The Shell Petroleum Development Company of Nigeria Limited Operator for the NNPC/Shell/NAOC/TEPNG

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF AGBADA NON ASSOCIATED GAS (NAG) PROJECT IN OBIO AKPOR LGA, RIVERS STATE

FINAL REPORT

SUBMITTED TO THE FEDERAL MINISTRY OF ENVIRONMENT, ABUJA

DECEMBER, 2015

Status Page

TITLE: ENVIRONMENTAL IMPACT ASSESSMENT (EIA) OF AGBADA NON ASSOCIATED GAS (NAG) PROJECT IN OBIO - AKPOR LGA, RIVER STATE

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Author:

Approved by:

Document Number: SPDC

Date:

Version: 02

Security:

Change History:

Version	Date	Pages	Reason
02		Whole Document	Final Report

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List of Acronyms and Abbreviations

AG	Associated Gas
AQ	Air Quality (Sample Station)
ALARP	As Low As Reasonably Practicable
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
Ba	Barium
Ca	Calcium
CAP	Community Assisted Projects
CAPEX	Capital Expenditure
CBR	Crude Birth Rate
CBO	Community Based Organization
Cd	Cadmium
CDC	Community Development Committee
CLO	Community Liaison Officer
CO	Carbon monoxide
COD	Chemical Oxygen Demand
CTB	Confirmatory Time Break
Cr	Chromium
CRNI	Crude Rate of National Increase
Cu	Copper
DC	Direct Current
DO	Dissolved Oxygen
DOMGAS	Domestic Gas
DPR	Department of Petroleum Resources
DPT	Diphtheria, Pertussis and Tetanus
EAR	Environmental Audit Report
EDG	Eastern Domestic Gas
EER	Environmental Evaluation Report
EIA	Environment Impact Assessment
EIS	Environmental Impact Statement
EGASPIN	Environmental Guidelines and Standards for the Petroleum Industry in Nigeria
EMP	Environmental Management Plan
EPA	Environmental Protection agency
EPIRBs	Emergency Position Indicating Radio Beacons
Fe	Iron
FMA	Federal Ministry of Aviation
FEPA	Federal Environmental Protection Agency
FMEnv	Federal Ministry of Environment
GDP	Gross Domestic Product
GHF	Gas Handling Facility
GHG	Green House Gas
GPS	Global Positioning System

HB	Heterotrophic Bacteria
HUB	Hydrocarbon Utilising Bacteria
HSE	Health Safety and Environment
HSE MS	Health Safety and Environment Management System
IAGC	International Association of Geophysical Contractors
IMDG	International Maritime Dangerous Goods
IUCN	International Union for the Conservation of Nature
ISO	International Organization for Standardization
ITCZ	Inter tropical Convergence Zone
K	Potassium
LGA	Local Government Area
LTO	License to operate
LVL	Low Velocity Layer
Mg	Magnesium
MARPOL	International Convention for Prevention of Pollution from Ship
NAG	Non-Associated Gas
NAPIMS	National Petroleum Investment Management Services
NDT	Non-Destructive Testing
NDI	National Days On Immunization
NGO	Non-Governmental Organization
Ni	Nickel
NIMET	Nigerian Meteorological Agency
NNPC	Nigerian National Petroleum Corporation
NO_2	Nitrogen dioxide
NPC	National Population Commission
NPDC	Nigerian Petroleum Development Company
NPI	National Programme on Immunization
NTU	Nephelometric Turbidity Units
OML	Oil Mining Lease
OPEC	Organization of Petroleum Exporting Countries
OPL	Oil Prospecting License
OPTS	Oil Producers' Trade Section
OSHA	Occupational Safety and Health Administration
PAC	Project Advisory Committee
Pb	Lead
pH	Hydrogen ion concentration
PIA	Post Impact Assessment
PPE	Personal Protective Equipment
PSD	Particle Size Distribution
Q1	First Quarter
Q2	Second Quarter
QC	Quality Control
QHSE	Quality, Health, Safety and Environment

RF	Radio Frequency
SO_2	Sulphur dioxide
SOLAS	International Convention for the Safety of Life at Sea
SPDC	Shell Petroleum Development Company of Nigeria Limited
SPM	Suspended Particulate Matter
SREM	Security Risk Exposure Matrix
STD	Sexually Transmitted Diseases
STOIIP	Stock Tank Oil Initially in Place
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
ToR	Terms of Reference
THC	Total Hydrocarbon Content
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solids
UN	United Nations
UNEP	United Nations Environmental Programme
UPTH	University of Port Harcourt Teaching Hospital
cfu/ml	Colony forming unit per millilitre
cm	Centimeter
Eh	Oxidation Reduction Potential
ft	Feet
g	Grammes
g/l	Grammes per litre
g/kg	Grams per kilogramme
km	Kilometre
km^2	Square kilometere
m	Metre
m/s	Metre per second
m^3	Metre cube
m^2	Metre square
meq/100g	Milliequivalent per 100 gramme
mg/kg	Milligramme per kilogramme
mg/l	Milligramme per litre
mg/m^3	Milligramme per metre cubic
ml	Millilitre
mm	Millimetre
mm/hr	Millimetre per hour
mS/cm	MilliSiemens per centimetre
NTU	Nephelometric Turbidity Units
ppm	Parts per million
ppt	Part per thousand
STOIIP	Stock Tank Oil Ini
ton	Tonne
V	Vanadium
VGT	Vegetation
WCMC	World Conservation Monitoring Centre

%	Percentage
μS/cm	MicroSiemens per centimetre
s	Second
^{o}C	Degrees Celcius
"	Inches

Executive Summary

ES 1: Introduction

ES 1.1: Background

Shell Petroleum Development Company of Nigeria Limited is a major oil & gas exploration and production (E&P) Company in Nigeria. It operates a Joint Venture Partnership with Nigerian National Petroleum Corporation (NNPC), ELF Petroleum Nigeria Ltd (EPNL) and Nigerian Agip Oil Company (NAOC). The partnership participation are 55%, 30%, 10% and 5% for NNPC, SPDC, ELF and NAOC, respectively. Shell Petroleum Development Company (SPDC) on behalf of Joint venture partners viz: Nigerian National Petroleum Corporation (NNPC), ELF Petroleum Nigeria Ltd (EPNL) and Nigerian Agip Oil Company (NAOC) plans to develop its Agbada field in Oil Mining Lease (OML) 17. The field development is aimed at increasing gas production from Agbada field. The proposed project will involve the drilling and completion of two Non Associated gas (NAG) wells and re-completion of one of the wells in 2014, laying of 2Nos. 8" x 8km flowlines from wells at Agbada I to NAG plant at Agbada II.

ES.1.2: Administrative and Legal Framework

In line with SPDC's sustainable development goals and in keeping with applicable regulations (DPR Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, 2002, the Federal Ministry of Environment (FMEnv) Procedural / Sectoral Guidelines for the Oil and Gas Industry (1995), and the EIA Act 86 of 1992), the company has carried out an Environmental Impact Assessment (EIA) prior to the commencement of the proposed project. The Environmental Impact Assessment (EIA) Act No. 86 of 1992, DPR's EGASPIN, state legislations and all other applicable National legislations, and International Agreements and Conventions to which Nigeria is a signatory shall guide the implementation of the proposed project.

ES 1.3: Project Location

The Agbada field is located in SPDC's OML - 17 and it is situated approximately 16 km North-East of Port Harcourt in Rivers State. Agbada field is located in SPDC's OML 17 and falls within Rivers State (Ikwerre, Obio/Akpor, Etche, and Port Harcourt Local Government Areas). Latitudinal and longitudinal positioning of the Flow stations I and II were found to be 6.58°72'E, 4.56°02'N and 7.00°95'E, 4.55°94'N respectively using a GARMI Global Positioning System (GPS) on the field. The field is located on the same mega structural trend as the Obigbo North field. The planned field development activity falls within Rivers State (Ikwerre, Obio/Akpor, and Etche Local Government Areas).

ES 2.0: EIA Objectives

The main objectives of the EIA study include the following:

- Determine the current status of the Environment and impacts of the existing SPDC facilities and operations in the project area;
- Determine baseline conditions of the environment as well as the socio-economic and health conditions of the host communities;

- Evaluate the residual impacts of the existing facilities on the receiving environment;
- Determine and evaluate the potential impacts of the proposed project activities on the environment, using the current environmental conditions as the baseline;
- 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 as well as analysis of the opportunity cost to chemical spills during project activities;
- 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;
- Develop cost effective mitigation measures and appropriate Environmental Management Plan (EMP) for all identified impacts.

ES.2.1: EIA Methodology

The study was carried out, using standard scientific methods for data acquisition. It generally involved desktop studies, field research, consultation, laboratory analysis, impact assessment, recommendation of mitigation measures and development of an environmental management plan (EMP).

ES 3.0: Project Justification

In Nigeria, the Power Holding Company of Nigeria (PHCN) is empowered to maintain, co-ordinate and supply electricity to the Nigerian nation. It has nine (9) generating stations, made up of three (3) hydro stations: and six (6) thermal stations. In addition, some independent power plant projects have been commissioned. The total energy generated by the stations is grossly inadequate to meet the 6,000 MW of electricity target by end of 2009. Current power generation is believed to be below 4,000MW. This is because the hydro based stations, due to water level fluctuation and limitation, are not efficient throughout the year, while the gas stations are affected by inadequate supply.

Also, one major source of environmental problems and agitation in the Niger Delta in Nigeria is gas flaring. The World Bank reported in 2004 that, Nigeria currently flares between 70 and 75% of the gas it produces. Almost no vegetation can grow in the area directly surrounding the flare due to the tremendous heat it produces. Gas flaring emits carbon dioxide, carbon monoxide, methane, nitrogen dioxide, nitrogen monoxide, sulphur dioxide and in some cases hydrogen sulphide. Other substances released in the course of gas flaring are soot and smoke. Developing and ultimately producing NAG from Agbada field would facilitate SPDC's efforts to increase its gas utilization efforts and also enable Nigeria meet her target of increased gas utilization for power production and thus reduce gas flaring and its attendant environmental consequences.

ES 3.1: Envisaged Sustainability

Economic and Commercial Sustainability

This facility is envisaged to be economically and commercially sustainable because of the gas volume present in the Agbada field and the gas reserves in other nearby fields that can be produced in the future on depletion of the Agbada NAG reserves (circa 5years). With the Federal Government Power Plants (Alaoji & Ibom Power Plants) and ALSCON as major users and given the political drive for power development in the country as well as other domestic users, market for the gas is assured.

Technical Sustainability

The proposed project is expected to be technically sustainable because of the proven technology for the drilling and production operations being used. Strict adherence to internationally accepted engineering design and construction standards as well as codes of practice that shall be adopted at all stages of the project are expected to ensure technical sustainability.

Environmental Sustainability

Incorporation of the recommendations of this EIA at the appropriate stages of the project development is expected to ensure that the proposed Agbada Eastern Domgas Interim Growth Project is environmentally sustainable. The project will provide AG solutions for surge vessel gas from the existing Agbada 2 flowstation that is currently being flared thereby leading to a reduction in Green House Gas (GHG) emissions. Project has been planned in such a way that there will be minimal environment effect especially with respect to land take. The new NAG plant shall be sited at the location of existing disused gas lift compressor plant, which is currently being decommissioned and the wells drilled from an existing well location. Also, the flowlines shall pass through the existing SPDC RoW (Right of Way). In addition, strict adherence to the EMP shall ensure that every aspect of the proposed project is sustainable with minimum impact, especially as it concerns the natural environment and the people who inhabit it.

ES.3.2: Project Development Options

Project development options considered for the proposed field development project include:

Option 1: Do nothing/No Project Option

This option implies that the Agbada NAG development project would not be carried out and gas supply to the Eastern DOMGAS network to feed the proposed Alaoji power plant and other customers on the network will not be available. This will result in a shortfall in gas supply, frustrating Government's plan to boost electrical power generation in the country and hindering industrial activity and economic growth.

Decision: Not recommended

Option 2: Agbada wells only produced to Okoloma

This option involves the following:

- Procurement and installation of flowlines from Agbada wells to the cluster manifold.

- Procurement and installation of Flowline (bulkline) from Agbada to Okoloma Gas Plant.
- Procurement and installation of Manifolds.
- Installation of gas receiving facilities at Okoloma Gas Plant.
- Installation of surge vessel compressor at Agbada.

Decision: Not recommended

Option 3: Develop and Produce Agbada

This concept involves installation of 120mmscfd capacity gas plant as was proposed in the SPDC JV's Business Plan with an estimated start-up date of end 2010. Two wells have been identified to fill the plant

Decision: Recommended

ES 4.0: Project Description

The proposed Agbada NAG Field Development project activities consist of the following:

- Location preparation
- Drilling and Completion of 2 NAG wells (W67 and W68) Casing, logging, cementation and completion of all the wells;
- Well testing and hook-up
- Decommissioning of existing gas lift compressor
- Installation of GHF
- Installation of screw booster compressor at Agbada II
- Land acquisitions and claims settlement
- Right-of-way clearing(8.9316 hectares)
- Trench excavation
- Cleaning, bevelling and pipe bending
- Laying 2Nos. 8" x 8km flowlines from Wells at Agbada I to NAG plant at Agbada II
- Welding
- Field joint coating
- Inspection, testing and NDT of welds
- Lowering and backfilling
- Manifold works
- Site re-instatement
- Demobilization

Drilling Location Platform Preparation

This will include the following activities:

- Bush clearing to the appropriate size of location platform, including shoulders;
- Stripping of existing location platform earthworks;
- Reconstruction to suit the rig;
- Construction of generator platform;
- Excavation/concrete lining of standard waste pit;

- Construction of ancillary facilities such as perimeter drains and oil traps; and
- Block work fencing of location platform.

The size of the drilling site shall be approximately 1ha. The projected well depths well depths for W67/68 is 11,774ftah. Both wells (67/ 68) had the following casing sizes 24'' stove pipe - /(354ft), 10 ¾'' 60.7ppf- /(120ft) and 9 5/8'' 47ppf -/ (11,725ft). The well was drilled with Pseudo Oil based Mud (POBM) and the drill –in fluid across the reservoir was Thixal mud to reduce the reservoir impairment, thereby increasing the production potential. The POBM is recovered and treated for use in other wells by the Mud supplier. Single string completion per reservoir has been adopted to target gas reservoirs. The completion is 4 ½'' 13cr upper completions with external Gravel pack in the sand face. This is to enable 40Mmscf/day gas production

Laying of Flow lines and Pipeline Networks

The activities associated with Installation of 2Nos. 8" x 8 km flowline from well locations at Agbada I to the NAG facility at Agbada II consists of the following activities:

- RoW bush clearing;
- Trenching;
- Stringing;
- Welding;
- Radiography;
- Field joint coating;
- Lowering;
- Backfilling; and
- Hydrotesting.

These activities which shall be carried out in respect of laying of flow lines and pipeline networks include the installation of 2Nos. 8" x 8 km flow line from well locations at Agbada I to the NAG facility at Agbada II in accordance with existing SPDC practice, flow lines, pipelines and field manifold have been designed for unmanned operations. Thus, by means of the fitted trim chokes and instrument, the manifold shall be monitored from the flow stations. However, adequate access shall be provided to enable personnel operate the manifold as necessary. Scheduled operations activities (e.g. pigging and well testing) shall be carried out by operations staff when they visit.

The flow lines shall be equipped with on-line access sampling points. To enhance bulk line operations and increase service life, the lines shall be operated at full capacity flow, thus minimizing the chances of deposits that are likely to arise from low flow conditions. The design shall provide for safe and efficient means of freeing the bulk lines of all hydrocarbons. The proposed project was scheduled for commissioning by Quarter 3 of 2010.

ES 5.0: Environmental Baseline Description

The environmental baseline data acquisition involved two season field exercise, carried out between 24th October (late wet season) and 5th November 2008 (early dry season). Sampling of bio-physical components was completed by 30th October whilst socio-economic and health data gathering was completed on 5th November (early dry season). The dry season sampling was carried out from 26th – 30th January, 2009 (mid dry season). The field work was followed by laboratory analyses and interpretation of results. Environmental components studied include vegetation, soil, air quality / noise, surface and ground water, hydrobiology, socio-economics and health status.

Climate

The study area has equatorial rain forest climatic conditions where the temperatures and humidity are high all the year round. Also, high and persistent rainfall even in the dry months characterizes the proposed project area. The wind is predominantly in the South Western direction accounting for about 75% of the annual winds. The North-Easterly winds predominate during the dry season (November – March), this makes up about 25 % of the annual winds within the study area. Its penetration into the Niger Delta region between December and February is characterized by dry and low humidity with dusty haze. Temperature ranged from 26.60 – 33.60 ^{o}C while relative humidity ranged from 61.00 – 92.00%.

Generally, the wettest period of the year within the area is July - September with the peak period in July while lower rainfall values are usually recorded in the months of December, January, February and March. A brief period (few days to one week) of low rainfall usually occurs anytime between late July and early September in the study area and is often referred to as August break.

