as meeting point for youths and elders. Other forms of recreation currently enjoyed by the people include assembling in selected locations for drinking the local gin "*ogogoro*", or visiting the beer parlours.

5.16.11 Public Health

The most important disease among the people is malaria. The incidence of typhoid is no longer very common but occurs occasionally. A modern health institution (Primary Health Clinic) exists in the area. Access to modern health institutions available is within a radius of 3-5 km.

The use of traditional health institutions and spiritual homes are not common within the area, though people still collect herbs from the forest to treat common ailments of human beings and livestock. The clearing of some farmlands for the project may therefore not have any serious negative effect on the health of the people of the area.

5.17 Economic potential

The local government is endowed with abundant economic potential, which include the following:

Major industries and economic minerals

Oluwa Glass Company Plc, Igbokoda use to be the leading industry in that axis with its raw materials from the sea sands. This industry made use of the abundance of high-quality silica sand that are found in various parts of the Local Government. The sand account for not less than 75% of the raw materials for manufacturing glass sheets and occur in large quantity in Agerige, Akata, Olopemeji, Araromi Sea-side, Zion Pepe, Ode Etikan, Igbokoda Zion, Aboto and Orereara. It is unfortunate that the industry is presently shut down.

Crude oil/gas

Crude oil/gas which is the major source of income in Nigeria, is found in Ilaje Local Government. There are oil wells and fields spread all over the Local Government Area both onshore and offshore, operated by Oil Companies such as Shell, Chevron, Texaco Nigeria Ltd., in addition to Consolidated Oil, Express Petroleum and Gas Company, Atlas Oil Company, Allied Energy Oil Company, Cavendish Oil Company and Exxon-Mobil.

Ondo State earned revenue from oil is high as a result of the victory recorded in the disputed-on shore Oil wells formerly credited to Delta State which has since been returned to Ondo State. These wells are: Opuekepa, Omuro, Ojumole, MAlu, Eko, Parabe, Minna, Bella, Obe, Esan, Ewa, Opolo, Opuama and Isekelwu oil fields.

Bituminous Sand (Tar sand)

The coastal area of Ondo State is well endowed with Mineral resources including large deposits of bituminous sands. The exploitation of these minerals will transform the entire area and re-distribute wealth. The proposed seaport and exchange zone to be cited at Araromi Sea-Side will serve as a means of exporting the product to other parts of the world.

Plate: Bitumen Deposits in Ondo State.

Fishing terminal, Igbokoda

The foremost role played by this Local Government in national fish production has motivated the Federal Government to establish the Multi Million Naira Fishing Terminal at Igbokoda, as a result of available abundant local experience, labour supply and direct access to the sea. Consequent upon the proposed entrance for big fishing vessels, creeks and rivers, the fishing industry remains attractive to willing investors for large scale and subsistence fishing.

Boat building industry

Apart from the Boat yard at Igbokoda, the first Dockyard was at Ayetoro and later Orioke Iwamimo, Olotu kuwo. A few other towns engage in boat building and essentially through cooperative efforts. There is the need for the supply of more boats since about 75% of the Local Government is Riverine. There is also need for improved technology in the business of boat building in order to boast productivity. This is a vacuum that could be filled by potential investors.

OGOGORO/ALCOHOL DISTILLERY AND PALM WINE TAPPING.

The business dots all parts of the Local Government because of the availability of palm tree. However, improved mechanized distillery to boost large scale production on industrial alcohol is attainable. This orders a challenge to the world of investors.

MAT WEAVING INDUSTRY

The raw materials for this are also sourced locally. Raffia Palms form the basis of the mat weaving, in the entire Local Government but the current level of mat making can be increased through the introduction of modern implements or method of mat making.

CULTURE TRADITION

The Ilajes are a distinct migratory coastal linguistic group of Yoruba peoples spread along the coastal belts of Ondo, Ogun, Lagos and Delta states, and originally made up of four geo-political entities namely: Ode Ugbo, Ode Mahin, Ode Etikan and Aheri**.** They are said to have left Ile-Ife their original ancestral home/settlement of all yorubas in the 10th century. They mainly occupy the Atlantic coastline of Ondo State of Nigeria while a large population of them settles on land in the hinterland. The area they occupy remains the Ondo State of Nigeria only outlet to the sea.

The advent of the white missionaries saw majority of the Ilajes embracing Christianity, with a slight majority of the Christians among them worshipping with the Cherubim and Seraphim Church of Zion, which has its headquarters in Ugbo Nla. There are also considerable number of Anglican and Jehovah witness worshippers. Numerous cultural/traditional activities and mementos abound in the Local Government Area; the most prominent being the Ayelala Shrine. No tourist visits the area without taking second look at the Ayelala Shrine which is located at a river junction called "Ita Ayelala", a few kilometers from the Local Government Headquarters. Ayelala is a powerful and widely respected goddess because of its capacity to expose evil doers (including "wizards/witches") and ensure they confess their sins in the open. It could be invoked to unravel the causes of diabolical cause of mysteries.

5.17.1 Income Distribution and Household Consumption Patterns

Wide disparities exist in the income of the residents of the areas. The non-natives who purchase land and build houses or those who operate business enterprises in the city are much better off in terms of income than the natives. Active land market transactions were observed, which further confirmed the land use conversion in the areas. Very active sand business was observed and it costs about ten thousand naira (₦10,000.00) for 4 cubic measure of sand. With respect to housing and accommodation, it costs about ₦1000-1200/month to rent a single room in most communities. Similarly, it costs about ₦200.00 per meal at most of the nearby local restaurants.

5.17.2 Generation and Disposal of Solid Wastes

Waste is the inevitable consequence of human activities. It is either a by-product of production processes or it arises when objects or material are discarded after they have been used. Households and local processing factories within the study area generate large quantities of wastes. The wastes are generally disposed during the monthly environmental/sanitation exercise by dumping in the forests (rural areas) and by the roadsides or drainage channels in urban areas. Thus large volumes of wastes are found by the road sides after the monthly environmental exercise. Casual observation showed that large volumes of solid wastes are generated by the residents. The composition of the wastes varies with the seasons of the year. For example, agricultural waste materials like maize cobs constitute the bulk of the waste materials during the harvesting season while cassava peels constitute the by-products of local processing factories.

5.17.3 Social Organization/ Youth Forum

The social organization in some of the communities visited give prominence to the activities of Youth Organizations and the existence of a Youth Forum. This enables the youths to actively participate in social organization and leadership roles within the communities. There is peaceful coexistence among the youths and the elders. However, the youths get agitated when not part of the decision-making process. The Youth Council is led by the General President.

The Elders and Youths have been promoting the economic and social development of the area and other surrounding communities. The community members meet regularly, relax and have useful discussions among themselves.

CHAPTER SIX

ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

6.0 INTRODUCTION TO IMPACTS

All major development projects, such as the Deep-Sea Port field project, have environmental, socio-economic and health impacts. If the objectives of such projects must be realized, the associated and potential impacts of the project must be identified, well evaluated and adequate mitigation measures provided. Otherwise a project which is supposed to be a benefit may turn out to be a great disaster or loss in the end. The greatest concern of any project is about its impacts; which can either be negative or positive. Whilst the positive impacts must be enhanced, the negative impacts must be mitigated. In general, impacts vary considerably in magnitude, extent and in significance. All these attributes of impact must be duly evaluated. In the present chapter the associated and potential impacts of the proposed Deep-Sea Port project are assessed. The objectives of the assessment are to identify and describe the actual and potential of associated impacts of the project, predict the likelihood, magnitudes of such impact and evaluate the significance of the impacts.

As defined in the Terms of Reference, the following aspects of the environment are considered in the Impact Assessment:

i. Coastal Morphology, Sediment Processes and Meteorology
ii. Water and Sediment Quality
iii. Groundwater
iv. Air Quality
v. Noise and Vibration
vi. Marine and Coastal Ecology
vii. Lagoon Ecology
viii. Ornithology
ix. Terrestrial Ecology
x. Socio-economic Impacts
xi. Waste management
xii. Navigation
xiii. Landscape and visual quality
xiv. Recreation
xv. Cultural heritage
xvi. Health and Safety
xvii. Cumulative Effects Assessment

6.1 IMPACT ASSESSMENT METHODOLOGY

Some of the commonly used methods of impact assessment are as follows:

(i) Ad hoc methods
(ii) Checklist methods

(iii) Matrix methods

(iv) Leopold matrix

The Ad hoc method relies on the experience of the environmental assessors which may be biased and therefore subjective. The checklist method relies on the assessment of the potential impacts on a given number of environmental indices ranging from ecological, socio-economical to biodiversity. The value of this method also depends on the experience of the environmental assessor and the composition of the checklist used. Matrix method can be used only for impact identification. It uses an interactive matrix of the expected developmental activities against the environmental components to predict the presence of impact. The method thereby achieves the impact identification without qualifying them. The Leopold matrix (Leopold *et al.,* 1971) incorporates qualitative as well as quantitative information on cause and effect relationship.

The assessment of the potential environmental impacts of the Deep - Sea Port development project was based on three processes, namely: impact identification, impact description and impact rating. The latter includes the prediction of magnitude, consequence and the significance of impacts. The EIA process then considers the interactions between impacts of the various project phases activities and sensitivities (components of the environment).

6.2 STAGES OF IMPACT RATING

The main stages and events involved in the rating of impacts as used in the present study are as follows:

Stage 1: Description of impacts

Stage 2: Impacts qualification with regard to its likelihood of occurrence

Stage 3: Impact qualification with regard to potential consequence

Stage 4: Impact significance i.e. with regard to the degree of importance

Stage 5: Development of impact table involving the listing of each impact against it source and rating

The involvement and detailed information on these respective stages are as follows:

Stage 1: Description of impact

The following characteristics are used to describe each impact:

i. Positive/negative (beneficial/adverse)
ii. Direct/indirect (directly/via intermediate factors that influence the determinants of an impact).
iii. Duration: Permanent (long term)/temporary (short term)
iv. Magnitude: local or widespread
v. Reversibility/irreversibility: can the impact revert to previous condition or does it remain permanent?

Stages 2 and 3: Qualification of Impact.

This is based on two assessment characteristics:

(i) Likelihood of occurrence – this is an assessment of the probability of the effect happening (Table 6.3.1).

(ii) Potential consequence – this is the actual result and scale that an effect might have (Table 6.3.2)

Table 6.0: Likelihood of Occurrence of Impact

Impact probability	Likelihood	Frequency
High probability (80-100%)	A very likely impact	Very frequent impact
Medium high probability (60-80%)	A likely impact	Frequent impact
Medium probability (40-60%)	A possible impact	Occasional impact
Medium low probability (20-40%)	An unlikely impact	Few impacts
Low probability (0-20%)	A very unlikely impact	Rare impacts

Table 6.1: Potential Consequence of Impact

Potential Consequence	Effect
Extreme consequence	A massive effect
Great consequence	A big effect
Considerable consequence	A substantial effect
Little consequence	A slight effect
Hardly any consequence	A trivial effect

The potential consequence of an impact depends on two things: the magnitude of the potential changes to the environment, caused by a hazard, and the level of sensitivity of the receiving environment. This is depicted in Table 8.2

Table 6.2: Potential Conséquences Classification Matrix

	Magnitude of Effect		
RECEPTOR SENSITIVITY	LOW CHANGE	Medium change	High change
LOW RECEPTOR SENSITIVITY	Trivial effect	Slight effect	Substantial effect
MEDIUM RECEPTOR SENSITIVITY	**SLIGHT EFFECT**	Substantial effect	Big effect
HIGH RECEPTOR SENSITIVITY	Substantial effect	Big effect	Massive effect

Stage 4: Degree of significance

Table 8.3 shows the impact significance with associated impact rating.

Table 6.3: Degree of Impact Significance

Impact Significance	Impact Rating
Major significance	Major impact
Moderate significance	Moderate impact
Minor significance	Minor impact
Negligible significance	Negligible impact

Stage 5: Impact Assessment Matrix

The potential impacts were evaluated using the Impact Assessment Matrix shown in Table 8.4

Table 6.4: Impact Assessment Matrix

	Potential consequences					
Likelihood	**Positive**	**Negative**				
		Hardly any	Little	Considerable	Great	Extreme
High		Moderate	Moderate	Major	Major	Major
Medium high		Minor	Moderate	Moderate	Major	Major
Medium		Minor	Minor	Moderate	Moderate	Major
Medium low		Negligible	Minor	Minor	Moderate	Moderate
Low		Negligible	Negligible	Minor	Minor	Moderate

6.3 IMPACT IDENTIFICATION

Several activities of the Deep-Sea Port project have potential associated impacts through the various phases of activities of the project. The identified activities include mobilization to site, site preparation, Pile driving, deposition of rubbles, dredging of sand disposal of materials into sea, water and waste transportation, building of culverts, bridges, drainage channels, construction of buildings, service yards, intermodal yards, container yard , On-site fabrication (mainly by welding), supply of food, and other consumables, construction equipment, energy provision during construction, on -site construction, power generation , etc. Over the life of the project all these activities can be grouped and/ or classified into three major phases of the project as follows;

❖ Pre- Construction Phase activities.

1. Pre- construction phase is including preliminary activities at location of the Port such as land acquisition, structures/landfills, position of the development site.

- The estimated impact that can be caused by land acquisition activity in access road and back up area are the decreasing of land productivity, livelihood lost, and public unrest.

  Number of persons/communities affected for the Ondo Deep-Sea Port is insignificant for area is sparsely populated and the Resettlement Plan is outside the purview of this project.

  The access road is about 3.2 km on an area of 73.2 ha. (*Source: Ondo Port Report)*

  The government through the RAP evaluation will resettle and compensate those affected.

❖ **Construction Phase:** Involve activities in the sea and on land.

Construction phase activities involves mobilization of workers who will be employed to site, mobilization of heavy-duty equipment's, dredging, disposal of materials

A. Employment of Worker and Basecamp Operational

Ondo Deep-Sea Port Development will use services of various contractors both local and expatriates. In the recruitments, Contractors will be required to utilize the local Workers, especially from villages around the project site according to the Local Content Act. There is no law that prohibits the employment of foreign experts to work in Nigeria. The only requirement is that of obtaining an expatriate quota which entitles the foreigner to work in Nigeria. Nigerian expatriate quota policy states the requirements for hiring experts in Nigeria. In order to work as an expatriate in Nigeria, the company or employer must meet certain criteria, the main condition that the company be registered in Nigeria and fulfill all the requirements of obtaining all the Permits.

Construction workers for the project were estimated at 2000 in Phase I Stage 1 and 1,200 persons in Phase I Stage 2, of which about 30% will be unskilled locals.

Envisaged activities include:

i. Office and basecamp for commuter construction workers will be built.
ii. To keep the environmental cleanness as the result of workers domestic activities, so it will build toilet and temporary means of liquid waste disposal
iii. This will result in employment generation
iv. Possibility of break out of infectious disease.

B. Mobilization of Heavy Equipment and Material

i. The impact that can occur from these activities are air quality reduction (TSP and emission), the increasing of noise, land and offshore traffic disturbance, road damage, and public unrest.
ii. Types and numbers of heavy equipment's for Ondo Deep- Sea port cannot be exactly estimated in the course of this study; however, we know that several units of heavy-duty equipment like those listed below in several numbers will be deployed to the site.

Backhoe Tire Roller
Belt Conveyer
Soil Barge
Tug Boat
Patrol boat
Piling Barge
Material Barge
Tug Boat
Bulldozer
Concrete plant
Concrete Truck
Crane
Flat truck

Grab Dredger
Backhoe Barge
Material Barge
Tug Boat
Crane Barge
PVD Machine
TSHD Dredger
Dump Truck
Grab Dredger
Bulldozer
Tire Roller
Grader
Wheel roader
CDM Ship

Trucks, ships, barges required for the transportation of materials in volumes are high, so the noise, dust pollution in some areas outside the direct AOI is expected to be high.

C. Reclamation and Off-Shore Facility Development

Generally, the estimated impact from reclamation and off-shore facility development activity is the decline of water quality (increasing of TSS), marine life disturbance (nekton and benthos), Fishing ground change, and public unrest. Description of activities in reclamation and off-shore facilities development is as follow.

1. Reclamation

Reclamation activity is conducted in Phase I Stage 1 and Phase I Stage 2 construction, which is used in terminal development. Total soil material requirement for reclamation is 14,042,490. M^3(*Source: Ondo Port*

Report), which is for Phase I Stage 1 development. It is expected that material can be dredged using a Trailing Suction Hopper Dredger (TSHD). For the volume a 50.0% loss factor is assumed for dredging material to account for materials that are unsuitable for reclamation. Dredged material will be hydraulically reclaimed by either rainbowing or via pipe connection from the ship. Unwanted clay materials and organics will be carefully disposed.

2. Off-Shore Facility Development

Off-shore facilities construction are series of activities involving a wide variety of things to support the ongoing activities of port development, generally, there are few types of activities that performed from Phase 1 Stage 1 until Phase I Stage 2. The activities are listed below;

1. Construction of terminal
    i. Construction of Container Terminal
    ii. Construction of Vehicle Terminal
    iii. Construction of Ro-ro ship and Boat Terminal
    iv. Construction of Bitumen
    v. Construction of Cement export Terminal
    vi. Construction of Multipurpose Terminal
    vii. Construction of Offshore Supply Terminal.
2. Breakwater
3. Revetment / Seawall
4. Berth
5. Causeway
6. Quay wall

❖ **Operational Phase**

Includes ship related factors such as vessel traffic, ship discharges and emissions spills and leakages from ships, cargo related factors such as cargo handling and storage, handling equipment, hazardous materials, water front industry discharges and land transport to and from port and categorized as

- Procurement of employer
- Off-shore facilities operational
- On-shore facilities operational
- Maintenance of basin and sailing line
- Access road operational

A. Employment of Workers

Workers divided by functions:

i. Basic Operations of Port-based infrastructure to be managed by Port Authority's labor authorities will handle the Berth breakwater, navigation, maintenance of port facilities, the cost of rent and charges, collection of data and information.

ii. Government functions are coordinated by the port authorities to cover customs, quarantine, immigration, police, fire, safety delivery, and more.

iii. Security including port security, vessel and cargo field.

iv. Operational unloading ports by carriers, cleaning service

Workers for the container terminal and car terminal can be hired from local people.

B. Marine Facility Operational

Marine facility operational activity is a series of activities which is carried out after the construction of terminal has been completed, that will start to operate in 2026 Those activities consist of activity such as:

i. *Calling Vessel* Activity
ii. Loading and unloading ships activity
iii. Cargo and transportation storage activity
iv. Ship waste management activity
v. Water Sulky
vi. Waste Water Treatment
vii. Power Supply

Off-shore facilities operational activity predicted can produce impacts such as air quality decline (TSP and emission), sedimentation, sea line change, water quality decline (increasing of TSS), sea traffic disruption, marine life disruption (benthos and nekton), fishing ground change, and public unrest.

❖ **Summary of Hypothetic Significant Impact**

The probable receptors of impacts from the above listed project activities are: Air quality, soil and land use, vegetation, water quality, aquatic resources (including fisheries), socio-economics and health status in the project environment. These receptors can be grouped broadly under biophysical attributes (B), Socio-economics (S) and health (H). Biophysical attributes include air quality, soil and land use, vegetation (flora), wildlife and fisheries (fauna), hydrobiology and water quality.

Environmental facets to be considered in relation to port development are categorized into nine groups: (a) water quality; (b) coastal hydrology; (c) bottom contamination; (d) marine and coastal ecology; (e) air quality; (f) noise and vibration; (g) waste management; (h) visual quality; and (i) socio-cultural impacts.

Water quality includes five elements: (a) general features such as temperature, salinity, pH, color, transparency, oil and grease, and organic material concentration measured by total organic carbon (TOC), chemical oxygen demand (COD) or biochemical oxygen demand (BOD); (b) turbidity measured by suspended solids (SS); (c) eutrophication-related factors measured by dissolved oxygen (DO), nitrogen **(N)** and phosphorus (P); (d) harmful or toxic substances including heavy metals such as mercury, cadmium, lead, and pesticides; and (e) sanitation-related factors determined by measuring the amount of coliform bacteria.

Coastal hydrology cited here includes factors concerning currents, tidal flow, littoral drifts, beach erosion, water drainage, sediment deposition, groundwater flow, and other physical phenomena in the shore zone.

Bottom contamination encompasses many kinds of contamination of bottom sediments by toxic or harmful substances, oils, oily mixtures and other hazardous materials. Contamination of bottom sediments are often measured by the size of sediment particles, pH, color, smell, oil and grease, organic materials, and concentration of organic nitrogen, phosphorus, sulphide and toxic substances such as heavy metals and pesticides including toxic components of antifouling paints.

Marine and coastal ecology includes aquatic fauna and flora composed of a large number of species of bacteria, phytoplankton, zooplankton, benthonic organisms, coral, seaweed, shellfish, fish and other aquatic biota, terrestrial flora such as mangroves and wetlands. Loss of bottom habitat and fishery resources are also significant problems included in this category.

Air quality consists of two main elements: (a) soot and dust, measured by suspended particulate matter (SPM), which originate from dry bulk cargo handling and storage, construction work on land, and road traffic; and (b) concentration of sulfur dioxide ($S0_2$), nitrogen dioxide ($N0_2$), carbon monoxide (CO), and hydrocarbons (HC) emitted from ships, vehicles and various equipment used for port activities. Harmful substances and odour are also elements to be considered in this category.

Noise and vibration generated by road traffic, cargo operations, ship traffic and other port activities also cause nuisances to local people.

Waste management relates to all kinds of wastes, both liquid and solid, likely to be disposed of in the port area. These wastes include dredged materials, garbage and oily mixtures discharged from ships, wastes from cargo operations, and all types of discharges from municipal and waterfront industry activities.

Visual quality refers to the aesthetic value of the landscape, the view of port facilities, the nuisance of bright lights used for night operations in a port, and other visual problems.

Socio-cultural impacts include all kinds of influence on the local community and people's life style such as relocation of villages, industrialization, population growth nearby, and the formation of slums.

The following section reviews the potential impacts of port activities on each facet of the environment and possible measures against potential adverse effects. Relations between impact sources and various part of the environment are summarized in table 6.3.6.

Table 6.5 Matrix of Potential Impact

No	Environment Component	Component Activity											
		Pre-Construction Phase	**Construction Phase**						**Operational Phase**				
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
A	**Physic – Chemical**												
1	Decreasing of Air Quality (TSP and Exhaust Gas)			X			X	X		X	X		X
2	Increasing of Noise Level			X			X	X			X		X
3	Decreasing of Surface Water Quality							X					
B	**Hydrology**												
1	Increasing of Run Off Water						X	X			X		X
C	**Oceanography**												
1	Sedimentation									X			
2	Change of Shoreline									X			
3	Decreasing of Sea Water Quality		X		X	X	X			X	X	X	
D	**Space, Land, and Transportation**												
1	Land Conversion												X
2	Land Traffic Disruption			X									X
3	Marine Traffic Disruption			X						X			
4	Road Damage			X									X
E	**Biology**												
1	Disturbance of Marine Life (Nekton and Benthos)				X	X				X		X	
2	Disturbance of Terrestrial Fauna (Bird)						X				X		
3	Disturbance of Terrestrial Flora						X						
F	**Social, Economic, and Culture**												
1	Opened Employment and Bossiness Opportunities		X						X				
2	Loss of Land Productivity	X											
3	Change of Fishing Ground				X					X			
4	Loss of Livelihood and Income	X											
5	Social Unrest	X		X	X		X	X		X	X		X
G	**Public Health**												
1	Incidence of Communicable Diseases		X						X				
2	Pile of Waste									X			

Note

Pre – Construction Phase

1. Land Acquisition

Construction Phase

2. Mobilization of Workers and Operational Basecamp
3. Mobilization of Heavy Equipment and Material
4. Reclamation and Marine Facility Construction
5. Dredging and Disposal
6. Onshore Facility Construction
7. Access Road Construction

Operational Phase

8. Employment of Workers
9. Marine Facility Operational
10. Onshore Facility Operational
11. Maintenance of Basin and Shipping Line
12. Operational Access Road

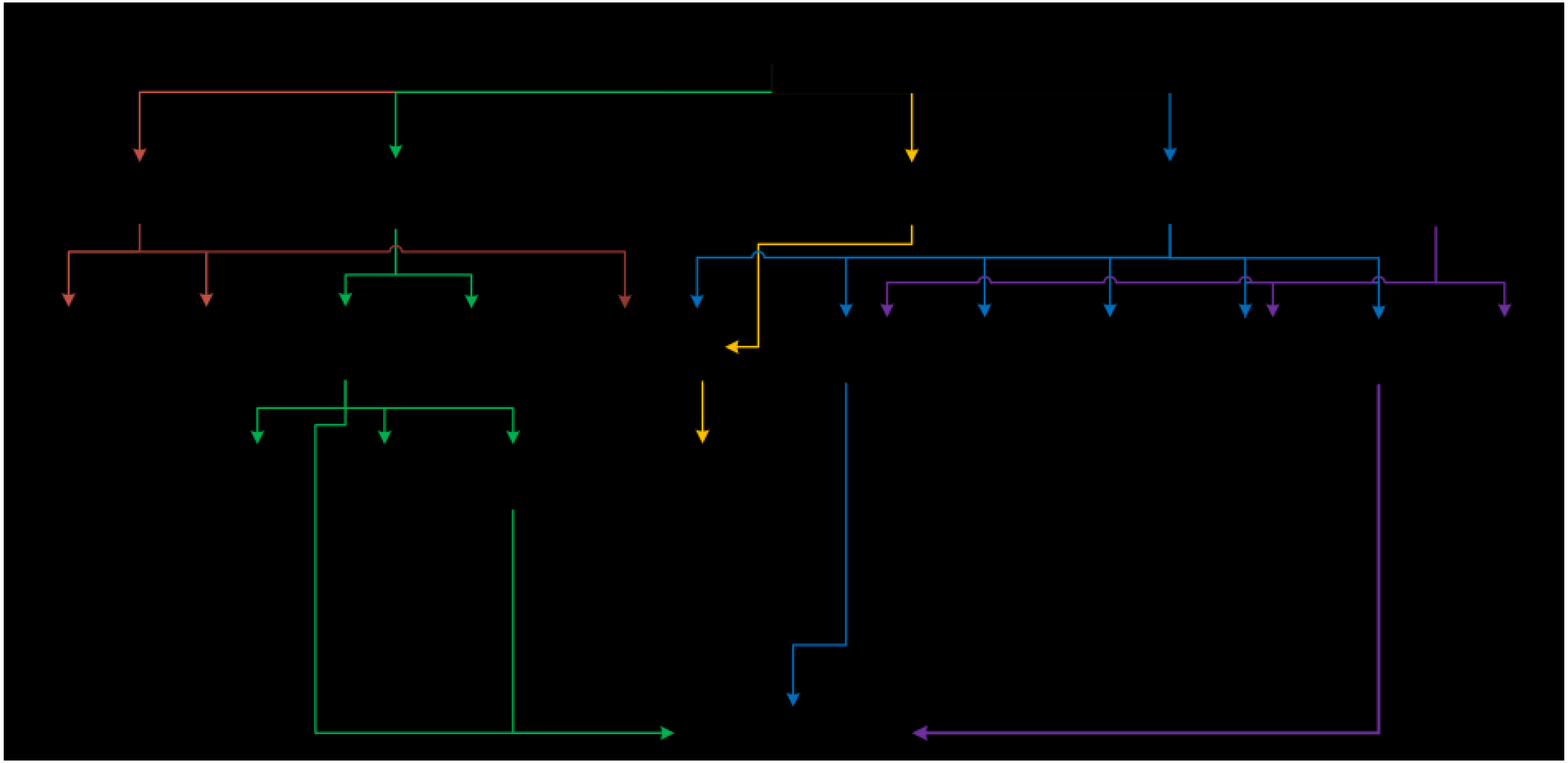

Fig: 6.1 Flow Chart for Construction Phase

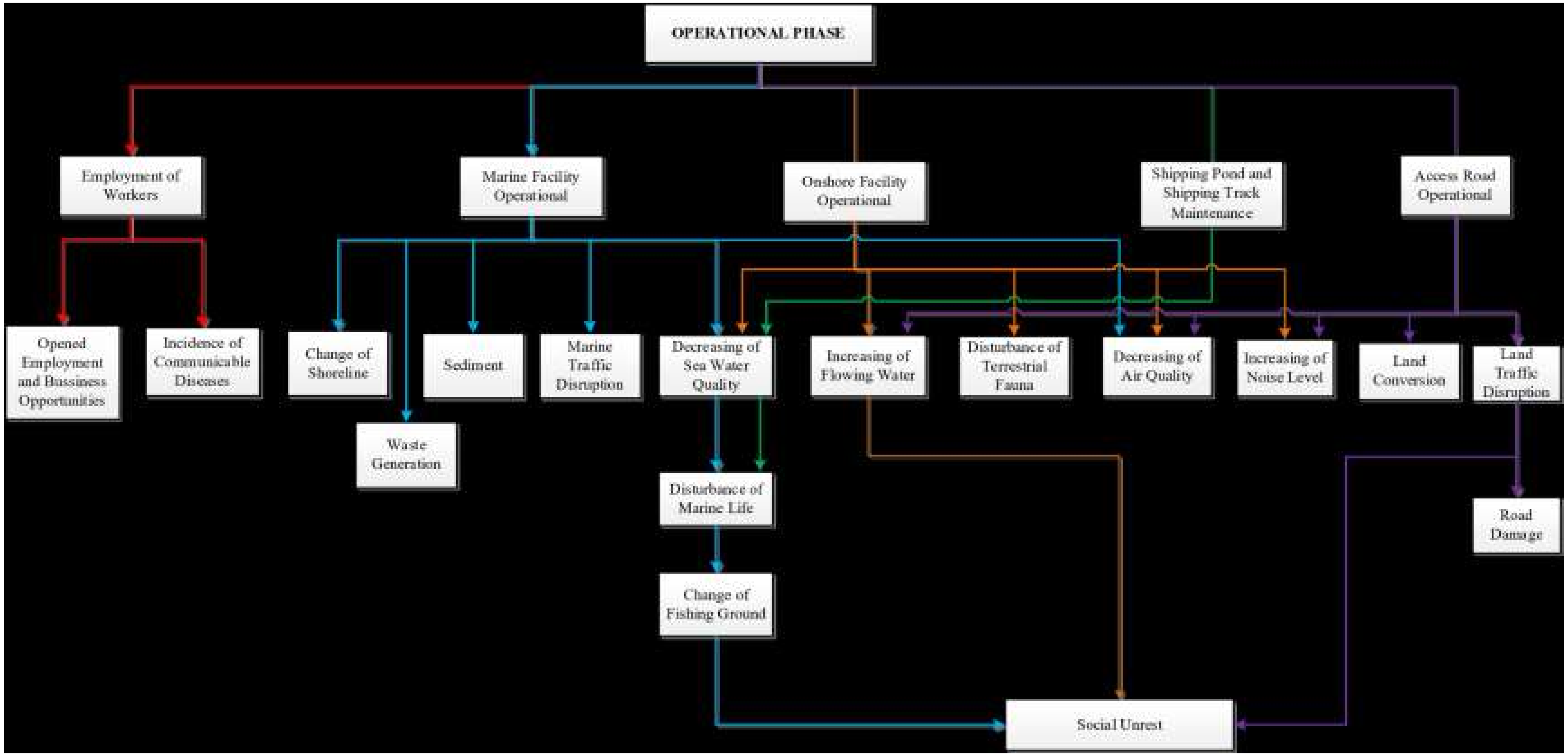

Fig: 6.2 Flow Chart for Operations Phase.

TABLE 6.6: Major impacts of Port Development Project on the Environment.

Source Facet of the Environment	location of port (A)	Construction and dredging (B)	Port operation	
			Ship traffic and discharges (C)	Cargo operations and waterfront industry (D)
Water quality (1)	A1	81	C1	01
Coastal hydrology (2)	A2	82	-	-
Bottom contamination (3)	A3	83	-	03
Marine/coastal ecology (4)	A4	84	C4	04
Air quality (5)	-	85	C5	05
Noise and vibration (6)	-	86	-	06
Waste management (7)	-	87	C7	07
Visual quality (8)	AS	-	-	08
Socio-cultural impact (9)	A9	-	C9	09

6.3.1 Potential impacts on water quality (A1 of Table 8.6)

- Breakwaters and landfills may change current patterns and cause stagnation of water behind the structures.
- stagnant port water can increase phytoplankton and decrease dissolved oxygen, resulting from eutrophication of water, caused by effluents containing nutrient salts (chemical compounds including N and P).
- Anaerobic water leads to the generation of hydrogen sulphide (H_2S} and can be identified by its odour which has serious effects on organisms

- Municipal sewage also brings coliform bacteria into the port and may cause contamination of the harbour.

Measures against adverse effects:

- Careful site selection and port design should be carried out, focusing on the possibility of water stagnation.
- If the basic pollution level is critically high, a sewage treatment system should be planned as part of the environment management of the area.
- Regulations on discharges of effluents into water and provision of sanitary treatment facilities must be given consideration.
- In a polluted bay or port, it could be effective to dredge or cover contaminated bottom sediment capping to reduce the flux of pollutants from the sediment to the water.

Fig. 6.3 Housing environment

6.3.2 Potential Impacts on Coastal Hydrology (A2 of Table 8.6)

The location of a port often:

i. causes changes in current patterns and littoral drifts due to alteration of wave refraction, diffraction and reflection.

ii. The change of littoral drift may lead to erosion or accretion in shore zones.

iii. Altered currents or reflected waves may endanger small ships maneuvering near structures.

iv. The creation of a port may cause changes in river flow and waterfront drainage.

Measures against adverse effects:

i. Careful site selection and port design could minimize changes in current.

ii. Model experiments or computer simulations of these changes are useful in developing an appropriate design.

iii. Typical measures against beach erosion are construction of sea walls, jetties, offshore breakwaters, and periodical beach nourishment.

6.3.3 Potential Impacts on Bottom Contamination (A3 of Table 8.6)

i. The location of a port may accelerate sediment deposition in stagnant water behind structures and cause contamination of the sea bottom.

ii. Sediment deposition covers bottom biota and physical habitat.

iii. Pile structures shade the bottom and affect habitat.

iv. Eutrophication of water induces sedimentation of dead plankton and changes chemical characteristics of bottom sediments, resulting in an increase of organic matter, hydrogen sulphide, and mobilization of harmful substances.

Measures against adverse effects:

i. Removal of contaminated sediments,

ii. capping,

iii. Ensure enforcement of effluent standards.

6.3.4 Potential impacts on marine/coastal ecology (A4 of Table 8.6)

i. The location of a port affects aquatic. fauna and flora through changes of water quality, coastal hydrology and bottom contamination.

ii. Land reclamation from the sea destroys bottom habitat and displaces fishery resources.

iii. Terrestrial fauna and flora may also be altered by the location of a port.

iv. Diminution of bottom biota is usually linked to a reduction of fishery resources, and occasionally to an increase of undesirable species.

v. Deterioration of water quality usually gives rise to changes in aquatic biota: a decrease in the number of species; and an increase in the quantity of one or two specific species.

vi. Further deterioration may lead to the destruction of all kinds of aquatic biota.

vii. Diminution of plants in a shore zone within enclosed water may degrade its aeration capability and worsen water pollution.

viii. Mangroves in wetlands play an important role in providing habitat for terrestrial and aquatic biota and indirectly recovering water quality.

Measures against adverse effects:

i. Adverse effects on marine and coastal ecology usually result from:

ii. deterioration of water and air quality;

iii. current pattern changes; bottom contamination;

iv. physical loss of water area; and changes in natural land habitat.

v. Careful survey of the ecological characteristics of a project area is indispensable if the welfare of endangered and fragile species is *to* be considered and disruption of their spawning seasons and areas and migration is to be minimized.

vi. Planting of green plants around a port may be an effective means to mitigate adverse effects on terrestrial habitat.

Fig. 6.4 Shoreline Erosion

6.3.5 Potential impacts on visual quality (A8 of Table 8.6)

i. The visual quality of a project area is affected by the creation of a port, port facilities, lighting, and other optical disturbances.

ii. The landscape may be changed into an artificial scene of industrialization.

iii. Some port facilities may give unpleasant impression to people.

Measures against adverse effects:

i. The design of port should cause it to blend with its surroundings.

ii. Special attention to the colors of port facilities and landmarks helps improve port scenery.

iii. A green belt zone around a port may block an unpleasant view of the port and be a more pleasant sight.

6.3.6 Socio-cultural impacts (A9 of Table 8.6)

i. Building or expanding a port often requires relocation of the local community, sometimes causing ethnic, cultural, tribal, or religious conflicts with local people.

ii. Industrialization and modernization may change the cultural traditions of the local community.

Measures against adverse effects:

i. An appropriate resettlement plan could minimize the disturbance to the local community and ensure smooth transition to industrialization.

ii. Survey of archaeological heritage sites should be undertaken well in advance and a preservation plan included in any port development plan.

iii. During the evaluation stage of a development information should be provided.

Distribution of population around the project area:

Initial population distribution, age composition, households, slums, social solidarity, public peace and order, infrastructure

(a) Race composition:

Majority and minority groups, cultural gaps, basic resources for life, racial conflicts

(b) Removal and resettlement of local people:

Removal population, conservation of community, condition of resettlement, opinions on removal and resettlement

(c) Cultural heritage:

Location of heritage, importance of heritage, legislation on preservation, possibility of removal

Fig 6.5 Flooding in the zone

6.3.7 IMPACTS OF CONSTRUCTION

6.3.7.1 Potential impacts on water quality (81 of Table 8.6)

i. Pile driving, deposition of rubble, dredging, sand compaction and other construction work in water cause resuspension of sediments and turbid water.

ii. Resuspension of sediments in water leads to an increase in the level of suspended solids (SS) and in the concentration of organic matter, possibly to toxic or harmful levels.

iii. It also reduces sunlight penetration.

iv. Work vessels are a possible cause of oil spills, garbage discharge, and leakage of other substances into water.

v. Diffusion from concrete work in water and overflows from landfills may be possible sources of water pollution.

Measures against adverse effects

i. The adverse effects of construction work could be minimized by appropriate selection of equipment in pile driving or dredging,

ii. proper use of silt curtains,

iii. careful planning of settling ponds and overflow weirs for landfills,

iv. and suitable transport of construction materials and dredged material.

v. Proper disposal of dredged material plays a critical part in preserving the environment.

vi. Deposition in landfills may offset problems being caused by dumping at sea.

6.3.7.2 Potential impacts on coastal hydrology (82 of Table 8.6)

i. The potential impacts of construction on coastal hydrology are nearly the same as the potential impacts of the location of a port which are listed above.

ii. Dredging may cause changes in current patterns and flows as well as salt wedge intrusion into a river mouth or littoral drifts in the shore zone.

iii. Changes in littoral drifts lead to beach erosion or accretion.

iv. Disposal of dredged material on land may possibly cause leakage of harmful substances into ground water or changes in waterfront drainage.

Measures against adverse effects

i. The impact of dredging on current flow is usually not serious and can be assessed by current flow simulation.

ii. Beach erosion could be avoided by carefully planning the steepness of the dredging slope and the deviation from the shore line.

6.3.7.3 Potential impacts on bottom contamination (83 of Table 8.6)

i. Construction work and dredging disturb bottom sediments and induce resuspension, dispersal and settlement of such sediments.

ii. Dumping of dredged material directly alters bottom configuration and biota and may disperse toxic or harmful chemicals around the disposal site.

iii. Dredging removes bottom habitat and may lead to a loss of fishery resources.

Measures against adverse effects:

i. A survey of contamination of bottom sediments should be undertaken before dredging.

ii. In case substances or materials listed in the annexes of the London Dumping Convention are found during the survey; the dredged material should be treated in accordance with the respective provisions of the convention (See appendix 4).

iii. Selection of disposal site, disposal methods and requirements for capping are key issues in undertaking disposal at sea.

iv. In shallow water, silt curtains, as well as careful selection of the dredging method, could be effective in minimizing dispersal of resuspended sediments.

v. Specific Guidelines for the Disposal of Dredged Material at Sea have been adopted by the Contracting Parties to the London Dumping Convention.

6.3.7.4 Potential impacts on marine/coastal ecology

(84 of Table 8.6)

i. Disturbance from construction activities may cause displacement of fishery resources and another mobile bottom biota.

ii. Dredging removes bottom biota

iii. D umping of dredged material covers bottom habitat, both of which may reduce fishery resources.

iv. Settlement of resuspended sediments on fragile marine fauna and flora damages the ecosystem particularly coral reefs, which are formed by the extracellular product of symbiotic plants. The great number of coral polyps attached need dissolved oxygen for respiration and the plants need sunlight for photosynthesis.

v. Piles, concrete surfaces, rubble mounds and other similar structures in water could form new habitats, which may introduce undesirable species.

vi. If toxic substances and other contaminants are resuspended through dredging or dumping, they may lead to contamination of fishery and shellfishery resources.

Measures against adverse effects

i. Careful survey of a fragile marine and coastal ecology is essential for appropriate planning of construction work, dredging, and disposal of dredged material.

ii. Selection of port site is the key to minimizing adverse effects

iii. Since adverse effects usually result from bottom contamination and deterioration of water quality, measures against those adverse effects are also effective for mitigating changes in aquatic and terrestrial habitat.

6.3.7.5 Potential impacts on air quality (85 of Table 8.6)

i. Emissions from construction equipment, work vessels, trucks and other vehicles used in construction work could be a source of air pollution.

ii. Dust from construction activities is also a possible source of air pollution.

Measures against the adverse effects:

i. Methods for controlling dust emission are water scattering in the construction site

ii. use of proper transport methods such as a conveyor belt, for excavated material and screens around the construction site.

iii. Create a buffer zone, a green belt zone or open space between the construction site and the local community could be an effective buffer.

iv. Temporary pavement of roads in a construction site could considerably reduce dust emission.

6.3.7.6 Noise and vibration (86 of Table 8.6)

- Construction activities may create a problem of noise and vibration generated by construction equipment, truck traffic, work vessels and other similar sources.

Measures against adverse effects:

i. Transmission of noise and vibration are limited by the distance from their sources

ii. Noise could be considerably reduced by adoption of low noise equipment or installation of sound insulation fences.

iii. Green belt of plants can be a good barrier.

iv. Limitation of working hours may be a possible means to mitigate the nuisances of construction activities.

6.3.7.7 Waste management

i. Wastes from construction activities are mainly spoils generated by dredging.

ii. Disposal of dredged material on land may cause destruction of plants, loss of vegetation, leakage of contaminated materials and salt, odour, an unsightly view and other nuisances to the local community

iii. Disposal in water may cause the breeding of other microorganisms

Measures against adverse effects:

i. The adverse effects of disposal of contaminated dredged material or other wastes from construction activities could be offset by including them in land reclamation.

ii. Appropriate design, according to the characteristics of the wastes, is a basic requisite for retaining walls, settling ponds, capping of landfills, and land use after completion.

iii. Dumping of dredged materials should be treated in accordance with the provisions of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972, and the Amendments Adopted in 1978 and 1980, the so-called London Dumping Convention, and relevant national regulations.

6.3.8 IMPACTS OF SHIP TRAFFIC AND DISCHARGES

6.3.8.1 Potential impacts on water quality (C1 of Table 8.6)

i. Possible discharges from ships that could be sources of water pollution are bilge water, ballast water, oily wastes, sewage, garbage and other residues in a ship.

ii. Spills of oils, lubricants, fuels and other oily liquids may be other sources of water pollution. Once an oil or oily compound is discharged into water, it is spread on the surface by winds and currents, forming a thin layer.

iii. On the surface of seas in tropical or temperate zones, oils can be polymerized gradually by biodegradation and eventually form dense particles which sink.

iv. Concentration of oily compounds in water is an important indicator of water quality, particularly in recreational water areas.

Measures against adverse effects

i. Appropriate regulations on ship discharges and provisions of reception facilities are indispensable for proper control of emissions and effluent from ships

ii. Detection of spills is also important for regulating ship discharges

iii. Accidental spills are unavoidable, recovery vessels, oil fences, and treatment chemicals should be prepared with a view to minimizing dispersal.

iv. Proper contingency plans and a prompt reporting system are keys to prevention of oil dispersal.

v. Periodical clean-up of floating wastes is also necessary for preservation of port water quality.

6.3.8.2 Potential impacts on marine and coastal ecology

(C4 of Table 8.6)

i. Leakage of oils, oily wastes and mixtures may directly cause damage to fishery resources, aquatic biota and coastal habitat.

ii. Biodegradation of oil also generates polymerized oil particles and toxic aromatic fractions using dissolved oxygen in the water, which indirectly cause damages to bottom biota and habitat.

iii. Both effects may seriously damage marine and coastal ecology.

iv. Fishery resources, including shellfish, may be spoiled by oil and toxic substances generated by biodegradation.

v. Some oils contain carcinogens and their contamination is reported in fishery resources.

6.3.8.3 Potential impact on air quality (C5 of Table 8.6)

- Ships are a possible source of airborne emissions such as gasses, smoke, soot and fumes. NO_2 and SO_2 are typical pollutants generated by ships while both maneuvering and berthing and may affect air pollution in the hinterland.

Measures against adverse effects

i. Regulation and proper detection of emissions from ships are effective means to reduce discharges of pollutants.

ii. Prohibition of the use of heavy diesel oil as fuel could be a possible means to reduce pollutants.

iii. Basic level of air pollution where considerably high, measures against air pollution should be planned on a regional basis, including port activities.

6.3.8.4 Waste management (C7 of Table 8.6)

i. Ships generate:

a) oily wastes such as bilge water, ballast water, washing water, lubricant oil and other residues in machinery space;

(b) sewage and garbage; and

(c) cargo residues such as wood bark.

ii. Discharges and spills of these wastes cause problems of oil pollution, floating garbage, unsanitary conditions, odour and other degradation of water quality.

Measures against adverse effects:

i. Ports are requested to provide sufficient reception facilities to receive residues and oily mixtures generated from ship operations according to provisions of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL, 19-,.) as amended by the 1978 Protocol (MARPOL, 1973/78).

iii. Besides oily residues, reception of sewage and garbage is also required in accordance with the needs of calling ships.

iv. Connection to sanitary treatment facilities or a municipal waste treatment system may be a means for a port to receive such wastes.

v. Provision of these facilities, promulgation of regulations on discharge of oily residues, and proper detection are keys to successful control of ship discharges. Unsanitary discharges from repair docks should also be connected to appropriate waste treatment systems.

6.3.8.5 Socio-cultural Impacts (C9 of Table 8.6)

i. Oil and oily wastes discharged from ships may reach nearby beaches and spoil recreational activities which cause serious damage to tourism.

ii. Ship traffic may disturb pleasure boat cruising and fishery boat operations.

iii. The possibility of accidents in the ship traffic becomes a worry to local people.

iv. Ship calls create many related jobs including pilotage, tug services, stevedoring, bunker and crew services, however, they may bring considerable changes in the life style of local people.

Measures against adverse effects:

- Appropriate regulations on ship traffic and discharges and contingency plan for ship accidents could mitigate the problem.

6.3.9 IMPACTS OF CARGO OPERATIONS AND WATERFRONT INDUSTRY

6.3.9.1 Impacts on water quality (01 of Table 8.6)

i. Runoff from raw material storage, spills from bulk cargo handling, and wind-blown dust are possible sources of contamination of port water.

ii. Toxic or harmful substances may be included in runoff from sulfur, bauxite, phosphates, nitrogenous manure, coal, metal ores and other raw materials.

iii. Organic materials in runoff are decomposed to the inorganic form, spending dissolved oxygen and increasing the nutrient level in water

iv. Accidental spills of toxic, harmful materials, oils or oily compounds, and other raw materials are also possible sources of contamination of water.

v. Effluent from waterfront industries may include toxic or harmful materials, unsanitary wastes, oily wastes and other hazardous materials.

vi. Electricity generation may release heated water and sewage treatment facilities produce nutrient salts, organic matter and some hazardous materials.

Measures against adverse effects

i. Counter measures against runoff are:

(a) covering or enclosing raw material storage areas;

(b) sprinkling water on raw material except anti-humid materials like grains or cement;

(c) providing special equipment for cargo handling and transport (e.g., covered conveyor or pneumatic unloader); and

(d) other methods to reduce the influence of wind and rain.

ii. A reversed slope apron is an effective means to avert rainfall from washing away from the apron and pouring into the sea directly. The drains from the apron are led to a settling pond and released into the sea after settlement of suspended materials.

iii. Regulations on effluent from waterfront industries and monitoring of water quality are essential for port environment protection.

iv. Separation of waterfront industry discharges from the harbour area could be an effective means to offset problems caused by such effluent.

6.3.9.2 Potential impacts on bottom contamination (03 of Table 8 .6)

i. Bottom contamination may result from runoff from quay and storage area, spills from bulk cargo operations, and windblown dust.

ii. Discharge from waterfront industries is a major source of contamination of bottom sediments.

6.3.9.3 Potential impacts on marine and coastal ecology (04 of Table 8.6)

i. Cargo handling and storage may cause runoff, spills or leakage of ingredients, which possibly include toxic or harmful materials, organic matter, or oily compounds.

ii. Water pollution and bottom contamination resulting from these effluents lead to deterioration of aquatic biota and fishery resources.

iii. Dust dispersion on land may cover plants and change terrestrial habitat. If toxic or harmful substances are included in dust emissions, the health of port workers and local people are endangered.

iv. Discharge from waterfront industries is a major source of water pollution which induces deterioration of aquatic biota due to toxic and harmful materials, poor oxygen dissolution and eutrophication of water.

6.3.9.4 Potential impacts on air quality (05 of Table 8.6)

i. Emissions of dust from bulk cargo handling and gasses from cargo handling equipment can be sources of air pollution.

ii. Liquid cargo handling may result in the release of vapour during the cleaning of storage tanks and by the breather system for ambient temperature changes

iii. Accidental leakage of gasses may cause problems such as toxic material emission, explosions, fumes, odours and hazardous airborne emissions.

iv. Waterfront industries may release various kinds of gasses and can be major sources of air pollution and odour.

Measures against adverse effects:

i. Monitoring of air quality is indispensable to ensure acceptable levels of emissions. Dust emission can be reduced by covers, screens, enclosures, sprinkling water or other similar methods

ii. Regulations on emissions from waterfront industries should be introduced in accordance with a regional environment management plan.

The environmental sensitivities attributes likely to be affected by the activities of the proposed Deep-Sea Port field project can be grouped under the three major receptors as follows:

A Biophysical Environment (B)

i. Air quality
ii. Noise / sound and vibration level
iii. Radiation / light
iv. Surface water quality
v. Ground water quality
vi. Soil and sediment quality
vii. Biodiversity

(vegetation, wildlife, fisheries, hydrobiology, and microbiology)

B Health Environment (H)

i. Access to drinking water
ii. Access to traditional medicine
iii. Exposure of wildlife attack (bees, snakes, scorpion, wildlife and poisonous plant effect).
iv. Exposure to nuisance (dust, noise, pollen etc)
v. Exposure to traffic accident

vi. Exposure to STIs HIV/AIDS

vii. Mortality rate

viii. Morbidity rate

C Social-Economic Environment (S)

i. Access to farmland

ii. Access to fishing/fishing ground

iii. Access to significant ancestral and cultural sites

iv. Cost of living and inflation

v. Ethnic balance

vi. Level of income and financial flows

vii. Lifestyle, alcohol and drug abuse / violence

viii. Morals and family values

ix. Opportunities for contracting and procurement

x. Opportunities for local and national employment

xi. Poverty alleviation

xii. Pressure on available food, water and accommodation

xiii. Religion / cultural / traditional structures and customs

Thus, a total of twenty-eight sensitivities were identified. The interaction matrix of these sensitivities against the major three project phases is presented in Table 8.7.

Table 6.7 Project Phase and Environmental Sensitivities Interaction Matrix

	Impact type	Sensitivities	Project Phase		
			Constriction including site preparation	Operations and maintenance	Specialisation
1	Biophysical Environment	Surface water quality	X		X
2		Air quality	X	X	X
3		Light/Solar radiation	X	X	X
4		Level of noise and sound	X	X	X
5		Groundwater quality	X	X	X
6		Soil and sediment quality	X	X	X
7		Biological species (vegetation, wildlife, fisheries, microbes)	X	X	X
8		Access to clean drinking water	X	X	X
9	Health Environment	Bees, snakes, scorpions, wild life attack/poisonous plants contact	X	X	X
10		Exposure to nuisance (dust, noise etc.)	X	X	X
11		Exposure to STIs/HIV/AIDS	X	X	X
12		Mortality rate	X	X	X
13		Morbidity rate	X	X	X
14		Access to traditional medicine	X		X
15		Exposure to traffic accidents	X	X	X
16	Social Environment	Poverty alleviation	X	X	X
17		Ethnic balance	X	X	X

18		Access to farmlands	X		
19		Sense of place/well being /aesthetic value	X	X	X
20		Access to fishing grounds	X		
21		Access to ancestral and culturally significant sites	X		
22		Traditional occupations	X	X	X
23		Level of income and financial flows	X	X	X
24		Cost of living and inflation	X	X	X
25		Opportunities for contracting and procurement	X	X	X
26		Opportunities for local and national employment	X	X	X
27		Third party agitation (communities, NGO, CBO, etc.)	X	X	X
28		Lifestyle, Alcohol and drugs abuse/violence	X	X	X
29		Morals and family values	X	X	X
30		Religious/cultural/Traditional structures and customs	X	X	X
31		Pressure on available food, water, accommodation			

6.4 DETERMINATION OF IMPACTS

The impacts of the proposed Deep-Sea Port project with regard to the project phases and activities are presented in Table 8.8.

Table 6.8: Associated and Potential of Deep-Sea Port Impacts Project

		Impact Description			Impact quantification		
Project Phase	**Project Activities**	**Potential Impact**	**Type of impact[2]**	**Description**	**Likelihood**	**Consequence**	**Rating**
Site Preparation (vegetation clearing, Pilling, road upgrade, sand filling, grading, concreting)	Increased level of disease vectors (mosquitoes etc.)	B, H, S	Direct Negative Long term Local Reversible	Medium	Extreme	Major	Positive
	Destruction of vegetation (medicinal, economic and food)	B, H, S	Direct Negative Long term Local Irreversible	Medium High	Considerable	Moderate	Moderate
	Loss of habitat for wildlife, microorganisms etc.	B,	Direct Negative Long term Local Reversible	Medium High	Considerable	Moderate	Moderate
	Exposure of field workers/ community members to attacks by poisonous snakes, bees, spiders, scorpions/other wildlife	B, H, S	Direct	High	Great	Major	Minor

	and contact with poisonous.		Negative Long term Local Reversible				
	Traditional occupation (farming, hunting) could be adversely affected.	S	Direct Negative Long term Local Reversible	Medium	Considerable	Moderate	Major
	Increased erosion of the cleared area	B, S	Direct Negative Long term Local Reversible	Medium	Considerable	Moderate	Moderate
	Increased access for hunting and logging	B, S	Direct Positive Long term Local Reversible	High	Positive	Positive	Moderate
	Third party agitation	S	Direct Negative Long term Local	High	Great	Major	Minor

			Reversible				
	Opportunities for employment	S	Direct Positive Long term Local Reversible	High	Positive	Positive	Moderate
	Nuisance (noise, emissions, vibrations) from heavy machinery	B, H, S	Direct Negative Long term Local Reversible	High	Great	Major	Minor
	Change in topography of excavated filled area	B, S	Direct Negative Long term Local Reversible	Medium low	Hardly any	Negligible	Minor
	Impairment of water quality by increased turbidity	B, S	Direct Negative Short term Local Reversible	Medium High	Little	Minor	Moderate
	Traditional occupation could be adversely affected.	S	Direct Negative	High	Little	Moderate	Minor

			Long term Local Reversible				
	Disturbance of aquatic life (zooplankton, phytoplankton, benthic communities, fisheries etc)	B,	Direct Negative Long term Local Reversible	Medium	Considerable	Moderate	Minor
	Groundwater quality could be impaired by leachates	B, H, S	Direct Negative Long term Widespread Irreversible	Low	Considerable	Minor	Moderate
	Opportunities for employment	S	Direct Positive Long term Local Reversible	High	Positive	Positive	Minor
Site Construction	Increased pressure on existing infrastructure (health, housing, transport, sanitation and waste management etc) due to increased population	B, H, S	Direct Negative Short term Local Reversible	High	Little	Moderate	Moderate

	Disturbance of aquatic life (zooplankton, phytoplankton, benthic communities, fisheries etc)	B,	Direct Negative Long term Local Reversible	Medium	Considerable	Moderate	Major
	Reduction in the quality of surface and groundwater	B	Direct Negative Long term Widespread Reversible	Medium High	Considerable	Major	Positive
	Increase in employment/ contract opportunities	S	Direct Positive Long term Local Reversible	High	Positive	Positive	Major
	Increased social vices, drug abuse, commercial sex workers (CSW), teenage pregnancies	H, S	Direct Negative Long term Local Reversible	High	Great	Major	Positive
	Shift from traditional occupations to other activities	S	Direct Negative Long term	High	Little	Moderate	Minor

			Local Reversible				
	Increased in population leading to diffusion of culture and traditions	S	Direct Negative Long term Local Reversible	Medium	Considerable	Moderate	Moderate
	Increased in cost of living/inflation	S	Direct Negative Long term Local Reversible	High	Considerable	Major	Major
	Attract third party agitation	S	Direct Negative Long term Local Reversible	High	Great	Major	Major
	Increased nuisance from dust, emissions, noise and vibration etc	B, H, S	Direct Negative Long term Local Reversible	Medium	Considerable	Moderate	Minor
	Increased potential for road and	H, S	Direct	Medium	Extreme	Major	Major

	water traffic accidents		Negative Long term Local Reversible				
	Increased nuisance from dust, emissions, noise and vibration etc	B, H,	Direct Negative Short term Local Reversible	Medium	Considerable	Moderate	
	Impacts of associated wastes (solid, effluent, pollutant gases)	B, H, S	Direct Negative Short term Widespread Reversible	High	Considerable	Major	
Operations	Maintenance of acquired land	Increased opportunities for employment /contract	S	Direct Positive Long term Local Reversible	High		Positive
		Exposure of workers to attack by poisonous snakes, bees, scorpions, other wild animals and contact with poisonous plants	B, H, S	Direct Negative Long term Local Reversible	Medium low		Extreme

		Impairment of air quality	B, H, S	Direct Negative Long term Widespread Reversible	Medium	Considerable	
		Increased Morbidity from upper respiratory tract diseases	H, S	Direct Negative Long term Local Reversible	Low	Considerable	
		Third party agitation	S	Direct Negative Long term Local Reversible	High	Great	
		Contamination of surface and underground water	B, H, S	Direct Negative Long term Widespread Reversible	Medium	Considerable	

		Pressure on water, food, accommodation	S	Direct Negative Short term Local Reversible	Medium	Considerable	
		Impairment of health of Aquatic (fisheries, breeding ground, nurseries) and terrestrial life (flora and fauna)	B, H, S	Direct Negative Long term Local Reversible	Low	Considerable	
		Traditional occupations adversely affected thereby reducing income	S	Direct Negative Long term Local Reversible	High	Little	
		Increased morbidity rate thereby putting pressure on existing health facilities	B, H, S	Direct Negative Long term Local Reversible	Low	Great	

		Increased level of disease vectors (mosquitoes, rats, cockroaches, flies, e.t.c)	B, H, S	Direct Negative Long term Local Reversible	Medium Low	Considerable	
		Increased potential for road accidents.	B, H, S	Direct Negative Long term Local Reversible	Medium	Great	
		Nuisance from obnoxious odour	H, S	Direct Negative Long term Local Reversible	Medium	Hardly any	
		Reduced acceptability of habitat to humans and wild life (recreational, sense of place)	S	Direct Negative Long term Local Reversible	Medium High	Hardly any	

		Reduced quality of habitat for humans, plants and wild life due to continuous lighting	B, S	Direct Negative Long term Local Reversible	Medium High	Little	
	Routine operations and maintenance of flow station, flow lines and pipeline	Pressure on available water for domestic use, food and accommodation	S	Direct Negative Long term Local Reversible	Medium	Little	
		Pressure on existing health and social infrastructure	H, S	Direct Negative Long term Local Reversible	Medium	Considerable	
		Increased social vices, drug abuse, commercial sex workers (CSW), teenage pregnancies	H, S	Direct Negative Long term Local Reversible	High	Great	

		Opportunity for employment and contracting	S	Direct Positive Long term Local Reversible	High	Positive	
		Increased potential for third party agitation	S	Direct Negative Long term Local Reversible	High	Great	
Decommission	-Equipment dismantling - Structures dismantling - Waste disposal - Removal of contaminants - Soil remediation	Opportunity for employment and conti	S	Direct Positive Long term Local Reversible	High	Positive	
		Increase in cost of living/Inflation	S	Direct Negative Long term Local Reversible	Medium	Little	

		Increase noise and waste generation	B, H, S	Direct Negative Short term Local Reversible	Medium High	Considerable	
		Increase in community unrest/third due to Loss of job	S	Direct Negative Long term Local Reversible	High	Great	
		Injury / fatalities in workforce an accident	H, S	Direct Negative Long term Local Reversible	Medium	Great	
		Stress on existing security, socia structures	H, S	Direct Negative Long term Local Reversible	Medium	Little	

		Impairment of air quality causing respiratory Diseases	H,	Direct Negative Long term Local Reversible	Medium	Great	
		Contamination and alteration of soil fauna community and soil profile	B	Direct Negative Long term Local Reversible	High	Considerable	

Measures against adverse effects:

iii. Monitoring of air quality is indispensable to ensure acceptable levels of emissions. Dust emission can be reduced by covers, screens, enclosures, sprinkling water or other similar methods

iv. Regulations on emissions from waterfront industries should be introduced in accordance with a regional environment management plan.