Ambient Air Quality and Noise

Suspended particulate matter (SPM) ranged from 20.50 – 27.00µg/m^3 during the wet season and 30.40 – 36.00µg/m^3 during the dry season. Carbon monoxide (CO) ranged from 4.00 – 19.00 ppm for wet season and 1.80 – 8.20 ppm for the dry season. Nitrogen IV Oxide ranged from 0.60 – 1.00 ppm and 0.90 – 1.90 ppm for wet and dry seasons respectively.

The mean noise levels recorded for wet season ranged from 32.60 – 63.80 dB (A) while that of dry season ranged from 36.65 – 59.55 dB (A). These values are well within FMEnv and Occupational Safety and Health Administration (OSHA) permissible exposure limits of 90dB (A) per day for an 8-hour working period.

Geology

The study area lies within the Niger-Delta; its geology is therefore typical of the Niger Delta Basin. The area forms part of a geological sequence of the Quaternary and Tertiary formations of the Niger-Delta, consisting mainly of three main geologic formations, which are: Benin Formation, Agbada Formation, and Akata Formation.

The sub-surface soil revealed by the boreholes show clayey sand, sandy and gravely sand soil horizons. The clayey sand horizon is dark at the surface. The dark colour fades out with increasing depth. The sandy horizon is brownish, and its colour also becomes lighter with depth. The gravelly sand horizon has very light colour tending towards colourless. It contains the aquifer material.

Soil Characteristics

The soils from Agbada FDP project area are predominantly loamy sand at top and mid-depth horizons and sandy clay loam at bottom soil horizons. The colour of the soil is dark-greyish-brown to black on top, changing to light brown in the subsoil. The soil is arable and weakly acidic to slightly alkaline with the pH of the project area in the wet season varying between 5.80 and 6.89 (top soil) and 5.70 and 6.77 (bottom soil) while the recorded value during the dry season ranged from 5.4 – 7.3 (top sol) and 5.7 – 7.6 (bottom soil). Conductivity of soil from the project area ranged from 18.00 – 60.00 µS/cm for both top and bottom soils in the wet season and 10.00 – 58.00 µS/cm for the same samples during the dry season.

The nitrate values ranged from 6.90 – 13.98 mg/kg for top soil and 7.31 -14.43 mg/kg for bottom soil in the wet season while the values for dry season were 2.84 – 7.14 mg/kg for top soil and 2.98 – 6.41 mg/kg for bottom soil. The concentration of sulphate ranged from 2.00 – 18.81 mg/kg for top soil and 2.03 -18.99 mg/kg for bottom soil in the in the wet season while the values for dry season were 2.37 – 22.69 mg/kg for top soil and 2.27 – 20.85 mg/kg for bottom soil. Phosphate concentration for wet season ranged from 0.06 – 0.11mg/kg and 0.06 – 0.12 mg/kg for top and bottom soil, respectively while the values for dry season were 0.18 – 0.57 mg/kg and 0.33 – 0.56mg/kg for top and bottom soil, respectively. The concentrations of oil and grease in the soil of the study area obtained during the wet season for top and bottom soil ranged from 0.13 - 1.40 mg/kg and 0.44 - 0.88 mg/kg, respectively while the dry season values ranged from 0.10 – 1.20 mg/kg and from 0.22 – 0.72 mg/kg for top and bottom soil, respectively. Cation exchange capacity (CEC) values for topsoil ranged from 3.41 – 4.88 meq/100g and from 2.30 and 3.98meq/100g for top and bottom soil respectively, while that of dry season ranged from 3.13 – 4.12 meq/100g and from 2.01 – 3.65 meq/100g for top and bottom soil, respectively.

The concentrations of heavy metals in top soil of Agbada FDP area during the wet season were: lead (Pb): 0.06-0.98mg/kg, Nickel (Ni):6.40 - 8.50 mg/kg, Chromium (Cr):15.70-24.30 mg/kg, Zinc (Zn):0.53-9.87 mg/kg, Cadmium (Cd):0.45 - 0.68 mg/kg, Iron (Fe):35.56-148.23 mg/kg, Manganese (Mn): 9.10-46.50 mg/kg, Vanadium (V):0.02-0.16 mg/kg and Copper (Cu):5.65-6.45 mg/kg while concentrations of heavy metals in bottom soil for the wet season were: lead (Pb):0.01-0.85 mg/kg, Nickel (Ni): 6.00 - 8.00 mg/kg, Chromium (Cr):15.30 - 23.80 mg/kg, Zinc (Zn):0.42 - 9.10 mg/kg, Cadmium (Cd):0.41 - 0.64 mg/kg, Iron (Fe):32.67 - 145.47 mg/kg, Manganese (Mn): 8.90 - 42.00 mg/kg, Vanadium (V):0.03 - 0.09 mg/kg and Copper (Cu):5.42-6.13 mg/kg.

The concentrations of heavy metals in top soil of Agbada FDP area during the dry season were: lead (Pb):0.04 - 0.89 mg/kg, Nickel (Ni):6.10 - 8.10 mg/kg, Chromium (Cr):14.56-24.00 mg/kg, Zinc (Zn):0.46 - 9.42 mg/kg, Cadmium (Cd):0.35 -9.41 mg/kg, Iron (Fe):32.20 -142.19 mg/kg, Manganese (Mn):7.80 - 42.30 mg/kg, Vanadium (V):0.01 - 0.11 mg/kg and Copper (Cu):5.25-6.12 mg/kg while in bottom soil, the concentrations of heavy metals for the same season were: Lead (Pb):0.01- 0.74 mg/kg, Nickel (Ni):5.60 - 7.70 mg/kg, Chromium (Cr):1.70 -22.50 mg/kg, Zinc (Zn): 0.37 – 8.69 mg/kg, Cadmium (Cd):0.31-0.57 mg/kg, Iron (Fe):30.14 -140.73 mg/kg, Manganese (Mn):7.10-40.10 mg/kg, Vanadium (V):0.01-0.07 mg/kg and Copper (Cu):5.12-5.89 mg/kg.

The oil degrading bacteria genera in the soils in all the fields are mainly *Bacillus, Pseudomonas, Acinetobacter, Micrococcus* and *Actinomyces*. The hydrocarbon utilizing fungal genera in the soil were *Penicillium, Aspergillus, Fusarium* and yeasts.

Groundwater

The temperature of the groundwater from the study area was slightly warm, with values ranging from 27.00 – 29.70^{0}C during the wet season and 28.00 – 30.60^{0}C during the dry season. The result for the Total Dissolved Solid (TDS) showed relatively low values with a range of 22.80-72.00 mg/l during the wet season and 62.10 – 94.00 mg/l during the dry season while the level of total suspended solids varied between 0.04and 0.15mg/l and 0.04 – 1.38 mg/l for the wet and dry seasons, respectively.

The conductivity levels ranged from 0.09-0.10 µS/cm and from 0.03 – 0.07 µS/cm for wet and dry seasons respectively. The pH of the groundwater of Agbada field ranged from 6.43 – 8.95 and 6.30 – 7.30 for wet and dry seasons, respectively, indicating relatively acidic to alkaline pH. The COD concentration in the groundwater sample ranged from 26.50-31.00mg/l and from 21.70 – 28.10mg/l for wet and dry seasons, respectively while the BOD values ranged from 8.50-9.40mg/l and from 4.37 – 5.00mg/l for wet and dry seasons, respectively. The regulatory limit for COD is <75mg/l. The THC of ground water ranged 0.30 – 1.30mg/l for the wet season while the dry season value ranged from 0.12 – 1.32 mg/l.

The concentration of nitrates (NO_3^-) in groundwater from the study area ranged from 7.26 – 8.73 mg/l, phosphate levels varied between 0.06 and 0.12mg/l while Sulphate (SO_4^{2-}) ranged from1.02 mg/l – 2.11mg/l for wet season. In the dry season, the concentrations ranged from 5.77 – 6.68mg/l, 0.07 mg/l and 1.41 – 1.79mg/l for nitrate, phosphate and Sulphate, respectively.

The following concentrations were recorded for heavy metals during the wet season: Lead: 0.005 - 0.008mg/l, Iron: 0.20 – 0.75 mg/l, Zinc: 0.09 - 0.117 mg/l, Nickel: 0.03 mg/l, Copper: 0.002 – 0.004 mg/l, Cadmium: 0.002 – 0.004 mg/l. Chromium, mercury, arsenic, vanadium and were mostly below detection limits. In the dry season, the heavy metal concentrations recorded ranged as follows: Lead: 0.001- 0.003mg/l, Iron: 0.06 – 0.43 mg/l, Zinc: 0.03-0.06 mg/l, Nickel: 0.68-1.02 mg/l, Copper: 0.56 – 1.05 mg/l, Cadmium:0.001 –

0.003 mg/l. The results showed that in the wet season, the THBC of groundwater ranged from 0.10 x 10^2 – 0.20 x 10^2 cfu/ml and HUB ranged from 0.0 to 0.80 x 10^2 cfu/ml. The Total Fungal Counts (THFC) for groundwater ranged from 0.10 x 10^2 – 0.20 x 10^2cfu/ml. HUF range was between 0 and 0.07 x 10^2 cfu/ml. Total coliform ranged from 0.0 – 0.3 x 10^2 cfu/ml. In the dry season, THBC of groundwater ranged from 0.20 x 10^2 – 0.80 x 10^2 cfu/ml and HUB ranged from 0 to 0.30 x 10^2cfu/ml. The Total Fungal Counts (THFC) for groundwater ranged from 0.30 x 10^2 – 0.50 x 10^2. Hydrocarbon utilizing fungal counts ranged from 0.0 to 0.30 x 10^2. Total coliform ranged from 2.50 – 4.00 x 10^2 cfu/ml.

Vegetation

Vegetation in most of the study area would be classified as the oil palm variant. This is indicative of (dry-land) lowland rain forest that is undergoing active regeneration. Such areas have been long under cultivation with the oil palm (*Elaeis guineensis*) being the dominant emergent canopy species. The species diversity index in the area ranged from 1.05 to 1.99. The dominant emergent canopy species included *Musanga cecropioides, Hunteria umbellatum, Raphia hookeri* (wine palm), *Anthocleista vogelii, Musanga cecropioides, Alstonia boonei, Hevea brasiliensis,* and *Pycnanthus angolensis.*

The ground vegetation in the area was dominated by a variety of shrubs, herbs and weeds including *Nephrolepis biserata, Selaginella myosurus, Lycopodium cernuum, Chromolaena odorata, Ipomoea involucrate, Panicum maximum, Scleria vogelii, Dissotis rotundifolia, Dissotis erecta, Sporobolus pyramidalis, Aspilia africana, Sida acuta, Paspalum orbiculare, Stachytarpheta indica* and *Datura stramoniu.*

The levels of heavy metal concentrations in representative plant species from the study area were within the usual range of such elements in plant tissues. The concentrations of Iron, Zinc and Manganese ranged from 83.75-189.10mg/kg, 20.0-28.0mg/kg and 20.0-37.80mg/kg dry weight respectively. Chromium, Cadmium, Nickel and Lead which are toxic even at low concentrations were either not detected or found at very low concentrations of 0.01 – 0.07mg/kg.

Generally vegetation was luxuriant with no obvious signs of stress. Leaf spots were the dominant disease symptoms on the foliage of unhealthy plants. *Fusarium, Aspergillus* and *Penicillium* spp were the pathogens with the highest relative incidence. The major farm crop found in the project area was *Manihot esculenta* (cassava). Trees which offer non-timber forest products (barks, fruits, roots etc) that play roles in traditional medicine and nutrition included *Elaeis guineensis* (oil palm), *Raphia vinifera* (wine palm), *Musanga cercropioides, Costus afer, Alchornia cordifolia* and *Harungana madagascariensis* (blood tree).

Wildlife

All the four classes of vertebrates were found in the study area. The mammals and avifauna were the dominant groups (with 11 species of each class identified). The mammalian species included some primates (*Cercopithecus mona*) and some rodents (small mammals) like

Thryonomys swinderianus (cane rat), *Protoxerus strangeri* (forest tree squirrel) and *Atherurus africanus sp* (brush tailed porcupine). The avifauna included guinea fowls weaver birds (*Plesiositagra cucullatus*), hawks (*Polyboroides radiatus*) and kites (*Milvus nigrans*). Herpetofaunal species (amphibians and reptiles) lizards and snakes.

Consultation and Socioeconomic Survey

Consultation exercise commenced at the very early stage of the Environmental Impact process and it is planned to continue throughout the project duration in line with recommended approach to Project Consultation Process. One of the stages of consultation was carried out by the Community Relations Department of SPDC and involved paying homage to the selected communities, and informing them of the proposed project and the visit of the impact assessment consultants for the EIA studies.

SPDC shall sustain consultations with the Regulatory Agencies, the host communities, all stakeholders concerned with or likely to be affected by the project at all stages of project development. The consultations will continue throughout the duration of the proposed project. The socio-economic survey for the proposed Agbada FDP project area covered 6 communities from 2 Local Government Areas LGAs in Rivers State. The Local Government Areas were Obio Akpor and Ikwerre, Etche LGAs. In 2006 Obio-Akpor LGA had an estimated population of 464,789 persons while Ikwerre LGA had a population of 654,515. In 2009 Obio-Akpor LGA had a population of 504,934 persons while Ikwerre had a population of 206,113 persons. In 2015 Obio-Akpor had an estimated population of 512, 927 persons while Ikwerre has an estimated population of 707,653 persons.

The local language of the indigenous people of the area is either Ikwerre or Etche. There were strong similarities in the culture, tradition, beliefs and taboos from the groups studied. The Chieftaincy and Traditional hierarchical structure are similar. Each community is headed by a village head who is lower in hierarchy than the clan head. The clan head is in turn lower than the paramount ruler. Within the community, the people are governed by the leaders of the various groups with which they have affiliation.

History shows that people from the communities sampled during the study came from diverse stocks. Nonetheless, many of the communities however are related to one another as some of them are of the same stock of the children of Apara, Evo and Akpor. Eledo who is the father of the Eledo group of communities in Rukpokwu is the sixth son of Apara. The children of Apara form the Obio part of Obio-Akpor. These are said to have come from the Akaloka tribe in the old Bendel State. The people of Omunike and Omonoba, on the other hand are believed to have migrated from the ancient Benin Empire. The traditional dances and masquerades in the area are many and varied. The common ones were the *eregbu* dance, *arungu*, *egelege*, others include *ogumabiri*, *egbukele*, *mkpa*, *obini*, etc. These dances feature during merry making and general celebrations in the communities.

The level of infrastructural development in the communities varied slightly from place to place. The sampled communities lacked one basic infrastructure or the other. The fears of the people in the communities visited were quite similar and said to be based on their experiences of similar operations in the past. The fears expressed on the proposed project included: destruction of farm land, inadequate compensations, destruction of existing earth roads, noise, possible gas leaks and fire outbreaks. The expectations and needs of the people as gathered in each community varied in other of priority. However, the most common needs in order of priority across the communities were community roads, proper drainage system, employment for locals, adequate compensation for land-take, provision of healthcare facilities and potable water.

Community Health

Most communities in the study area lacked functional healthcare facilities. There were a few private clinics and patient medicine stores in the area. The health centres in the area, included, Community Health Center, Mbodo Aluu – (SPDC provided), Bon Maria Clinic, Rukpokwu and Patfare Clinic, Rukpokwu which are both privately owned. Despite the scarcity of health facilities, traditional birth attendants, traditional medicine practitioners and other forms of alternative medical practice were also few. Most patients were usually taken to the University of Port Harcourt Teaching Hospital (UPTH) since most private clinics charges were high. The commonest ailments and diseases in the area are: malaria, typhoid fever, measles, diarrhea, hypertension and diabetes.

ES 6.0: Potential and Associated Impacts

Environmental Impacts were assessed using ISO 14001 method. Both Beneficial and Adverse impacts were identified and quantified. The identified Impacts include:

Positive Impacts

- Gainful utilization of flared gas
- Employment opportunities for members of the communities.
- Increased power generation
- Contract opportunities for locals
- Cleaner environment from reduction in gas flaring
- Community development programmes such as good roads, potable water, improved health care facilities etc.
- Stimulation of local economy

Negative Impacts

- Increased usage of roads with risks of accidents leading to injury / death of personnel and loss of asset
- Damage to the road infrastructure as a result of movement of heavy equipment
- Loss of vegetation during camp sites construction leading to increased access for hunting and poaching activities

- Possible gas leaks and fire outbreak
- Interference with other public and private transport activities during transportation of materials and personnel.
- Workplace accidents / incidents
- Lack of /inadequate compensation for acquired land
- Increased rate of social vices (theft, prostitution, etc.) within the communities due to population increase
- Risk of invasion, hostage situation, theft and robbery leading to loss of belongings and possible injury / death
- Emission of atmospheric pollutants from machineries and vehicle exhaust.
- Alteration of land use pattern and loss of arable lands.
- Loss of biodiversity (floral and faunal) including loss of plants of economic value.
- Fragmentation of habitats; Disruption of wildlife migration routes.
- Injury from abandoned heavy metals in the environment

ES 7.0: Mitigation Measures

In order to mitigate negative impacts, SPDC shall:

- as much as possible carry out community development programmes in line with the desires and needs of the people.
- employ locals from the host communities as much as feasible.
- maintain an open door policy to enhance flow of information to and from host communities to maintain a cordial relationship.
- enforce journey management rules and ensure that its drivers are well trained on safety
- avoid, as much as possible, movement of equipment during peak traffic periods
- ensure the development of an appropriate contingency plan
- ensure that all work crew use appropriate PPEs
- ensure that safety briefing are conducted prior to work
- ensure that all drilling wastes are managed in accordance with regulatory standards
- ensure that certified-damaged earth roads by the project activities are repaired.