The environmental sensitivities attributes likely to be affected by the activities of the proposed Deep-Sea Port field project can be grouped under the three major receptors as follows:

A Biophysical Environment (B)

(i) Air quality

(ii) Noise / sound and vibration level

(iii) Radiation / light

(iv) Surface water quality

(v) Ground water quality

(vi) Soil and sediment quality

(vii) Biodiversity (vegetation, wildlife, fisheries, hydrobiology, and microbiology)

B Health Environment (H)

(i) Access to drinking water

(ii) Access to traditional medicine

(iii) Exposure of wildlife attack (bees, snakes, scorpion, wildlife and poisonous plant effect).

(iv) Exposure to nuisance (dust, noise, pollen etc)

(v) Exposure to traffic accident

(vi) Exposure to STIs HIV/AIDS

(vii) Mortality rate

(viii) Morbidity rate

C Social-Economic Environment (S)

i. Access to farmland
ii. Access to fishing/fishing ground
iii. Access to significant ancestral and cultural sites
iv. Cost of living and inflation
v. Ethnic balance
vi. Level of income and financial flows
vii. Lifestyle, alcohol and drug abuse / violence
viii. Morals and family values
ix. Opportunities for contracting and procurement
x. Opportunities for local and national employment
xi. Poverty alleviation
xii. Pressure on available food, water and accommodation
xiii. Religion / cultural / traditional structures and customs

Thus, a total of twenty-eight sensitivities were identified. The interaction matrix of these sensitivities against the major three project phases is presented in Table 8.9.

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2		Air quality	X	X	X
3		Light/Solar radiation	X	X	X
4		Level of noise and sound	X	X	X
5		Groundwater quality	X	X	X
6		Soil and sediment quality	X	X	X
7		Biological species (vegetation, wildlife, fisheries, microbes)	X	X	X
8		Access to clean drinking water	X	X	X
9	Health Environment	Bees, snakes, scorpions, wild life attack/poisonous plants contact	X	X	X
10		Exposure to nuisance (dust, noise etc.)	X	X	X
11		Exposure to STIs/HIV/AIDS	X	X	X
12		Mortality rate	X	X	X
13		Morbidity rate	X	X	X
14		Access to traditional medicine	X		X
15		Exposure to traffic accidents	X	X	X

16	Social Environment	Poverty alleviation	X	X	X
17		Ethnic balance	X	X	X
18		Access to farmlands	X		
19		Sense of place/well-being /aesthetic value	X	X	X
20		Access to fishing grounds	X		
21		Access to ancestral and culturally significant sites	X		
22		Traditional occupations	X	X	X
23		Level of income and financial flows	X	X	X
24		Cost of living and inflation	X	X	X
25		Opportunities for contracting and procurement	X	X	X
26		Opportunities for local and national employment	X	X	X
27		Third party agitation (communities, NGO, CBO, etc.)	X	X	X
28		Lifestyle, Alcohol and drugs abuse/violence	X	X	X
29		Morals and family values	X	X	X
30		Religious/cultural/Traditional structures and customs	X	X	X
31		Pressure on available food, water, accommodation			

6.5 LIST OF IDENTIFIED MODERATE AND MAJOR IMPACTS

The negative (moderate and major) and positive impacts identified for the different phases of the project activities comprise the following:

6.5.1 Construction Phase and Location

i. Increased level of disease vectors (mosquitoes etc.)
ii. Destruction of vegetation (medicinal, economic and food)
iii. Loss of habitat for wildlife, microorganisms etc.
iv. Exposure of field workers/ community members to attacks by poisonous snakes, bees, spiders, scorpions/other wildlife and contact with poisonous plants.
v. Traditional occupation (farming, hunting) could be adversely affected.
vi. Increased erosion of the cleared area
vii. Increased access for hunting and logging
viii. Opportunities for employment
ix. Nuisance (noise, emissions, vibrations) from heavy machinery
x. Change in topography of sand filled area
xi. Causes accretion
xii. Impairment of water quality by increased turbidity
xiii. Traditional occupation could be adversely affected.
xiv. Disturbance of aquatic life (zooplankton, phytoplankton, benthic communities, fisheries etc)
xv. Groundwater quality could be impaired by leachates
xvi. Increased pressure on existing infrastructure (health, housing, transport, sanitation and waste management etc) due to increased population
xvii. Reduction in the quality of surface and groundwater
xviii. Increases chances of spillage

xix. Increased social vices, drug abuse, commercial sex workers (CSW), teenage pregnancies
xx. Shift from traditional occupations to other activities
xxi. Increased in population leading to diffusion of culture and traditions
xxii. Increased in cost of living/inflation
xxiii. Attract third party agitation
xxiv. Increased nuisance from dust, emissions, noise and vibration etc
xxv. Increased potential for road and water traffic accidents
xxvi. Increased nuisance from dust, emissions, noise and vibration etc
xxvii. Impacts of associated wastes (solid, effluent, pollutant gases)

6.5.2 Port Operations and maintenance phase

i. Increased opportunities for employment /contract
ii. Exposure of workers to attack by poisonous snakes, bees, scorpions, other wild animals and contact with poisonous plants
iii. Impairment of air quality
iv. Increased Morbidity from upper respiratory tract diseases
v. Third party agitation
vi. Contamination of surface and underground water
vii. Pressure on water, food, accommodation
viii. Impairment of health of Aquatic (fisheries, breeding ground, nurseries) and terrestrial life (flora and fauna)
ix. Traditional occupations adversely affected thereby reducing income
x. Increased morbidity rate thereby putting pressure on existing health facilities
xi. Increased level of disease vectors (mosquitoes, rats, cockroaches, flies, e.t.c)
xii. Increased potential for road accidents.

xiii. Nuisance from obnoxious odour

xiv. Reduced acceptability of habitat to humans and wild life (recreational, sense of place)

xv. Reduced quality of habitat for humans, plants and wild life due to continuous lighting

xvi. Pressure on available water for domestic use, food and accommodation

xvii. Pressure on existing health and social infrastructure

xviii. Increased social vices, drug abuse, commercial sex workers (CSW), teenage pregnancy

xix. Opportunity for employment and contracting

xx. Increase in cost of living/Inflation

xxi. Increase in noise level and dust generation

xxii. Increase in community unrest/third party agitation

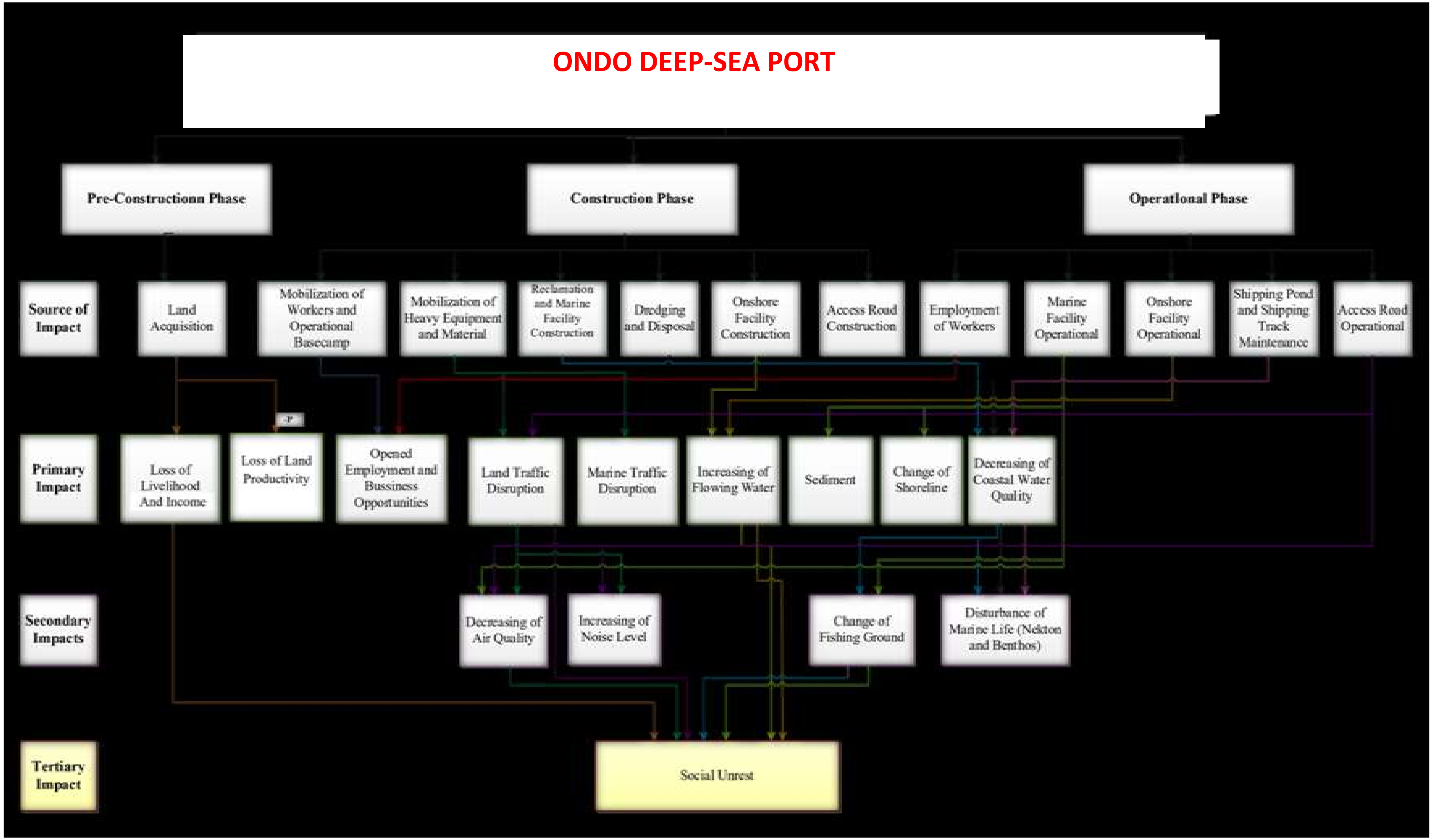
xxiii. Injury / fatalities in workforce and road traffic accident

xxiv. Stress on existing security, social and health structures

xxv. Increase in respiratory diseases

xxvi. Alteration of soil fauna community and soil profile

Table 9.0: Flow chart of Significant Impact



6.6 HIGHLIGHTS OF SOME SPECIFIC IMPACTS

6.6.1 Impacts on Air Quality

During mobilization to site, there will be emissions of gaseous and particulate air pollutants from vehicles. The air pollutants may have negative and direct impairment on the air quality of the environment with widespread associated impacts. The likelihood of these impacts is high with considerable consequence and can be thus rated major. However, these emissions are expected to be local and to last only the period of these activities. The likelihoods are high with considerable consequence thus rated moderate. Energy provision for construction activities and power generation will generate emissions of gaseous and particulates air pollutants with the quantity depending on fuel consumption rates among other factors. These are within medium high likelihood and little consequence therefore rated moderate. The impact may be short term and reversible with medium likelihood of occurrence, considerable consequence thus of a moderate rating.

6.6.2 Noise Impacts

Mobilization to site will require the use of vehicle expected to generate some levels of noise on the road. The resulting noise levels may have negative and direct impairment on the ambient noise levels with widespread associated impacts and high likelihood of occurrence combine with considerable consequence thus rated moderate. This same impact on ambient noise levels is expected during the supply of construction equipment and materials. The likelihoods are high with considerable consequence thus rated moderate. These are within medium high likelihood and little consequence therefore rated moderate. During demobilisation (equipment and personnel from site) from construction activities, anticipated impacts on noise levels are from vehicles and other transportation facilities which may be of negative and direct impairment on the ambient noise levels of the environment with associated impacts on the roads thus widespread. The impact may be short term and reversible with medium likelihood of occurrence, considerable consequence and moderate rating.

6.6.3 Impacts on Terrestrial Vegetation

The removal of the various forms of vegetation cover from the project site without its replacement is the major impact during the land preparation for the project. There will also be alteration of the landscape during and after the construction in the site. The impact of the clearing and construction/civil work on the environment will depend on the types of clearing and construction equipment used.

The construction in the site will consume large area of vegetation and it will involve felling of trees, shrubs and herbs without any thought being given to regeneration in the study area (project site). The cutting of these plant species will leave behind a loss balanced ecosystem. This removal involve loss of numerous shrubs and herbs of food and medicinal value (*Alstonia boonei and Pycnanthus angolensis*), as well as valuable plant genetic resources.

The other chief threats of vegetation removal include destruction of wildlife habitats leading to the death of relatively immobile animals (micro-organisms) as well as the migration of the animals that are capable of escaping and thus will drastically reduce animal populations, their productivity and species diversity, while rare species are being threatened with extinction and this will lead to reduction of biodiversity in the area.

6.6.4 Socio-Economics and Health Impacts

The proposed Deep-Sea Port Project development when operational will have very little negative impacts on the socio-economic and cultural environment of the people. Land acquisition will not be a problem as the project will not cover a large area of farmland and timely but adequate compensation will be paid to the original owners of the land and for crops on the land. Forest and vegetation clearing may however impact negatively on household food security as farmlands are destroyed. On the positive side, the various construction works are expected to boost the economic activities, marketing and household food security of those employed by the various contractors and services providers working on the project.

6.6.5 Impacts on Wildlife and Fisheries

The wildlife fauna in the study area would be affected during the construction in uncleared areas. There will however be minimal loss of wildlife during the construction phase. The duration of the impact can be rated as medium, magnitude low and the probability of occurrence is low hence the overall impact rating will be low. Majority of the wildlife fauna are likely to migrate to the uncleared area during construction phase. After the construction, the wildlife fauna will be negatively impacted. The impact can be rated as medium, magnitude low and the probability of occurrence would be low and hence the overall impact on wildlife would be low.

The bush clearing during the construction phase will not impact negatively on the fish fauna. The duration of the impact during the construction phase will be medium, magnitude low and the likelihood of occurrence will be low, hence the overall rating would be low. The post-construction phase impact on the fish would also be medium. The duration of the impact can be rated medium, magnitude low and likelihood of occurrence low.

6.6.6 Impacts on Water Quality and Hydrobiology

Water pollution, leading to biodiversity loss, loss of basin carrying capacity and reduced biological productivity are the most likely negative impacts of the project activities on water quality and hydrobiology in the project environment. Based on the physico-chemical and microbial qualities of waterbodies in the area (as revealed by the obtained fieldwork results) such impacts may be severe. This is because water sources in the area especially surface water are very dilute and characterized by low alkaline reserve. However, the likelihood of occurrence of such impacts on surface waterbodies in the project area is low because there are very few surface waterbodies (swamps, marshes and streams). Again, as a result of the sandy nature of the area any pollutants that may be drained off the project site through runoff will most likely be loss by percolation through the sandy overburden into the subsurface aquifer. The incidence during site preparation and operational phases are relatively minimal and negligible.

Table 6.10: Impacts of Increased Suspended Solids on Water Quality

Description of Impact	**Impacts of Increased Suspended Solids on Water** Quality
Receptor(s)	Marine Water Quality
Investigation/reference	Surveys and analyses
Features of Impact	Temporary
Significance of Impact	**Moderate adverse impact**
Mitigation advice	☐ Reclamation activities to be conducted to minimize spillage and loss of material from the reclamation site *e.g.* creation of breakwater early in project to create sheltered reclamation site. ☐ Sediments to be dredged should be selected with the lowest percentage of fine material available in order to reduce potential for fines to be dispersed during dredging
	the physical and chemical parameters of the discharge should be maintained. ☐ Turbidity monitoring should occur as described in Table 8.1.
Residual Impact	**Minor adverse impact**

6.7 IMPACT ON MARINE AND COASTAL ECOLOGY DURING CONSTRUCTION

Impact on Marine Ecology from Increased Suspended Sediments

The project involves the dredging of large areas and placement of the dredged material on the area to be reclaimed. Sediment mobilization and subsequent deposition is likely to arise through both the dredging and reclamation activities. It is likely therefore that this could result in a fine layer of sediment over wider areas with the potential to impact benthic organisms through the smothering of feeding/respiratory organs and the restriction of light for photosynthesis. Mobile fauna (*e.g.* fish) and epifauna (*e.g.* crabs) and active burrowers in the area are least likely to be affected by smothering, with sessile organisms being vulnerable and more sensitive.

The increase in suspended sediment within the water column arising from the proposed dredging and reclamation works also has the potential to affect the physiology of fish. Although adult fish are often able to move away from an area of increased suspended sediment, fish eggs, larval stages and juveniles may be unable to move away and avoid such areas and can be impacted though smothering, the ingestion of sediment or blockage of gills. Therefore, shellfish species or species of fish which deposit eggs on the sea floor are most likely to be affected by this source.

Increased turbidity resulting from elevated levels of suspended sediments may also result in a reduction in photosynthetic activity of marine flora due to decreased light penetration.

It is probable that organisms present within the area of impact would be used to some level of naturally turbid water, due to the presence of the commodore channel which provides a source of riverine sediment to the nearshore zone and from the action of waves causing disturbance to the seabed.

The species present in the area (as identified during the baseline survey work) showed that the species were widespread in distribution and no species highly sensitive to smothering or increase in suspended sediment were identified. As such it is expected that there would be high levels of tolerance and quick recovery from adjacent species. As such, although the impacts from dredging and reclamation are on a large scale, the receptor sensitivities are considered to be medium to low. Therefore, it is predicted that the suspended sediments resulting from dredging and reclamation activities would result in an impact of **moderate adverse** significance upon marine ecology. If mitigation measures are implemented to help reduce the suspended sediments it is expected that a residual impact of **minor adverse** significance would occur from this effect (See Table 9.1).

Table 6.11 Impact on Marine Ecology from Increased Suspended Sediments

Description of Impact	**Impact on Marine Ecology from Increased Suspended**
Receptor(s)	Marine Ecology
Investigation/reference	Surveys and analyses
Features of Impact	Long term
Significance of Impact	**Moderate adverse**
Mitigation advice	☐ Reclamation activities to be conducted to minimize spillage and loss of material from the reclamation site *e.g.* creation of breakwater early in project to create sheltered reclamation site. ☐ Sediments to be dredged should be selected with
Residual Impact	**Minor adverse**

6.8 IMPACTS ON SOIL AND LAND USE

The likely impacts of the project on soil and land use can be summarized as follows:

- Land take may lead to altered land use pattern
- There may be environmental degradation from increased pressure on land especially site preparation using heavy equipment for excavation, backfilling and compaction all of which may lead to risks of erosion and drainage problem to adjacent land.
- There will be loss of nutrient in the project footprint area due to erosion resulting from overland runoff.
- Soil contamination through improper disposal of effluent, solid and hazardous wastes.

6.8.1 Matrix of Associated Impacts

The matrix of the associated impact that would be resulting from the Deep-Sea projects are presented in Tables 9.2 to 6.12 respectively.

Table 6.12: Matrix of Associated and Potential Project Impacts on Air Quality and Noise

Project Activities	Impact	Description of Impact	Likelihood	Consequence	Rating
Mobilisation (transport) to site	Impairment of air quality	Direct, Negative, Widespread, Reversible, Short term	High	Considerable	Moderate
	Noise nuisance	Direct, Negative, Widespread, Short term, Reversible	Medium	Little	Moderate
Site Preparation	Nuisance (noise, emissions, vibrations) from heavy machinery	Direct, Negative, Short term, Local, Reversible	Medium high	Considerable	Moderate
Construction	Impairment of air quality by emissions from drilling machine	Direct, Negative, Local, Reversible, Short term	Medium high	Considerable	Moderate
	Noise nuisance from drilling machine	Direct, Negative, Local, Short term, Reversible	Medium high	Considerable	Moderate
Supply of food & other consumables	Emission of noxious substances (emissions) to atmosphere	Direct, Negative, Local, Short term, Reversible	Low	Little	Minor
Supply of construction equipment & materials	Emission of noxious substances (emissions) to atmosphere	Direct, Negative, Local, Short term, Reversible	Low	Considerable	Minor
Energy provision for construction activities	Emission of noxious substances (emissions) to atmosphere	Direct, Negative, Local, Short term, Reversible	Medium	Little	Minor

Project Activities	Impact	Description of Impact	Likelihood	Consequence	Rating
Onsite construction	Nuisance (noise, emissions, vibrations) from heavy machinery	Direct, Negative, Local, Short term, Reversible	Medium	Considerable	Moderate
Power generation	Emission of noxious substances (emissions) to atmosphere	Direct, Negative, Local, Short term, Reversible	Medium	Little	Moderate
Demobilisation (transport) from site	Impairment of air quality	Direct, Negative, Widespread, Reversible, Short term	High	Considerable	Moderate
	Noise nuisance	Direct, Negative, Widespread, Short term, Reversible	High	Little	Moderate
Decommissioning	Nuisance (noise and emissions) from power and allied equipment	Direct, Negative, Short term, Local, Reversible	Medium high	Little	Minor

Table 6.13: Matrix of Associated and Potential Impacts on Vegetation and Wildlife

Project Activities	Impact	Descriptions	Likelihood	Consequence	Rating
Site Preparation	Removal of vegetation	• Direct • Negative • Long term • Local • Reversible	Medium	Significant	High
	Destruction of wildlife habitat	• Direct • Negative • Long term • Local • Reversible	High	Significant	High
	Migration of the animals that are capable of escaping	• Direct • Negative • Long term • Local • Reversible	High		High
	Threatening of rare species	• Direct • Negative • Long term • Local • Reversible	High	Moderate	Moderate
	Accelerated runoff/flash floods	• Direct • Negative • Short term • Local • Reversible	High	Significant	High
	Wind erosion	• Direct • Negative • Short term • Local • Reversible	Medium	Little	Minor

Table 6.14: Matrix of Associated and Potential Impacts on Vegetation and Wildlife

	Elimination of Economic trees	• Direct • Negative • Short term • Local • Reversible	Medium	Significant	Moderate
Construction Activities	Alteration of the Landscape	• Direct • Negative • Short term • Local • Reversible	High	Significant	Medium
	Migration of the remaining animals	• Direct • Negative • Long term • Local • Reversible	High	Significant	High
	Death of relatively immobile animals	• Direct • Negative • Long term • Local • Irreversible	Medium	Little	Low
Operation	Trampling on regenerated plant species	• Direct • Negative • Long term • Local • Reversible	Medium	Little	Low
Abandonement	Regeneration of plant species	• Direct • Positive • Long term • Local • Reversible	High	Significant	Medium

Table 6.15: Matrix of Impact on Socio-Economics

1	2	3	4	5
Project Activity	**Description of Impact**	**Likelihood**	**Consequence (Severity)**	**Rating**
Construction	Destruction of farmland	Low	Low	Low
Post-construction	Destruction of habitats	Low	High	High

Table 6.16: Impact Matrix for Geology and Hydrogeology

SN	Project phase	Impact	Description	Likelihood	Consequence	Overall Rating
1	Construction	Aquifer pollution subsidence	Direct Negative Long term Local Reversible	Low	Moderate	Moderate
2	Operation and maintenance	Aquifer pollution and subsidence	Direct Negative Long term Local Reversible	Medium	Minor	Low
3	Decommissioning and abandonment	Aquifer pollution and subsidence	Direct Negative Long term Local Reversible	Low	Low	Low

Table 6.17: Impact Matrix for Water Quality and Biology

SN	Project phase	Impact	Description	Likelihood	Consequence	Overall Rating
1	Pre – Construction	Water pollution (from overall runoff and effluent waste handling & disposal)	Negative Direct Short term Local Irreversible	Low (rainy season)	Medium	Low
2	Construction	Water pollution (increased turbidity, nutrient input, reduced primary production) from runoff and water intake	Negative Direct Local Irreversible	Low	Medium	Low
3	Operational	Water pollution, loss of biota (phytoplankton, zooplankton, benthic, macro-invertebrate) nuisance weed growth	Negative Direct Widespread Irreversible	Medium	Medium	Moderate
4	Abandonment	Water pollution	Negative Indirect Local Reversible	Medium	Medium	Moderate

Table 6.18: Impacts of Pollution Incidents from Activities during Dredging and Reclamation

Description of Impact	Impacts of Pollution Incidents from Activities during Dredging and Reclamation
Receptor(s)	Marine Water Quality
Investigation/reference	Surveys and analyses
Features of Impact	Temporary
Significance of Impact	**Minor Adverse**
Mitigation advice	• Where discharges to water are necessary strict control on the physical and chemical parameters of the discharge should be maintained. Discharges should be in line with the FMEnv Guidelines on Water Quality. • Close supervision of all plant refuelling to minimise spillage. • Fill portable fuel tanks and containers away from water and never overfill. • Maintain plant regularly and using drip trays. • No washing of tools or plant in water. • Prevention of dust or litter being blown into water. • Keep the site and access roads free from excessive build-up of materials. • Prevent washout from concrete mixing drainy into the ground. • Ensure the works are secure from vandals and thieves. • Supervise the delivery of any hazardous materials. • Adequately bund all storage areas and tanks for oil and chemicals. • Carry out all refuelling of plant in a designated area.
Residual Impact	**Negligible**

Table 6.19: Impact Matrix for Fisheries and wildlife

SN	Project phase	Impact	Description	Likelihood	Consequence	Overall rating
1	Mobilization movement of personnel and goods	Decrease in wildlife fauna population	Negative Direct Negative Short term Local Reversible	Low	Medium	Low
2	Construction phase	(a) Depletion-in fish population (b) Decrease of wildlife	Negative Direct Negative Short term Local Reversible	Low	Medium	Low
3	Operational phase	(a) Decrease in wildlife (fom noise) and fish population (from overland runoff) (b) Over fishing	Negative Direct Negative Long time Local Reversible	Low	High	Moderate
4	Project Abandonment	Increase in wildlife	Negative Direct Negative Long time Local Reversible	High	High	Moderate

Table 6.20: Impact Matrix for Socio-Economics and Health Pre-Construction Phase

SN	Project activities	Impact	Description	Likelihood	Consequence	Overall Rating
1	Site preparation	Promotion of economic activities	Direct Positive Local	High	Moderate	Moderate
2	Access road construction and camp site construction	Promotion economic activities	Direct Positive local	High	Moderate	Moderate
3	Transportation of equipment and materials	Increase Road traffic and Heavy trucks	Direct Negative Short time Local Reversible	Moderate	High	Moderate

6.9 Introduction of the Risk Analysis Assessment

Risk is a combination of:

1. The frequency (likelihood, probability or chance) of a **hazard** realization;
2. The consequence (severity or impact) of the hazard reaching its potential.

In practice, **hazards** will normally have a range of consequences and associated probabilities. In some quarters, risk is viewed as a simple product of frequency and consequence, which is misinformed. The relationship between frequency and consequence is different across the range of possible accidents and their outcomes.

There are basically two types of risk assessment undertaken - qualitative and quantitative. The quantitative approach requires vast amounts of incident data across different sites and requires significant resources to establish a numerical evaluation of the level of risk.

Deep-Sea ports play an important role in world trade, international logistics and global supply chain management. Their operations are associated with a high level of uncertainty because they operate in a dynamic environment in which hazards may cause possible accidents.

A generic risk assessment model which is based on a risk management (RM) framework to priorities and detects the critical hazards that can lead to catastrophic damages to ports is the sin-qua-non for risk assessment analysis worldwide. The proposed model uses a FAHP method to determine the relative weights of the risk factors identified for the port's operations and management.

The key phase of any RM framework or cycle is the risk assessment phase to evaluate the identified hazards or risk factors (USCG, 2010).

There is thus the need to carry out cause and consequence analysis on the identified risk management (RM) factors. We attempt to identify the different types and categories of hazards or risk factors that can put the proposed Ondo State Deep-Sea port in danger. After risk factors were identified and assessed in order to complete the RM cycle it is appropriate by using a proper decision-making tool or technique to select the best available strategies in order to manage and control the hazards.

We aim to propose a RM framework and develop a generic risk-based model for dealing with potential hazards and risk factors that would likely be associated with the proposed Deep-Sea port's operations and management in order to choose the best proposed alternatives (control options) to mitigate risk factors.

In order to ensure to ensure a holistic risk assessment appraisal for the proposed Deep-Sea port, we answered the following questions during two season data gathering in relation to the deep port:

- What are the hazards or sources of risks and uncertainties associated with the proposed Ondo State Deep-Sea port, and how can they be identified?
- How can the identified hazards or risk factors be prioritized and ranked? The prioritization of hazards or risk factors is fundamental to analysis of them. There are a number of ways in which this can be done and these will vary depending upon the risk factors under consideration and the particular methodology being employed
- What are the most appropriate and useful tools for evaluating the risk factors? For application of any specific risk-based model (identified and ranked risk factors), there are numerous techniques and software tools for decision support systems that can be used in this regard.
- What are the most appropriate and useful tools to analyze the causes and consequences of the most significant identified risk factors and how can they be used?
- Individually for any of the most significant risk factors, how can a separate Risk management (RM) methodology and strategy be mapped and implemented?
- How can the identified hazards or risk factors be mitigated and controlled (**See Plates 4.25, 4.26 and 4.27**)

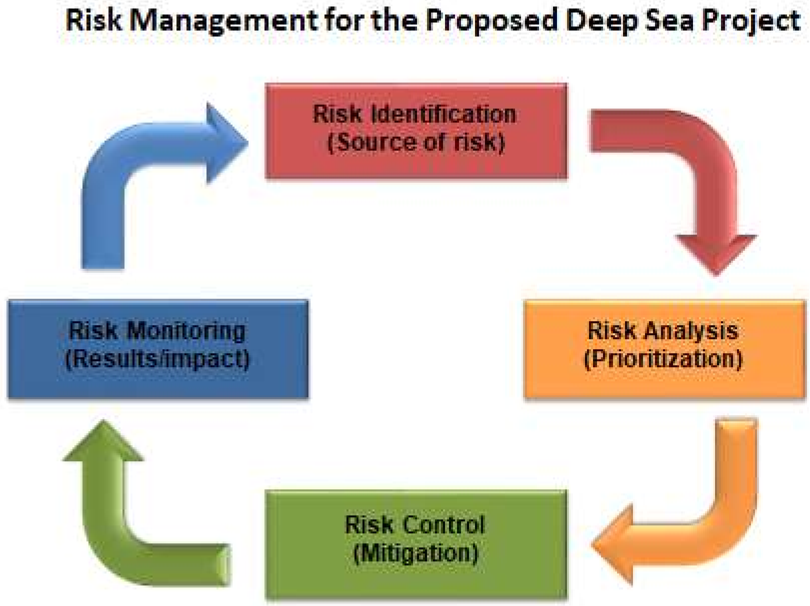


Plate 4.25: Risk Management for the Proposed Deep-Sea

Plate 4:26 Risk Process Overview for the Deep-Sea Port

The flow chart in **Plate 6.26** depicts a RM framework designed for managing hazards and risk factors associated with the proposed Ondo State Deep-Sea port operations and management.

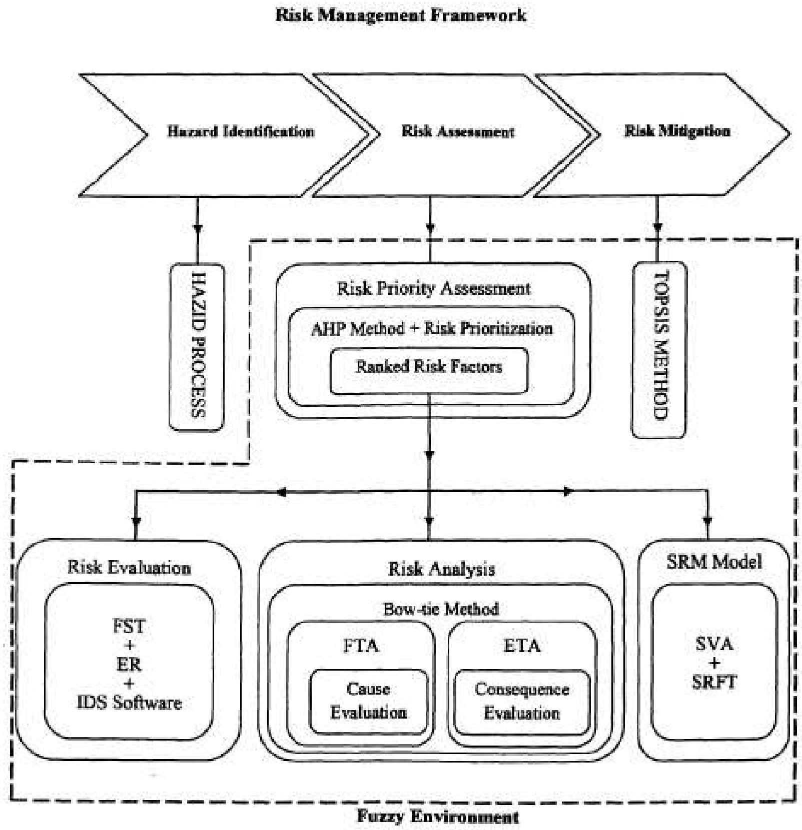


Plate 4.27: Adopted a RM framework designed for managing hazards and risk factors associated with the proposed Ondo State Deep-Sea port operations and management.

6.10 Risk Factors Methodology

The risk factors associated with the proposed Deep-Sea port in the form of qualitative data were identified through the HAZID process i.e. literature review, and FAHP, computation simulation.

The data collected in the form of qualitative variables which were used during the experts' judgments were transformed into quantitative data. Therefore in order to ensure that the gathered data are reliable and consistent, an additional test called consistency test was carried out on the data collected.

The flow chart shown in **Plate 4.28** depicts the generic Risk Assessment methodology adopted for the proposed Ondo State Deep-Sea port.

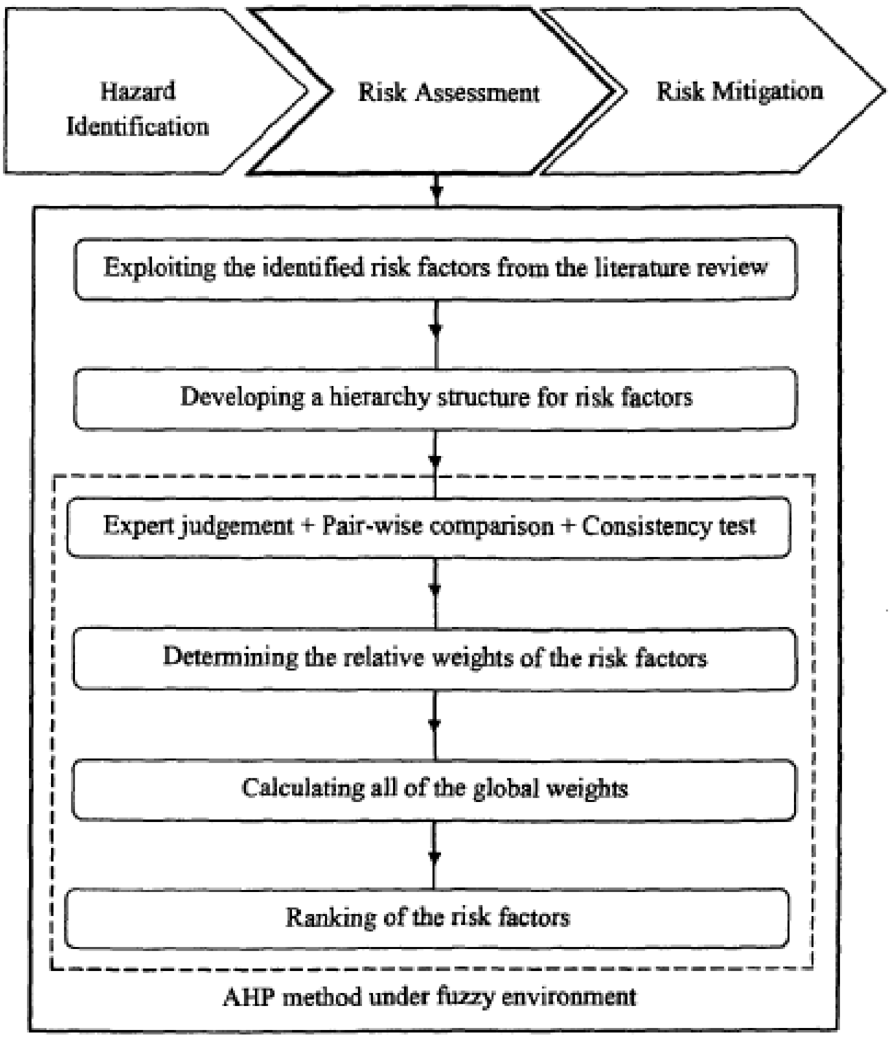


Plate 4.28: The proposed generic Risk Assessment Model for the Deep-Sea port

The proposed FAHP-based risk assessment model was implemented during risk assessment phases through the following steps:

- **Step 1**: Exploiting the identified risk factors (hazards) in offshore terminals and marine ports. The identified risk factors are obtained through HAZID process.
- **Step 2**: Developing a generic hierarchical structure based on the risk factors obtained in previous step. The risk-based hierarchy is structured in such a way that the title of the "sources of risks and uncertainties in offshore terminals and marine ports" is the main goal and is placed on the

top of the hierarchy labelled main goal. Country and business risks from externally driven environments plus organizational and operational risks from the internally driven environments are placed under Level O. Sub-risk factors are placed under Level 2 and finally the sub sets of Level 2 subs are gathered under Level 3 risk factors.

- **Step 3**: By use of the experts' judgment and opinions, the significance of the risk factors structured hierarchically in Step 2 (i.e. Level l, Level 2 and Level 3 risk factors) will be explored. These judgements will be carried out in the form of the pre-defined linguistics variables which have been explained in the previous sections of this chapter. The linguistic variables then will be transformed into the TFNs and will be made ready for the pair-wise comparisons. Moreover, a consistency test will be conducted on the comparison matrices in order to ensure that experts' judgments and pair-wise comparisons were reasonable.
- **Step 4**: By use of the experts' judgments and-pair-wise comparison matrices the local weights of the risk factors in Level I, Level 2 and Level 3 will be determined.
- **Step 5**: Determination of global weights for the risk factors in Level 3. The global weights for Level 3 risk factors will be calculated directly by multiplying the local weights of the Level 1, Level 2 and Level 3 risk factors.
- **Step 6**: At the end the risk factors will be ranked directly as per their numerical priorities in order to show their significance.

Table 6.21 shows the occurrence likelihood grades to be used for rating the causes and consequences of the risk factors that would be associated with the Deep-Sea port.

Table 6.21: Different occurrence likelihood grades to be used for rating the causes and consequences of the risk factors

Occurrence Likelihood (OL)	Grade
Very Low	1
Low	2
Medium	3
High	4
Very High	5

6.11 Risk Assessment Results

Table 6.22 illustrates the final results estimated for the operational risk factors for further investigations and developments through the FAHP methodology.

The work breakdown structure (WBS) and the number of identified risk that would be associated with the Deep-Sea project are: Breakwater, Building and land construction, Building and land design, Dredging, Engineering and project management, General site, Health and safety, Marine works general, Quay, Rock supply (for breakwater), Reclamation and soil improvement (**See Table 6.22**).

Table 6.22: RISK IDENTIFIED DURING INITIAL RISK ASSESSMENT

S/N	Work breakdown structure (WBS)	Number of risks
1	Breakwater	24
2	Building and land construction	6
3	Building and land design	8
4	Dredging	16
5	Engineering and project management	26
6	General site	3
7	Health and safety	10
8	Marine works general	11
9	Quay	21
10	Rock supply (for breakwater)	11
11	Reclamation and soil improvement	15
12	**Power Supply**	**20**
TOTAL		**171**

The belief degrees of the operational risk factors evaluation results obtained from our analysis is shown in **Plate 4.29** for the grades of medium, high and very high (i.e. the worse possible cases). From Plate 9.5, it is obvious that the operational risk factor has got zero percentage for the grade of very high, which implies minimum percentage. Thus, the operational risk in the proposed Deep-Sea port is rated low and non-risky venture.

In another attempt the percentage scores for 22 individual operational risk factors which were calculated and separately derived for three different risk levels (Level 1, Level 2 and level3). The percentage risk factors which were obtained from the IDS software are plotted and shown in **Plate 4.29** In order to read the following chart it can be said that moving out from the center reduces the risk while points closer to the center are worse with lower scores.

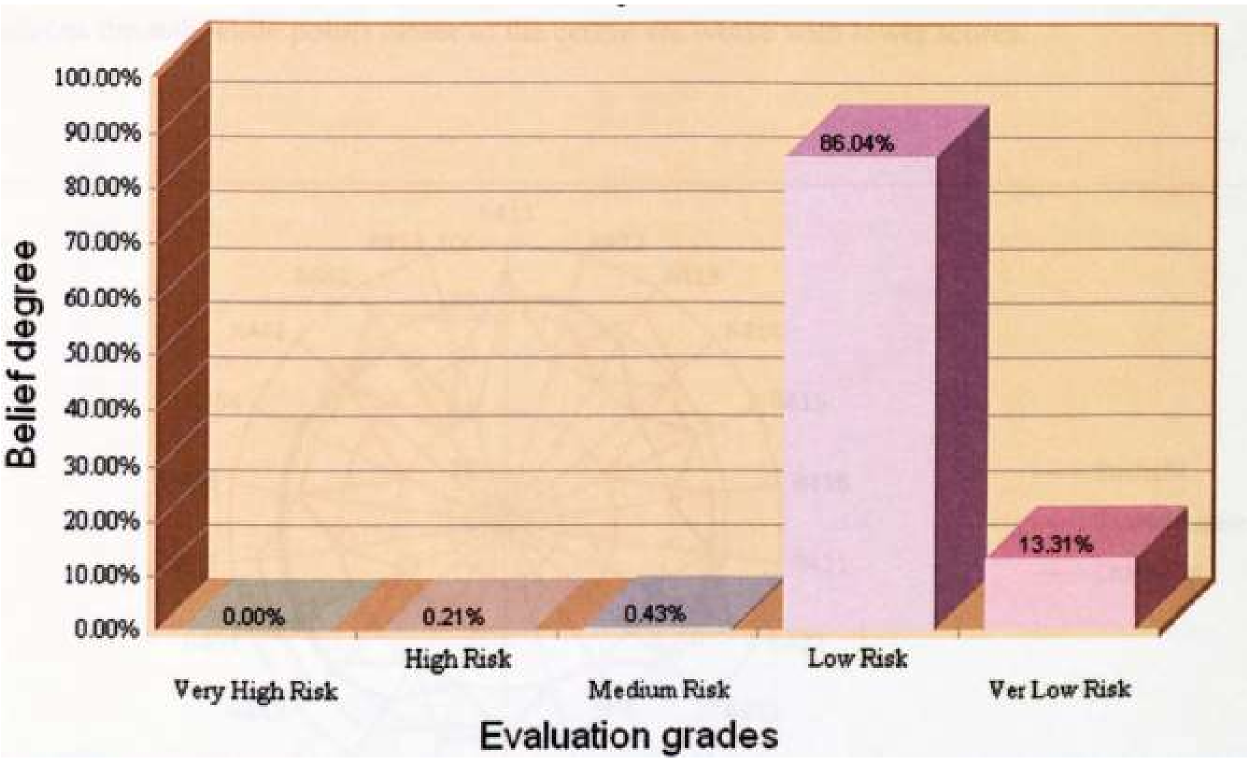


Plate 4.29: The belief degrees of the operational risk factors evaluation

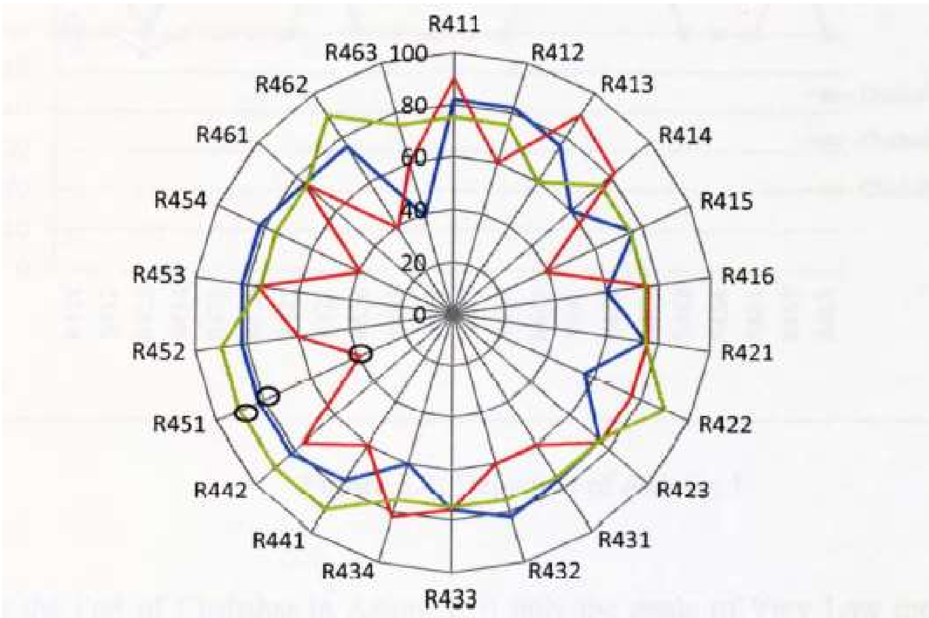


Plate 4.30: Percentage Scores of the operational risk factors.

COLOUR CODE:

Risk Level 1

Risk Level 2

Risk Level 3

Based on the *CCi values*, rankings for mitigation alternatives for different criteria i.e. RI, R2, R3 and R4 etc. and raking for the Fuzzy TOPSIS results for mitigating country risk factors and, for mitigating organizational risk factors for different scenarios are depicted in Tables 9.14, 9.15, 9.16 and 9.17 respectively.

Table 6.23: Fuzzy TOPSIS results for mitigating country risk factors

Alternatives	D_i^*	D_i^-	CC_i	Rankings
A1	4.428	0.608	0.1207	3
A2	4.085	0.923	0.1843	1
A3	4.422	0.609	0.1210	2
A4	4.660	0.393	0.0778	8
A5	4.440	0.592	0.1176	5
A6	4.464	0.571	0.1134	6
A7	4.477	0.608	0.1196	4
A8	4.464	0.571	0.1134	6
A9	4.511	0.528	0.1048	7
A10	4.440	0.592	0.1176	5

Table 6.24: Fuzzy TOPSIS results for mitigating business risk factors

Alternatives	D_i^*	D_i^-	CC_i	Rankings
A1	2.307	0.726	0.2394	2
A2	2.160	0.853	0.2831	1
A3	2.384	0.648	0.2137	3
A4	2.919	0.143	0.0467	8
A5	2.919	0.143	0.0467	8
A6	2.422	0.614	0.2022	5
A7	2.450	0.585	0.1927	7
A8	2.388	0.644	0.2124	4
A9	2.919	0.143	0.0467	8
A10	2.446	0.589	0.1941	6

Table 6.25: Fuzzy TOPSIS results for mitigating organizational risk factors

Alternatives	D_i^*	D_i^-	CC_i	Rankings
A1	4.459	0.587	0.1163	6
A2	4.104	0.907	0.1810	3
A3	4.128	0.924	0.1829	2
A4	4.919	0.143	0.0282	9
A5	4.627	0.477	0.0934	7
A6	4.146	0.868	0.1731	4
A7	4.181	0.844	0.1680	5
A8	4.919	0.143	0.0282	9
A9	4.585	0.463	0.0917	8
A10	4.085	0.924	0.1845	1

Table 6.26: Fuzzy TOPSIS results for mitigating operational risk factors

Alternatives	D_i^*	D_i^-	CC_i	Rankings
A1	5.936	0.112	0.0185	9
A2	5.851	0.196	0.0324	8
A3	5.505	0.527	0.0874	6
A4	5.623	0.439	0.0724	7
A5	5.423	0.617	0.1021	4
A6	5.200	0.820	0.1362	3
A7	5.085	0.923	0.1536	1
A8	5.095	0.914	0.1521	2
A9	5.510	0.513	0.0879	5
A10	5.085	0.923	0.1536	1

Table 6.26 illustrates the final rankings of the alternatives based on the *CCi* values shown in Tables 6.23, 6.24, 6.25 and 6.26.

It is obvious that the identified risk factors RI, R2, R3 and R4 had equal weights in respect of each other. Thus, in order to calculate the final CCi values, the CCis was summed up and then divide them by four to get the final CCi values as shown in Table 6.27.

Table 6.27: Overall Fuzzy TOPSIS results for mitigating risk factors

Alternatives	Names	CC_i	Rankings
A1	Internal Audits and Inspections	0.1237	7
A2	Privatisation	0.1702	1
A3	ISPS Code	0.1512	5
A4	ISO 20000	0.0563	10
A5	Port Risk Manager	0.0899	8
A6	Safety Cases and Safety Reports	0.1562	4
A7	IMS (ISO: 9000,14000,18000)	0.1585	3
A8	VTMS	0.1265	6
A9	Deregulation	0.0828	9
A10	HSE-MS	0.1624	2

Additionally **Plate 4.31** depicts the results for different criteria i.e. RI (Country risk factors), R2 (Business risk factors), R3 (Organizational risk factors) and R4 (Operational risk factors) and the sensitivity of the results on different mitigation alternatives for the purpose of managing the mentioned risk factors for the proposed Ondo State Deep-Sea port.

Table 6.27 and Plate 6.7 shows the final results indicate that A2 (Privatization) is the best alternative with *CCt* value of 0.1702. Alternatives of AlO (HSE-MS) with *DCt* value of 0.1624 and A7 (IMS) with *CCi* value of 0.1585 are ranked in second and third positions respectively. **Plate 4.32** depicts the most significance mitigation alternatives for the purpose of the Deep-Sea port.

Regarding A2 i.e. privatization and in order to provide evidence for its importance World Bank (2007) explains motives that force without delay governments or port authorities to enter in the privatization course of action. These results suggest that privatization would lead to the Deep-Sea port to improve its performance, become more competitive and better managed. This in fact can reduce business, operational and organizational risk factors.

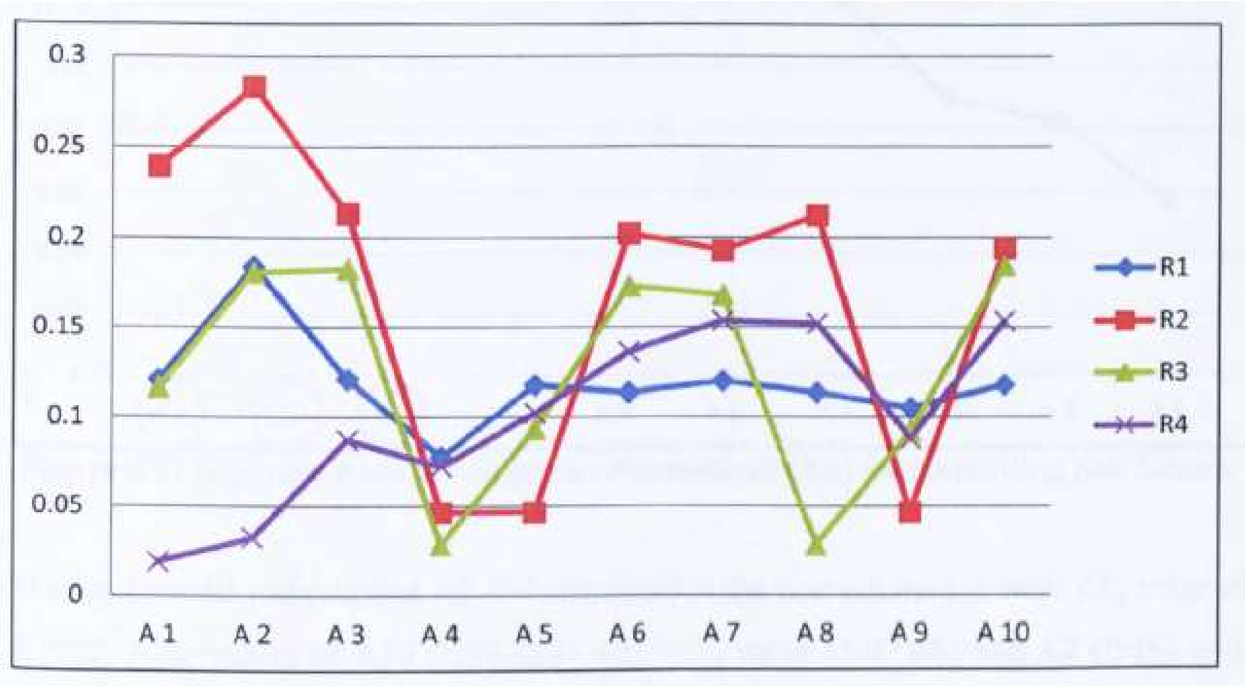


Plate 4.31: Sensitivity of the results on different mitigation alternatives

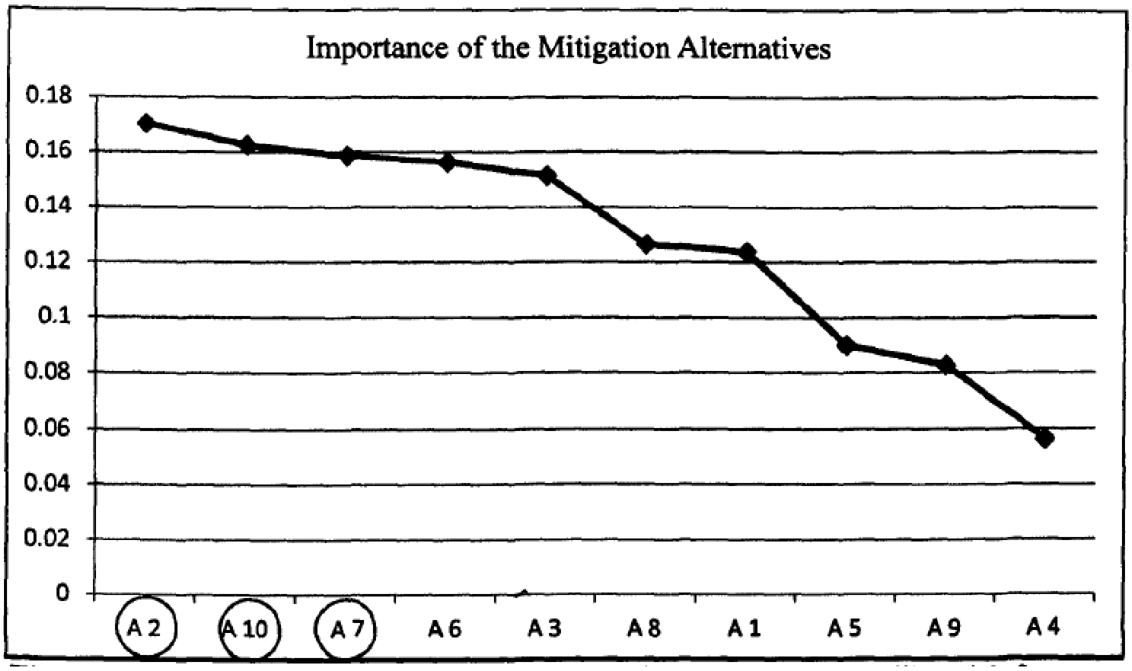


Plate 4.32: The most significance mitigation alternatives for the proposed Deep-Sea Port

In order to mitigate the identified hazards (risk factors) through the HAZID process, the FTOPSIS method was utilized in order to complete the RM framework analysis.

The consequences of the project on people will be major; on properties and/or housing is rate moderate; on the environment is moderate, and on the harbor and stakeholders is rated major (**Plate 4.33**).

Consequence

Scale	People	Property	Environment	Harbour Stakeholders
C0	Insignificant	Insignificant	Insignificant	Insignificant
C1	Minor	Minor	Minor	Minor
C2	Moderate	Moderate	Moderate	Moderate
C3	Major	Major	Major	Major
C4	Catastrophic	Catastrophic	Catastrophic	Catastrophic

Plate 4.33: Consequences of the Proposed Deep-Sea Port on Four Factors

From the results of risk assessment matrix analysis for the proposed Deep-Sea project, we arrived at a logical conclusion that the proposed Deep-Sea project has a likelihood risk of remote (< 1%) to unlikely risk of (1 to 10%). The rate of return (RRI) on investment over the years is excellent (**See Plate 4.34**).

Also, the project has insignificant to minor negative impacts, whilst the positive impact is rated major. The positive impacts outweigh the negative impact (**See Plate 4.34**).