ES 8.0 : Environmental Management Plan

The Environmental Management Plan (EMP) for the proposed Agbada Field Development Project incorporates various mitigation measures to ensure that adverse impacts associated with the project are reduced to As Low As Reasonably Practicable (ALARP) levels. The long-term objectives of the programme of environmental management for the proposed project shall be achieved by:

- ensuring compliance with existing legislation and SPDC's HSE policy;
- enhancing and demonstrating excellent environmental performance built around the principle of continuous improvement;
- integrating environmental issues fully into the field development;

- rationalizing and streamlining environmental activities to add value in efficiency and effectiveness;
- enabling management to establish environmental priorities for the proposed project;
- ensuring that appropriate recovery preparedness is in place in the event that control is lost during the implementation and operation of the proposed project;
- providing the basis and standards to be used in overall planning, monitoring, auditing and reviewing of socio-economic and environmental performance throughout the project life cycle;
- assigning roles and responsibilities to appropriate personnel to ensure effective EMP implementation.

The EMP addresses waste management, environmental audit and environmental monitoring programmes of the proposed project using SPDC's document – SPDC 2004-0002714 volume V as the guideline for its management system. Wastes generated during the proposed project shall be handled, stored, treated, recycled, and disposed based on the nature of each waste stream. The project-specific waste management guidelines shall take into consideration the nature of each waste stream to be generated during the lifetime of the proposed project.

Environmental audit will be conducted on a regular basis for all operations facilities throughout the life span of the proposed project. The EMP audit programme shall be conducted bi-annually during construction and start-up, and during operations in accordance with SPDC policy and regulatory requirements. The Environmental Monitoring Programme for the proposed project, which shall cover environmental components and discharge types, shall comply with DPR/FMEnv regulatory requirements. Generally the monitoring shall check alterations in the interactions between project activities and environmental sensitivities, and interactions between the sensitivities.

ES 9.0: Site Closure / Decommissioning

The FMEnv/DPR Guidelines for decommissioning of oil and gas facilities shall be employed to decommission the proposed project. All assets (including pipeline) which have reached the end of their useful life, will be decommissioned and either abandoned, dismantled and removed, or will be left in a state compatible with the next expected use in accordance with prevailing statutory requirements and standards. Management of wastes during this process will be in accordance with applicable Nigerian requirements and the SPDC Waste Management Plan.

ES 10.0: Conclusion

The Environmental Impact Assessment of the Agbada Field Development Project showed that the project shall have significant benefits as well as some temporary negative impacts particularly on the soil and air quality. The potential impact on the components will be largely short-term, occurring mostly during the drilling activities.

The economic gains of the proposed project to the government and people of Nigeria cannot be overemphasized. The EIA of the proposed project shows that the project can be executed and operated within minimal negative impacts on the surrounding environment and personnel by strict implementation of the recommended mitigation measures. The EIA has also developed an Environmental Management Plan (EMP), which incorporates various mitigation measures that will eliminate or reduce the potential impacts of the proposed project implementation on the environment. The EMP shall be implemented and maintained throughout the duration of the project with the adverse impacts mitigated to as low as reasonably practicable levels. Impact mitigation monitoring shall also be carried out with the involvement of regulators to check compliance with the EMP.

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Regulators

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Acknowledgements

The Shell Petroleum Development Company of Nigeria Limited wishes to express sincere appreciation to the Federal Ministry of Environment (FMEnv) and Department of Petroleum Resources (DPR), for their support, advice and invaluable assistance throughout the period of this study. The efforts of our environmental consultants, relevant Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs) are also highly commendable. Finally, we give special thanks to the Paramount Rulers, Clan Heads, Village Heads, Women and Youth Groups, Local Government Councils, etc. for their co-operation and willingness to express their views, concerns as well as expectations.

CHAPTER ONE
INTRODUCTION

1.1: General

Shell Petroleum Development Company (SPDC) on behalf of its joint venture partners Nigerian National Petroleum Corporation (NNPC), ELF Petroleum Nigeria Ltd (EPNL) and Nigerian Agip Oil Company (NAOC) plans to develop its Agbada Field to boost oil and gas output. The major activities associated with the proposed project include the drilling and completion of two (2) Non-Associated Gas (NAG) wells and re-completion of one of the wells in 2014, as well as the laying of two 8" x 8km flowlines from wells at Agbada I to NAG plant at Agbada II.

In line with SPDC's corporate Safety, Health and Environment (SHE) policy and in keeping with applicable regulations (Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, DPR; 2002), the FMEnv Procedural / Sectoral Guidelines for the Oil and Gas Industry (FEPA, 1995) and the EIA Act 86 (1992) the company has carried out an Environmental Impact Assessment (EIA) prior to the commencement of the proposed project.

1.2: The Project Location

The planned onshore Agbada field development project is located in SPDC's OML 17 and falls within Rivers State (Ikwerre, Obio/Akpor, Etche, and Port Harcourt Local Government Areas).

	Easting	**Northing**
1	492156.4	95203.2
2	492125.2	113491.8
3	516334.3	113491.8
4	516334.3	95172.0
5	492156.4	95203.2

Fig 1.1: Map of Nigeria showing Rivers State

Fig 1.2: Map of Rivers State showing Local Government Areas

1.3: The Proponent

Shell Petroleum Development Company of Nigeria Limited is a major Oil & Gas exploration and production (E&P) Company in Nigeria. It operates a joint venture partnership with NNPC, EPNL and NAOC. The partnership participation is 55%, 30%, 10% and 5% for NNPC, SPDC, ELF and NAOC, respectively. SPDC first discovered oil in commercial quantities in Nigeria in 1956, although it had been operating in Nigeria since 1938. The company finally adopted the name Shell Petroleum Development Company of Nigeria Limited in 1978 after previously changing its name from Shell D' Arcy to Shell-BP. Shell Petroleum Development Company has two operational divisions: the Eastern Division based in Port Harcourt, Rivers State, and the Western Division based in Warri, Delta State. These divisions together operate more than one thousand (1,000) oil and gas wells and a network of 2,700km of pipelines with export terminals in Forcados and Bonny, serving the Western and Eastern Divisions respectively. The oil and gas wells are spread across 92 producing oil fields. These fields, including the Agbada Field, are located in the sedimentary basin of the Niger Delta region. Agbada field was the first land-based oil-field in the Eastern Division of SPDC.

Agbada NAG project is located within Agbada field in SPDC's OML 17 and falls within Rivers State (Ikwerre, Obio/Akpor, Etche, and Port Harcourt Local Government Areas). There are two Flow Stations in this field. The two flowstations, Agbada I and II were commissioned in 1960 and 1965 respectively with a combined capacity of 90,000 bbl/d. Agbada I is a single bank flowstation with a nominal capacity of 30,000 bbl/d having 30 flowlines laid to the station while Agbada II is a double bank flowstation with a nominal capacity of 60,000 bbl/d and having 57 flowlines. The project centers on six (6) communities from two (2) Local Government Areas LGAs in Rivers State. The Local Government Areas are Obio Akpor and Ikwere LGAs. The communities Omuoda Aluu, Mbodo Aluu, Omunike Omunoba and Omuigwe Aluu in Ikwere LGA and Rumujima Eledo Rukpokwu and Elikpokwodu Rukpokwu in Obio Akpor LGA

1.4: EIA Objectives

The objectives of the EIA study include the following:

- determine the baseline ecological conditions of the study area;
- determine the environmental sensitivities prevalent in the area;
- identify, evaluate, and predict the impact of the project on the ecological, socio-economic and cultural settings with adequate interfacing and project interaction;
- identify health hazards that may result from the different phases of the project and evaluate local population exposure to these hazards.
- develop control strategies with a view to mitigating and ameliorating significant impacts that the projects would have on the totality of measurable environmental characteristics;
- develop a cost effective Environmental Management Plan (EMP) for the impacts identified.

1.5: EIA Methodology

The EIA study of the proposed Agbada FDP was carried out in accordance with the FMEnv Procedural and Sectoral Guidelines (FEPA, 1995), the DPR's Environmental Guidelines and Standards for the Petroleum Industry (DPR; 2002) and the new SPDC EIA Manual. The study involved a blend of a multidisciplinary team and standard methods from pure science, engineering, social and health sciences in order to obtain basic data for impact identification and establishment of mitigation and amelioration measures. The study generally involved desktop studies, field research, consultation, impact assessment and proffering of mitigation measures and development of an EMP.

Desktop Studies

Desktop studies were undertaken to acquire information on climate, geology, soil, vegetation, socio-economics, and other environmental components of the proposed Agbada FDP Area. The materials consulted include textbooks, articles, and previous study reports on the proposed project area.

Field Research

A field research was used to harmonize and verify information gathered from desktop studies and also to fill data gaps identified. The fieldwork was carried out in line with the FMEnv Procedural Guidelines (FEPA, 1995) and Environmental Guidelines and Standards for Petroleum Industry in Nigeria (DPR, 2002) whilst maintaining SPDC HSE and QA/QC standards. The data gathered from the field investigation were used in determining relevant baseline ecological, socio-economic and health conditions of the proposed project area.

Consultation

Consultation was carried out with the proposed project stakeholders (FMEnv, Rivers State Ministry of Environment, communities and community-based organizations (CBOs). Some of these were consulted during the scoping stage, prior to the start of the field campaign. This was done to ensure that the views and opinions of all stakeholders regarding the proposed project and its associated and potential impacts are integrated into the EIA.

1.6: Legal and Administrative Framework

There are legislations, guidelines and standards that govern the assessment of environmental impacts of development projects in the oil and gas industry in Nigeria. These regulations can be classified as follows:

1.6.1: International Laws and Regulations

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

- 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)
- Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal and.
- 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 EIA in the upstream oil and gas industry include the following:

- Biological Diversity
- Coastal and Marine Resources Management
- Cultural Properties
- Hazardous and Toxic Materials and
- International waterways.

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

The IUCN in conjunction with the Oil Industry International Exploration and production Forum presented a set of guidelines for oil and gas exploration and production in mangrove areas. These guidelines are aimed at conservation of mangroves and enhancing the protection of marine ecosystems during E & P activities. The document also discusses the policy and principles for environmental management in mangrove areas as well as EIA procedures, Environmental Audit and Monitoring.

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.

Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal

The convention focuses attention on the hazards of the generation and disposal of hazardous wastes. The convention defines the wastes to be regulated and control their trans-boundary movement to protect human and environmental health against their adverse effects.

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.

1.6.2: Legislations guiding Environmental management in Nigeria

The Mineral Oil (Safety) Act CAP 350 LFN 1990

Sections 37 and 40 of the Mineral Oil (Safety) Act CAP 350 LFN 1990 require provision of Personal Protective Equipment (PPE) and the safety measures for workers in drilling and production operation in accordance with international standards.

Federal Environmental Protection Agency (Now FMEnv) Act No. 58, 1988

This Act, which was issued in 1988 and amended by Act No. 59 of 1992, provides the setting up of the Federal Environmental Protection Agency, as the apex organization for the overall protection of the Environment and Conservation of Natural Resources. The act also makes environmental impact assessment (EIA) mandatory for all new major projects. In compliance with its mandate, FEPA issued the procedure, guidelines and standards for the execution of EIA with emphasis on the significance associated with current and potential impacts of such projects. The procedure also indicates the steps to be followed (in the EIA process) from project conception to commissioning in order to ensure that the project is executed with adequate consideration for the environment.

EIA Sectoral Guidelines for Oil and Gas Industry Projects, 1995

In compliance with its mandate, FEPA issued the EIA Sectoral Guidelines for Oil and Gas Industry Projects, 1995. Contained in the Procedural Guidelines (pg. 8) are Category I projects (mandatory study activities) and listed under item 15, sub-item (a) on page 10) (Petroleum) is Oil and Gas Fields Development, making an EIA mandatory for the proposed project. The Procedural Guidelines also indicate the steps to be followed (in the EIA process) from project conception to commissioning in order to ensure that the project is executed with adequate consideration for the environment. Annex C contains the EIA writing format as required by FMEnv. The guidelines are intended to assist in the proper and detailed execution of EIA studies of projects in consonance with the EIA Act.

S.I. 15 - National Environmental Protection Management of Solid and Hazardous Wastes Regulation (1991) (FMEnv)

This provides that the objective of solid and hazardous waste management shall be to:

- Identify solid, toxic and extremely hazardous wastes dangerous to public health and environment,
- Provide for surveillance and monitoring of dangerous and extremely hazardous wastes and substances until they are detoxified and safely disposed,
- Provide guidelines necessary to establish a system of proper record keeping, sampling and labelling of dangerous and extremely hazardous wastes,
- Establish suitable and provide necessary requirements to facilitate the disposal of hazardous wastes;
- Research into possible re-use and recycling of hazardous wastes.

Environmental Impact Assessment Act CAP E12 LFN 2004

This Act provides guidelines for activities of development projects for which EIA is mandatory in Nigeria. The Act also stipulates the minimum content of an EIA as well as a schedule of projects, which require mandatory EIAs.

FEPA (Now FMEnv) Nigeria's National Agenda 21 (1999)

Nigeria's National Agenda 21 was developed to:

- Integrate environment into development planning at all levels of government and the private sector,
- Intensify the transition to sustainable development,
- Address Sectoral priorities, plans, policies and strategies for the major sectors of the economy and,
- Simultaneously foster regional and global partnerships.

FEPA (Now FMEnv) National Policy on the Environment (1989)

This gave the policy goals, conceptual framework and strategies for implementation.

Forestry Law CAP 51 LFN 1994

The Forestry Act 1958 which was amended as the Forestry Law CAP 51 LFN 1994 prohibits any act that may lead to the destruction of or cause injury to any forest produce, forest growth or forestry property in Nigeria. The law prescribes the administrative framework for the management, utilization and protection of forestry resources in Nigeria, which is applicable to the mangrove, and other forests of the Niger Delta.

Land Use Act CAP 202 LFN 1990

The land-use Act of 1978 states that "… it is also in the public interest that the rights of all Nigerians to use and enjoy land in Nigeria in sufficient quality to enable them to provide for the sustenance of themselves and their families should be assured, protected and preserved".

National Environmental Standards Regulatory and Enforcement Agency (NESREA), 2007

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established as a parastatal of the Federal Ministry of Environment. NESREA is charged with the responsibility of enforcing all environmental laws, guidelines, policies, standards and regulations in Nigeria.

Endangered Species Act CAP E9 LFN 2004

This Act prohibits hunting, capture and trade of some *endangered species* like crocodile, alligator, turtles, Parrot, etc. The Endangered (Control of International Trade and Traffic) Decree (No. 11 of 1985) has been enacted by the Federal Republic of Nigeria specifically to implement CITES. It is broader than CITES in that it also covers domestic taking of listed species. Two schedules are included: Schedule I (Endangered Species – Animals in relation to which International Trade is absolutely Prohibited), and Schedule 2 (Animals in Relation to which International Trade may only be conducted under License). The decree prohibits taking of Schedule 1 species and requires that taking of Schedule 2 species be in accordance with a license issued under the decree.

Petroleum Act CAP 350 LFN 1990

An Act to provide for the exploration of petroleum from the territorial waters and the continental shelf of Nigeria and to vest the ownership of, and all on-shore and off-shore revenue from petroleum resources derivable therefrom in the Federal Government and for all other matters incidental thereto.

1.6.3: Legislations guiding Environmental Management in Rivers State

The Rivers State regulations guiding Environmental management includes but not limited to the following:

- Rivers State Private Health and Allied Establishments Authority Law, 2001;
- Rivers State Public Health Law, 1999;
- Rivers State Noise Pollution Control Law of 1984;
- Rivers State Environmental Protection Agency Law No. 2 of 1994.

1.6.4: SPDC Policies and Principles

Shell Petroleum Development Company (SPDC) operates under the guidelines of Shell International and complies strictly with them. Where national standards and regulations are more stringent than Shell guidelines, SPDC's policy is to comply with the existing national legislation.

(a) Business Principles

Shell companies have a systematic approach to health, safety, security and environmental management in other to achieve continuous performance improvement. To this end, Shell companies manage these matters as critical business activities, set standards and targets for improvement, and measure, appraise and report performance externally.

(b) Governing Policies

The SPDC 1998 Corporate Policies emerged with five Business Governing policies. Of interest to this document is the section on HSE referred to as 'Health, Safety and Environment Policy'. This policy addresses the health, safety, and environmental risks to the business and the potential impacts on staff, personnel, and the host communities. The policy reflects good practice and is mandatory.

(c) HSE Policy

It is SPDC's Policy that all activities shall be planned and executed in a manner that,

- Preserves the health, safety and security of all Company and contractor personnel and members of the public;
- Preserves the integrity and security of Company assets;
- Minimizes the impact of operations on the environment; and
- Is sensitive to the needs and concerns of the Host Communities.

The implications of implementing this policy are that,

- All activities shall be analyzed to systematically identify related hazards, risks and sensitivities;
- Arrangements shall be put in place to control the hazards, risks and sensitivities and to deal with consequences should they arise;
- Any activity which is unhealthy, unsafe, environmentally unsound or may adversely impact relations with the community, shall be suspended until an acceptable solution is found;
- All personnel, including those of contractors, shall be trained and made fully aware of the hazards, risks, sensitivities and controls in place; and
- Plans and procedures shall be in place to respond to any emergency or loss of control.

Every employee and contractor employee must plan and perform his work in accordance with this policy. Each employee is required to report, and where necessary, suspend any activity considered to be in contravention of this policy.

(e) SCiN Biodiversity Policy

''In Shell, we recognize the importance of biodiversity. Therefore, we are committed to:

- Work with others to maintain Ecosystems
- Respect the basic concept of Protected Areas
- Partner with others to make positive contributions towards the conservation of biodiversity in our areas of operations
- Conduct Environmental Assessments with increased focuson impacts on biodiversity
- Engage and collaborate with other stakeholders to manage biodiversity responsibly especially in sensitive environments''

(f) Waste Management Policy

It is the policy of SPDC to:

- Take all practical and reasonable measures to minimize the generation of solid and liquid wastes, as well as emissions from construction equipment and otherwise;
- Manage and dispose off wastes in an environmentally responsible manner;
- Track and maintain records of waste streams and provide an auditable trail as to their management and disposal.

(g) Emergency Response Policy

This states that the response to any emergency within SPDC will be directed towards

- Saving life
- Care for the injured
- Protection of the environment
- Limitation of damage to assets
- Defence of SPDC's good corporate image
- SPDC shall provide appropriate organization, facilities, procedures and training so that immediate coordinated action can be taken to manage the situation in line with the above
- Maintenance of emergency equipment shall receive high priority. Close liaison will be maintained with appropriate Government and industry organization and communities
- Regular exercises will be carried out to confirm effectiveness, and any necessary improvements made promptly so as to maintain our readiness at all times.

(h) Community Relations Policy

In order to pursue mutually beneficial relations with host communities, SPDC shall:

- Establish and maintain close relationships with all segments of the local population to better understand their concerns, needs and aspirations
- Continuously assess and abate social and economic impact of all business activities and take needed preventive or mitigating measures
- Respond to formal community request in an appropriate and timely manner
- Bring relevant issues affecting host communities to the attention of appropriate authorities and other bodies that can be of assistance
- Manage settlement of compensation for land acquired for company operations and for damages in a demonstrably fair, accountable and transparent manner and in accordance with statutory provisions and approved procedures.

1.7: Structure of this EIA Report

- **Chapter One** - Introduction presents the background information, EIA objectives, Legal and administrative framework.
- **Chapter Two** - Project Justification, discusses the project background, project objectives, rationale for the project, envisaged sustainability, and development options considered;

- **Chapter Three** - Project Description, describes the type of project, scope, location, material input/output and by-products, waste generation, technical layout and process, operation and maintenance, project schedule;
- **Chapter Four -** Description of Existing Environment - provides information on the baseline environmental conditions of the project area describing the physical, chemical, biological social, and health environment
- **Chapter Five** - Associated and Potential Environmental Impacts - highlights the Associated and Potential Environmental Impacts of the proposed project;
- **Chapter Six** – Mitigation Measures/Alternatives – describes the mitigation options of impacts;
- **Chapter Seven -** Environmental Management Plan - provides the proposed plans for environmental management;
- **Chapter Eight -** Conclusion and Recommendations – provides remediation plans after decommissioning/abandonment.

CHAPTER TWO
PROJECT JUSTIFICATION

2.1: Background

The Agbada field is located in the Eastern Land Area operation of Shell Petroleum Development Company (SPDC) in OML 17 situated approximately 16 km North-East of Port Harcourt in Rivers State. The field was discovered in 1960 by SPDC and to date sixty-six (66) wells have been drilled in the field.

2.2: Need for the Project

The drivers for this project are as follows:

- Targets meeting the Federal Government aspiration to make gas available to the Federal Government (FGN) Power Plants in Alaoji (Abia State) and in Ikot Abasi (in Akwa Ibom); to the Geometric Independent Power Plant (IPP) and to local industries like the Notore Chemical Industries & ALSCON.
- To supplement the identified 250MMscf/d shortfall in short term gas supply to the Eastern Domestic Gas (EDG) network.
- AG Solution provision for the existing SV gas from Agbada 2 flowstation, which is currently being flared in line with Government flares out position.

2.3: Value of the Project

The benefits of the project include:

- Supply of gas to the Federal Government Power Plants and thereby supporting the provision of a reliable power generation capacity for the Nigerian electricity grid.
- Supporting the Nigerian economy by provision of gas to local industries.
- Increased production. The project will potentially contribute about 100MMscfd of gas to the EDG market.
- Functional excellence in the maximum use of ullage in existing facilities thereby eliminating provision of separate gas export lines

The total estimated CAPEX for the Agbada GHF, wells and facilities is about $(US) 122M.

2.4: Envisaged Sustainability

2.4.1: Economic and Commercial Sustainability

This facility is envisaged to be economically and commercially sustainable because of the gas volume present in the Agbada field and the gas reserves in other nearby fields that can be produced in the future on depletion of the Agbada NAG reserves (circa 5years). With the Federal Government Power Plants (Alaoji & Ibom Power Plants) and ALSCON as major users and given the political drive for power development in the country as well as other domestic users, market for the gas is assured.

2.4.2: Technical Sustainability

The proposed project is expected to be technically sustainable because of the proven technology for the drilling and production operations being used. Strict adherence to internationally accepted engineering design and construction standards as well as codes of practice that shall be adopted at all stages of the project are expected to ensure technical sustainability.

2.4.3: Environmental Sustainability

Incorporation of the recommendations of this EIA at the appropriate stages of the project development is expected to ensure that the proposed Agbada Eastern Domgas Interim Growth Project is environmentally sustainable. The project will provide AG solutions for surge vessel gas from the existing Agbada 2 flowstation that is currently being flared thereby leading to a reduction in Green House Gas (GHG) emissions. Project has been planned in such a way that there will be minimal environment effect especially with respect to land take. The new NAG plant shall be sited at the location of existing disused gas lift compressor plant, which is currently being decommissioned and the wells drilled from an existing well location. Also, the flowlines shall pass through the existing SPDC RoW (Right of Way). In addition, strict adherence to the EMP shall ensure that every aspect of the proposed project is sustainable with minimum impact, especially as it concerns the natural environment and the people who inhabit it.

2.5: Project Options

The alternatives considered are the "No Project" Alternative and Project alternatives with respect to carefully selected criteria. The weighting of the concept selection criteria is a reflection of the measure with which each criterion impacts the ability to achieve the business objective, hence the emphasis on Schedule, Capex (Facilities and Drilling), Constructability, Government and Community issues. These alternatives are discussed in detail in the following sections.

2.5.1: The 'No Project' Option

This option implies that the Agbada NAG development project would not be carried out and gas supply to the Eastern DOMGAS network to feed the proposed Alaoji power plant and other customers on the network will not be available. This will result in a shortfall in gas supply, frustrating Government's plan to boost electrical power generation in the country and hindering industrial activity and economic growth. Also, existing Agbada facilities will continue to operate below installed capacities (sub-economic) and a proven hydrocarbon resource base will be under-exploited thereby depriving Nigeria of increased hydrocarbon production and potential revenue. This will also imply that the current situation where Surge Vessel gas is being flared will continue. Since the main objective of this project is to supplement the anticipated short-term shortfall in gas supply to the Federal Government Power Plants and Eastern Domestic gas market and also increase production and mature more reserves, this option was rejected.

Decision: Not recommended

2.5.2: Eastern Domestic Gas Supply Development Options

To address the identified gas supply shortfall in the short-term, the gas supply options in the catchment area were revisited with the intention of proposing only quick win projects that can be delivered in the tight timeframe of achieving first gas by end 2010.

Option 1: - Agbada wells only produced to Okoloma

The schematic below shows Agbada wells producing to Okoloma Gas Plant. Located at Okoloma Gas Plant is a gas treatment package that can be used for gas dehydration and hydrocarbon dew pointing of the gas from Agbada. Where the twister may not be able to dehydrate to the required gas specification as already envisaged, there will be need to install a GHF at Okoloma to handle the Agbada incoming streams. The Agbada Wells produced in Okoloma is presented in fig. 2.1.

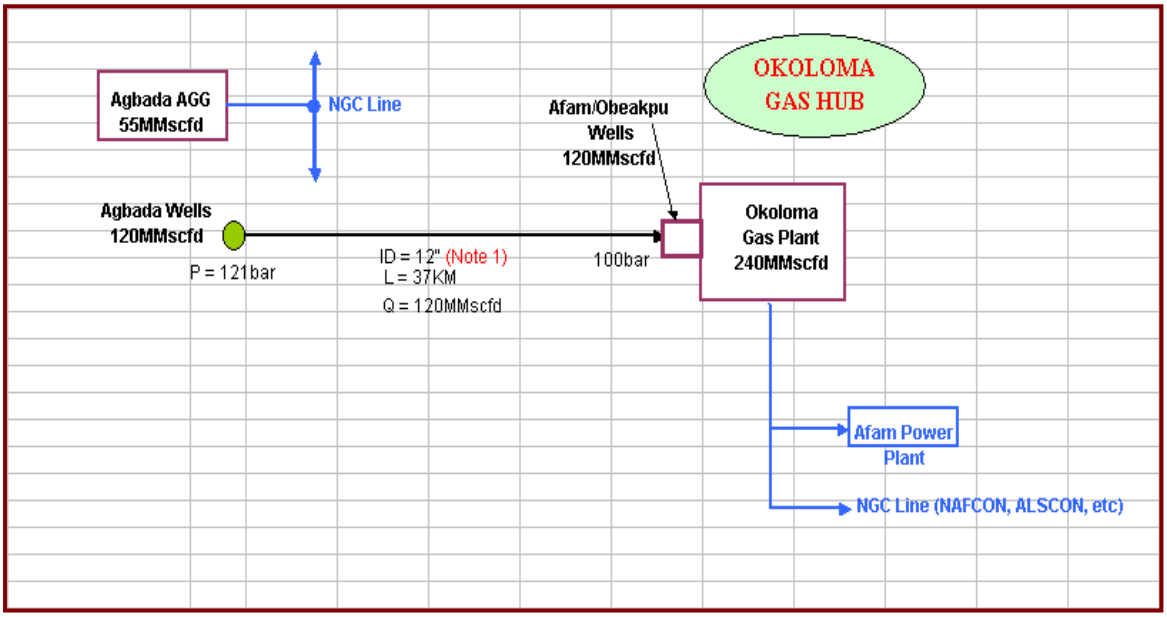


Figure 2.1: Agbada wells only produced to Okoloma

Concept - 1 Work scope

- Procurement and installation of flowlines from Agbada wells to the cluster manifold.
- Procurement and installation of Flowline (bulkline) from Agbada to Okoloma Gas Plant.
- Procurement and installation of Manifolds.
- Installation of gas receiving facilities at Okoloma Gas Plant.
- Installation of surge vessel compressor at Agbada.

Decision: Not recommended

Option 2: Develop and produce Agbada

This concept involves installation of 120mmscfd capacity gas plant as was proposed in the SPDC JV's Business Plan with an estimated start-up date of end 2010. Two wells have been identified to fill the plant with drilling planed this year Q4 2009. The schematics of Agbada Gas Plant is presented in fig. 2.2

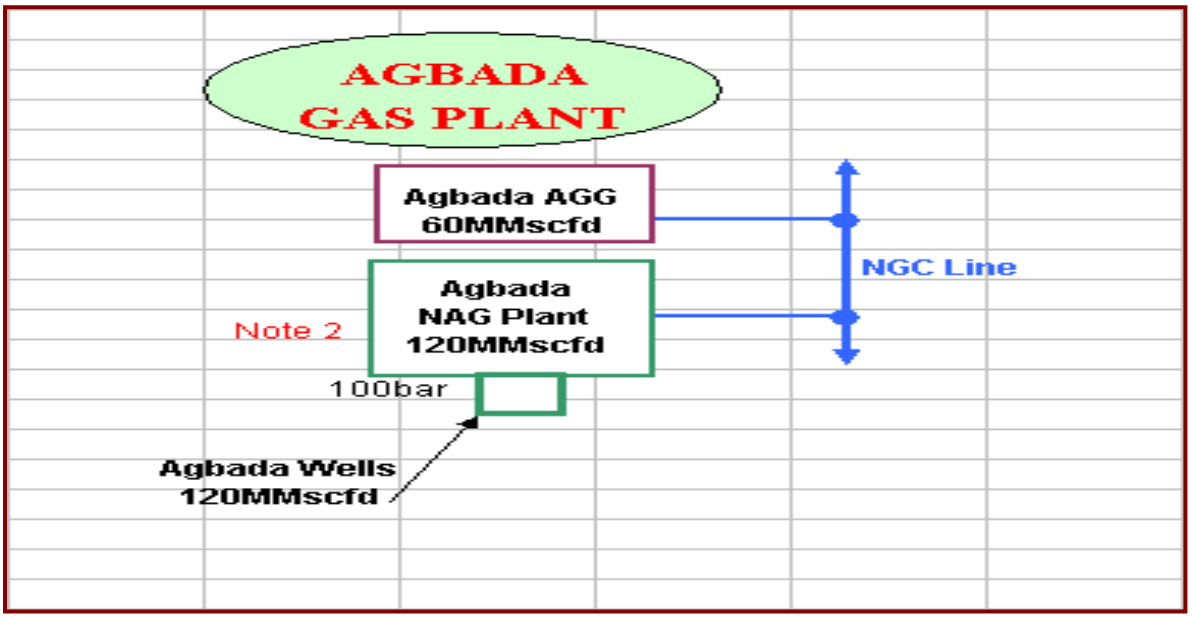


Figure 2.2: Schematics of Agbada Gas Plant

Concept - 2 work scope

- Drill wells
- Install Packaged Gas Handling Facility.
- Install Surge vessel gas compressor.
- Install 2 nos. 8''x 8.0km flowlines from existing well location-3 at Agbada-1 to proposed NAG plant at Agbada-2.

Decision: Recommended

(A lease NAG plant will be considered if it offers better schedule and cost gains)

2.5.3: Details of the Recommended Option

Sub-surface scope

The following subsurface developments are planned to ensure the delivery of the additional 100 MMscf/d of gas from the Agbada field:

- Drill and complete one NAG well in Q4 2009 on the G6000 reservoir with a 50 MMscf/d potential. This well will appraise the G4000 and H block reservoirs.
- Drill and complete a 2nd new NAG well on the G8000 Reservoir with a 50 MMscf/d potential in Q4 2009/Q1 2010.

- Re-complete a 3rd NAG well on the G4000 reservoir with a 50 MMscf/d potential in Q1 2014.

Surface scope

The proposed surface development scope is summarized below:

Flowlines

The flowline scope at Agbada field involves the following:

- Lay 2 nos. 8" x 8km carbon steel NAG flowlines from Agbada 1 to Agbada 2 NAG plant (including well hook-up) in Q1/Q2 2010.
- Install a corrosion inhibitor system in Agbada 1 plus 2" x 1.5km flowline, a kill manifold and tubings to take the inhibitor to the 2 NAG wellheads.

Facilities

The facilities scope involves the following at Agbada Field:

- Purchase and Installation of 120MMscf/d NAG processing plant complete with inlet gas heating, gas/liquid separation, dehydration, dew point control, metering, gas/condensate stabilization, liquid export pumping, and corrosion inhibition at Agbada 2.
- Install screw booster compressor to gather gas from the surge vessel operating at 0.2 barg at Agbada 2 flowstations.

2.5.4: Agbada NAG Development – Concept Selection Criteria

Table 2.1 shows a set of concept selection criteria used for the selection of the best feasible option that will deliver the project in line with the project and business objectives. These criteria have been carefully selected as they cover not just the surface facilities but also the impact on sub-surface realizations of current and future reserves, cost, schedule, operability, and value chain contribution and reputation issues.

The weighting of the concept selection criteria is a reflection of the measure with which each criterion impacts the ability to achieve the stated business objective, hence the emphasis on Schedule, Capex (Facilities and Drilling), Constructability, Government and Community issues.

Table 2.1: The Concept Selection criteria and associated weightings

S/N	Selection criteria	Description	Weight
1	Facilities Capex	Sum of total project net facilities capex over field life. On-costs excluded.	20%
2	Drilling Capex	Sum of total net drilling and flowlines capex	15%
3	Schedule	The total period and time required to execute the proposed work or concept.	30%

S/N	Selection criteria	Description	Weight
4	Scalability	Assessment of the ability of the selected facility concept to accommodate future development (e.g. Buguma and new fields) by: (1) Providing nearby infrastructure (2) Offering future ullage in a reasonable time scale	10%
5	Constructability and Operability	Ease of construction with minimal disruption	15%
6	Government and Community issues.	Mainly how the project impacts on the communities	10 %
Total			100 %

For the overall assessment, position ranking have been used in relation for scoring levels is presented in Table 2.2.