ICS (2007) showed that in private port development, everything is owned and operated by the private sector, apart from regulatory and statutory functions which are performed by the public authority. Private ports managements are less influenced by political decisions and there will be higher efficiency in asset and human resources management. This option of public private partnership that would be bring about very running of the proposed port and effective management of it is recommended for the new port. This is based on our findings from the risk assessment analysis carried out for this project.

Likelihood					
5 Almost certain (>75%)	5	10	15	**20**	**25**
4 Likely (36-75%)	4	8	12	**16**	**20**
3 Moderate (11-35%)	3	6	9	12	15
2 Unlikely (1-10%)	2	4	6	8	10
1 Remote (<1%)	1	2	3	4	5
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic

Impact

Plate 4.34: Risk Assessment Matrix for the Proposed Project

CHAPTER SEVEN

MITIGATION MEASURES

7.0 Introduction to Mitigation Measures

It is axiomatic that all major development projects have environmental and/or socio-economic impacts. If the objectives of such projects must be realized, the associated and potential environmental, socio-economic and health impacts of the projects must be identified, well evaluated and adequate mitigation measures provided. Otherwise a project which is supposed to be a blessing may turn out to be a great disaster or loss. It is in view of this that impact prediction is considered the heart of EIA process. Although the greatest concern about impacts is with regard to the negative aspects, some impacts are positive and should be enhanced. Either positive or negative, impact can vary considerably in magnitude, extent and in significance. All these attributes of impact must be duly evaluated. In the present chapter the associated and potential impacts of the proposed Deep-Sea Port development project are identified and evaluated for the various activities of the different project phases.

7.1 Impact Assessment Methodology

Some of the commonly used methods of impact assessment are as follows:

i. Ad hoc methods
ii. Checklist methods
iii. Matrix methods
iv. Leopold matrix

The Ad hoc method relies on the experience of the environmental assessors which may be biased and therefore subjective. The checklist method relies on the assessment of the potential impacts on given number of environmental indices ranging from ecological, socio-economical to biodiversity. The value of this method also depends on the experience of the environmental assessor and the composition of the checklist used. Matrix method can be used only for impact identification. It uses an interactive matrix of the expected developmental activities against the environmental components to predict the presence of impact. The method thereby achieves the impact identification without qualifying them. The Leopold matrix (Leopold *et al.,* 1971) incorporates qualitative as well as quantitative information on cause and effect relationship. The Peterson matrix is a modification of the Leopold matrix and depends to a large extent on the multiplication properties of the matrices. In each cell of the matrix, two scores are given based on the quantification of the impact and its level of importance judged on effect on human environment. The weighted impacts are finally aggregated to produce a single overall impact score.

7.2 Impact Identification

Several activities of the proposed Deep-Sea Port project have potential associated impacts. These identified activities include mobilization to site, site preparation.

The probable receptors of impacts from the above listed project activities are: Air quality, soil and land use, vegetation, water quality, aquatic resources (including fisheries), socio-economics and health status in the project environment. The commutative effect of these various impacts may have a serious or devastating effect both on the biophysical properties and life amenities in the project environment such that the project cannot be sustained.

The significant impacts identified in the Pre-Construction phase with land acquisition are loss of livelihood, loss of land productivity and public unrest and they are declared negative impacts. However, all the impacts can be mitigated on and classified as non-significant impact.

Five activities will cause significant impact in construction phase, these are Procurement of Labor and Operation Basecamp (1 impact), Mobilization of Heavy Equipment and Materials (5 Impacts). Reclamation and Marine Facility Construction (4 Impacts), Dredging and Disposal (2 Impacts) and Onshore Facility Construction (2 Impacts).

There are **11 significant impact** in construction phase, those are 1 positive impact of job and business opportunity in procurement of workers and operation basecamp, 1 negative impact of decreasing air quality, 1 negative impact of road traffic disruption, 1 negative impact of sea traffic disruption in mobilization of heavy equipment and materials, 1 negative impacts of increase of run-off in construction of onshore facilities, 2 negative impacts of decreasing of sea water quality in reclamation; dredging and disposal, 1 negative impact of fishing ground changes in reclamation and marine facility construction, and 3 negative impacts of public unrest as derivative impact from mobilization of heavy equipment and materials, reclamation and marine facilities construction, and onshore facilities construction. Besides that, there are **3 non-significant impact** consist of 1 negative impact of increasing noise, 2 negative impact of marine life (nekton and benthos) disruption in reclamation; dredging and disposal.

There are 5 activities cause significant impact on operational phase, those are procurement of workers (1 impact), marine facility operational (5 impacts), onshore facility operational (2 impacts), maintenance of basin and access channel (2 impacts) and operation of access road (4 impacts).

There are **8 significant impact** in operational phase, those are 1 negative impact of increasing noise and 1 negative impact of road traffic disruption in operation of access road; 1 negative impact of sedimentation, 1 negative impact of coastline change and 1 negative impact of fishing ground changes in marine facility operational ; 2 negative impact of public unrest in marine facility operational and access road operational ; and also 1 positive impact of job and business opportunity in workers recruitment. Beside that there are **6 non-significant impact,** those are 2 negative impact of decreasing air quality in marine facility operational and access road operational, 1 negative impact of increasing of run-off in operation of onshore facilities, 1 negative impact of decreasing sea water quality, and. negative impact of marine life (nekton and benthos) disruption in maintenance of basin and access channel, and 1 negative impact of public unrest in operation of onshore facilities. The loss of livelihood impact for the people who depend on the land acquired an area of 2,771.6 ha is the important thing to be considered before and after the land acquisition process is done. Improper handling of the impact will lead to problems of public dissatisfaction and negative perceptions that could lead to public unrest.

Public unrest if there since the beginning of land acquisition will have implications for the next stage of development activities, especially the construction process of building the port itself. The impact that occurred at the stage of construction will accumulate to the impact of previously incurred and may continue in the next development phase.

Disruption to fishermen activities (fishing ground) due to the project plan (during construction) will further burden the lives of fishermen around, beside that with the loss of livelihood for the people who depend on the land acquired, making the potential for public unrest will be higher.

Disruption to the fishing ground will also occur continue until the operational phase and it is irreversible, because one of fishing ground locations has change

become an area of sea port facilities. So that, this impact will occur continuously and strengthen the probability for public unrest that may occur.
But on the other hand, the project plan will also bring employment opportunities for local residents, estimated at more than 1,200 workers required for the implementation of the port construction, and 700 workers needed during the operation. This is the minimum number of employment opportunities open for local residents to participate in accordance with the qualifications possessed.

Business opportunities that arise with the project plan is also a huge positive impact for the benefit of local people. Balancing the positive impact that occurs is expected to reduce the potential negative impacts. Appropriate management to reduce the impact and minimize the negative impacts that will occur is indispensable. Based on the significant impact flow chart (Fig:), it can be seen that derivative impacts that occur in many times so primary impact must be really noted and managed wisely, so the negative impact can be minimalized or overcome, while positive impact can be optimized.

- ❖ **Summary of impacts from activities.**

The construction phase activities have 11 significant impacts.

During construction activities heavy equipment and materials mobilization to project site causes 4 significant impact.

Activity components that is rated from the less significant to the biggest in the project location;

1. Mobilization of Heavy Equipment and materials during construction phase that can inflict negative significant impact in form of: decreasing of air quality, road traffic disruption, sea traffic disruption, and public unrest (4 significant impacts).
2. Operation of marine facilities creates negative significant impact in form of: sedimentation, coastline changes, fishing ground changes

and public unrest as result of fishing ground changes (4 significant impact)

3. Reclamation and Construction of marine facilities (construction phase) creates negative significant impact in form of: decreasing of sea water quality, fishing ground changes and public unrest especially fishermen as result of fishing ground changes occurs (3 significant impacts).
4. The land acquisition creates 3 significant impacts which are loss of land productivity, loss of lovelihood and income, and public unrest (3 significant impact).
5. Operation of access road creates negative significant impact: increasing of noise, road traffic disruption and public unrest (3 significant impacts).
6. Procurement of Labor in construction and operational phases creates negative significant impact: Job and Business Opportunity (2 positive impact)
7. Construction of Onshore facilities results in negative significant impact are increasing of run-off and public unrest (2 significant impacts).
8. Dredging and Disposal (construction phase) that inflict significant impact in form of decreasing of sea water quality (1 significant impact)

- **Component of environment that are most inflicted by impacts** are social economy, and culture component, inflicted by 10 significant impact. 6 negative significant impacts as public unrest in construction and operational phase, 2 positive significant impacts as job and business opportunity, 2 negative significant impact of fishing ground changes, 1 negative significant impact as loss of livelihood and 1 negative significant impact as loss of land productivity at pre construction phase.

- **The region that is the most inflicted by impact** is the area of influence covering about seven communities which are Aiyetoro, Ugbo, Ugboland, Eruna Ado, Erruna, Asuku, Womitere, Ogboti while towns as Ore, Okitipupa will also be impacted.
- **Environment component and sensitive area are:**

i. Public unrest may be triggered if land acquisitions and compensations are mis-managed.

ii. Seawater quality in terminal area and port marine facility and around dumping site

iii. Impact beach & fishing ground areas that direct bordering with project site

iv. Noise along the access road that direct bordering with residences

v. Volume of run off in water channel receiver around project site

vi. Traffic generation and road damage in access road to project site

vii. Livelihood of farmer and fishermen around project site affected

viii. Chance of working and entrepreneur at construction and operational phases for residence around project site

7.2.1 Impacts on Air Quality

During mobilization to site, there may be emissions of gaseous and particulate air pollutants from vehicles. The air pollutants may have negative and direct impairment on the air quality of the environment with widespread associated impacts. The likelihood of these impacts is high with considerable consequence and can be thus rated moderate. This same impact on air quality is expected during the supply of construction equipment and materials. Equipment required during site preparation, onsite are expected to generate emissions into the environment. However, these emissions are expected to be local and to last only the period of these activities. The likelihoods are high with considerable consequence thus rated moderate. Energy provision for construction activities and power generation during the life of the production well will generate emissions of gaseous and particulates air pollutants with the quantity depending on fuel consumption rates among other factors. These are within medium high likelihood and little consequence therefore rated moderate.

7.2.2 Noise impacts

Mobilization to site will require the use of vehicle expected to generate some levels of noise on the road. The resulting noise levels may have negative and direct impairment on the ambient noise levels with widespread associated impacts and high likelihood of occurrence combine with high considerable consequence thus rated moderate. This same impact on ambient noise levels is expected during the supply of construction equipment and materials. Equipment required during site completion will generate noise levels in the proposed field which are expected to be local and to last only the period of the activities. The likelihoods are high with considerable consequence thus rated moderate. Energy provision for construction activities and power generation during the life of the production well will generate noise with the levels depending on age of equipment among other factors. These are within medium high likelihood and little consequence therefore rated moderate. During demobilisation (equipment and personnel from site) from construction activities, anticipated impacts on noise levels are from vehicles and other transportation facilities which may be of negative and direct impairment on the ambient noise levels of the environment with associated impacts on the roads thus widespread. The impact may be short term and reversible with medium likelihood of occurrence, considerable consequence thus of a moderate rating.

7.2.3 Impacts on Terrestrial Vegetation

The removal of the various forms of vegetation cover from the project site without its replacement is the major impact during the land preparation for the project. There will also be alteration of the landscape during and after the construction in the site. The impact of the clearing and construction/civil work on the environment will depend on the types of clearing and construction equipment used.

The construction in the site will consume large area of vegetation and it will involve felling of trees, shrubs and herbs without any thought being given to regeneration in the study area (project site). The cutting of these plant species will leave behind a loss balanced ecosystem. This removal involves loss of numerous shrubs and herbs of food and medicinal value (*Alstonia boonei and Pycnanthus angolensis*), as well as valuable plant genetic resources.

The other chief threats of vegetation removal include destruction of wildlife habitats leading to the death of relatively immobile animals as well as the migration of the animals that are capable of escaping and thus will drastically reduce animal populations, their productivity and species diversity, while rare species are being threatened with extinction and this will lead to reduction of biodiversity in the area.

7.2.4 Socio-economics and Health Impacts

The proposed Deep-Sea Port Project development when operational will have very little negative impacts on the socio-economic and cultural environment of the people. Land acquisition will not be a problem as the project will not cover a large area of farmland and timely but adequate compensation will be paid to the original owners of the land and for crops on the land. Forest and vegetation clearing may however impact negatively on household food security as farmlands are destroyed. This is more so for those currently farming on the land now acquired for the project. This may necessitate the need for alternative farmland or other sources of employment either within the locality or outside.

On the positive side, the various construction works are expected to boost the economic activities, marketing and household food security of those employed by the various contractors and services providers working on the project.

7.2.5 Impacts on Wildlife and Fisheries

The wildlife fauna in the study area would be affected during the construction phase. There would be movement of wildlife from the cleared area to the uncleared areas. There will however be minimal loss of wildlife during the construction phase. The duration of the impact can be rated as medium, magnitude low and the probability of occurrence is low hence the overall impact rating will be low. Majority of the wildlife fauna are likely to migrate to the uncleared area during construction phase. After the construction, the wildlife fauna will be negatively impacted. The impact can be rated as medium, magnitude low and the probability of occurrence would be low and hence the overall impact on wildlife would be low.

The bush clearing during the construction phase will not impact negatively on the fish fauna. The duration of the impact during the construction phase will be medium, magnitude low and the likelihood of occurrence will be low, hence the overall rating would be low. The post-construction phase impact on the fish would also be medium. The duration of the impact can be rated medium, magnitude low and likelihood of occurrence low.

7.2.6 Impacts on Water Quality and Hydrobiology

Water pollution, leading to biodiversity loss, loss of basin carrying capacity and reduced biological productivity are the most likely negative impacts of the project activities on water quality and hydrobiology in the project environment. Based on the physico-chemical and microbial qualities of waterbodies in the area (as revealed by the obtained fieldwork results) such impacts may be severe. This is because water sources in the area especially surface water are very dilute and characterized by low alkaline reserve. It is envisage that waste disposal both on the surface would affect the groundwater quality.

7.2.7 Impacts on Soil and Land Use

The likely impacts of the project on soil and land use can be summarized as follows:

i. Land take may lead to altered land use pattern
ii. There may be environmental degradation from increased pressure on land especially site preparation using heavy equipment for excavation, backfilling and compaction all of which may lead to risks of erosion and drainage problem to adjacent land.
iii. There will be loss of nutrient in the project footprint area due to erosion resulting from overland runoff.
iv. Soil contamination through improper disposal of effluent, solid and hazardous wastes.

7.3 Matrix of Impact Evaluation and Ratings

Usually the last step in impact assessment is the evaluation and final rating of impact. This usually takes into consideration the following factors / features of the project impacts.

i. Nature of impact (positive or negative, direct or indirect)

ii. Magnitude of impact (qualitative or quantitative)
iii. Areal extent of impact (local or widespread)
iv. Frequency or likelihood of occurrence
v. Duration of impact (short term or long-term effect)
vi. Overall rating of cumulative effect, severity significance

The matrices of impacts and their evaluation with regard to impact description, likelihood of occurrence, consequence and overall rating or significance for the respective receptors are provided in Table 7.4.1 respectively.

Table 7.4.1: Impact Management and Mitigation Plan for the Proposed Project

Impact arising as a result of the sea port development covers pre-construction, construction, and operational phase. In pre-construction and construction generally, impacts that are created are usually temporary, while impacts from operational phase are long-term.

A glance of the mitigation plans for the 3phases

Pre-Construction

i. Give alternative livelihood for communities to be relocated and prioritize in construction workers recruitment
ii. Accommodate public aspiration by engaging in dialogue
iii. Develop a livelihood recovery program

Construction

i. Prioritize local workers
ii. Cooperate with local government officer in recruitment
iii. Using noiseless vehicles and trucks for transportation of heavy equipment
iv. Program delivery periods of goods to avoid interference with sleeping times of communities

v. Keep the cleanliness of the road that passed by near residence Place officer to arrange traffic in entrance access road
vi. Limit tonnage of delivery trucks vehicle
vii. Repair damaged road

Operational

i. Optimalize the managements of the impacts
ii. Optimalize local worker potential for operational of the port
iii. Cooperate with local government officer in recruitment
iv. Maintain the breakwater and revetment/seawall
v. Coordination with head of TPI and other party the related to TPI about fishing ground
vi. Install the silt protection to restrict sediment spreading in sea water
vii. Place the officer to arrange the circulation of ship flow and ship parking
viii. Create wetland to replace previous wetland for fauna new habitat Mangrove cultivation and many types of trees to the available land

Associated Impacts on Air Quality and Noise

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation
Mobilisation (transport) to site (equipment, personnel & construction modules)	Impairment of air quality	Moderate	• vehicles shall be serviced and regularly maintained • equipment shall be turned off when not in use	Minor
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not in use	Minor
	Traffic Accident	Moderate	• ONDIPA must have speed limit within their facility • Traffic Code should be duly placed to warm vehicles of the state of the road • Make sure that all vehicles entering and leaving their facility obey all traffic rules and regulation	Minor
	Vehicle maintenance	Moderate	• All vehicles must be properly maintained • A service log book kept for each vehicle	Minor

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation
	Increased Social Vices	Major	• Awareness campaign shall be carried out to enlighten the communities/field workers on the implications of drug and alcohol abuse, unprotected sex, prostitution and the need to sustain cultural values • Movement of field workers shall be restricted to camp/work sites • Alternative recreational facilities shall be provided at camp sites • Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers	Moderate
Site preparation	Impairment of hearing noise	Moderate	• HPDs shall be provided for workers on and visitors to site.	Minor
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not use	Minor
Supply of construction equipment & materials	Emission of noxious substances to atmosphere	Moderate	• ONDIPA shall ensure regular maintenance of vehicles	Minor
Energy provision for construction activities	Emission of noxious substances to the atmosphere	Moderate	• Equipment shall be tuned off when not in use • regular maintenance of equipment	Minor

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation
Power generation	Emission of noxious substances	Moderate	• Equipment shall be tuned off when not in use • regular maintenance of equipment	Minor
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not in use	Minor

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation
Demobilisation (transport) from site (equipment, personnel)	Impairment of air quality	Moderate	• vehicles shall be serviced and regularly maintained • equipment shall be turned off when not in use	Minor
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not in use	Minor
Well operation and maintenance	Impairment of air quality due to release of VOCs from flares	Moderate	• ONDIPA shall ensure regular maintenance of gas flares • Pan Ocean shall prevent fugitive emissions at all time	Minor
	Noise impairment due to noise from gas flares	Moderate	• Liquid carryover into gas flares shall be avoided by Pan Ocean all the time	Minor

Table 7.1A: Mitigation Plan for surface and groundwater resources

Impact	Rating before mitigation	Description of mitigation	Residual impact rating
Impairment of water quality by increased turbidity, this could adversely affect the quality of household water and lead to clogging of the gills of fishes and subsequent death of aquatic life	Major	❑ During sand filling, the generated sand materials shall be used in constructing sedimentation basins, thus allowing the water to gradually drain back without turbulence ❑ Top soil materials shall be used to hedge the surroundings of the site to control flooding and control sand ❑ Potable water shall be supplied to the affected communities during sand filling operations. ❑ The potable water quality shall conform to acceptable WHO, FMENV, DPR standards (TSS, TDS, Turbidity, Chemical parameters, Biological parameters)	Minor
Disturbance of aquatic life (zooplankton, phytoplankton, benthic communities, fisheries etc)	Major	❑ Sedimentation basin with effluent drains shall be constructed to allow water to gradually drain back into the river without turbulence ❑ Indigenous aquatic flora and fauna shall be used to restock the aquatic system ❑ Recovery of bottom sediment shall be monitored ❑ Sand filling activities shall be completed on schedule	Minor

Table 7.1B: Mitigation Plans for Social-Economic Impacts

Impact	Rating before mitigation	Description of mitigation	Residual impact rating
Increase in population leading to diffusion of culture and traditions	Moderate	❑ Construction workers shall be accommodated in contractor camps to reduce adverse impact on existing culture and tradition ❑ Awareness campaign shall be carried out on the need to sustain native culture and traditions	Minor
Increase in cost of living/inflation	Moderate	❑ Work camps shall be provided with necessary utilities to reduce pressure on local community facilities ❑ Communities shall be empowered through provision of jobs, increased patronage to produce (fishes, farm produce etc) and encourage income generating activities	Minor

Nuisance (noise, emissions, dusts, vibrations) from heavy machinery	Moderate	❑ Standard machinery with noise levels within acceptable limits (85 dB (A)) shall be used ❑ Site construction shall be done within the shortest possible time ❑ Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits ❑ High sound energy equipment shall be enclosed in noise insulators in line with ONDIPA policy ❑ ONDIPA HSE policy of wearing ear muffs/ plugs, with signs indicating noisy areas shall be applied in all construction sites ❑ Sufficient separation distances shall be provided for sources of high energy sound to reduce noise levels ❑ Workers with existing hearing impairment shall not be deployed to site ❑ Ambient air quality/noise level shall be monitored in line with FMENV/DPR requirement (NO_x, CO_x, SO_x, SPM etc)	Minor
Pressure on existing infrastructure (accommodation, health, recreational, educational facilities etc) and could alter the demographic pattern	Major	❑ Awareness shall be created on the potential of increased use of the facilities ❑ ONDIPA shall support (provision of drugs, upgrading of facilities and staff training) existing health, recreational, educational facilities etc ❑ ONDIPA shall provide accommodation/relevant amenities (health and recreational facilities) for workers to reduce stress and health vulnerabilities	Minor

Increased social vices	Major	❑ Awareness campaign shall be carried out to enlighten the communities/field workers on the implications of drug and alcohol abuse, unprotected sex, prostitution and the need to sustain cultural values ❑ Movement of field workers shall be restricted to camp/work sites ❑ Alternative recreational facilities shall be provided at camp sites ❑ Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers	Moderate
COULD LEAD TO THIRD PARTY AGITATION	Major	❑ The relevant stakeholders/ legacy issues shall be identified ❑ Regular consultation with stakeholders (Govt., Community, NGOs, CBOs etc.) shall be carried out ❑ Adequate and prompt compensation shall be made ❑ Provision of MOU with community	Moderate
Reduction of access to natural environment and its resources	Moderate	❑ Natural resources shall be identified ❑ Alternative income generating activities shall be supported (micro-credits, youth development scheme, women trade centers, aquaculture and improved farming techniques etc) ❑ Land take shall be limited to the minimum required	Minor

Table 7.1C: Mitigation Plan for Health Impacts

Impact	Rating before mitigation	Description of mitigation	
Increased morbidity rate thereby putting pressure on existing health facilities	Moderate	❑ Regular medical check-up for site personnel shall be undertaken, with the above mitigations for air quality impact ❑ Standard solid waste collection and segregation area shall be provided on site. ❑ Material Safety Data Sheets shall be provided on all sites where chemicals are handled	
Increased level of disease vectors	Moderate	❑ Site specific solid waste management plan in line with waste management guidelines shall be put in place before operations ❑ Fumigation shall be carried out, where applicable	Minor

Increased accidents/ injuries, therefore increase pressure on healthcare facility	Major	❑ Health and recreational facilities to be provided for all workers to reduce stress and health vulnerabilities ❑ All contractors shall ensure that their personnel are medically certified fit for their different activities and medical reports submitted. ❑ Retainer ship clinics and site medical facilities such as first aid shall be provided in line with standard guidelines. ❑ Health Risk Assessment (HRA) shall be carried out for all jobs to manage the potential health hazards associated with the activities. ❑ Adequate training shall be provided on basic life saving techniques such as basic first aid, resuscitation, care of the unconscious.. ❑ All contractor personnel shall be adequately trained to acquire the pre-requisite competence for the different jobs. ❑ All operations personnel shall be provided with appropriate Personnel Protective Equipment (PPE), and it shall be mandatory that they are worn as may be applicable. ❑ Permit to Work system shall be enforced at all stages of the operational activities	Minor

Table 7.4.1D: Mitigation Plan for Solid Waste Disposal

Impact	Rating before mitigation	Description of mitigation	Residual impact rating
Improper disposal of solid waste could lead to contamination of soil, surface/ groundwater, disrupt fishing activities and decrease aesthetic value of the environment	Moderate	❑ Generated solid waste shall be segregated at source by the provision of colour coded bin for different types of waste and disposed of according to standard waste management guidelines; ❑ The generated paper waste shall be shredded and sold to any approved paper recycling company ❑ De-contaminated scrap metals/drums shall be collected and taken to waste recycling depot (scrap yard). ❑ Generated glass materials shall also be transported to approved glass company ❑ Spent batteries shall be taken to any approved battery re-cycling company ❑ Oily waste materials shall be collected and taken to FMENV approved incinerator or any other approved alternative ❑ Kitchen waste shall be collected and handled at any approved composting plant ❑ Medical waste shall be collected and taken to medical incinerators	Minor

Table 7.4.1E: Mitigation Plans for Soil and Vegetation Impacts

Impact	Rating before mitigation	Description of mitigation	Residual impact rating
Increased erosion of the cleared areas	Moderate	◻ Re-vegetation of top soil shall be undertaken to reduce runoff, increase moisture retention and facilitate soil stabilization Top soil/cleared vegetation shall be used to hedge the proposed project sites (well locations, flow stations etc) to reduce run-off (control flooding and contain sand)	Minor
Increased access for hunting and logging	Moderate	❑ Awareness campaign of the adverse effects of hunting and logging shall be undertaken/ incentives shall be introduced for compliance ❑ ONDIPA shall support programmes aimed at sustainable use of forest resources	Minor
Change in topography of sand filled area areas and this could lead to death of soil dwelling organisms	Major	❑ Adequate drainage channels shall be provided around the sand filled area and other project sites ❑ Bund walls (using top soils /vegetation {tree trunks}) shall be erected around the sand filled area to contain sand ❑ The areas to be sand filled shall be restricted to the minimum required ❑ Sand filling activities shall be completed on schedule	Moderate

7.4 Mitigation Measures for Impacted Zones

The EIA of the proposed Deep-Sea Port are evaluated with the Matrix method. The method essentially consists of a list of different activities during the project implementation and their likely impacts on the environmental indices, presented in a matrix format. The matrix allows the identification of cause-effect relationships between specific activities and their impacts. In preparing the matrix, the mitigation measures that are in operation presently were taken into consideration. The Matrix includes:

* All major activities of the project likely to have impact on the environment,
* The qualitative estimates of the impact of each activity on the environment,
* The mitigation measures already in place to reduce impacts on the environment,
* Additional mitigation measures suggested, wherever feasible,
* The qualitative estimates of the impact of each activity on the environment after implementation of the additional mitigation measures.

The qualitative evaluation of the impacts based on the above matrix is done on the basis of a few indicators presented below:

No Impact - This indicates that the project activity is unlikely to have any impact on a particular environmental index.

7.4.1 Physical Disturbance

The physical disturbance of the environment resulting from the Deep-Sea port construction activities can have a negative impact on the fauna, especially if it causes changes in factors on which the recruitment and survival of wildlife populations in the area are dependent.

Soil erosion, which accompanies the loss of vegetation cover, is another area of concern, especially given the heavy rainfall and flood prone zone in which the exploratory drilling project is proposed to be implemented. Loss of topsoil will not only result in a degradation of terrestrial habitats but will also increase sediment supply to streams in the area, leading to changes in their hydrology and geomorphology. This can cause alteration of ecological processes in these aquatic ecosystems with effects ranging from impacts on filter feeding organisms to alterations in carbon processing and nutrient cycling.

Finally the ecological costs of an increase in vehicular traffic in the area cannot be ignored. The increased traffic has the potential to disrupt wildlife and cause more road kills.

7.4.2. Routine Operations

For routine (planned) operations, the process of environmental impact assessment considers each interaction qualitatively on the basis of the criteria of expected consequences.

7.4.3. Non-Routine Events

Hazards associated with unplanned events. This classification assists in identifying the greatest risks to the environment from unplanned events. Those hazards resulting in negligible or minor consequence to the environment, with a negligible to low expected frequency of occurrence are generally acceptable, whereas those resulting in severe consequences which have a high likelihood of occurrence are not. Medium risks need to be reduced as far as reasonably practicable and procedures should be set in place to minimize impacts should an incident occur.

7.4.4. Routine Hazards

7.4.4.1. Hazard Identification

Potential hazards to the environment that will occur from routine operations are:

(i) Soil and Sediment Disturbance. The construction activities may affect soil quality of the area and subsequently sediment quality of the rivers and streams.

(ii) Noise. Construction activities and movement of equipment will generate noise. Noise is thought to have the potential to disturb or confuse the birds and animals.

(iii) Atmospheric Emissions. Routine emissions to air result from power generation.

(iv) Wastes. These will be collected and treated for disposal or transferred. Any effects from controlled disposal of such wastes should be negligible.

(iii) **Air environment**

For the purposes of impact predictions on air environment, emission sources can be classified into point and area sources. There is no area sources considered for the purposes of predictions. The point sources identified are diesel engines/generator sets. In this respect, the following have to be taken into consideration:

- The diesel engines and associated generators will be in operation 24 hours a day during the drilling period, for operation of drill rig, and mud circulation system.
- Diesel will be used as a fuel for operation of diesel engines/power generators and will contain negligible sulfur and ash content.

The meteorological data recorded during the study (Chapter 4) have been used for the predictions. For predictions of impacts of NOx on air environment are insignificant.

(iv) **Water environment**

The survey of the water environment in the area reveals that both surface water and ground water sources are free from the usual contaminants (Chapter 4). However, the surface water is bacteriologically contaminated. The water can be used for drinking and other purposes by appropriate disinfection procedure.