Table 2.2: Scoring and Ranking Table

Criteria Based Evaluation: Ranking Position	1	2	3	4	5
Scoring Levels	5	4	3	2	1

Criteria considered equal for all development scenarios are not carried in the above table, these include: Nigerian content: the level of local content will only be defined during FEED, and cannot be a differentiator at this stage. It is relatively insensitive to the scenarios, except for the absolute volume of work. This should not be used at this stage.

Overall Assessment

An assessment of the scores for each concept was evaluated against the six broad criteria and came up with overall positions of the concepts. Criteria / issues that have potential delivery exposures such as schedule, cost and constructability were considered more critical than those with shorter exposure to the overall project delivery. The overall scores are shown in Table 2.3.

The result for the well drilling capex criteria shows no change in scoring because whichever option is selected the wells have to be drilled at Agbada, but for all other criteria used for evaluation, Concept –2 scored better than Concept –1. Hence, the option of developing and producing the Agbada field through a NAG facility at Agbada was selected as the concept of choice. The option though of a leased NAG plant is now being considered, should it offer better schedule and cost gains it will be the option of choice.

Table 2.3: Overall Assessment Chart

Overall Assessment Chart								
Factor Description	Facility Capex	Drilling Capex	Schedule	Scalability	Construction and Operability	Government and Community Issues		
							Total	**Position**
Weighting	20	15	30	10	15	10	**100**	
Concept-1	4	2	3	2	1	2		
	80	30	90	20	15	20	**255**	**2**
Concept-2	5	2	4	4	3	5		
	100	30	120	40	45	50	**385**	**1**

CHAPTER THREE
PROJECT DESCRIPTION

3.0: General

This chapter presents a concise description of the project and all the activities to be carried out during each phase, including timeline and project schedule.

3.1: The Project Location

The planned onshore Agbada field development project is located in SPDC's OML 17 and falls within Rivers State (Ikwerre, Obio/Akpor, Etche, and Port Harcourt Local Government Areas). Latitudinal and longitudinal positioning of the Flowstations I and II were found to be 6.58^{o}72'E, 4.56^{o}02'N and 7.00^{o}95'E, 4.55^{o}94'N respectively using a GARMI Global Positioning System (GPS) on the field. Agbada field was the first land-based oil-field in the Eastern Division of SPDC. The two flowstations, Agbada I and II were commissioned in 1960 and 1965 respectively with a combined capacity of 90,000 bbl/d. Agbada I is a single bank flowstation with a nominal capacity of 30,000 bbl/d having 30 flowlines laid to the station while Agbada II is a double bank flowstation with a nominal capacity of 60,000 bbl/d and having 57 flowlines. The Map of Rivers State showing the proposed Local Government Areas were the Agbada Non Associated Gas is located is presented in fig. 3.1.

Fig. 3.1: Map of Rivers State showing the proposed project LGAs (Arrowed)

The scope of the EIA are within the area with the following coordinates below:

	Easting	**Northing**
1	492156.4	95203.2
2	492125.2	113491.8
3	516334.3	113491.8
4	516334.3	95172.0
5	492156.4	95203.2

The project centers on six (6) communities from two (2) Local Government Areas LGAs in Rivers State. The Local Government Areas are Obio Akpor and Ikwere LGAs. The communities Omuoda Aluu, Mbodo Aluu, Omunike Omunoba and Omuigwe Aluu in Ikwere LGA and Rumujima Eledo Rukpokwu and Elikpokwodu Rukpokwu in Obio Akpor LGA. The Map of the proposed EIA Project location is presented in fig. 3.2.

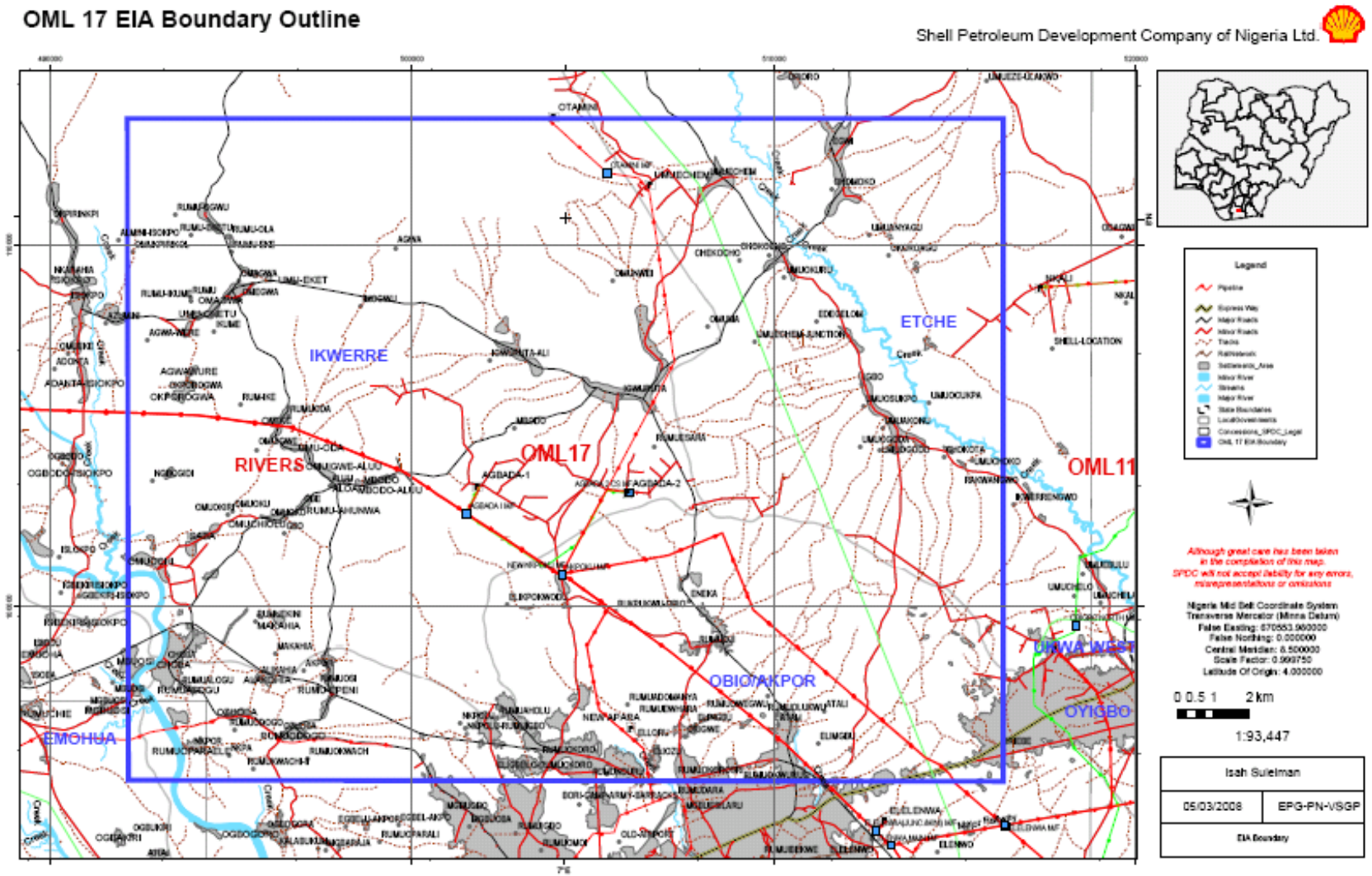


Fig. 3.2: Map of the proposed EIA project location – Agbada (OML 17)

3.2: Conceptual and Detailed Design

The conceptual design for the new facilities involves pipeline sizing, process simulation, slug catcher, material selection and requisition. Others include preliminary sizing of the separators, compressors and dehydration facilities, which is part of in-house design responsibility. The detailed design is part of the Engineering Procurement and Commission (EPC) contract, which covers plant layout, survey, soil investigation, foundation, and inter-skid piping system. Also included in the detailed design contract are slug catcher, separators, corrosion inhibition plant, instrumentation, electrical, detailed process and pipeline design including interface to the existing facilities, material requisition, start-up/commissioning procedures and production of operators and maintenance manuals. The design contractor is to ensure a fit-for-purpose design.

3.3: Quality Assurance of Design

In a design of a system such as this project, it is imperative that certain basic parameters must be defined in the overall project specification to ensure that the full objectives of the project are realised. SPDC has therefore, specified the following quality objectives for the design:

- Compliance with statutory requirements;
- System must meet performance requirements;
- Production availability;
- Environment and safety;
- Operationability and maintainability;
- Life expectancy;
- Extendibility;
- Compatibility with existing facilities.

3.4: Applicable Standards and Codes

The engineering design, procurement and installation will be in accordance with the latest revisions of the following Statutory Codes and Standards: Federal Republic of Nigeria National Standards, SHELL Design and Engineering Practices (DEPs), SPDC Standard Facility Design Manuals, and applicable International standards and Manuals.

3.5: Design Considerations:

The facilities and pipeline, which shall have a design life of 25 years, shall be constructed in accordance with SPDC's DEPs, standard construction specifications and relevant government and other regulatory standards. Innovative technology that will reduce negative impact of facilities construction on the environment shall be utilized during the construction phase. All wastes generated during construction shall be disposed off in accordance with approved industry regulations (DPR and FMEnv). Emission to the atmosphere and noise pollution shall be minimized to acceptable regulatory limits. All the facilities shall have in-built special containment facilities for hydrocarbon spills, if any. Bulk/flowlines in marshy/swampy areas and at water crossings shall have a yard applied tape wrapping over the anti-corrosion priming. The wrapping shall be done in a pipe yard before transportation to the site. The

handling, loading and stacking of wrapped pipes shall be carried out strictly in accordance with the SPDC standard specifications.

3.6: Project Activities

The proposed Agbada NAG Field Development project consists of the following activities:

- Location preparation
- Drilling and Completion of 2 NAG wells (W67 and W68) Casing, logging, cementation and completion of all the wells;
- Well testing and hook-up
- Decommissioning of existing gas lift compressor
- Installation of GHF
- Installation of screw booster compressor at Agbada II
- Land acquisitions and claims settlement
- Right-of-way clearing (8.9316 hectares)
- Trench excavation
- Cleaning, beveling and pipe bending
- Laying 2Nos. 8" x 8.15km flowlines from wells at Agbada I to NAG plant at Agbada II
- Welding
- Field joint coating
- Inspection, testing and NDT of welds
- Lowering and backfilling
- Manifold works
- Site re-instatement
- Demobilization

3.6.1: Land Take

There shall be additional land take 10% (8.9316 hectares) along the RoW. The GHF & SV compressor will be located within SPDC owned Agbada 2 facility, the NAG wells will be drilled from existing SPDC acquisition and the flowlines will be along existing SPDC ROW.

3.6.2: Location Preparation, Land Clearing and Excavation

Site preparation activities shall be necessary prior to rig entry, flow line and GHF installation activities.

3.6.3: Drilling Location Platform Preparation

The size of the drilling site shall be approximately 1ha. This will involve:

- Bush clearing to the appropriate size of location platform, including shoulders;
- Stripping of existing location platform earthworks;
- Reconstruction to suit the rig;
- Construction of generator platform;
- Excavation/concrete lining of standard waste pit;

- Construction of ancillary facilities such as perimeter drains and oil traps; and
- Block work fencing of location platform.

Drilling Camp Site Preparation

The campsite preparation activities will also involve bush clearing, earth works and surface dressing of campsite. The drilling camp layout will accommodate the following:

- Offices;
- Kitchen;
- Soak away toilets, showers and sumps;
- Sleeping units for senior and intermediate staff;
- Stores and workshops; and
- Fuel store/dump.

3.6.4: Site Preparation for GHF Installation

This will involve:

- Bush clearing;
- De-commissioning of old gas lift compressor & utilities;
- Excavation;
- Equipment foundations;
- Sand and earth fill for levelling of ground; and
- Fencing.

3.6.5: Drilling, Workover and Completion of Wells

The drilling activities will involve the following major activities, details of which shall be in accordance with Standard Methods as clearly stated in the SPDC Drilling Engineering Procedures Manual (SPDC, 2003) and the DPR Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN, 2002).

- **Surface Hole/Intermediate/Production Drilling**

Both wells will have the following 67/ 68;24'' stove pipe - /(354ft10 ¾'' 60.7ppf- /(120ft) 9 5/8'' 47ppf -/ (11,725ft). The operation will include driving a 24" stovepipe to refusal depth. A 12-1/4" surface hole will be drilled to isolate the upper unconsolidated sands to a depth just before the topmost hydrocarbon sand and a 9-5/8" casing set. An 8 ½ - 10½" hole will be drilled to TD penetrating the reservoir and a 7" liner set. Communication with the reservoir will be established by perforating the casing with deep penetrating charges. The well will then be completed with 4 ½" chrome tubing based on the well potential. The projected well depths for W67/68 is /11,774ftah.

Single completion per reservoir has been adopted for the development of the target gas reservoirs due to the favourable reservoir properties that support one well adequacy to drain

each reservoir. The target reservoirs are consolidated and do not require sand control, hence through tubing recompletion can be achieved.
The well was drilled with Pseudo oil based Mud (POBM) and the drill –in fluid across the reservoir was Thixal mud to reduce the reservoir impairment, thereby increasing the production potential The POBM is recovered and treated for use in other wells by the Mud supplier.

- **Logging**

This is the electrical/nuclear investigation of the drilled well to ascertain the lithology and fluid content. The interpretation of the log data gives an indication of the presence and the quantity of hydrocarbon (oil and gas) in the formation.

- **Completion**

This is the process of hooking up a well for production. The process involves logging, well-bore clean-up, perforation, production testing, sand consolidation and installation of the Christmas tree. The completion is 4 ½'' 13cr upper completions with external Gravel pack in the sand face. This is to enable 40Mmscf/day gas production. The completion of the drilling will be the hooking up to the field manifold. Casing strings are an important element of the protection of groundwater resources as they ensure the isolation of fresh water zones and groundwater inside the well. Casing is further used to transmit flowback fluids from well treatment and is the first line of defense and a second layer of protection for groundwater,
We also carry out frequent sampling and laboratory analysis of waters from boreholes drilled within the location to provide a groundwater monitoring array that will enable the setting of an environmental baseline and the ability to study and record groundwater conditions throughout the lifecycle of the operation.

This frequent monitoring, sampling and laboratory analysis is regulated by Nigerian Laws & International Standards viz;

- EGASPIN (2002) Part III Section E3.8
- Federal Ministry of Environment Regulation (Guidelines and Standards for Environmental Pollution Control in Nigeria),
- American Public Health Association (APHA, 1998),
- American Society for Testing and Materials (ASTM), and
- American Petroleum Institute (API)

3.3.6: Pipelines

Design will be in accordance with the requirements of SPDC's Pipeline and Flowlines Design Manual and Shell DEP 31.40.00.10-Gen., Pipeline Engineering and other relevant DEP's. Pipelines routing shall be as per the completed route survey. Pipelines shall be designed according to the Design case.

Design parameters

Pipe design is determined based on the maximum fluid flow rate without an additional design margin. Pipe size selection is to be in accordance with DEP 31.38.01.11-Gen. "Piping General Requirements". All designs shall be based on site survey findings of the terrain, soil resistivity, stray currents and other possible interactions with neighbouring pipelines' cathodic protection systems. All inter-field gas gathering pipelines shall be buried. Pipelines shall be trenched and back filled such that there is 1.5 meter of fill above the pipe.Three-layer polyethylene coating will be used as external anti-corrosion coating for the pipelines. Concrete coating shall be applied to swamp sections and river/estuary crossings. Intelligent pigging facilities shall be provided for all pipelines. Pipeline between flowstations and adjacent or nearby (less than 200 meter) booster stations are considered plant piping and designed accordingly. Slugcatcher surge volumes shall be sized to accommodate sphere generated slugs during controlled pigging under reduced flow operations.

Selection of pipe grade will be made on the basis of the following criteria:

- Pressure containment and stresses
- Construction lay stresses
- Pipe standardization
- Corrosion allowance and mitigation
- Design life of pipeline

3.3.7: Laying of Flow lines and Pipeline Networks

The activities associated with Installation of 2Nos x 8" x 8.15km flow lines (i.e. Total length of both flow lines is 16.3km) from NAG Wells at Agbada-1 to the pig receiver at Agbada-2 NAG plant consist of: RoW bush clearing;

- Trenching;
- Stringing;
- Welding;
- Radiography;
- Field joint coating;
- Lowering;
- Backfilling; and
- Hydrotesting.

ROW survey and bush clearing

Prior to commencement of any construction works, SPDC shall perform a detailed pipeline corridor survey to establish all crossings (road, creeks and rivers) including locations of existing facilities. SPDC surveyors shall re-open the pipeline Right of Way (RoW) and confirm all set out boundaries along the ROW including those at all manifolds. SPDC shall also be responsible for ensuring that the existing survey pillars are maintained and not destroyed by construction activities.

SPDC shall clear, grade and strip as need be, the ROW and prepare the areas where the new lines shall be laid. Grading operations shall be carried out only on dry land. The RoW shall

be cleared for its complete width. At road crossings, removal of topsoil shall be kept to a minimum, and surface materials shall be removed (where necessary) only at the time of crossing. SPDC shall provide adequate room for handling of materials and equipment on site. All worksites shall be prepared in accordance with Shell Standard Construction Specifications sections 2, 3 and 4.

Trenching

Trench dimensions shall be at least 30cm more than the outside diameter of the coated pipe. Trench depth and width shall be increased as necessary where the pipeline approaches crossings or other specialized route sections. Where required, the excavated trench shall be secured against collapse by suitable means e.g. timber planks, sheet piles, etc. All existing structures shall be located by manual excavation. After completion of pipeline installation activities, timber planks, sheet piles, etc. shall be completely removed.

Road Crossing

The pipeline will be 3m beneath the road at road crossings.

Stringing & Bending

8" PE coated carbon steel pipes (L450/X65 grade) for flow lines and (L360/X52 grade) for 2" corrosion inhibition lines. The choice considerations for the flow lines from design parameters includes; the design well flow rates, NAG production forecast, NAG temperature, pressure and composition.

SPDC shall string the line pipes along the ROW beside the open ditch with suitable equipment and handling tools. Stringing of pipes shall be interrupted where necessary to allow passage of vehicles, livestock, etc. Coated pipes shall rest on padded supports or timbers to avoid damage to coating. This shall apply also during transportation of pipes. Strung pipes shall be provided with caps at both joint ends to keep the joint free from dirt and extraneous materials. Joint and weld numbers shall be permanently marked on the external surface of the pipe at suitable locations to allow proper recording of welds.

Factory-made hot bends having a minimum bend radius of 15D shall be used in the project. Horizontal and vertical deviations shall be obtained as much as possible by stress free elastic bends. Stringing and Bending shall be carried out in accordance with Section 25 of the Shell Standard Construction Specification.

Bevelling, Welding and Non-destructive Weld Inspection

The welding procedure specification (WPS) approved for manual welding is in line with ASME B31.8 (Gas transmission and distribution piping systems), DEP 61.40.20.30-Gen (Welding of pipelines and related facilities -amendment/supplement to API 1104), DEP 31.40.00.10-Gen (Pipeline Engineering) and Standard Construction Specification Section 21(Welding).

An approved pipe cutter or thermal cutting and bevelling machine shall be used to perform joint bevelling. Manual cutting shall not be permitted. Bevels shall conform to the requirements of the welding specification. Pups required for tie-ins shall be cut from undamaged pipes. The minimum length of pup to be inserted in the line shall be 1.0m. The line pipes will be laid and welded by separate crews. They will be laid on padded supports or timber skids for welding along the ditch.

All field bends, required lengths of cut pipes and welds shall be in accordance with section 21 and 25 of Shell Standard Construction Specifications. Non-destructive testing of welds using radiographic procedures, which expose the full circumference of the joint, will be carried out following the completion of the weld. One hundred percent radiography of all weld joints shall be employed. All radiography films will be processed and interpreted on site to facilitate quick repairs of defective welds. Fillet weld joints shall be subjected to dye penetration tests. SPDC QA/QC representative on site prior to acceptance must certify the entire weld joints okay.

Pipeline Coating

The coating system for the proposed condensate line will be as follows:

- Anti-Corrosion Coating: Polyethylene-coated line pipes with shrink sleeve used for field joints; and
- Weight Coating: The section of the delivery line that falls in seasonal swamp area and river crossings will be coated with concrete to protect the anti-corrosion coating and to overcome negative buoyancy during installation.

The thickness of concrete coating will be determined after detailed buoyancy calculations are carried out as part of the detailed design. Heat shrinkable sleeves or repair patches shall be used for repairs of defective field joint coatings taking into account the extent of the portion to be repaired. Holiday test shall be conducted on all field joint coatings. SPDC QA/QC representative on site must certify this okay before lowering can commence. Defective coatings shall be clearly marked. All repairs shall be inspected visually and with a holiday detector to confirm that they are acceptable. All riser sections shall be protected using Riser clad.

Lowering and Backfilling

The welded pipe shall be lowered gently into the ditch without subjecting the line to any stress. The pipes will conform to the ditch and substantially supported by the ditch bottom. The bed underneath the pipe shall be prepared by installation of soft material (medium sand bed) to obtain a soft surround for the installed pipe. The material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of 150mm.

During lowering in dry land special care shall be taken to ensure the pipe coatings sustain no damage. Coated pipes shall be handled with rubber-covered broadband slings adequate for the pipe diameter. Strings shall be constructed so that they can be removed from under the pipe without dragging any metal parts against the pipe coating.

Backfilling

Initial backfilling shall be carried out by installation of soft material (medium sand bed) to obtain a dampened surround for the installed pipe. Initial backfill material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of 150mm. Stockpiled spoil and shall crown it (heap up) along the top of the trench line. Backfilling operations shall be carried out with due attention to avoid pipeline uplifting.

Cathodic Protection

The cathodic protection test stations will be done in two phases. The below ground installation (cable connections) will be carried out soon after lowering-in prior to backfilling. The above ground installation will be carried out on completion of the back-filling exercise. The sacrificial anode design lifespan is 5years. This would be replaced by a deep ground bed cathodic protection system upon commissioning.

Cleaning, Gauging, Pressure testing and De-watering

Pipeline Cleaning:

In line with SPDC standard Construction Specification procedure on completion of pipeline construction, pre-commissioning activities will include cleaning by introducing swabbing and brushing pigs into lines via the pig traps.hydrotest of pipelines to 1.25 of the design operating pressure for 24h using tested borehole water (will most likely be used and the time the water kept in the pipes will be kept to a minimum so to eliminate the use of inhibitors).

Pipelines were properly cleaned by running air-driven swabbing and brushing pigs in order to ensure the lines were free of debris. Filling of the lines with tested potable water followed and introduction of two swabbing pigs in order to ensure removal of air. On arrival of water filling pigs, flushing continued until an acceptable clean level of the lines were achieved. Water pressure-driven gauging pigs were thereafter introduced and deformity checks carried out upon arrival at the exit point. Thereafter, hydrostatic pressure was applied moderately up to 30% of the test pressure ensuring that the air content in the line does not exceed 0.5% of volumetric capacity and held for 2hours to confirm no pressure loss. On satisfactory completion, pressure was moderately raised to 70% of the test pressure with a maximum pressure of 20bar/hour. After attaining 70% of the specified test pressure, raising of the pressure continued moderately at 15% of the test pressure (or 10bar/hour) until the specified test pressure was achieved. This was held for 2hours and thereafter, the pressure was reduced to 50% of the test pressure at a rate of 20bar/hour for the first hour and later 60bar/hour. This process was repeated in order to achieve the required test pressure. Then the ambient and water in the line temperatures were recorded. After ensuring stabilization of the lines, the

chart recorder was now connected and monitored for 24hours with the initial temperature and pressure readings taken. Also, gauge pressure and temperature readings were recorded on hourly basis. On successful completion of the hydrostatic pressure test, the lines were depressurized immediately at a rate of 20bar/hour at first and thereafter 60bar/hour. The specified test pressures used are 1.25 of the design operating pressure for flow lines and 1.5 for piping. Water in the lines were properly discharged into an impermeable containment pit using air-driven high density foam pigs. Drying process followed immediately by introducing low density foam pigs through the pig traps and blowing of the lines continuously with air in order to remove moisture and achieved the required dew point of -20^{o}c.

Gauging and Pressure Testing:
Hydrotest of pipelines to 1.25 of the design operating pressure for 24h using tested borehole water will be used and the time the water kept in the pipes will be kept to a minimum so to eliminate the use of inhibitors.

Dewatering:
There will also be depressurizing and drying of the lines with compressed air-driven high and low density foam pigs in order to remove moisture from the lines to the required dew point of -20^{o}c were all carried out. Thereafter, leak test, purging/preservation of lines with nitrogen and awaiting final commissioning which will involve introducing the products. SPDC site representative shall supervise the pressure test. Calibrated pressure and temperature charts shall be used to record pressure and temperature respectively during the pressure test. The new line shall be de-watered after pressure testing using compressed air and foam pig.

Corrosion inhibitors will be injected continuously via an injection skid at each wellhead to help reduce internal corrosion and extend the lifespan of the flow lines. The effluent during the chemical treatment will be transferred to the SPDC Produced water system in the Agbada I and II flowstations for subsequent export to Bonny terminal.

Concrete Works
All civil works involved in the hook-up of the new line shall be carried out in accordance with the SPDC Standard Construction Specification Section 12. All existing concrete works damaged by the construction exercise shall be re-instated to its original grade.

3.3.8: Commissioning and Handover
A pre-commissioning audit of the new lines to verify their conformity with the construction drawings shall be carried out. All spades and temporary connections shall be removed and a physical check will also be carried out on all facilities to confirm their operability prior to commissioning the lines.

SPDC personnel shall return all manifold valves to normal operating positions open up the flow stations and commission the new line. Crew support shall be provided during start-up and introduction into the line. Baseline Cathodic Protection (CP) Survey and intelligent

pigging shall be carried out prior to handover to the asset owner (SPDC Area Team A Manager).

3.3.9: Site Clean-up and Demobilization from Site

At the end of site works, SPDC shall ensure that the ROW and work site are properly cleaned and reinstated. All identified scrap/surplus materials shall be documented and returned to SPDC's scrap yard at Kidney Island, Port Harcourt.

Installation of GHF

The EPIC contractor shall establish a construction base near the work site in a location to be approved by SPDC. Contractor will fabricate the NAG plant in standardised modules off-site in his fabrication yard. The modulus shall then be transported to site and installed on pre-constructed foundations, after which the balance of plant and inter plot pipe works will be carried out.

Decommissioning of disused gas-lift compressor

The existing disused gas-lift compressor and associated utilities occupying the proposed location of the Gas Handling Facility shall be decommissioned. Decommissioning will involve dismantling compressors and carting away from site, flushing of pipes, cutting, back loading and carting away from site. Also all utilities and other non-required concrete structures and facilities of the old compression station shall be dismantled and transportation to SPDC dumpsite at Kidney Island.

Civil/ Foundation Works

All civil works involved in the installation of the GHF shall be carried out in accordance with the SPDC Standard Construction Specification Sections 3,4 and 12. All existing concrete works damaged by the construction exercise shall be re-instated to its original grade. Civil works to be executed in clued the construction of equipment foundations, drains, perimeter fence, control building, utility sheds etc.

Modules fabrication

The main vendor packages such as dehydration package, dew pointing package, metering package and power generation package will be prefabricated and pre-commissioned in the vendor works. They will subsequently undergo full power, full pressure, and full load tests at the vendor works before shipping out.

Modules delivery to site

The Contractor shall be responsible for the transportation of materials after custom clearance from Onne terminal and for transportation to the construction site(s). The contractor is expected to conduct a route survey to determine weight and height restrictions imposed by existing roads between the construction site and the Onne terminal.

Installation of modules at site
Fabrication at site and installation of the modules shall be in accordance with SPDC Standard Construction Specifications sections 12 and 14.

Pre-commissioning
A pre-commissioning audit of the installed facilities will be carried out to ascertain that relevant construction documentation is in place and to prove and validate the functioning of equipment. The activities will be conducted by the contractor, agreed by the Commissioning team and fully documented.

Tie-in/ flowlines hook-up
When the new modules are fully installed and pre-commissioned, a 5-day shutdown will be required to carry out tie-ins to the flowlines, sales gas header, condensate export pipeline, and any other tie-in identified by the Contractor and agreed by SPDC.

Site clean-up and demobilisation
At the end of site works, SPDC shall ensure that the ROW and work site are properly cleaned and reinstated. All identified scrap/surplus materials shall be documented and returned to SPDC's scrap yard at Kidney Island, Port Harcourt.

3.3.10: Operations and Maintenance of Manifold and Pipeline

In accordance with existing SPDC practice, flow lines, pipelines and field manifold have been designed for unmanned operations. Thus, by means of the fitted trim chokes and instrument, the manifold shall be monitored from the flow stations. However, adequate access shall be provided to enable personnel operate the manifold as necessary. Scheduled operations activities (e.g. pigging and well testing) shall be carried out by operations staff when they visit.

The flow lines shall be equipped with on-line access sampling points. To enhance bulk line operations and increase service life, the lines shall be operated at full capacity flow, thus minimizing the chances of deposits that are likely to arise from low flow conditions. The design shall provide for safe and efficient means of freeing the bulk lines of all hydrocarbons.

3.4: Operating and Maintenance Philosophy

For standardization, and to enable easy maintainability, the facilities provided in this project shall, as far as possible, and with the exception of unavoidable new technology, be similar to facilities already installed and operated elsewhere by SPDC. All maintenance and inspection activities shall be carried out with the objective of achieving or restoring 100% design integrity and availability at minimum cost throughout the lifecycle of the facility.

3.5: Technical Risk and Uncertainties

The key technical risks and uncertainties identified include:

- **Pressure Depletion**:

Pore pressure data shows depletion in the D2.0, D5.2, D6.0, E3.0 and F2.0 reservoirs, the lowest being 0.41psi/ft due production.

***Mitigation*:** To mitigate expected pressure depletion in these reservoirs sufficient stock of loss circulation material (LCM) will be made available on the rig, mud over balance will be minimized and long stationary string time will be avoided

- **Collision Risk:**

These wells will be drilled from existing Agbada-03 location.

***Mitigation*:** During top hole drilling deviation survey will be monitored rigorously, if necessary the well will be nudged away to avoid collision. Collision risk will be managed by continuously updating the anti-collision plot.

3.6: Execution Risks

The following execution risks have been identified.

- **Social Performance & Community Interface:**

The Global Memorandum of Understanding (GMoU) is the corporate platform for managing community interface as well as the delivery of social benefits to communities in the project site area. The GMoU structure consists of Community Trusts (CTs) for each host community and a Cluster Development Board (CDB) for clustered communities. Though the project will affect a limited number of communities in Ikwerre cluster, community issues could impact negatively on project execution if not properly managed from the onset.

Mitigation: *A* 5-year GMoU was signed with Ikwerre Cluster, to which Agbada Fields belong in February 2007,and there is an active Cluster Development Board and as well as Community Trusts in place as platform for managing community interface. SPDC is currently up-to-date with payment and development projects are currently ongoing as a result. Additionally, a percentage of project base CAPEX cost is expected to be paid into the GMoU account to support requisite funding for the cluster. Also adequate resources will be provided by the project for pro-active management of community issues throughout project duration.

- **Security Threats During Project Execution**

In view of the security situation in the country and the Niger Delta there is the possibility of security threats such as armed robbery and kidnapping during project execution especially during flowline installation. An attack in line with the overall MEND stated objectives can not be ruled out.

Mitigation: Contract stipulates that the contractor shall provide adequate security arrangements during the execution period. These will be detailed in Contractor's Security

Plan, which shall be approved by SPDC Security department. In addition to this, the project team will also provide for security coverage during project execution. Links will be created with the Security Information Centre (SINC) to enable the flow of Early Warning.

- **FDP And Well Proposal Approvals:**

Subsurface work is concluded; Field Development Plan (FDP) has been approved internally. However DPR approval is being awaited.

Mitigation: FDP and Well proposal have been submitted to NAPIMS and DPR for approval and a formal FDP presentation was made to DPR in June 2009. Agbada field has associated gas-gathering (AGG) facilities; hence approval of the NAG wells proposed is not expected to be a major challenge.

- **Procurement Delays & Alignment of NAG Projects:**

Delay on placement of orders for long lead items will have considerable impact on project completion.

Mitigation: Contract was awarded in 01/09/08 for Gas Handling Facilities including Agbada gas handling facility. FEED has commenced and it is hoped that orders for long lead items will be placed before the end of 2009.

3.7: Decommissioning and Abandonment

The design of the facilities recognized the need to decommission at the end of their operational life. The activities planned for this phase of the project include:

- Dismantling of all surface equipment.
- Excavation to remove buried facilities
- Removal and disposal of concrete works and pipes.

Methods and procedures for wells which have no foreseeable future use shall be as contained in the SPDC's Drilling Engineering Procedures Manual. The abandonment procedure involves removal of all equipment and machinery from the site, removal and disposal of wastes and re-instatement of adversely impacted sites. All drilling camp facilities shall be removed from the campsite and the site re-instated to be as close as possible to the original state.

3.8: By-products and Waste Generation

Drilling wastes expected to be generated during the drilling operations are:

- Drill cuttings / excess or spent drilling mud and completion fluids
- Rig wash (Detergent) water.
- Cementing waste.
- Discarded consumables.
- Domestic waste (solid and sewage).

- Drilling effluents.

Drilling a hole/well shall be achieved by making up the bottom-hole assembly (BHA) below pipes. Rotating this assembly would generate formation cuttings. During this operation, a special fluid (mud) is continuously pumped through the pipe and comes out of the drilling bit. The mud carries the drilled cuttings through the annular space between the drill string and the hole to surface. The drilling mud is a mixture of inert bentonite suspended in a liquid phase with barite as weighting material. The liquid phase may be made up either water or Pseudo-oil. The main constituents of the water-based mud are bentonite, calcium carbonate and barites, both of which are natural minerals. The type of mud generally in use is made up of the following components: Spud (Gel Suspension) mud for the upper hole section. This contains bentonite, polymer additives {e.g. CMC HV}, KCl (shale inhibitors). Pseudo Oil Based Mud (POBM) system for the lower section of the hole (below 9-5/8" casing depth). The wells will be drilled with POBM and the drill –in fluid across the reservoir will be Thixal mud to reduce the reservoir impairment, thereby increasing the production potential.