(vii) **Socio-economic environment**

The Deep-Sea Port activities are likely to have the following impacts on the existing socio-economic profile of the area:

The proposed activities will generate indirect employment in the region due to the requirement of workers in road construction, site preparation, supply and transport of raw materials and equipment, auxiliary and ancillary works, etc. These would give temporary relief to the people of the locality and their socio-economic conditions would improve:

i. The activities would also result in enhancing the local skill levels through exposure to drilling activities and technology, and help in capacity building for future employment opportunities.
ii. Some of the existing roads may have to be upgraded to facilitate the movement of the heavy equipment and vehicles, leading to improvement in transport facilities in the area.

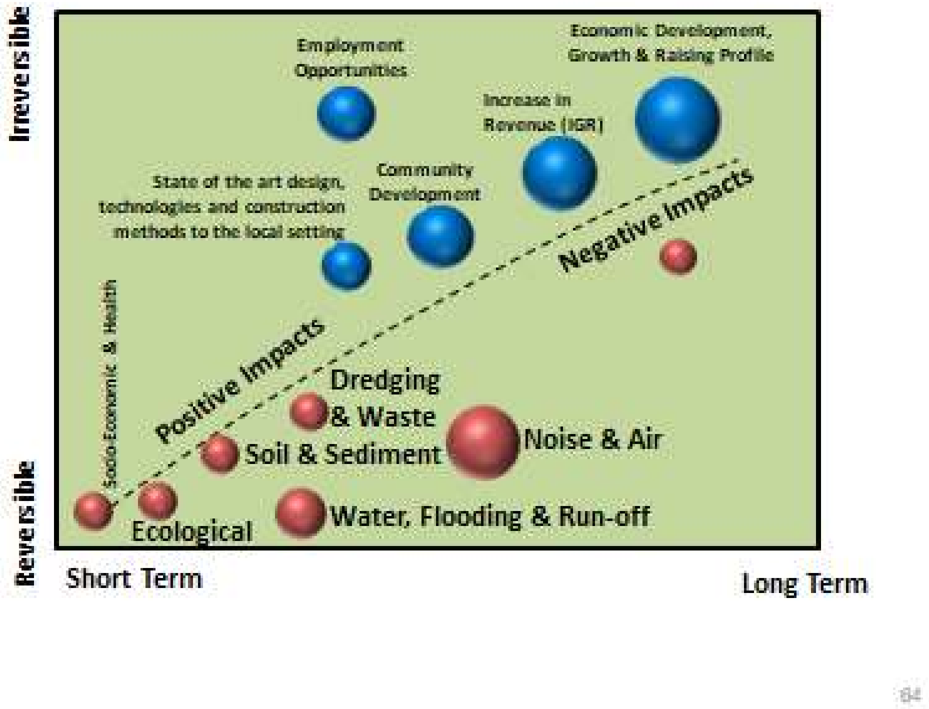


Plate 6.11: Identified Impacts of the Proposed Dee Sea Project

CHAPTER EIGHT

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

8.0 Introduction to Environmental Management Plan

Environmental Management Plan (EMP) is a tool which ensures continuous assessment of the associated impact of a project operation as well as proactive response to reduce the overall effect of impacts on the environment. It makes an organization to do the right thing at the right time instead of reacting to situation out of statutory or legal compulsion. It is a component of the International Standards Organization Environmental protection blue print code named ISO 14000.

The effectiveness of EMP of any organization however rests on the composition, efficiency and management commitment to the following three other ISO standards namely: ISO 14001, Environmental Auditing (comprising ISO 14010, ISO 14011 and ISO 14002) and ISO 14031. ISO 14001 is a structured control method employed by organizations to attend to environmental effects of their actions and also to improve on their environmental performance. Environmental Auditing (EA) works along with life cycle assessment standards to ensure effective implementation of any environmental management system. ISO 14031 provides a management framework for monitoring and measuring performance against set targets.

Based on the baseline environmental conditions established in this study and the impacts identified, and taking into account the environmental values to be safeguarded, the magnitude of each potential impact and the risk or probability of each impact occurring, key aspects and parameters for the proposed Ondo State Deep-Sea Port and the Environmental Management Plan (EMP) are presented in this section. For each aspect, the major causes for environmental change, the legislation/standards/parameters which must be adhered to and possible monitoring methods.

8.1 Objectives and Components of EMP

For any environment responsible organization, the followings should form an integral part of its environmental protection policy:

i. Ensure that all legal standards for waste, effluent and emissions are not exceeded.
ii. Alive and responsive to constant compliance with all the mitigating measures that are contained in the EIA report;
iii. Provide early warning of environmental damage so that emergency procedures can be activated to prevent or reduce deterioration of the environment; and
iv. Ensure regular training of staff on environmental safety and management in line with ever changing environmental systems and technologies.

Thus, EMP provides the means of meeting up with the commitment made in an EIA report. There are some pre-requisites for effective operation of Environmental Management System (EMS) in any organization. These are as follows:

i. Top management of the organization ensures that all contents of the EMS are implemented.
ii. EMS is made part of the existing management system instead of leaving it as an isolated system to the organization. Specific unit or department is established to owe responsibility for its actions, conducts and performance.
iii. Funding of the system shall be consistent both in the area of procuring environmental management equipment. Environmental

Management System comprise the following components (ISO 14001)

- Environmental policy
- Planning
- Implementation and operation
- Checking and creativeness
- Management review

8.1.1 Environmental Policy

In line with its corporate environmental policy, ONDIPA will ensure that its operations are carried out with due regard to environmental safety by minimizing or completely eliminating all harmful discharges into the air, land or water.

To achieve its environmental policy, the company is committed to the followings:

i. Ensuring compliance with all international, federal, state and local statutory regulations (as highlighted in Chapter One).
ii. Ensure periodic auditing of its environmental policy and operations especially in regard to sensitive environmental parameters highlighted in the EIA.
iii. Establishment of effective information dissemination networks on company policy to workers, governmental environmental agencies and interested public (i.e. creating awareness).
iv. Proactive response to pollutant releases into the environment through the use of state-of-the-art environmental pollution control technology;
v. Prompt response to emergencies and accidents;

8.1.2 Planning

i. As a part of its environmental management policy, ONDIPA has existing procedures for identifying and procuring all relevant materials useful and/or that can be extended to the proposed Deep-Sea Port project.

ii. ONDIPA will continue to maintain its environmental objectives and targets;

iii. Provide adequate funds for achieving the environmental objectives through the company's annual budgeting. This ensures that all set objectives are realized without hindrance.

8.1.3 Implementation and Operation

One of the basic requirements of EMS is that the implementation and operation at all stages must be given the highest level of seriousness and commitment since it is the pivotal stage of EMP in an organization. This is where most organizations irrespective of their beautiful environmental policy statement, objectives and goals fail. Many companies pay lip service at this stage unless there is effective monitoring by the regulatory authorities. In this regard, ONDIPA will ensure strict compliance and full implementation, because:

i. It will clearly spell out roles, responsibilities and authorities with appropriate distribution and allocation of responsibilities to concerned staff to reduce conflict and confusion; and

ii. Through its safety, health and quality control Department oversee the implementation of its environmental responsibilities.

In addition to the above,

i. There will be monthly quality control evaluation of all the key environmental parameters of the company's operation especially the emissions;

ii. The company will ensure up-to-date environmental knowledge among its staff through regular training of staff on the impacts of their operation on work environment;

iii. ONDIPA has operational manual on how to prevent accident and / or attend to accident cases;

8.1.4 Checking and corrective action

ONDIPA operates well established and documented procedures to monitor, on regular basis, the key characteristics of its operation and environmental parameters to determine their impact and conformity with mitigating measures contained in the EIA.

It will achieve these through the establishment and maintenance of periodic programme of environmental audit reporting to ensure that;

i. the level of impacts by operations of the company conforms with set standard (national and international standards)

ii. there are available data or results of the auditing for management and regulatory bodies for review and action when necessary;

iii. all data relating to monitoring and measurement are adequately stored (hard disk, CD) for safe keeping for future use as necessary.

8.1.5 Management Review

This is also a key component of EMS which requires management attention to existing environmental management policies and practices to assess its effectiveness and achievement of the desired goal. ONDIPA top management will periodically review the existing company's environmental policy to ensure conformity with company's goal, effectiveness and adequacy. During this period, any area of lapses will be corrected while new strategies and measures are introduced to take care of any obsolete technology or to meet new innovation in international environmental market.

8.2 Guidelines for Waste Management

8.2.1 Waste Minimization

This implies the reduction to the maximum possible extent of the volume or the relative toxicity of liquid or solid waste being handled. The four principles of waste minimization process, namely: reduction, reuse, recovery and recycle shall be adopted as applicable.

8.2.2 Waste Segregation

For effective implementation of appropriate waste disposal method, it is important that waste material be segregated into clearly designated bins at strategic location. The contents of the separate bin shall be disposed of differently.

8.2.3 Waste Handling

Waste shall be defined at source and regarded as such until the final disposal stage. The project waste contractor shall define, and document appropriately all wastes generated in the course of his / her assignment. The general information required as a minimum for adequate definition of wastes includes:

i. Waste stream identification
ii. Appropriate handling and disposal practice
iii. Recommended management practices

8.2.4 Waste Disposal

All debris, spoil materials, rubbish and other waste, except excavated soil, shall be cleared regularly from the site disposed of accordingly. Instructions on the material safety handling sheet shall be strictly adhere to and shall form the basis for the disposal of wastes related to such products. Adequate treatment measures shall be undertaken, where applicable for all wastes before final disposal.

All waste in transit shall be tracked by waste consignment note. The waste consignment note record shall be kept, as a minimum contain the following information:

i. Date of dispatch
ii. Description of waste
iii. Waste quantity / container type
iv. Designated disposal site and method
v. Consignee / driver name and names of transportation; and
vi. Confirmation of actual disposal (time and date).

8.3 General Safety and Sanitation

8.3.1 Noise Waste

Generators to augment public power supply will be fitted with mufflers and silencers to reduce the noise levels. In the production area workers will also be provided with ear mufflers and their use will be enforced. Machinery will be regularly maintained to minimize noise level.

8.3.2 Personnel Safety

Boots, hand gloves, overalls and helmets will be supplied their need arises and strict usage will be ensured by ONDIPA. Fire protective devices such as alarms, fire hydrants, smoke detectors and fire extinguishers both manual and automatic will be provided at strategist locations in the production area and station. HSE officers shall be in charge of emergency cases. A high level of sanitation shall be maintained generally.

8.4 Environmental Auditing

Companies and organizations are required to assess how friendly their operations are to the environment. The process of doing this is called environmental auditing. In a broad sense, Environmental Auditing is a management tool comprising a systematic, documented, periodic and objective evaluation of how well environmental organization management and equipment are performing with the aim of helping to safeguard the environment by facilitating management control of environmental practices and assessing compliance with company policies, which include meeting regulatory requirements.

In EIA process, Environmental Auditing is not a stay-alone activity, rather, it is an integral part of the EIA programme which serves as a watch dog to ensure that all major issues raised in the EIA with regard to impacts of the project operations and their mitigating measures are strictly adhered to. Life Cycle Assessment (LCA) and Performance Evaluation system (EPE) are all parts of auditing process. or the

successful conduct of an auditing exercise, there must be monitoring of the environmental systems.

8.4.1 Environmental Monitoring

In EIA, monitoring is the process of generating, collecting, analyzing and evaluating data. Monitoring differs from supervision and surveillance in that it deals with quantitative measurable activities while the latter is considered as observational and inspectional activities to ensure that terms, conditions, permits and contracts are complied with. The objective of environmental monitoring is to:

i. detect and measure changes in the environment over time.

ii. study the effects of management activities on the environment,
iii. test impact predictions, understand the environment the more and as a result, improve operational capability.
iv. check, effectiveness of mitigating measures; and
v. Finally, to provide evidence to dismiss or support claims for damages and consequent compensation.

For the proposed Deep-Sea Port project, the Environmental Auditing System indicated in Table 8.1 with the frequencies as indicated, shall be carried out by ONDIPA.

Table 8.1: Environmental Auditing Systems / Frequencies for the Proposed Deep-Sea Project

Type	Aim/Objective	Schedule
Regulatory Compliance Audit (RCA) And Process Safety Audit	To ensure compliance with all FMEnv standards, guidelines on emission/effluent discharge and production safety	Quarterly
Product Quality Audit	To ensure that its product quality meets the standards of MEnV	Once every year
Occupational Health Audit	To ensure the safety of workers in the work environment in accordance with factory decree of 1987 (now an act of the parliament).	Quarterly
Management Audit	To review the policy procedures and strategies of the company's environmental policy by ONDIPA management	Once every three months

8.4.2 Parameters to be Monitored

The following parameters are to be monitored on the proposed project during full operation:

- Air quality
- Underground water quality;
- Surface water quality;

- Solid waste generation and management

The following parameters (**Table 8.2**) are to be monitored for air and surface water quality.

Table 8.2: Parameters to be Monitored for Air and Water Quality for the Deep-Sea Project

Pollution Medium	Parameters	Units	Frequency of monitored	Responsible Authority
Air quality	Sulphur Oxide (SO_2)	Mg/m^3	Quarterly	ONDIPA
	Carbon oxide (CO_2)	Mg/m^3		
	Nitrogen oxide (NO_2)	Mg/m^3		
	Ammonia (NH_3)	Mg/m^3		
Surface / ground water quality	Ph		Quarterly	
	BOD_5 at 20^0C	Mg/l	Quarterly	
	COD	Mg/l	Quarterly	
	Total dissolved solids	Mg/l	Quarterly	
	Total suspended solids	Mg/l	Quarterly	
	Dissolved Oxygen (DO), BOD	Mg/l	Quarterly	
	Grease & Oil	Mg/l	Quarterly	
	Coliform	MPN/100ml	Quarterly	
Solid wastes	Grit/sand & Gravel from wheat	Kg	Monthly	
	Domestic wastes	Kg		
	Dust leakages from the field	Kg		

8.5 Reporting

The Quality Control Department of the proposed Project shall make periodic report of monthly internal audit and send the report to the management every three months for review, comments, advice and possibly, effect a change in strategy to achieve the best environmental practice in the production activities. Other hazards such as fire, accidents etc. shall be promptly responded to through well Institutionalized contingency plan in the economy.

8.6 Social Responsibilities of the Project Proponent

As part of its corporate policy, ONDIPA shall render social oriented services to both its project host communities and the nation at large. In this regard, the company shall support social oriented programme of its host communities such as community development project if such assistance is of course solicited. At the national level, it shall assist in educational advancement of the youth by co-financing some youth educational programmes and other activities of interest to the youth.

8.7 Staff Training

A staff (including contractors) training programme shall be developed to increase their awareness of safety, safe ways of working, environmental adherence, etc. such training shall range from induction training, through risk analysis, job safety analysis to tasks related to oil spill or well blow out. The key elements of the training programme shall include.

- An organization chart with associated training resources
- Descriptions of course contents, testing and verification method

An environmental training for staff is also required to increase their awareness about environmental resource conservation in work area and the importance of mitigation compliance, environmental hazards and environmental protection measures.

8.8 EMP For Air Quality and Noise

As air quality and noise impacts are the most important of all the impacts evaluated these are considered further in Table 9.19.

Table 8.3: Impact Management and Monitoring Plan for the Proposed Deep-Sea Project Associated and Potential Impacts on Air Quality and Noise

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
Mobilisation (transport) to site (equipment, personnel & construction modules)	Impairment of air quality	Moderate	vehicles shall be serviced and regularly maintained equipment shall be turned off when not in use	Minor	Before mobilization	CO, NO_X, SO_2, TSP, VOCs	Once, before mobilization	Project Subject Matter Expert for Environment and HSE Team Leader
	Noise nuisance to humans and wildlife	Moderate	ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not in use	Minor	Before and during mobilization	Noise level	Before mobilization	Project Subject Matter Expert for Environment and HSE Team Leader

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
	Traffic Accident	Moderate	• ONDIPA must have speed limit within their facility • Traffic code must be displaced to warm vehicles of the state of the road • Make sure that all vehicles entering and leaving their facility obey all traffic rules and regulations	Minor	All through the duration of the Project		HSE team	
	Vehicle Maintenance	Moderate	• All vehicles must be properly maintained • A service log book kept for each vehicle	Minor	All through the duration of the project		HSE team	

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
	Increased social vices	Major	• Awareness campaign shall be carried out to enlighten the communities/ field workers on the implications of drug and alcohol abuse, unprotected sex, prostitution and the need to sustain cultural values • Movement of field workers shall be restricted to camp/work sites • Alternative recreational facilities shall be provided at camp sites • Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers	Moderate	ONDIPA	During land acquisition, construction, decommission During land acquisition, construction, decommission		

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
Site preparation	Impairment of hearing noise	Moderate	• HPDs shall be provided for workers on and visitors to site.	Minor	During site activities	Noise level	Project Subject Matter Expert for Environment	
Pre-Construction	Impairment of air quality	Moderate	• vehicles shall be serviced and regularly maintained • equipment shall be turned off when not in use	Minor	During pre-construction	CO, NO_X, SO_2, TSP, VOCs	Project Subject Matter Expert for Environment and HSE Team Leader	
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not use	Minor	During pre-construction	Noise level	Project Subject Matter Expert for Environment and HSE Team Leader	

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
Supply of construction equipment & materials	Emission of noxious substances to atmosphere	Moderate	• ONDIPA shall ensure regular maintenance of vehicles	Minor	Before mobilization	CO, NO_X, SO_2, TSP, VOCs	Project Subject Matter Expert for Environment and HSE Team Leader	
Energy provision for construction activities	Emission of noxious substances to the atmosphere	Moderate	• Equipment shall be tuned off when not in use • regular maintenance of equipment	Minor	During operation	CO, NOX, SO2, TSP, and VOCs	Project Subject Matter Expert for Environment	
Power generation	Emission of noxious substances	Moderate	• Equipment shall be tuned off when not in use • regular maintenance of equipment	Minor	During operation	CO, NOX, SO2, TSP, and VOCs	Project Subject Matter Expert for Environment	

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not in use	Minor	Before and during mobilization	Noise level	Project Subject Matter Expert for Environment and HSE Team Leader	

Continue table 8.3

Project Activities	Impact	Rating before mitigation	Description of Mitigation	Rating after mitigation	Timing	Parameters to monitor	Frequency of monitoring	Action party
Demobilisation (transport) from site (equipment, personnel)	Impairment of air quality	Moderate	• vehicles shall be serviced and regularly maintained • equipment shall be turned off when not in use	Minor	Before mobilization	CO, NO_X, SO_2, TSP, VOCs	Once, before mobilization	Project Subject Matter Expert for Environment and HSE Team Leader
	Noise nuisance to humans and wildlife	Moderate	• ONDIPA shall ensure regular maintenance of vehicles • Equipment shall be tuned off when not in use	Minor	Before and during mobilization	Noise level	Before mobilization	Project Subject Matter Expert for Environment and HSE Team Leader
	Noise impairment due to noise from gas flares	Moderate	• Liquid carryover into gas flares shall be avoided by ONDIPA all the time	Minor	During operation and maintenance	Noise level	B-weekly during Site and completion	Project Subject Matter Expert for Environment and HSE Team Leader

Table 8.4a: EMP for surface and groundwater resources

Impact	Rating before mitigation	Description of mitigation	Residual impact rating	Responsible party	Timing (Phase)	Parameters for Monitoring	Monitoring Frequency
Impairment of water quality by 2increased turbidity, this could adversely affect the quality of household water and lead to clogging of the gills of fishes and subsequent death of aquatic life	Major	❑ During sandfilling, the generated sand materials shall be used in constructing sedimentation basins, thus allowing the water to gradually drain back without turbulence ❑ Top soil materials shall be used to hedge the surroundings of the site to control flooding and control sand ❑ Potable water shall be supplied to the affected communities during sand filling operations. ❑ The potable water quality shall conform to acceptable WHO, FMENV standards (TSS, TDS, Turbidity, Chemical parameters, Biological parameters)	Minor	ONDIPA	During construction	Post Impact Assessment report Compliance monitoring report for potable water supplied	 Weekly
Disturbance of aquatic life (zooplankton, phytoplankton, benthic communities, fisheries etc)	Major	❑ Sedimentation basin with effluent drains shall be constructed to allow water to gradually drain back into the river without turbulence ❑ Indigenous aquatic flora and fauna shall be used to restock the aquatic system ❑ Recovery of bottom sediment shall be monitored ❑ Sandfilling activities shall be completed on schedule	Minor	ONDIPA	Pre & during construction	Determination of biomass and species of aquatic communities	Twice a year (dry and rainy seasons)

Table 8.4b: EMP for Social-Economic Impacts

Impact	Rating before mitigation	Description of mitigation	Residual impact rating	Responsible party	Timing (Phase)	Parameters for Monitoring	Monitoring Frequency
Increase in population leading to diffusion of culture and traditions	Moderate	❑ Construction workers shall be accommodated in contractor camps to reduce adverse impact on existing culture and tradition ❑ Awareness campaign shall be carried out on the need to sustain native culture and traditions	Minor	ONDIPA	During construction activities	Community engagement sessions Site inspection report	Quarterly
Increase in cost of living/inflation	Moderate	❑ Work camps shall be provided with necessary utilities to reduce pressure on local community facilities ❑ Communities shall be empowered through provision of jobs, increased patronage to produce (fishes, farm produce etc) and encourage income generating activities	Minor	ONDIPA	During construction activities	Register of ONDIPA sponsored income generating projects	Quarterly

Nuisance (noise, emissions, dusts, vibrations) from heavy machinery	Moderate	❑ Standard machinery with noise levels within acceptable limits (85 dB (A)) shall be used ❑ Site construction shall be done within the shortest possible time ❑ Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits ❑ High sound energy equipment shall be enclosed in noise insulators in line with ONDIPA policy ❑ ONDIPA HSE policy of wearing ear muffs/ plugs, with signs indicating noisy areas shall be applied in all construction sites ❑ Sufficient separation distances shall be provided for sources of high energy sound to reduce noise levels ❑ Workers with existing hearing impairment shall not be deployed to site ❑ Ambient air quality/noise level shall be monitored in line with FMENV/DPR requirement (NOx, COx, SOx, SPM etc)	Minor	ONDIPA	During construction activities	Site inspection report. Compliance monitoring report	Monthly
Pressure on existing infrastructure (accommodation, health, recreational, educational facilities etc) and could alter the demographic pattern	Major	❑ Awareness shall be created on the potential of increased use of the facilities ❑ ONDIPA shall support (provision of drugs, upgrading of facilities and staff training) existing health, recreational, educational facilities etc ❑ ONDIPA shall provide accommodation/relevant amenities (health and recreational facilities) for workers to reduce stress and health vulnerabilities	Minor	ONDIPA	During-construction	Site inspection report	

Increased social vices	Major	❑ Awareness campaign shall be carried out to enlighten the communities/field workers on the implications of drug and alcohol abuse, unprotected sex, prostitution and the need to sustain cultural values ❑ Movement of field workers shall be restricted to camp/work sites ❑ Alternative recreational facilities shall be provided at camp sites ❑ Alcohol and drug policy shall be implemented to encourage healthy lifestyle for workers	Moderate	ONDIPA	During land acquisition, construction, decommission	Reports on community engagement sessions Site inspection report/tool box meetings	
COULD LEAD TO THIRD PARTY AGITATION	Major	❑ The relevant stakeholders/ legacy issues shall be identified ❑ Regular consultation with stakeholders (Govt., Community, NGOs, CBOs etc.) shall be carried out ❑ Adequate and prompt compensation shall be made ❑ Provision of MOU with community	Moderate	ONDIPA	During land acquisition, construction, decommission	Stakeholder engagement document	Monthly during land acquisition period
Reduction of access to natural environment and its resources	Moderate	❑ Natural resources shall be identified ❑ Alternative income generating activities shall be supported (micro-credits, youth development scheme, women trade centres, aquaculture and improved farming techniques etc) ❑ Land take shall be limited to the minimum required	Minor	ONDIPA	Land acquisition	Site inspection activities report	Monthly during land acquisition period

Table 8.4c: EMP for Health Impacts

Impact	Rating before mitigation	Description of mitigation	Residual impact rating	Responsible party	Timing (Phase)	Parameters for Monitoring	Monitoring Frequency
Increased morbidity rate thereby putting pressure on existing health facilities	Moderate	❑ Regular medical check-up for site personnel shall be undertaken, with the above mitigations for air quality impact ❑ Medical facilities shall be provided on site, with critical cases transferred to ONDIPA clinic at Warri (MEDEVAC) ❑ Standard solid waste collection and segregation area shall be provided on site. ❑ ONDIPA shall support (provision of drugs, upgrading of facilities and staff training) existing health, facilities ❑ Material Safety Data Sheets shall be provided on all sites where chemicals are handled	Minor	ONDIPA	During operations	Medical reports	Once a year
Increased level of disease vectors	Moderate	❑ Site specific solid waste management plan in line with ONDIPA waste management guidelines shall be put in place before operations ❑ Fumigation shall be carried out, where applicable	Minor	ONDIPA	During operations	Site inspection reports	Quarterly

Increased accidents/ injuries, therefore increase pressure on healthcare facility	Major	❑ ONDIPA shall provide health and recreational facilities for workers to reduce stress and health vulnerabilities ❑ All contractors shall ensure that their personnel are medically certified fit for their different activities and medical reports submitted to ONDIPA. ❑ Retainership clinics and site medical facilities such as first aid shall be provided in line with ONDIPA guidelines. ❑ Health Risk Assessment (HRA) shall be carried out for all jobs to manage the potential health hazards associated with the activities. ❑ Adequate training shall be provided on basic life saving techniques such as basic first aid, resuscitation, care of the unconscious and control of bleeding and ONDIPA medical emergency response procedures. ❑ All ONDIPA/ contractor personnel shall be adequately trained to acquire the pre-requisite competence for the different jobs. ❑ All operations personnel shall be provided with appropriate Personnel Protective Equipment (PPE), and it shall be mandatory that they are worn as may be applicable. ❑ Permit to Work system shall be enforced at all stages of the operational activities	Minor	ONDIPA	During decommissioning	Site inspection, Medical/HRA reports	Quarterly

Table 8.4d: EMP for Solid Waste Disposal

Impact	Rating before mitigation	Description of mitigation	Residual impact rating	Responsible party	Timing (Phase)	Parameters for Monitoring	Monitoring Frequency
Improper disposal of solid waste could lead to contamination of soil, surface/ groundwater, disrupt fishing activities and decrease aesthetic value of the environment	Moderate	❑ Generated solid waste shall be segregated at source by the provision of colour coded bin for different types of waste and disposed of according to ONDIPA waste management guidelines (Site and other wastes; ❑ The generated paper waste shall be shredded and sold to any ONDIPA approved paper recycling company ❑ De-contaminated scrap metals/drums shall be collected and taken to ONDIPA waste recycling depot (scrap yard), for onward delivery to any ONDIPA approved metal scavengers ❑ Generated glass materials shall also be transported to KI scrap yard for onward delivery to any ONDIPA approved glass company ❑ Spent batteries shall be taken to any ONDIPA approved battery re-cycling company ❑ Oily waste materials shall be collected and taken to FMENV approved incinerator at Soku Gas Plant or any other approved alternative ❑ Kitchen waste shall be collected and handled at any ONDIPA approved composting plant ❑ Medical waste shall be collected and taken to medical incinerator at ONDIPA	Minor	ONDIPA	During construction activities	Site inspection reports Availability of waste inventory data/site specific waste management plan	Quarterly

Table 8,4e: EMP for Soil and Vegetation Impacts

Impact	Rating before mitigation	Description of mitigation	Residual impact rating	Responsible party	Timing (Phase)	Parameters for Monitoring	Monitoring Frequency
Increased erosion of the cleared areas	Moderate	◻ Re-vegetation of top soil shall be undertaken to reduce runoff, increase moisture retention and facilitate soil stabilisation Top soil/cleared vegetation shall be used to hedge the proposed project sites (well locations, flowstations etc) to reduce run-off (control flooding and contain sand)	Minor	ONDIPA	During-construction	Site inspection report	Twice a year
Increased access for hunting and logging	Moderate	❑ Awareness campaign of the adverse effects of hunting and logging shall be undertaken/ incentives shall be introduced for compliance ❑ ONDIPA shall support programmes aimed at sustainable use of forest resources	Minor	ONDIPA	During-construction	Report on stakeholder engagement Availability of forest resources preservation programme	Twice a year
Change in topography of sandfilled area areas and this could lead to death of soil dwelling organisms	Major	❑ Adequate drainage channels shall be provided around the sand filled area and other project sites ❑ Bund walls (using top soils /vegetation {tree trunks}) shall be erected around the sandfilled area to contain sand ❑ The areas to be sandfilled shall be restricted to the minimum required ❑ Sandfilling activities shall be completed on schedule	Moderate	ONDIPA	During construction	Site inspection reports	Quarterly

8.9 Environmental Management Plan (EMP) For other Environmental Parameters

The mitigation plan for the activities proposed for the Deep-Sea port site in the block is presented in section **8.9**

Table 8.4f: Environmental Management Plant-Mitigation Management Matrix

ROUTINE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Land Acquisition Obtain necessary permits for Land acquisition from State government and community relation with the host community	• Ensure that all necessary protocols are followed and legal requirements implemented. • Ensure that the host community is carried along.	• ONDIPA Company to initiate interaction with the concerned officials in the state government prior to release of actual location to identify necessary permits and the approval mechanism.	Chief – QHSE/Community Liaison officer	Pre-deployment of topographic survey team and community leader to establish boundary of oil field.