The functions of the mud are to:

- Exert hydrostatic pressure on the down-hole and prevent the entry/migration of the formation fluid into the well bore;
- Suspends drill cuttings in the hole when the mud pumps are not running;
- Lubricate and cool the drill bit and drill string;
- Deposit an impermeable cake on the wall of the 'well bore' effectively sealing and stabilizing the bore of the hole being drilled.

Waste water shall be treated/flocculated and used for building new mud and also for the rig and equipment washing. The POBM will be recovered and treated for use in other wells by the Mud supplier. The drilling waste management principles in this project will focus on waste minimization and recycling. Typical wastes expected in this Project and options/methods for managing them are summarized in Table 3.1.

Table 3.1: Waste Streams from the FDP Project

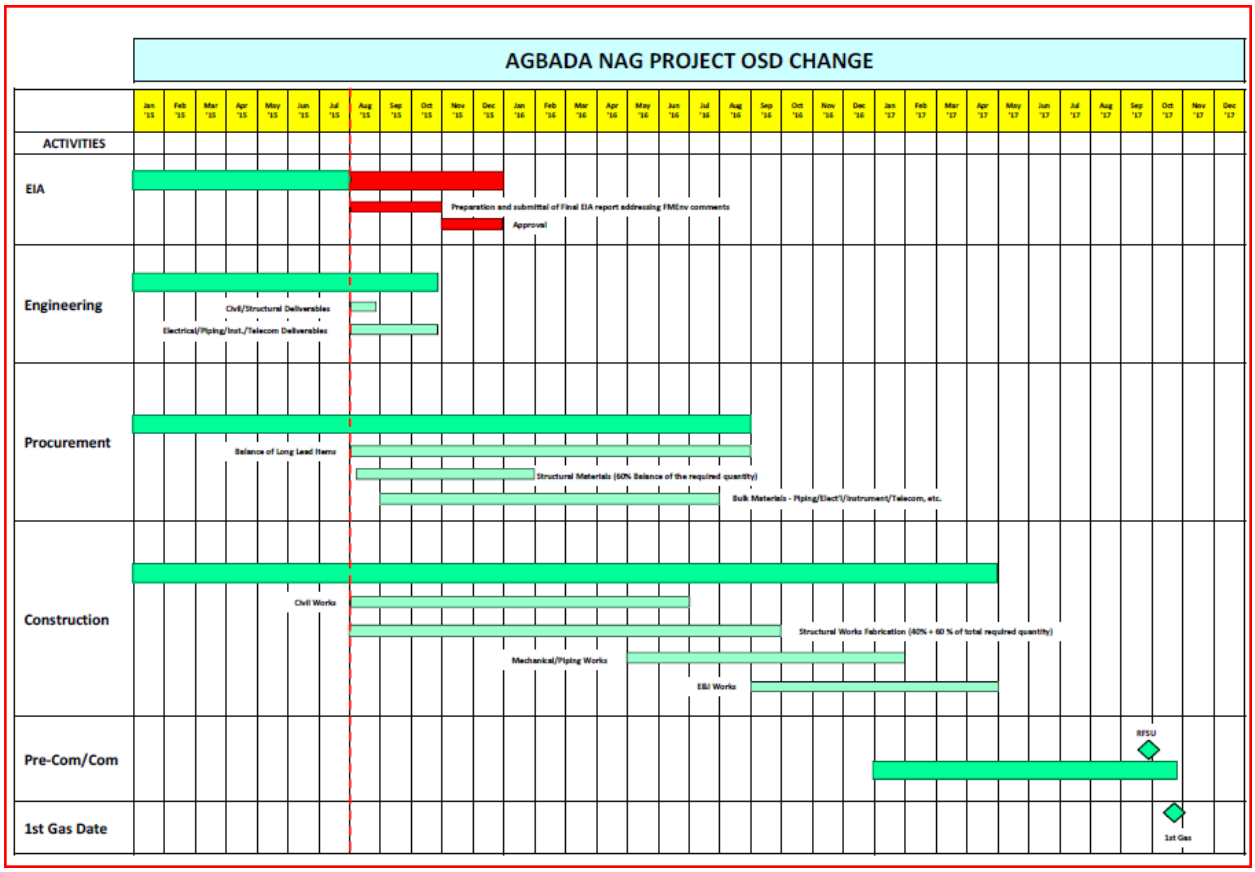
S/No.	Waste Types	Classification	Management Options/Methods
1.	Domestic wastes	Non-hazardous	Move to Government.-approved dump sites at East-West road, location road in Mgbuoba, Elekahia, Abuloma and Wimpy for disposal
		Hazardous	Move to re-cycling depot at Shell I.A in Port Harcourt
2.	Sanitary waste	Grey water	Well-engineered soak-away system at the NAG plant location
			Water treatment plant, Agbada site
		Black water	Well-engineered soak-away system at the NAG plant location

S/No.	Waste Types	Classification	Management Options/Methods
			Sanitary treatment plant, Agbada Accommodation site
3.	Drill cuttings	Top hole cuttings	Wash, land farm and use to fill up waste pits, or use for construction
		Synthetic mud cuttings	Slurrify and treat at TDU in Onne
4.	Waste fluids	Spent mud	Re-inject and treat at TDU in Onne
		Deck wash-offs	Treat on site and transfer to Agbada produced water system for onward export to Bonny terminal
		Storm water	Treat on site and transfer to Agbada produced water system for onward export to Bonny terminal
5.	Work over fluids	Brine, inhibited water, etc.	Treat on site and transfer to Agbada produced water system for onward export to Bonny terminal
6.	Construction waste	Pipe off-cuts, metal scraps, etc.	Move to the SPDC dumpsite at K.I for segregation and subsequent move to Metal Recycling Depot.
		Welding electrode stumps	Move to I.A. Waste Dumpsite for segregation and subsequent move to Metal Recycling Depot.
7.	Vegetation	Non-Hazardous	Allow for turn to mulch for use by community members or move to government approved dumpsite for disposal. Do not burn.
8.	Paper	Non-Hazardous	Move to I.A. Waste Dumpsite for segregation and subsequent move to paper mill for recycling.

3.9: Project Schedule

The planning and implementation schedule of the Agbada FDP project is shown in Table 3.2.

Table 3.2: Timing and Implementation Schedule Project Level 1 Schedule



CHAPTER FOUR
DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1: General

Environmental Impact Assessment procedure involves the use of adequately planned and well structured analyses to establish the environmental condition of the proposed project area. This environmental status will provide the basis for identification of potential impacts of the project activities on ecological system and the resource use of the area. In addition, information on the existing environmental status of the proposed project area shall serve as a reference data for further studies and environmental monitoring. This chapter presents the environmental baseline description of the proposed Agbada Field Development Project (FDP) Area. The details of the methodologies adopted for data acquisition for each of the environmental components and the Impact indicators are described in **Appendix II** while the sampling location map is provided in **Appendix 1**.

4.2: Data Acquisition

The ecological, social and health data was produced using a two-season field data gathering exercise carried out between 24th October (late rainy season)- 5th November 2008(early dry season) and 26th – 30th January, 2009. Data was acquired on vegetation, soil, air quality/noise, rain and ground water, socio-economics and health. A multi-disciplinary approach was employed in the acquisition of baseline data of the proposed project area. Desktop research was carried out to augment information obtained from the field data gathering. Relevant textbooks, articles, research publications, previous study reports were adequately searched to generate the desktop information. The data generated from these processes include maps, demographic data, meteorological data and soil/ground water characteristics of the study area. A map of the study area showing sampling points is shown in **Appendix I**.

4.3: Climate and Meteorology

Temperature, rainfall, relative humidity, wind speed and direction are the climatic factors considered in the proposed field development project. Table 4.1 and 4.2 presents the trend of temperature; rainfall and relative humidity during the period of study (24th October - 5th November 2008 and 26th – 30th January, 2009).

Table 4.1: Climatic Conditions at Agbada NAG Area (Oct-Nov 2008)

S/No	Sampling Location		Temp. ^{o}C	Wind Speed (m/s)	Relative Humidity %	Wind Direction
	Latitude	Longitude				
1	497200.339	102450.430	32.90	0.20	68.20	SW
2	505095.077	98885.770	26.60	0.60	92.00	NE
3	502195.647	104534.072	33.60	0.20	69.30	SW
4	502195.647	104534.072	32.10	1.00	81.30	SW

S/No	Sampling Location		Temp. °C	Wind Speed	Relative Humidity %	Wind Direction
5	506625.912	103565.753	32.80	0.50	69.00	NE

Table 4.2: Climatic Conditions at Agbada NAG Area (January 2009)

S/No	Sampling Location		Temp. °C	Wind Speed (m/s)	Relative Humidity %	Wind Direction
	Latitude	Longitude				
1	497287.066	102833.556	29.50	0.00	58.20	SW
2	504361.758	100596.078	32.00	0.00	56.00	SW
3	501932.496	104410.445	34.30	0.50	58.50	SW
4	506386.143	106243.046	31.00	1.80	53.00	SW
5	507302.44	103515.454	28.30	0.50	51.40	SW

Wind Pattern

The prevalent wind direction within the study area is generally the South-West (210 –240^{o}) for 8 months. Wind speed in the study area for dry season ranged from 0.5m/s to 1.8m/s while the wet season wind speed ranged from 0.2 to 1.00m/s. The wind is predominantly in the South Western direction accounting for about 75% of the annual winds. The North-Easterly winds predominate during the dry season (November – March); this makes up about 25 % of the annual winds within the study area. Its penetration into the Niger Delta region between December and February is characterized by dry and low humidity with dusty haze (Ayoade, 1982).

Sunshine

The mean daily sunshine is between three and six hours in dry season and it often falls to less than two hours in the wet season. The mean annual solar radiation varies from 1.5 – 1.9 J/cm^2/day (Oguntoyinbo and Hayward, 1987). The longest monthly sunshine hours occur in December/January in the dry season while July usually experiences the lowest values of sunshine hours. This can be attributed to constant cloudiness from rain clouds in the wettest months. Sunshine hours are directly proportional to the net radiation. Net radiation and air temperature are highest during the dry season except when relatively cold harmattan winds occur.

Temperature

Figure 4.1 shows the 10-year average maximum, minimum and the mean monthly temperatures for the project area. Temperatures are usually high and vary little year round which is typical of the equatorial belt. The mean temperature for the hottest months February/March is 34 ^{o}C while that of the coolest month (August) is 28 ^{o}C. The average temperature difference between the hottest and coolest months is about 3 ^{o}C while the mean

daily temperatures range is over twice that (at about 6.5 ^{o}C). The temperatures measured in the field during the dry season ranged from 28.30^{o}C and 34.30^{o}C while temperature range measured during the wet season was 26.60 – 33.60 ^{o}C.

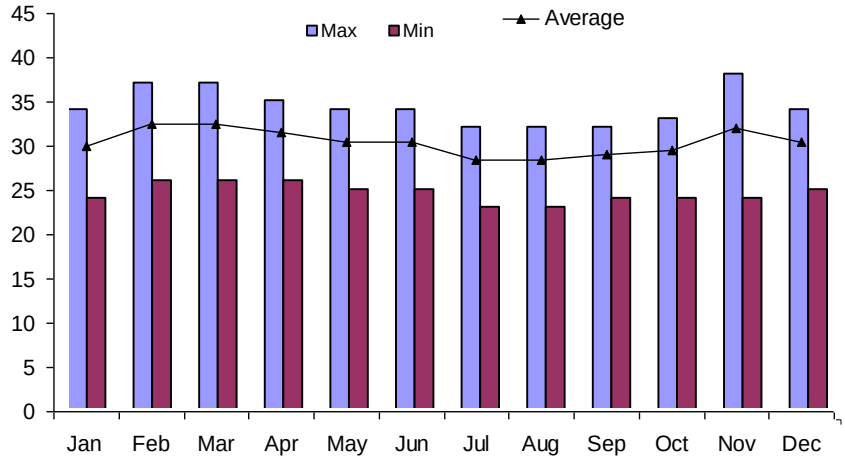


Fig. 4.1: Average Monthly Temperatures for Port Harcourt Synoptic Station
Source: Nigerian Meteorological Agency, NIMET (Port Harcourt Zone)

Rainfall

Fig 4.2 shows rainfall pattern within the study area. Generally, the wettest period of the year within the area is July - September with the peak period in July while lower rainfall values are usually recorded in the months of December, January, February and March. However, a brief period of low rainfall usually occurs between late July and early September in the study area most often referred to as August break.

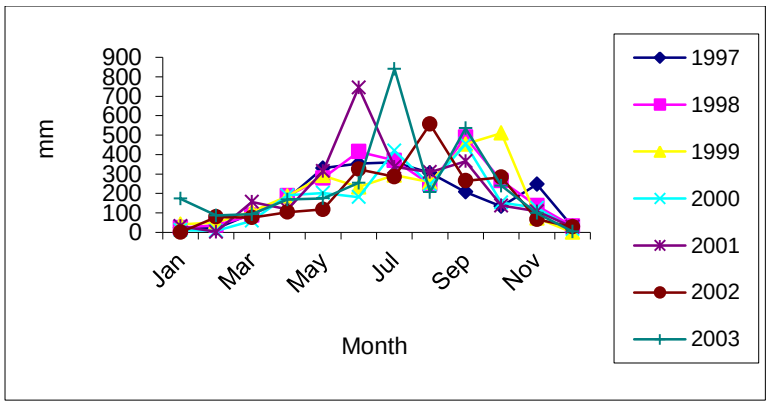


Fig 4.2: Trend in Rainfall from 1997 – 2003 in the Study Area.
Source: Nigerian Meteorological Agency, NIMET (Port Harcourt Zone)

Relative Humidity

The relative humidity recorded in Agbada FDP area ranged from 51.40% - 58.50% in the dry season and 68.20% - 92.00% in the wet season. Fig. 4.3 shows the trend in relative humidity from 1997 to 2003 in the study area.

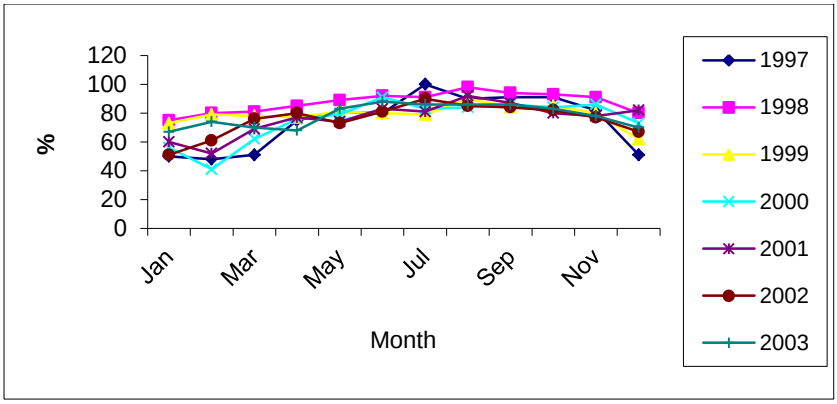


Fig 4.3: Trend in Relative Humidity from 1997 – 2003 in the Study Area
Source: Nigerian Meteorological Agency, NIMET (Port Harcourt Zone)

4.4: Ambient Air Quality

The results of in-situ air quality in the Agbada FDP area are presented in Table 1a of Appendix III (Dry season) and Table 1b of Appendix III (Wet season). Some of the pollutants measured during the study and their ranges are as follows: Suspended particulate matter (SPM) ranged from 20.50 – 27.00µg/m^3 during the wet season and 30.00 – 36.00µg/m^3 during the dry season. Carbon monoxide (CO) ranged from 4.00 – 19.00 ppm for wet season and 1.80 – 8.20 ppm for the dry season. Nitrogen IV Oxide ranged from 0.60 – 1.00 ppm and 0.90 – 1.90 ppm for wet and dry seasons, respectively.

Other parameters measured include Volatile organic carbon (VOC) which ranged from <0.01 – 0.03 ppm and <0.01 ppm for wet and dry seasons respectively. The values of ammonia for both seasons were below 0.01 ppm for both seasons.

4.5: Noise Level

Table 4.3 presents the mean noise levels recorded in the study area. The wet season mean value ranged from 43.30 – 63.80 dB (A) while that of dry season value ranged from 36.65 – 59.55 dB (A). These values are well within FMEnv and OSHA permissible exposure limits of 9+0dB (A) per day for an 8-hour working period. The ambient noise level recorded around the study area is presented in **Appendix III, Tables 2a and 2b.**

Table 4.3: Mean Noise Level around the Proposed Project Area

STN. CODE	Mean Noise Level (DBA-Wet Season)	Mean Noise level (DBA-Dry Season)
NSS1	49.65	36.65
NSS2	43.30	55.55
NSS3	56.55	36.80
NSS4	51.45	59.55
NSS5	63.8	55.95
FMENV	**90**	**90**

4.6: Rain Water Characteristics

The physico-chemical characteristics of rainwater from the study area are presented in **Table 6a** of **Appendix III.** Rainwater temperature ranged from 30.40 to 32.10^{o}C for the wet season and 31.70 – 32.30 ^{o}C for the dry season. The electrical conductivity of water refers to its ability to carry electric current, which in turn is related to the total concentration of ions, their mobility, valence, and their relative concentration. The conductivity of natural waters ranged from 50 to 1500mS/cm (GEMS, 1992). The conductivity level at the sampled stations ranged from 0.03 to 0.06µS/cm for the wet season and 0.02 to 0.05mS/cm for the dry season. The total dissolved solids (TDS) ranged from 37.10 to 45.00mg/l for the wet season and 48.40 to 113.00mg/l for the dry season. The dissolved oxygen (DO) level ranged from 1.30 – 2.20 mg/l for the wet season and 1.90 – 2.40 mg/l for the dry season. The biochemical oxygen demand (BOD), which gives a measure of the relative oxygen consuming properties of rain water ranged from 6.50 to 6.80mg/l for the wet season and 1.8 – 2.0mg/l for the dry season. The chemical oxygen demand (COD) measures the oxidisable organic material present in the sample. The COD concentration levels in the area ranged from 10.50 to 12.40mg/l for the wet season and 9.30 – 10.20mg/l for the dry season. The levels of BOD and COD in the sampled areas indicate a low amount of bio-chemically degradable organic matter in the sampled areas.