ROUTE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Soil Erosion	• Minimize the extent of site clearance area, by choosing best layout with respect to existing topography. • Minimize removal of trees at site • Collect topsoil removed during road development/construction, site preparation, etc. and stockpile the same at edge of site to be used to the extent possible for site restoration later.	• Detailed contour maps of the site to prepared with trees marked on it to work out the best layout to minimize cut & fill & avoid cutting of trees. • To see that arrangement is in place for collection. • Plan to minimize tree cutting prior to site construction and ensure implementation on ground during site construction phase.	Assit. Manager Civil Contractor Assist. Manager	Prior to site preparation and other construction activities- -Do- To be continued till demobilization.
Habitat Disturbance	• Mark our road & site	• To ensure that clear boundary	Assist. Manager	Prior to any construction

	boundaries. • All bulldozer operators and other manual laborers involved in road and site preparation will be trained to strictly confine to their works within the defined site boundaries. • Pits for containment of cuttings and liquid effluents will be dug at site after fencing is in place.	marks are in place. • To ensure that integrity of boundary markers is maintained by the workforce at all times. • Ensure that fencing of site is in place prior to cutting of pits at site. • To appoint guards to be stationed at site during construction phase.	-Do- Site Team Civil contractor	activity (road or site) Throughout the road & site construction operations. -Do- -Do-

Table 8.5: **Environmental Management Plan – Mitigation Management Matrix**

ROUTE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Waste and Effluent Management Poor planning and execution might pose a threat to environment. Contamination of rain/storm water	• Block operator to identify different type of waste anticipated during operations, work out estimated quantities, lay down procedures for collection, handling, treatment and disposal of each type of waste. • Waste Management Plan to be implemented during operations. • Detailed drainage design will be developed as a part of the site design and associated drainage system is isolated from the rain/storm water drainage system. • Pits must have adequate capacity to prevent flooding during high rains (maintain free board) and should be fully bunded.	• Finalizing Waste Management Plan (draft plan given in EMP report) • Waste management plan to be implemented during Site and be made available for inspection at site to all regulatory bodies. • Block operator to work with Civil works consultants/contractors to develop detailed drainage system addressing concerns outlined here. • Block operator to work out required pit volumes based on maximum case scenario including rainwater.	Chief QHSE in association with Site Team Chief - QHSE in association with Site Manager Site Manager Site Manager	During all operations Implementation During all operations at site and during demobilization Site Design phase -Do-

ROUTE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Wastewater	• All wastewater, which will be generated from washings & spent mud will be contained in HDPE lined (1 mm thick) pits. The wastewater will be treated through flocculation and dilution to achieve SPCB compliance for discharge.	• Site design will include adequately sized pits to contain wastewater & also treated water prior to discharge.	Site Team	Site Design/Contractor procurement. Planning & Procurement phase
	• Prepare a comprehensive Contingency Plan	• Finalizing the Contingency Plan	Site Team	Contractor Procurement operations.
Fuels, Lubricants and Chemicals Management pose threat.	• Keeping all fuels, lubricants and chemicals in well –designed storage facility with regular inventory checking.	• Checklist of all drums and containers located within footprint of the storage area	Chief - QHSE in association with Site Team	Prior to commencement of Site operations

ROUTE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
	• Executing delivery of fuel to Site site under strict supervision and carrying out refueling operations in an area with impervious flooring and surface drainage with oil interceptor.	• Keeping an inventory of all fueling and refueling operations.	Site Team	Site Design phase
	• Impervious liners in place for fuel, lubricants storage area. Fuel/lubricant containment & generator area to have drains with oil entrapment provision.	• Check all delivery trucks for suitable & ensure that they meet safety requirements.	Construction contractor during construction phase & Rig's maintenance staff during Site phase.	Site design & through out the operations.
	• Effective bunds capable of containing 100% of the volume of the largest container within and enclosing all potentially contaminating materials to be used for fuels/lubricants storage area.	• Impervious liners to be installed in the fuel & lubricant storage area. Fuel/lubricant storage area & generator area to have drains with oil entrapment mechanism.	HSE coordinator	-Do-

ROUTE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Noise and Vibration	• Checklist of all machineries with record of date of procurement, installation and age. • Regular maintenance of all equipments. • Implement good working practices to minimize noise. • Wearing of ear protector when appropriate	• Inventory of all machineries to be prepared and submitted to Block operator for review. • Maintenance Log Block to be prepared and submitted to Block operator for review. • No machinery running when not required. • Block operator to distribute noise protection equipment and ensure utilization by the work force.	Site Engineer -Do- HSE Coordinator	During operations Prior to and during operations During operations -Do-
Air Emissions	• Operate all equipment within specified design parameters. • Store all dry, dusty material (chemicals, etc.) in sealed containers. • Minimize duration of testing by careful planning.	• Ensure proper Equipment maintenance • Ensure absence of stockpiles or open containers of dusty materials.	Site Mechanic Site's maintenance staff	During operations. -Do- Planning phase

CHAPTER NINE

9.0 INTRODUCTION TO STAKEHOLDER PLAN

In line with best international practices, it is imperative to give a detailed stakeholders plan because it is a category A project even though outside the scope of our work but will serve as a continuous guide and reference.

9.1 Purpose and Scope

The stakeholder Engagement Plan (SEP) is critical to the successful construction and operation of any infrastructure especially when it interfaces with the social lives of the people living in the area proposed for the construction. The SEP will assist with managing and facilitating future engagement through the various stages of the Project's life cycle from conceptualization through construction and management.

This SEP adopts an inclusive life-of Port perspective. It details engagement undertaken with stakeholders during the Pre-feasibility stage of the Project and serves as a guide to engagement during the ESIA project stage. Stakeholders engagement has been a key component of this project from the incubatory phase as attested to by the Paramount Ruler Olugbo of Ugbo Kingdom, Oba Akinruntan who gave an overview of the Plan for development of the entire region and the proposed deep -sea Port as shared with them by Mr. Governor during scooping.

9.2 Brief on the Project

The Ondo State government, ODSG is desirous of developing a multi-purpose deep-sea port to provide marine logistics support to the Sunshine Industrial City with Free Trade Zone status at Erunna/Ogboti, Ilaje LGA, Ondo State. The Pre-feasibility studies was commissioned in Sept 2018 while Jabridep was commissioned to undertake the Environmental and social Impact Studies on 6TH November 2019 after competitive presentation.

9.2.1 Port location and site assessment

Through a multi-criteria analysis, (MCA) the preferred port site selected is located between Latitudes N06° 09' 50.0″ and N06° 07′ 37.6″ and Longitudes E004° 47′ 34.8″and E004°45′01.4″ at Erunna/Ogboti in Ilaje Local Government area of Ondo State. The site is connected by a single road at 91 km distance of the highway at Oro. The road crosses several creeks and wetlands. The "Port of Ondo" is a green field port project consisting of an artificial island port proposed in front of the coastline of Ondo State. The artificial island Port design was selected based on a number of comparative analyses of which the muddy nature of the coastline is topmost. It would directly connect to a 2,771.2-ha free trade zone (FTZ) in which port related activities, industrial, commercial activities and an industrial city are planned. The location is considered the most central location for port development in the axis.

Additional expansion maybe required subject to demand growth in the cargo segments for which an area of 116 ha is available for future port expansion.

9.2.2 Location options

In general, the coastline is relatively similar throughout the state. It is characterized by mud beaches with a number of small creek outlets, rivers running parallel to the beach and some rivers connecting perpendicular to this coastal river originating from small lakes or wetlands. The mud along the coast is caused by these rivers through overflows after rainfall. Along the beaches several communities exist with their main living income sourced from fishery and some small farming. The lands of the free trade zone (FTZ) adjoining the Port is generally speaking not inhabited. There is no coastal road running parallel to the coast and transportation is mainly done by (wooden) boats along the rivers. The river is an important waterway for people living along the river and coastline.

Project Justification the Port of Ondo will be developed as a green field port, located along the coast of Ondo State. It aims to serve as a multi-purpose deep-sea port. The strategic positioning of the Port makes it economically viable. The market analysis, location analysis and design adopted to overcome the environmental site conditions are quite encouraging. It surely will open up Ondo State economically and ease the Apapa Port of the serious congestion. The Port of Ondo is located well to serve the middle of the country and will be the closest port to the Capital Abuja. It has existing road connections to the shore. The rate of return on investment on the project makes it a revolutionary turn around project to catapult the socio-economic life of the environment and Ondo state in general

9.3 Work Plan and Time Table of Activities

Site Verification exercise was carried out on 22nd November, 2019. Before the site verification, a courtesy visit was paid to Oba Fredrick Akinrutan, the Olu of Ugbo land to intimate him about the Deep-Sea Port project and our activities. The officials of ONDIPA, State and Federal Ministry of Environments accompanied the consultants and technical personnel of Jabridep Nigeria Limited to the field for the site verification exercise.

The Wet Season EIA Sampling was carried out between 22nd and 26th November, 2019 (Five Days). Navigational movement into the very deep area was impaired because of the unavailability of big vessel that would navigate and carry our personnel into the deep offshore area on the one hand, and the prevalent ocean tides when the survey was done.

1. The Screening and scoping that involved preliminary identification of environmental and social impacts by predicting the potential interactions between the project and the environmental and social receptors was done. The potential interactions were identified by cross-referring the project (i.e. construction works and operational activities) with the baseline conditions for the surrounding environment and social receptors.
2. The interactions and potential impacts were identified using a scoping matrix and, accordingly were scoped into or out of the EIA process as follows:
3. No identified interaction, so no impact – scoped out of the EIA process
   i. Identified interaction and potentially significant negative impact – scoped into the EIA process
   ii. Identified interaction and potentially significant positive impact – so scoped into the EIA process.
   iii. The Screening and Scoping exercise were done between 22nd and 26th November, 2019.
   iv. Stakeholders Meeting was held on the 19thFebuary, 2020 in Akure at the Dome.
   v. Risk Assessment of the Identified activities to be forwarded for OBC report end of March 2020 after dry season data collection.
   vi. Dry Season Sampling was undertaken in November 2019 and the rainy season sampling in March, 2020
   vii. Interim Draft Report is scheduled for submission by second week in April, 2020
   viii. Expert Review of the Report is scheduled for end of May, 2020
   ix. Final Report will be submitted by first week in June, 2020.

Plate 4.35 Government officials and consultants at stakeholders meeting

9.4 The objectives of the Stake Engagement Meeting and Plan (SEP) are;

The expanded stakeholders meeting was organized to ensure a hitch free environment for the implementation of the project and ensure that all stakeholders are well informed about the demands and impacts of the project when completed on them as mandated by law.

- The SEP seeks to define a technically and culturally appropriate approach to consultation and disclosure. The goal of this SEP is to improve and facilitate decision making and create an atmosphere of understanding that actively involves project- affected people and other stakeholders in a timely manner, and that these groups are provided sufficient opportunity to voice their opinions and concerns that may influence Project decisions. The SEP is a useful tool for managing communications between government and its stakeholders.

9.4.1 The stakeholder engagement requirements of Nigerian legislation demand that;

i. Provide guidance for stakeholder engagement such that it meets International Best Practice;
ii. Provide an all-inclusive developmental project and promote community participation
iii. Identify key stakeholders that are affected, and/or able to influence the Project and its activities;
iv. Identify the most effective methods and structures through which to disseminate project information, and to ensure regular, accessible, transparent and appropriate consultation;
v. Guide government/concessionaires to build mutually respectful, beneficial and lasting relationships with stakeholders;
vi. Develop a stakeholder's engagement process that provides stakeholders with an opportunity to influence project planning and design;
vii. Establish formal grievance/resolution mechanisms;
viii. Define roles and responsibilities for the implementation of the SEP;
ix. Define reporting and monitoring measures to ensure the effectiveness of the SEP and periodical reviews of the SEP based on findings and
x. Assist government/concessionaires with securing and maintaining a social license to operate throughout the life of the Project.

9.5 Overview of Stakeholder Engagement and Consultation

The concept we adopted

Stakeholder engagement is usually informed by a set of principles defining core values underpinning interactions with stakeholders. Common principles based on International Best Practice include the following

i. **Commitment** is demonstrated when the need to understand, engage and identify the community is recognised and acted upon early in the process;

ii. **Integrity** occurs when engagement is conducted in a manner that fosters mutual respect and trust;

iii. **Respect** is created when the rights, cultural beliefs, values and interests of stakeholders and neighbouring communities are recognised;

iv. **Transparency** is demonstrated when community concerns are responded to in a timely, open and effective manner;

v. **Inclusiveness** is achieved when broad participation is encouraged and supported by appropriate participation opportunities; and

Trust is achieved through open and meaningful dialogue that respects and upholds a community's beliefs, values and opinions
All these principles we adopted in our previous engagements and will continue to be adopted in future engagements.

Our engagement was devoid of manipulation, interference, coercion, and intimidation, and conducted on the basis of timely, relevant, understandable and accessible information, in a culturally appropriate format as seen (*See pictures in annexure* 2) in our encounter with the people in Olugbo's palace during our scooping and verification exercise's ONDIPA scheduled a larger meeting with over 700 persons in attendance as representatives from the various communities cutting across the various groups, women, youths, clubs, professional groups, community leaders etc. which was held on the 19th of February 2020 having given two months notification to enable them understudy the document. The long notice allowed for good interaction and identification of more groups in the various communities and provide stakeholders with the needed opportunity to raise their concerns and opinions and ensures that this information is taken into consideration when making project decisions.

ONDIPA is determined to develop a robust plan of engagement with the people and which will serve as a means of future engagement between Government, Port Operators and the stakeholders. The social license when adopted enhances the relationship, performance and of economic benefits.

Plate 4.36: Governor of Ondo Addressing Stakeholders at meeting

9.6 Stakeholder Analysis and Identification of Stakeholders

stakeholder analysis: the selection of stakeholders was handled by OSOPADEC and ONDIPA since they have a deeper understanding of the cultural relationship, local boundaries and political understanding of the terrain based on the following criteria namely extent of impact, extent of influence and the culturally acceptable engagement and information dissemination methods.

the construction of a deep-sea port in front of a free trade zone is a project that will completely transform the area culturally apart from the infrastructural transformation and population influx.

All engagement is based on culturally acceptable and appropriate methods for each of the different stakeholder groups. For example, government officials were consulted formally while public meetings were held with the various communities and informal focus group discussions was facilitated by posters, non-technical pamphlets etc. Different consultation methods were deployed in reaching out to each group.

Plate 4.37: Audiences at Stakeholders Meeting

We deployed some of the common methods used to consult stakeholders which includes (**See Tables 9.22 and 9.23**):

i. Phone/email;
ii. One-on-one interviews;
iii. Focus group discussions;
iv. Distribution of pamphlets and newsletters;
v. Public meetings; and
vi. Radio (Ondo state based)

Table 9.1: ENGAGEMENT TECHNIQUES

TECHNIQUE	METHOD
INFORMATION CENTER	ONDIPA SHALL SERVE AS THE INFORMATION CENTER AND INFORMATION BOARD SHALL BE INSTALLED IN EACH LOCAL GOVERNMENT SECRETARIAT AND KING'S PALACE FOR EFFECTIVE DISSEMINATION OF INFORMATION
CORRESPONDENCE BY PHONE/EMAIL/TEXT/MESSAGING	ONDIPA, OSOPADEC & JABRIDEP NIG LTD DISTRIBUTED PROJECT INFORMATION TO GOVERNMENT OFFICIALS, AGENCIES AND COMPANIES AND ALSO INVITED STAKEHOLDERS TO THE MEETING.
ONE-ONE INTERVIEWS	SSSS SOLICITED VIEWS AND OPINIONS. BUILT RELATIONSHIPS WITH STAKEHOLDERS AND CONDUCTED RECORDED INTERVIEWS
FORMAL MEETINGS/PUBLIC MEETINGS	HELD ON THE 19TH FEBRUARY WHERE PROJECT INFORMATION WAS PRESENTED TO ALL THE STAKEHOLDERS OF DIFFERENT GROUPS, INCLUDING THE MEDIA, CONSULTANTS, MINISTRY OF ENVIRONMENT OFFICIALS AT FEDERAL AND STATE LEVELS, NGOS TO HEAR THEIR VIEWS, DISTRIBUTE TECHNICAL DOCUMENTS, RECORD DISCUSSIONS AND DOCUMENT EVERY DOCUMENT AND QUESTIONS RAISED.
	PROJECT INFORMATION WAS DISCUSSED EXTENSIVELY AND THEIR VIEWS NOTED. (SEE VIDEO RECORDINGS) AND PROCESSED FOR INTEGRATION.
SURVEYS	PROVIDED STRUCTURED QUESTIONS FOR INFORMATION GATHER BASELINE DATA AND DEVELOP BASELINE DATA FOR MONITORING IMPACT

TABLE 9.2: THE STAKEHOLDERS CONSULTATION GROUP INCLUDES:

STAKEHOLDER GROUP	CONSULTATION METHODS
Government officials	• Phone / email / text messaging • One-on-one interviews • Formal meetings
Neighbouring Communities	• text messaging and radio announcements • Public meetings • Focus group meetings facilitated by OSOPASEC/ONDIPA • Surveys • Information Centre
Vulnerable Groups	• text messaging and radio announcements • Public meetings • Focus group meetings • Surveys • Information Centre
Employees and Managers	• Phone / fax / email / text messaging • Focus group meetings • Surveys
NGO's and Conservation organizations	• Phone / fax / email / text messaging • One-on-one interviews • Focus group meetings • Information Centre

This list of stakeholders is likely to expand/change in composition as the Project moves to design, construction operations. Additional stakeholder groups might include:

vii. Suppliers and businesses;
viii. Shareholders;
ix. Trade unions
x. Port Operators etc.

GOVERNMENT OFFICIALS

The Government of Nigeria regulates Environmental laws and construction of sea Ports are under the purview of the Federal Government through the Nigerian Port Authority. Approval for Port Construction is granted by the NPA.

Plate 4.38: The Olugbo and The Management of ONIDPA led by Mr. Oyewumi

The principal government departments that will be continuously consulted in the course of the project are;

i. Federal Ministry of Transport /Nigeria Port Authority.
ii. Nigeria inland Water ways Authority
iii. NIMASA
iv. Federal Ministry of Environment,
v. Federal Ministry of Water Resources.
vi. Nigeria Meteorological Agency
vii. Nigeria Institute of Oceanography
viii. Ecological Fund Office; Integrated coastal zone Management
ix. ONDIPA
x. Ondo state Ministry of Environment
xi. Ondo state Ministry of Health;
xii. Ondo state Ministry of TOWN Planning
xiii. Ondo state Ministry of Health
xiv. OSOPADEC/NDDC
xv. All local governments in the immediate project area.
xvi. Ministry of Culture;

Impacted communities

Emphasis for the stakeholders to participate is drawn from communities impacted directly or indirectly (positively or negatively) affected by the project through components of natural or social environment as a consequence of various aspects of the Deep-Sea project in varying degrees over its lifecycle

To ascertain which communities are impacted and the level of impact, the early studies have firstly established the area of influence of the Project. As such, the primary area of influence of the project is Ilaje and Ese Odo local government area, within which the proposed project will be located. Within this primary area of influence some communities will experience more direct impacts (positive and negative) as a consequence of their vicinity to the proposed project site, the haul road or because the community will act as the principal service center to the project and they are considered directly impacted. These communities are illustrated in the table below. Other villages and hamlets within the primary area of influence may also experience impacts (positive and negative), however to a lesser degree and the impacts will be predominantly indirect.

The following settlements have been identified as being directly affected within primary area of influence (**See Table 9.24**).

Table 9.3: List of Settlements Directly Affected

Name of Kingdom	Towns/villages	Component
Ode Ugbo kingdom	Eruna,Aiyetoro,Alagbon,Ogboti,Idiogba,Idogun,Kesumeta,Maran,Oloja,Olotu, Orioke Iwamimo, Oroto,SejaOdo,Yaye,Zion Pepe and several others listed in Appendix	Direct impact felt here for Port is located in Erunna/Ogboti
Ode Etikan	Agba Gana, Ago Apeja, Ago Bull, Ago Festus, Aiyetuntun,OdeETIKAN,Okonla	Communities in Ode Etika in Ilaje, along the coast line
Aheri	Ideghele, Mofehintokun, Enu - Ama,Ubalogun, Akata, Agerige Zion, Agerige Town	Aheri kingdom is within the coastal town
Igbotu kingdom	Igbotu, Iyara,Ogunmade, Onisosi, Zion, Yogha, Kurugbene, EBIDLO	Igbotu kingdom is also one of the coastal communities.
Okitipupa and its environs	All neigbbouring towns in Okitipupa LGA	About 37km from area of Primary Impact
Irele	All communities in Irele LGA especially because of the Bitumen deposits	About 45km from direct impact zone
Odigbo, Ondo, Ileoluji-Okeigbo LGA	The major towns will be impacted by the influx of population	All within the. The south senatorial belt of Ondo state
Edo, Delta, Lagos and Bayelsa states	Neighbouring states will be impacted	The major towns adjoining /sharing boundaries with project area.

Ilaje is a Local Government Area in Ondo State, Nigeria with headquarters in Igbokoda. It consists of over four hundred towns and villages, covering an area of 3,000 square kilometers. The list below lists some of the towns. It is covered by troughs and undulating low land surfaces. The extreme South is covered by silt, and mud and superficial sedimentary deposits.

There is sand formation at the Western part of the Local Government extending from the Lekki peninsula in Lagos State to Araromi Sea-side and Zion pepe, Agba to Etugbo and Ipare all, Mahin and Ugbonla the Eastern part of the Local Government Area can boast of the largest coconut plantation in West Africa. Ilaje Local Government is the largest local Government in Ondo State in terms of its landmass. According to the 1991 National Population Census, the Local Government is one of the most populated in Ondo State, with a population figure of two hundred and seventy seven thousand and thirty four (277,034) Ondo land area of 1,318 km² . it has a shoreline covering about 180 km thereby making State, a state with the longest coastline in Nigeria, Crude oil, which is the mainstay of the Nigerian economy. Traditionally, it is grouped into 8 kingdoms namely: Mahin land under His Royal Majesty, Amapetu of Mahin, Ugboland which is under His Royal Majesty Olugbo of Ugbo Kingdom. Aheri land under the Maporure and Etikan land under the Onikan of Etikan, Odonla land under the Alagho of Odonla, Obenla land under the Olubo of Obenla, Obe Ogbaro land under the Odoka of Obe Ogbaro, Igbokoda under the Olu of Iggbokoda and Igboegunrin under the Odede of Igboegunrin.

Towards the western reaches, the Aheri and Etikan share border with the Ijebus. The Ikale to the north bound the Mahins, the Itsekiri people who the Ilajes consider their cousins, share the eastern border with the Ugbos, the Yoruba speaking Apoi and Arogbo Ijaws are located to the north east in Ese Odo LGA, and the Atlantic Ocean is situated on the southern boundary. The Ilajes are one of the most dynamic and enterprising people in Nigeria. Their aquatic skill, coupled with their ability to adapt enabled them to conquer their harsh geographical environment and turn it to their advantage. Consequently, they were able to build large communities like Ugbonla, Aiyetoro, Zion PePe and Orioke.

9.7 NGO AND CONSERVATIVE ASSOCIATIONS

NGO and Conservation organisations which have been identified include:-

- Association of Environmental Impacts of Nigeria AEIAN with a strong social media presence on social media
- Nigeria Environmental Conservation Organisation (NECOR)
- Gender Equality and the girl Development
- Guarantee Environment on water, sanitation and Hygiene and several others yet to be identified.

Project Personnel

We ensure that ONDIPA working in collaboration with OSOPADEC enhances their Community Relations Unit to manage stakeholder consultation, address grievances, and implement community development programmes to minimize any residual potential impacts identified in the ESIA study.

We recommend that employees of ONDIPA and in particular the Corporate Services Department are included in the consultation and engagement processes from the on-set. A solid foundation is important in guaranteeing an excellent consultative process recommended in the ESIA

Vulnerable Groups

The vulnerable groups within the Project area are mainly women and youths ~~are~~ identified during the scoping phase for participation. However, as the project progress more vulnerable groups should be expanded and further grouped into categories of elderly, youth, women, unemployed. Attendance will be encouraged at consultation meetings and certain additional measures will be put in place to encourage participation (**See Table 9.25**).

Table 9.4: Consultation methods recommended for vulnerable groups

Category	Organization	Leader	Method of consultation
Elderly	Pensioners & Home for the elderly		Focus Group meetings: Assisted transport to meetings
Women	Women associations		Additional Focus Group meetings
Youth	Youth associations		Additional Focus Group meetings
Disabilities			Focus Group meetings: Assisted transport to meetings

STAKEHOLDER REGISTER

Jabridep Nig Ltd on behalf of ONDIPA created a stakeholder register which recorded all stakeholders, contact details, dates of engagement. The minutes of the stakeholders meeting and register are included in the annexure.

9.8 Stakeholder Engagement Approach Engagement Phases

Stakeholder engagement within the ESIA process is critical for supporting the project's risk management process, specifically the early identification and avoidance/management of potential impacts (negative and positive) and cost-effective projected sign.

Stakeholder engagement is an on-going process throughout the ESIA and there are three phases relevant to the Deep-sea Port Project

- ESIA Baseline Engagement Phase;
- ESIAD is closure & Consultation Phase; and,
- On-going engagement after the ESIA disclosure process is complete and throughout the project lifecycle.

9.8.1 ESIA Baseline Engagement Phase

During the ESIA baseline field work the focus of engagement was ~~is~~ primarily on gathering information and opinions from stakeholders. Our Engagement activities included interviews with some stakeholder representatives (informal leaders) and key information organizations (communities, authorities,)

Objectives of the ESIA are to:

Establish the Project to the Stakeholders.

- Establish the existing baseline conditions of the environmental and social receptors and resources that could be affected by the Project.
- Document the engagement with stakeholders-including the Government of Ondo State and its Ministries, non-governmental organization (NGOs), the local community and the public- and address the comments received from stakeholders.
- Assess the environmental and social impacts associated with the Project – including both positive and negative impacts- including the prediction and determination of significant impacts, evaluation of alternatives.
- Identify and recommend/design appropriate mitigation measures to mitigate significant negative impacts such that residual impacts are acceptable.
- Develop mitigation measures and monitoring requirements, including the development of an Environmental Mitigation and Monitoring Plan (EMMP), and supporting thematic management plans.

9.8.2 ESIAD is closure & Consultation Phase

This second phase of engagement focuses on disclosing and consulting on the draft results of the ESIA process. Within the overarching ESIA engagement objectives, the specific objectives for the draft ESIA phase of engagement are to:

Provide feedback to the stakeholders on the draft impact assessment and associated management/mitigation measures (disclosure) and gather stakeholders input on the initial impact assessment and identified mitigation and enhancement measures (consultation).

This phase of engagement took place on the 19th of February 2020 prior to the finalization of the ESIA Package Report.

During this engagement phase, the stakeholders were engaged by disclosing all available information's on the project having widely consulted and proactively publicised, among affected communities, at least 2-3weeks prior to the meeting;

The non-technical summary was accessible prior to the event to ensure that people are informed of the assessment content and conclusions in advance of the meeting;

The location and timing of the meeting is designed to maximise accessibility to project affected stakeholders;

Information presented was clear, simple and non-technical, presented was complemented with translation in the local language understood by those in the communities;

Facilitation was provided to ensure that stakeholders were able to raise their concerns; and Issues raised are answered at the meeting and will be actively followed up.

Feedback forms are distributed and will accompany all the disclosure documentation. Comments was either placed in a confidential comment box in the Info centre or sent/emailed to jabridep.nig.ltd@gmail.com.

Ongoing Engagement or continuous engagement would be encouraged as a path for ONDIPA to tow in the life of the project for conflict free community participation by establishing a community forum that will comprise community representatives, and aims to disseminate project information to community members.

9.8.3 POST ESIA DISCLOSURE, ON-GOING CONSULTATION AND DISCLOSURE

The SEP is a living document that will be refined and modified throughout the life of the Project. During this iterative process the focus and scope of the SEP will shift somewhat in response to changing engagement needs and priorities for the Project, and as such the SEP will be updated to reflect the objectives of the ESIA process in order to meet the challenges of Port construction life requirements.

The key elements to be considered when implementing stakeholder engagement during the Project's lifecycle areas follows; a consultant should be engaged by ONDIPA to ensure that:

i. The existing relationships with stakeholders are maintained
ii. Maintain ONDIPA's social license to operate;
iii. Assist ONDIPA with implementing environmental and social management plans; and
iv. Assist ONDIPA with monitoring and managing environmental and social impacts. This will be achieved by setting up a community liaison team and Local consultative Forum.

9.9 STAKEHOLDER ENGAGEMENT ACTIVITIES

The scoping phase took place between17thandthe 25th of November 2019. The team consisted of 22 scoping consultants, translator and officials of government both at Federal and State Ministry of Environment officials, OSOPADEC representatives and community representatives

The objectives of the scoping phase were to:

* To verify the range of social impacts and issues (risks and opportunities)

relevant to the Deep-sea port project

* To identify and verify stakeholders relevant to the Project.

We consulted widely through literature review on past projects and direct visitation to majority of the communities. We reviewed previous projects and utilized goggle map to identify hamlets and villages which are potentially directly and indirectly affected. Using this, the scoping team visited a number of the places and undertook consultations with stakeholders residing in these villages and hamlets (**See Table 9.26**).

Table 9.5: Issues and questions raised during the Scoping Consultation		
Issue	**Sub issue as perceived by potentially affected Population**	**Questions/comments from stakeholders**
Employment	Lack of job opportunities in the area and earnestly hope the construction of a Sea Port will not annihilate their fishing job or ability to compete	People in the area are in desperate need of employment opportunities. There is rural–urban migration away from the area as well as migration out of the Local government to neighboring Local governments and the state capital for job opportunities.
Environment	The environment al quality is described as poor at present.	There is a good understanding of potential environmental impact sea port as shown in our report.
Water quality (wells and surface water.	Pollution of water sources used for drinking. The water bodies are also very polluted. No pipe borne water in the area	Water quality will potentially be affected by the project.
Air quality	Gaseous missions	The air quality is excellent, however there is the need for air quality monitoring as a result of the movement of ships and increased activities. Project goes a head this may be affected

Project Information Dissemination	Information about the project is averagely disseminated, however more work is yet to be done to communicate with the locals, especially women in particular, women, are not Receiving sufficient information about the purport project. Some potentially affected communities are oblivion of the planned project	When asked what residents in the potentially affected communities near the Deep-sea Port site knew about the project, they responded that they knew very little and where lying on second hand information or from observing activities to date from 'strangers "they observe in their localities.
Pollution	The consequences of such project will generate different kinds of man induced pollution	People have fears that toxic substances will be produced that will affect environmental quality Fishermen and women fear that their fishing operations will be negatively impacted.
Road safety	Road traffic density becomes high, so also noise level	What safety measures will be put in place?
Culture & Heritage	Impacting structure of dwellings	Relocation and re-settlement have serious impacts on the people
Population and Diversity	The influx of people into the area with different mind sets	The area has always been a fishing destination dominantly.

9.9.1 MONITORING AND EVALUATION, AND REPORTING MONITORING AND EVALUATION ONDIPA WILL MAINTAIN A DATA BASE AND ACTIVITY FILE DETAILING ALL PUBLIC CONSULTATION, DISCLOSURE INFORMATION AND GRIEVANCES COLLECTED THROUGHOUT THE PROJECT, WHICH WILL BE AVAILABLE FOR PUBLIC REVIEW ON REQUEST.

Stakeholder engagement would be periodically evaluated by senior management of ONDIPA, assisted by the CLSO/community liaison senior officer. The following indicators will be used for evaluation:

i. Level of understanding of the project stakeholders;
ii. Annual grievances received and how they have been addressed; and
iii. Level of involvement of affected people in committees and joint activities and in the project itself.

In order to measure these indicators, the following data will be used:

i. Issues and management responses linked to minutes of meetings;
ii. Monthly reports;
iii. Feedback from primary stakeholder groups (through interviews with sample of affected people);
iv. Commitment and concerns register and
v. Grievance register.

9.9.2 REPORTING

Monthly Reports

The CLSO will prepare brief monthly reports on stakeholder engagement activities for the Operations Director, which include:

i. Activities conducted during each month;
ii. Public outreach activities (meetings with stakeholders and newsletters);
iii. Entries to the grievance register;
iv. Entries to the commitment and concerns register;
v. Number of visitations to the information Centre;
vi. Progress on partnership and other social projects;
vii. New stakeholder groups (where relevant);and
viii. Plans for the next month and longer-term plans.

Monthly reports will be used to develop annual reports reviewed by senior managers at ONDIPA

9.9.3 Stakeholder and Community Engagement Program

The development of the Ondo State Deep-Sea Project includes community and stakeholder engagement with local area residents and businesses, to confirm project objectives and planning information, identify stakeholder interests, and obtain feedback to assist in potential refinements of project design.

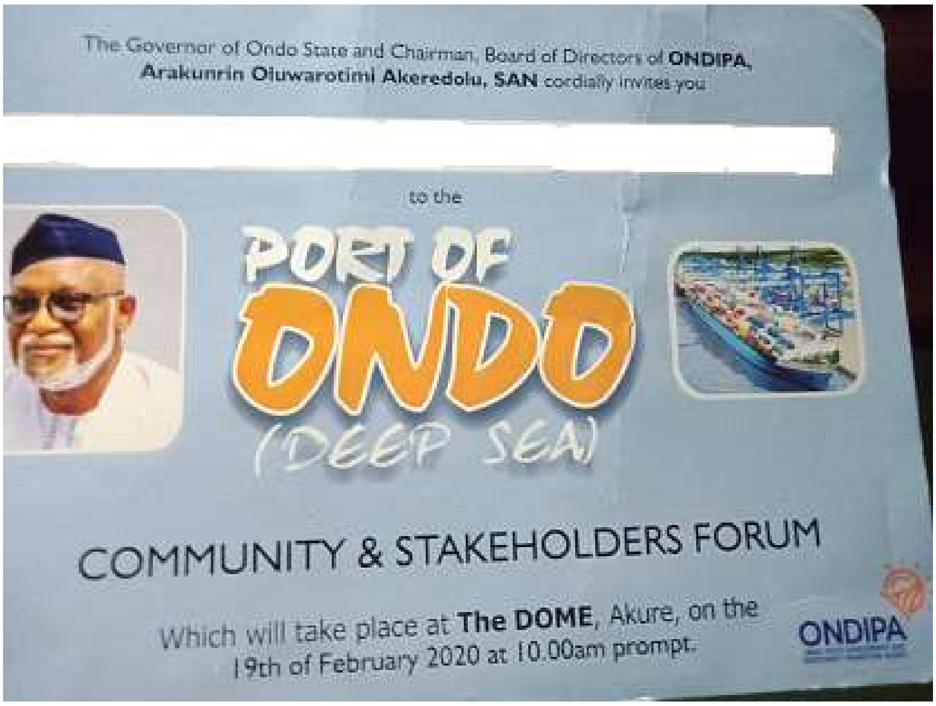
9.9.4 Approach and Methodology

As part of the project, Stakeholder mapping was undertaken. On the basis of this mapping, key stakeholders were selected for interviews and others invited to participate in the Stakeholder engagement workshops.

Between November 2019 and March 2020, Jabridep Nigeria Limited Project Team met with the community and those who represent the interests of communities adjacent to the project area. Several organizations were invited to participate in stakeholder engagement activities. Four meetings were held with representatives from community and a number of follow up meetings have also been planned. Representatives of the Federal Ministry of Environment and Ondo State Ministry of Environment were in attendance at each meeting and provided a brief presentation on the project, including design and timeline, followed by general questions and answers.

Stakeholder forum meeting was held on 19th February, 2020 at the DOME event, Akure, Ondo State. The event was chaired by Ondo State Governor, Arakunrin Oluwarotimi Akeredolu, **SAN**, and co-chaired by the Deputy Governor of Ondo State. The representative of the Federal Ministry of Environment, Ondo State Ministry of Environment, Federal Director of Environment, ONDIPA, Commissioner of Environment, Ondo State, and local Government and State officials.

Plate 4.39: Invitation to stakeholders meeting



As we envision, the stakeholder forum engage representatives of the cluster five distinct kingdoms: UGBO KIGDOM, MAHIN KINGDOM, ETIKAN KINGDOM, AHERI KINGDOM and IGBOTU that s comprising of the following towns, villages and harmlets: **UPLAND :** Ugbo and Ugbonla, and **SEA SIDE:** Eruna Ado, Eruna Asuku, Eruna Ero, Abe Okun Ipin, Olotu Temuhi, Olotu Kwo, Olotu – Yara, Olutu Niyi, Yaye, Ojabineni, Womitere. Ogboti, Lepe, Ayadi, Idiogun, Zion -Ehimoren, Ehimoren, Aiyetoro.

Three categories of stakeholders as given below were identified during the scoping and initial community engagement meetings:

i. The Primary stakeholders –Those who are directly impacted within the community;
ii. The secondary stakeholders – the neighboring villages in the upstream and downstream;
iii. The Tertiary stakeholders –Those outside the village but whose plans influence the Deep-Sea Port, service providers eg NGOs, the government officials at the local, State and Federal levels.

Five members of each community, community leaders and interest groups were sponsored by the EIA Consultant, Jabridep Nigeria Limited, ONDIPA and Ondo State Government to the Stakeholders meeting that took place in Akure.

Also, all the major paramount rulers in all the Ilaje communities, community heads, Baales and youth leaders were arranged according to their influence: High influence, medium influence and low influence.

This session elicited an active discussion among all the participants at the Stakeholders forum meeting.

Following the general introduction, the objective of the Deep-Sea project was presented to the participants, who did agree that it was a subject that was important to all.

The Stakeholders forum meeting commenced at 9am with National anthem. The event came to an end at 4pm.

PROGRAM OF EVENTS

1. Arrival of Participants
2. National Anthem
3. Opening Prayer
4. Introduction of Guests
5. Governors speech : Opening the Session
6. Goodwill message from the Federal Ministry of Environment
7. Presentation of overview of project by the CEO of ONDIPA
8. Comments by stakeholders
9. Communiqué
10. Vote of thanks
11. Closing Prayer

Plate 4.40 Pprogramme of invent

9.9.5 Key Theme Summary

Through an iterative process that spans over four hours; the summary of key theme that emerged from the jointly issued communiqué that attended the Stakeholders meetings is:

i. **Project Support** – The majority of the community, port tenants, NGOs, Political groups, women groups indicated general support for the development of the Deep-Sea project as presented by the Governor of Ondo State.

ii. At the end the stakeholders meeting, there was a general agreement by all stakeholders present that the proposed Ondo State Deep-Sea Project should be embark upon for the economic benefit of the State.

iii. The stakeholders further agree that there is a need for a strategic and targeted approach to be engage by the Ondo State Government for the development of the proposed Deep-Sea Port.

iv. See the appendix for the communique.

CHAPTER TEN

CONCLUSIONS AND RECOMMENDATIONS

The proposed Deep-Sea development project in Ondo State of Nigeria by the Ondo State Development and Investment Promotion Agency (ONDIPA) is planned with due regards to the EIA decree No 86 of 1992. The project will be of immense economic and socio-cultural benefits including job creation, man power development and reduced youth restiveness in the project area.

Based on this EIA study it has been predicted that the Project will have minimal adverse environmental effects on the majority of receptors. Analyses of project- level design and planning of engineering and procedural mitigation measures have resulted in the minimization and avoidance of potential negative impacts over the lifetime of the Project. As the table illustrates, following mitigation, there are no impacts greater than minor adverse significance are predicted. As per the definition of significances used, in the majority of adverse impacts are expected to be small scale and of little concern, being undesirable but acceptable. A number of beneficial impacts have also been identified, including some major beneficial impacts which are defined as being large scale and providing a significant positive gain to the environment. The identified associated and potential impacts of the project are due mainly to increased noise and effluent discharge which will occur mainly during site preparation and construction phase of the project. All the significant adverse impacts can be reduced to insignificant level with the mitigation measures proposed for the project. An environmental management plan (EMP) to guarantee effective mitigations, environmental audit, monitoring and staff training will be put in place.

The project option adopted is very sound and the most acceptable of all the alternatives considered. All the elements of the option are in line with best engineering practice. The scope of the EIA study, its overall study approach and the methodologies of the specific investigations involved are all in line with national and international standards and regulatory requirements. Data gathering was based on desktop research, consultation with stakeholders and field survey.

It was established through stakeholders meeting that the entire communities where the project will be sited are favorably disposed to the proposed project in view of it associated good benefits.

On the whole, the need for the project is justified and it is sustainable economically, technologically and environmentally.

10.0 Recommendation

It is recommended that the Ondo State Development and Investment Promotion Agency (ONDIPA) ensure strict compliance with all of the mitigation and monitoring requirements provided in this EIA Report.

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ISO 14004 Environmental management systems - General guidelines on implementation

ISO 14005 Environmental management systems - Guidelines for a flexible approach to phased implementation

ISO 14006 Environmental management systems - Guidelines for incorporating ecodesign

ISO 14015 Environmental management - Environmental assessment of sites and organizations (EASO)

ISO 14020 to 14025 Environmental labels and declarations

ISO/NP 14030 Green bonds -- Environmental performance of nominated projects and assets; discusses post-production environmental assessment

ISO 14031 Environmental management - Environmental performance evaluation - Guidelines

ISO 14040 to 14049 Environmental management - Life cycle assessment; discusses pre-production planning and environment goal setting

ISO 14050 Environmental management - Vocabulary; terms and definitions

ISO/TR 14062 Environmental management - Integrating environmental aspects into product design and development

ISO 14063 Environmental management - Environmental communication - Guidelines and examples

ISO 14064 Greenhouse gases; measuring, quantifying, and reducing greenhouse gas emissions

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APPENDIX A

ENVIRONMENTAL BASELINE STUDIES FOR THE ONDO STATE DEEP-SEA PORT QUESTIONNAIRE FOR SOCIO-ECONOMIC AND HEALTH STUDY Check List/Key Informant Interview

1 (a) **Name of Community/Area:**……………..

(b) **Population:**…………………………………..

2. **Settlement Pattern:** Size……… Topography. …………………Layout…………….

3. **Presence of Infrastructures within 5 km radius**- viz:- Market ( ) School: Primary, Secondary, Vocational, Quaranic ( ), Hospital or Health Centre ( ) Mosque ( ), Church ( ), Motorable road ( ), Foot path ( ) Potable water ( ), Recreation Areas ( ), etc.

4. **Migration Pattern, Cultural Ties and Local Administration**:

………

………

………

……..

5. **Major Occupation of People (and extent of Involvement):** ……………………………………

Adult Male: ……………………………………………………………………………….

Adult Female: ………………………………………………………………………….

Children: ……………………………………………………………………………….

6. **Other Occupations:** ………………………………………………………………….

7. **Extent of Cropping Season:** ……….. **From** …………….. **To**…………

8. **Types of Crops Grown:**

Major ………………………………………….**Minor**…………………………

9. **Farms Sizes:** ………………. **Number of Plots** …………………….

10. **Off-Season Occupation:**

Adult Male: ……………………………………………………

Adult Female: …………………………………………………

Children: ……………………………………………………

11. Average Income:

On-Season	**Off Season**
Adult Male	Adult Male ....
Adult Female	Adult Female ....
Children...............................	Children..................................

12. Sources of water to the Community:

(1) Drinking: ____

(2) Other Household uses (cooking, washing, bathing, etc0:__________________

(3) Livestock:____

13. Dominant Religion: ____

14. Other Religions: :____

15. Marketing of Products:

(1) Distance to Local Market: :____

(2) Frequency of Market days: :____

(3) General Organization/Control of market: :_____________________________

16. Public Health:

(1) Common Diseases (List): :____

(2) Available Orthodox Health Institutions:______________________________

(3) Available Traditional Health Institutions:______________________________

(4) Distance to nearest (Govt or Private) Clinic/Hospital: _________________

(5) Collection of Herbs from Local forest Yes/No

17. Major Means of Transportation:

Human beings: ____

Farm Products: ____

Others (Industrial Goods): ____________________________________

18. Amenity and Recreation:

(1) Parks: _______________________________________

(2) Hunting: _____________________________________

(3) Fishing/Farming: ______________________________

(4) Others (Specify): ______________________________

19. Land Conflict between People in the Area/Community:

Date: ____

Nature/Extent of Conflict: ____

How Resolved: ____

20. Livestock Raised:

Type	**Average Flock Size**
Cattle	____
Sheep	____
Goats	____
Poultry	____
Pigs	____
Fish	____
Others	____

21. Staple Food (Items/Preparations): ________________________________

22. Vegetable Sources: Grown ___________ Wild __________ (Give examples)

23. Household Protein Sources:

Cattle ________Sheep/Goats _______ Fish ______ Bush Meat(Hunting)________

Poultry & Eggs __________ Soybean/G'nut ____________Others__________

24. Finance

Membership of CO-OP Societies _______________________________________

Membership of Community Development Associations______________________

Services rendered to members ____

25. Do you use any of these on your Farm?

(a) Fertilizer (b) Herbicides/Pesticides (c) Improved Seeds

(d) Soil Conservations Method: (i) Traditional (ii) Modern

(e) Storage Facilities: (i) Traditional (ii) Modern

26. Disposal of Household and Human Wastes

(a) Burning (b) Burying (c) Just throw into bush

(d) Dump into stream and ponds (e) Organic manure thorough compositing.

(f) Paid Refuse Collectors (g) Pit Latrine/Water System (h) Others

27. **Do you eat Fish or Fish Products?:** Yes/No

28. **If Yes, from what Source(s)?**

(a) Fishing in streams and ponds (b) Fish Culture/Fish farms around

(c) Local Markets (d) Far Markets

29. **Which Type(s) of Fish do you like?**

(a) Fresh Fish (b) Smoked Fish (e) Sun dried Fish

(d) Frozen Fish (e) Fried Fish (f) Others (specify)

30. **If you fish in Streams or Ponds, which method(s) do you use?**

(a) Hook and line __________ (b) Gill Nets ___________ (c) Chemicals __________

(d) Baskets_____________ (e) Traps ______________ (f) Others ____________

31. **State the Advantages you are expecting from the proposed Water Project:**

(a) Drinking Water ___________ (b) Employment Opportunities________

(c) Recreation_________________ (d) Business Opportunities____________

(e) Clean Environment __________ (f) Government Goodwill____________

(g) Others (Specify) _____________

32. **State the Disadvantages Likely to Occur**

(a) Loss of farmland/buildings on distribution routes _________________________

(b) Loss of forest products (e.g. wild fruits, vegetables and herbs) _____________

(c) Loss of Business opportunities (Please Specify) ___________________________

(d) Loss of Income _________________________

(e) Environmental Pollution _________________

(f) Others (specify) _________________________

APPENDIX B

DRY SEASON (NOVEMBER, 2019)

SITE MEETING WITH THE CONSULTANTS AND PROJECT TEAM MEMBERS

SCOPING




SITE VERIFICATION






WATER AND HYDROLOGY




WILDLIFE AND FISHERIES

MAGNETIC AND OCEAN BOTTOM CREW MEMBERS


SURVEY CREW MEMBERS




SOIL AND LAND USE


NOISE AND AIR QUALITY

SOCIO-ECONOMIC AND HEALTH


VEGETATION

RAINY SEASON (MARCH, 2020)

Project supervisor passing instructions to workers

Local Ferry conveying EIA workers

Unloading equipment to be used for the survey

Aiyetoro Waterside

Supervisor giving instructions to workers on how the survey would be carried out

FISHERIES AND WILDLIFE

SOCIO-ECONOMICS AND HOUSING

Aerial view of Aiyetoro community

Some pupils of Aiyetoro community

EIA Team Group meeting Government Recognized King, Dr. Mican Olaseni Ajijo of Ayetoro

The King and the chiefs in the Ayetoro community

Supervisor explaining the scope of work of the EIA team to the King

The EIA team with the King and the Queen

EIA supervisor explaining scope of work to the King of Ayetoro EIA team with the King and some of the leaders in the community

Supervisor with the King and the Leaders in the Ayetoro community

Youth Leaders of the Ayetoro community

SEA WATER AND SEDIMENT SAMPLIING

NOISE AND VIBRATION

VEGETATION

STAKEHOLDERS ENGAGEMENT MEETING

HYDROLOGY AND SOIL SCIENCE SECTION
CENTRAL SCIENCE LABORATORY
OBAFEMI AWOLOWO UNIVERSITY
ILE-IFE, NIGERIA

Certificate of Analysis

This is to certify that the analyses of TWENTY WATER SAMPLES AND SEDIMENT SAMPLES submitted by Jabridep Nigeria Limited for their physico-chemical properties and microbial contents were carried out in our Laboratory between 28th November, 2019 and 30th December, 2019.

Standard methods approved by the Nigerian regulators, and the Federal Ministry of Environment were used for laboratory analyses of water and sediment samples (See Table 1).

Table 1: Laboratory analytical methods used for water and Sediment Analysis

Parameter	Unit	Method
pH (H_2O)		ASTM D4972
Turbidity	(NTU)	APHA 214
Salinity	$^0/_{00}$	API-RP 45
Total Dissolved Solids	(mg/L)	APHA 209C
Total Solids	(mg/L)	APHA 209D
TSS	(mg/L)	APHA 209D
Electrical Conductivity	(µS/cm)	APHA 209
Bicarbonate	(mg/L)	API-RP 45
Alkalinity	(mg/L)	APHA 2320-ALKALINITY-B
Acidity	(mg/L)	APHA 2310 B
Ammoniac Nitrogen	(mg/L)	EPA 350.2
THC	(mg/L)	APR – RP 45
Nitrite	(mg/L)	EPA 354.1
Chloride	(mg/L)	APHA 4500-Cl-
Sulphate	(mg/L)	EPA 375.4
Total Phosphorous	Ppm	APHA 4500
P0 43- Calcium	Ppm	APHA 3111
Magnesium	Ppm	APHA 3111/ASTM D3561
Potassium	Ppm	APHA 3111/ASTM D3561
Cadmium	Ppm	APHA 3111
Chromium	Ppm	APHA 3111
Lead	Ppm	APHA 3111
Manganese	Ppm	APHA 3111
Iron	Ppm	APHA 3111
Copper	Ppm	APHA 3111
Zinc	Ppm	APHA 3111
PCB	ppb	EPA 625

CENTRAL SCIENCE LABORATORY
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04 DEC 2019

Dideola Stephen Olabanji. A. O, Ph.D
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HYDROLOGY AND SOIL SCIENCE SECTION
CENTRAL SCIENCE LABORATORY
OBAFEMI AWOLOWO UNIVERSITY
ILE-IFE, NIGERIA

Certificate of Analysis

This is to certify that the analyses of TWENTY WATER SAMPLES AND SEDIMENT SAMPLES submitted by Jabridep Nigeria Limited for their physico-chemical properties and microbial contents were carried out in our Laboratory between 9th March, 2020 and 23rd March, 2020.

Standard methods approved by the Nigerian regulators, and the Federal Ministry of Environment were used for laboratory analyses of water and sediment samples (See Table 1).

Table 1: Laboratory analytical methods used for water and Sediment Analysis

Parameter	Unit	Method
pH (H_2O)		ASTM D4972
Turbidity	(NTU)	APHA 214
Salinity	$^0/_{00}$	API-RP 45
Total Dissolved Solids	(mg/L)	APHA 209C
Total Solids	(mg/L)	APHA 209D
TSS	(mg/L)	APHA 209D
Electrical Conductivity	(μS/cm)	APHA 209
Bicarbonate	(mg/L)	API-RP 45
Alkalinity	(mg/L)	APHA 2320-ALKALINITY-B
Acidity	(mg/L)	APHA 2310 B
Ammoniac Nitrogen	(mg/L)	EPA 350.2
THC	(mg/L)	APR – RP 45
Nitrite	(mg/L)	EPA 354.1
Chloride	(mg/L)	APHA 4500 Cl-
Sulphate	(mg/L)	EPA 375.4
Total Phosphorous	Ppm	APHA 4500
P0 43- Calcium	Ppm	APHA 3111
Magnesium	Ppm	APHA 3111/ASTM D3561
Potassium	Ppm	APHA 3111/ASTM D3561
Cadmium	Ppm	APHA 3111
Chromium	Ppm	APHA 3111
Lead	Ppm	APHA 3111
Manganese	Ppm	APHA 3111
Iron	Ppm	APHA 3111
Copper	Ppm	APHA 3111
Zinc	Ppm	APHA 3111
PCB	ppb	EPA 625

CENTRAL SCIENCE LABORATORY
OBAFEMI AWOLOWO UNIVERSITY
ILE-IFE, OSUN-STATE, NIGERIA
23 MAR 2020

Dideola Stephen Olabanji. A. O, Ph.D
Laboratory Technical Manager
08067163658

Page 1 of 1

HYDROLOGY AND SOIL SCIENCE SECTION
CENTRAL SCIENCE LABORATORY
OBAFEMI AWOLOWO UNIVERSITY
ILE-IFE, NIGERIA

Certificate of Analysis

This is to certify that the analyses of TWENTY WATER SAMPLES AND SEDIMENT SAMPLES submitted by Jabridep Nigeria Limited for their physico-chemical properties and microbial contents were carried out in our Laboratory between 9th March, 2020 and 23rd March, 2020.

Standard methods approved by the Nigerian regulators, and the Federal Ministry of Environment were used for laboratory analyses of water and sediment samples (See Table 1).

Table 1: Laboratory analytical methods used for water and Sediment Analysis

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Iron	Ppm	APHA 3111
Copper	Ppm	APHA 3111
Zinc	Ppm	APHA 3111
PCB	ppb	EPA 625

CENTRAL SCIENCE LABORATORY
OBAFEMI AWOLOWO UNIVERSITY
ILE-IFE, OSUN STATE, NIGERIA
23 MAR 2020

Dideola Stephen Olabanji. A. O, Ph.D
Laboratory Technical Manager
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AGEO

AUTOMATED GEOTECHNICS LIMITED

Plot 13, Block J, Otunba Jobifele way,
Central Business District,
Ikeja, Lagos, Nigeria

Telephone: 08033851254

CERTIFICATE OF ANALYSIS
(WATER AND SEDIMENTS)

We received 40 samples on 27th November, 2019 for analysis in our laboratory in Lagos from Jabridep Nigeria Limited for physiochemical properties and microbial contents analyses.

The analyses were performed in our laboratory between 28/11/2019 and 30/12/2019 using approved standard procedures of the Federal Ministry of Environment.

All results obtained were verified and approved by me. Should this analyses report require incorporation into client reports, it must be used in its entirety.

AUTOMATED GEOTECHNICS LTD
30 DEC 2019
SIGN

Mr. Makinde J. A.

30th December, 2019

Ref No: JAB/11/2019

AUTOMATED GEOTECHNICS LIMITED

Plot 13, Block J, Otunba Jobifele way,
Central Business District,
Ikeja, Lagos, Nigeria

Telephone: *08033851254*

CERTIFICATE OF ANALYSIS
(WATER AND SEDIMENTS)

[illegible] th March, 2020 for analysis in our laboratory in Lagos from Jabridep Nigeria Limited for physiochemical pr operties and microbial contents analyses.

The analyses were performed in our laboratory between 09/03/2020 and 23/03/2020 using approved standard procedures of the Federal Ministry of Environment.

All results obtained were verified and approved by me. Should this analyses report require incorporat ion into client reports, it must be used in its entirety.

AUTOMATED GEOTECHNICS LTD ... 10, OLABIRO STR: IKEJA, LAGOS

Mr. Makinde J. A.
23rd March, 2020

JAN/23/2020

Ref No:.......

AUTOMATED GEOTECHNICS LTD
2 C MAR 2020
SIGN...
10, OLABIRO STR: IKEJA, LAGOS

Tudaka Environmental Consultants Limited
Environmental Quaity Monitoring Services
1, Onorji Street, Off Hospital Road,
Back if Canewood Hotel,
Ekpan, Delta State.

CERTIFICATE OF ANALYSIS FOR WATER AND SEDIMENT SAMPLES

TUDAKA ENVIRONMENTAL CONSULTANTS LTD
1, ONORJI STR; OFF HOSPITAL ROAD, EKPAN, WARRI, DELTA STATE
30 DEC 2019
SIGN

TUDAKA ENVIRONMENTAL CONSULTANTS LIMITED

TUDAKA ENVIRONMENTAL
CONSULTANTS LIMITED

DATE:	3/1/2020
CUSTOMER:	JABRIDEP NIGERIA LIMITED, ABUJA
JOB NUMBER:	0056
NUMBER OF SAMPLES:	40
REPORT NO:	0-JABRIDEP-TENV-BTB
SAMPLES RECEIVED:	DECEMBER, 28, 2019
ANALYSIS PERIOD:	30 DAYS

CERTIFICATE OF ANALYSIS

All chemical and microbial tests were performed at Tudaka Environmental Consultants Limited Laboratory, Ekpan, Delta State in accordance with the **Standard methods approved by the Nigerian regulators for water and sediments.**

The results were verified and approved by me.

TUDAKA ENVIRONMENTAL
CONSULTANTS LTD
1, ONORJI STR: OFF HOSPITAL ROAD,
EKPAN, ... STATE
30 DEC 2019

Ejiro Oghale

Laboratory Manager

Tudaka Environmental Consultants Limited
Environmental Quaity Monitoring Services
1, Onorji Street, Off Hospital Road,
Back if Canewood Hotel,
Ekpan, Delta State.

CERTIFICATE OF ANALYSIS FOR WATER AND SEDIMENT SAMPLES

TUDAKA ENVIRONMENTAL CONSULTANTS LTD
1, ONORJI STR; OFF HOSPITAL ROAD,
EKPAN, WARRI, DELTA STATE
23 MAR 2020
SIGN

TUDAKA ENVIRONMENTAL
CONSULTANTS LIMITED

TUDAKA ENVIRONMENTAL CONSULTANTS LIMITED

DATE:	23/03/2020
CUSTOMER:	JABRIDEP NIGERIA LIMITED, ABUJA
JOB NUMBER:	0056
NUMBER OF SAMPLES:	40
REPORT NO:	0-JABRIDEP-TENV-BTB
SAMPLES RECEIVED:	9TH MARCH, 2020
ANALYSIS PERIOD:	14 DAYS

CERTIFICATE OF ANALYSIS

ĂŧĨĶĻĿŢ and microbial tests were performed at Tudaka Environmental Consultants Limited Laboratory, Ekpan , Delta State in accordance with the ĒŎandard methods approved by the Nigerian regulators for water and sediments.

The results were verified and approved by me.

TUDAKA ENVIRONMENTAL CONSULTANTS LTD
1, ONORJI STR; OFF HOSPITAL ROAD, EKPAN, WARRI, DELTA STATE
23 MAR 2020
SIGN

Ejiro Oghale

Laboratory Manager

ANNEXURE 2

PICTURES OF THE INSTRUMENT USED FOR THE CHEMICAL AND MICROBIAL ANALYSIS


SpectrAA


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Plate 3.15: Building built with raffia palm pole in the Study Area

Plate 3.16: Dwelling Unit Built with Wooden Plank in the Study Area

Plate 3.17: Typical toilet used by coastal dwellers in the study area