The pH is the negative logarithm of the hydrogen ion concentration. The practical pH scale extends from 0 (very acidic) to 14 (very alkaline) with the value of 7 corresponding to neutrality. The pH measurements of rainwater within the study area indicated slightly acidity with pH ranges of 6.01 – 6.18 for the wet season and 5.11 – 6.02 for the dry season. pH is a major factor in chemical reactions associated with the formation, alteration and dissolution of minerals. The pH of water also affects transformation processes among the various forms of nutrients and metals, and influences the toxicity of pollutants consisting of acids and bases because of the effects of ionization of these compounds. A drastic change in pH will affect all other physicochemical parameters of the water and aquatic life. Extreme pH values cause stress to fish and other aquatic organisms (GEMS, 1992, RPI, 1985).

The total suspended solids (TSS) levels ranged from 0.03 to 0.04mg/l for the wet season and 0.19 – 1.0mg/l for the dry season. Suspended solids are composed of clay, silt, sand, finely divided organic and inorganic matter and other microorganisms in water. High concentrations of suspended solids affect water clarity, and light penetration and is aesthetically unsatisfactory for recreational activities.

Ammonia is one of the nutrients important to phytoplankton growth. Ammonia in water consists of un-ionized (NH_3) and ionized form (NH_4^+). The level of ammonia in the study area ranged from 0.09 to 0.10mg/l for the wet season and 0.31 – 0.34mg/l for the dry season. Nitrite, which is an intermediate product in the nitrification of ammonia to nitrate, ranged from 5.44 to 5.61mg/l for the wet season and <0.01mg/l for the dry season. Usual concentrations of nitrite in natural waters are in the range of tenths of mg/l. At higher concentration, nitrite is toxic to fish and other aquatic organisms and is used as an indicator for biologically purified effluent and polluted waters (GEMS, 1992).

The value of nitrate ranged from 7.35 to 7.58mg/l for the wet season and 6.36 – 6.54mg/l for the dry season. Nitrate is the final product of nitrification and is a major phytoplankton nutrient in marine environment. It is the least toxic of the inorganic compounds. Unpolluted natural waters contain only minute amount of nitrate. Excessive concentration of nitrate (above 10mg/l) in water is considered hazardous to human. (GEMS, 1992).

The phosphorous concentration in the water is closely related to the primary productivity of the water. The value of phosphorous measured as phosphate recorded in the sampled stations ranged from 0.05 to 0.06mg/l for the wet season and 0.06 – 0.08mg/l for the dry season. In higher concentration, above 5mg/l phosphate may produce secondary pollution, being essential nutrients, by stimulating the growth of photosynthetic aquatic micro and macro organisms to nuisance quantities (GEMS, 1992).

The concentration of THC was from 0.84 to 0.94mg/l for the wet season and 0.41 – 0.53mg/l for the dry season. The heavy metals status of rain waters in the study area showed that the concentrations of mercury, copper, arsenic, chromium and vanadium in the rainy season and the same metals as well as nickel in the dry season were below detection limits.

Sulphate concentration in rain water samples ranged from 1.15 - 1.22 mg/l (wet season) to 1.72 - 2.10 mg/l. Other parameters were found to have the ranges of concentration; residual chlorine - 12.41 - 12.56 mg/l (wet season) to 7.44 – 8.15 mg/l (dry season), total hardness: 4.0 – 10.0 mg/l (wet season) to 5.0 – 20.0 mg/l (dry season), hydrogen sulphide: 13.1 – 13.4 mg/l (wet season) to 30.0 – 31.0 mg/l (dry season), Alkalinity: 40.0 – 50.0 mg/l (wet season) to 5.0 mg/l (dry season), bicarbonate (HCO_3): 9.76 - 4.0 – 10.0 mg/l (wet season) to 6.1 mg/l (dry season), salinity: 16.50 – 26.40 mg/l (wet season) to 19.20 – 22.40 mg/l (dry season), chloride: 10.0 – 16.0 mg/l (wet season) to 12.0 – 14.0 mg/l (dry season) and oil & grease: 2.53 -2.62 mg/l (wet season) to 2.71 – 2.84 mg/l (dry season).

Rain Water Microbiology

The ranges of abundance of total heterotrophic bacteria (THB), total heterotrophic fungi (THF), Hydrocarbon Utilizing Bacteria (HUB) and fungi (HUF) in rain water of the study area are as follows: The abundance of THB in water ranged from 1.4 to 2.4 x 10^2 cfu/ml (wet season) and from 4.0 to 4.5 x 10^2 cfu/ml (dry season) while that of THF ranged from 0.5 – 1.2 x 10^2 cfu/ml (wet season) and from 0.8 to 2.7 x 10^2 cfu/ml (dry season). The number of HUB in the water samples ranged from 0 to 0.6 x 10^2 cfu/ml (wet season) and from 0.3 to 0.7 x 10^2 cfu/ml (dry season), while that of HUF varied from 0.3 to 0.5x 10^2 cfu/ml (wet season) and from 0 to 1.7 x 10^2 cfu/ml (dry season). Total coliform ranged from 0.3 – 0.5 x 10^2 cfu/ml and from 0 to 3.1 x 10^2 cfu/ml in the wet and dry seasons respectively.

4.7: Soil Studies

General Description

Samples were collected at 0 –15 and 15 – 30cm depths within the study area. Soil samples were distributed within the study area along the pipeline RoW, location of the GHF and in the

control stations. There was no record of spills within the area otherwise a soil sampling station would have been located at the site.Two soil profile pits were located 50m from each of the flow stations(Agbada 1 and Agbada II). The objective was to determine whether the locations of the two Flow stations had a different soil profile. The soil of the project area are mainly of the rainforest type. It is mineral soil formed as a result of the weathering of siliceous sandstone fragments over varying periods of time. The soil ranged from the recently formed Entisols and Inceptisols, to mature Alfisols and Oxisols.

Soil Physico-chemistry

Soil pH and Conductivity

The pH of the soil of the project area in the wet season varied between 5.80 and 6.89 (top soil) and 5.70 and 6.77 (bottom soil) while the recorded values during the dry season ranged from 5.4 – 7.3 (top sol) and 5.7 – 7.6 (bottom soil). This shows a range of weak acidity to slight alkalinity. Conductivity of soil from the project area ranged from 18.00 – 60.00 µS/cm for both top and bottom soils in the wet season and 10.00 – 58.00 µS/cm for the same samples during the dry season.

Nitrate, Sulphate and Phosphate

The nitrate values ranged from 6.90 – 13.98 mg/kg for top soil and 7.31 -14.43 mg/kg for bottom soil in the wet season while the values for dry season were 2.84 – 7.14 mg/kg for top soil and 2.98 – 6.41 mg/kg for bottom soil. The concentration of sulphate ranged from 2.00 – 18.81 mg/kg for top soil and 2.03 -18.99 mg/kg for bottom soil in the in the wet season while the values for dry season were 2.37 – 22.69 mg/kg for top soil and 2.27 – 20.85 mg/kg for bottom soil. Phosphate concentration for wet season ranged from 0.06 – 0.11mg/kg and 0.06 – 0.12 mg/kg for top and bottom soil respectively while the values for dry season were 0.18 – 0.57 mg/kg and 0.33 – 0.56mg/kg for top and bottom soil respectively.

Total organic carbon and Cation Exchange capacity (CEC)

The total organic carbon content in soil from study area ranged between 3.76 – 4.67 mg/kg and 3.04 – 4.44 for top and bottom soil respectively, for wet season while that of dry season ranged from 0.70 – 3.49 mg/kg and 0.56 – 2.89 mg/kg for top and bottom soil, respectively. CEC values for topsoil ranged from3.41 – 4.88meq/100g and 2.30 and 3.98meq/100g for top and bottom soils respectively while that of dry season ranged from 3.13 – 4.12 meq/100g and from 2.01 – 3.65 meq/100g for top and bottom soil respectively.

Oil and grease

The concentrations of oil and grease in the soil of the study area obtained during the wet season for top and bottom soil ranged from 0.13 - 1.40mg/kg and 0.44 - 0.88mg/kg, respectively while the dry season values ranged from 0.10 – 1.20 mg/kg and 0.22 – 0.72 mg/kg for top and bottom soil, respectively.

Available Water Holding Capacity

The water holding capacity of soil from the study area varied between 19.41 – 23.44% for top soil and 19.48 – 23.47% for bottom soil during the wet season. The dry season values

recorded in the study area ranged from 10.35 – 23.19% and 10.56 – 23.38 % for top soils and for the bottom soils. The water holding capacity is sufficient to satisfy agricultural needs.

Heavy metals

The concentrations of heavy metals in top soil of Agbada FDP area during the wet season were: lead (Pb) – 0.06-0.98 mg/kg, Nickel (Ni) - 6.40 - 8.50 mg/kg, Chromium (Cr) – 15.70-24.30 mg/kg, Zinc (Zn) – 0.53-9.87 mg/kg, Cadmium (Cd) – 0.45-0.68 mg/kg, Iron (Fe) – 35.56-148.23 mg/kg, Manganese (Mn) – 9.10-46.50 mg/kg, Vanadium (V) – 0.02-0.16 mg/kg and Copper (Cu) – 5.65-6.45mg/kg while concentrations of heavy metals in bottom soil for the wet season were: lead (Pb) – 0.01-0.85 mg/kg, Nickel (Ni) - 6.00 - 8.00 mg/kg, Chromium (Cr) – 15.30-23.80 mg/kg, Zinc (Zn) – 0.42-9.10 mg/kg, Cadmium (Cd) – 0.41-0.64 mg/kg, Iron (Fe) – 32.67-145.47 mg/kg, Manganese (Mn) – 8.90-42.00 mg/kg, Vanadium (V) – 0.03-0.09 mg/kg and Copper (Cu) – 5.42-6.13 mg/kg.

The concentrations of heavy metals in top soil of Agbada FDP area during the dry season were: lead (Pb) – 0.04-0.89 mg/kg, Nickel (Ni) - 6.10 - 8.10 mg/kg, Chromium (Cr) – 15.20-24.00 mg/kg, Zinc (Zn) – 0.46 - 9.42 mg/kg, Cadmium (Cd) – 0.35 -9.41 mg/kg, Iron (Fe) – 32.20 -142.19 mg/kg Manganese (Mn) – 7.80 - 42.30 mg/kg, Vanadium (V) – 0.02 - 0.11 mg/kg and Copper (Cu) – 5.25-6.12 mg/kg while in bottom soil, the concentrations of heavy metals for the same season were: lead (Pb) – 0.01-0.74 mg/kg, Nickel (Ni) - 5.60 - 7.70 mg/kg, Chromium (Cr) – 14.90 -22.50 mg/kg, Zinc (Zn) – 0.37 – 8.69 mg/kg, Cadmium (Cd) – 0.31-0.57 mg/kg Iron (Fe) – 30.14 -140.73 mg/kg, Manganese (Mn) – 7.10-40.10 mg/kg, Vanadium (V) – 0.01-0.07 mg/kg and Copper (Cu) – 5.12-5.89 mg/kg

Soil Microbiology

During the wet season, the total heterotrophic bacterial counts in the topsoil and bottom soil in the proposed project area ranged from 0.4×10^2 to $1.4.0 \times 10^2$ cfu/g and 0.3 to 1.10×10^2 cfu/g respectively. The total fungal count for top and bottom soil ranged from 2.0 to 16.0 x10 cfu/g while bottom soils had a range of 4.1 to 10.0 $x10^2$ cfu/g. Hydrocarbon utilizing fungi in the soil of the proposed project area range from 0.10×10^2 to 0.30×10^2 for topsoil and 0.10×10^2 to 0.20×10^2 cfu/g for bottom soils. HUB was between 0.10×10^2 to 0.4×10^2 for and $0.1 \times 10^2 – 0.2 \times 10^2$ cfu/g for top and bottom soils respectively. The low hydrocarbon utilizing microbial load indicates an environment not grossly contaminated with hydrocarbon.

The oil degrading bacterial genera in the soils in all the fields are mainly *Bacillus, Pseudomonas, Acinetobacter, Micrococcus* and *Actinomyces*. The hydrocarbon utilizing fungal genera in the soil were *Penicillium, Aspergillus, Fusarium* and yeasts. These filamentous hydrocarbon utilizing fungi spread rapidly within the soil, exposing their large surface area to oil spilled on the soil, and consequently utilize greater quantities of oil than bacteria.

4.8: Geology and Hydrogeology

4.8.1: Geology

The study area lies within the Niger-Delta; its geology is therefore typical of the Niger Delta Basin. The Tertiary delta covers approximately 211,000 sq km and developed south-westwards out of the Anambra Basin and the Benue Trough. It lies south of the West African shield, and west of the Oban Massif and the Tertiary Cameroon Volcanic Trend. The delta is located east of the Benin Basin, and its southern margin is characterized by seafloor escarpments that lie over oceanic crust. The fact that oceanic crust is believed to extend beneath this prolific oil province, even under parts of the onshore delta, makes it unique among major oil provinces.

The area forms part of a geological sequence of the Quaternary and Tertiary formations of the Niger-Delta, consisting mainly of three main geologic formations (Reijers, 1994), which are:

i. The Benin Formation,
ii. The Agbada Formation, and
iii. The Akata Formation.

The Benin Formation is the uppermost unit and extends its limit from West to East side for the whole Niger Delta area and southward beyond the present coastline. This formation is composed of 90% sandstone with shale intercalations. Its thickness is variable but generally exceeds 1800 metres.

The Agbada Formation, which consists of sandstone and shales, underlies the Benin Formation. It consists of an upper predominantly sandy unit with minor shale intercalations and a lower shale unit, which is thicker than the upper one.

The Akata Formation consists of mainly dark grey sandy, silty shale with plant remains at the top. This Formation is over 1200m thick and ranges in age from Eocene to Recent.

The younger sediments (Holocene) found near the present shoreline consists of barrier beaches, coastal-barrier sands and river mouth sand bars which merge into laminated sandy and silty clays and eventually into fine clays on the continental shelf, edge and continental slope seaward. The Niger Delta is a coarsening upward regressive sequence of Tertiary clastics that prograded over a passive continental margin sequence of mainly Cretaceous sediments. The site of the Niger Delta was established at the initial rift separation of the African and the South American plates from Jurassic to Neocomian times.

There are 11 proven plays in the Niger Delta Basin. The Agbada group of plays are the main contributors of reserves. The most significant play is Agbada Stratigraphic-structural Play which accounts for 58% of the basin recoverable oil reserves (34,603 MMb) and 55% of the basin recoverable gas reserves (114,925 Bcf). The Agbada Structural Play accounts for another 40% of hydrocarbon reserves. The structures for both of these plays are best developed at the proximal margin of each successive depobelt, i.e at the point of major

growth faulting and associated roll-over. The stratigraphic trap elements are typically facies-related pinchout features (channel fills) with the growth faults providing the structural element. Apart from the Agbada plays, the other plays, which are really marginal, are related to the Benin, Isongo and Nkporo formations. The known onshore and nearshore Tertiary reservoirs of the Niger Delta Basin are all units of the Agbada Formation. These paralic and deltaic sands are comprised mainly of quartz arenites and, except for occasional shale laminae, they are very clean. Due to the high sedimentation rates of this formation, the sands are under-compacted. Deepwater channel and turbidite equivalents of these sands have been found seawards within the Akata Formation.

4.8.2: Hydrogeology

Ground water samples were collected from 3 boreholes within study area. The bearing and depth of the boreholes are presented in **Table 4.4**.

Table 4.4: Co-ordinates and elevations of boreholes

Borehole No.	Eastings (m)	Northings (m)	Depth (m)
BH1	501399.163	104037.794	42.06
BH2	505798.164	103076.422	41.50
BH3	504118.192	101085.705	40.23

Data from borehole drilling indicate that the static water level ranged from 5.24 – 8.17m. The groundwater in the project area flows in a South-Westerly direction. The sub-surface soil revealed by the boreholes show clayey sand, sandy and gravely sand soil horizons. The clayey sand horizon is dark at the surface which could be attributed to the presence of silt. The dark colour fades out with increasing depth. The sandy horizon is brownish, and its colour also becomes lighter with depth. The gravelly sand horizon has very light colour tending towards colourless. It contains the aquifer material.

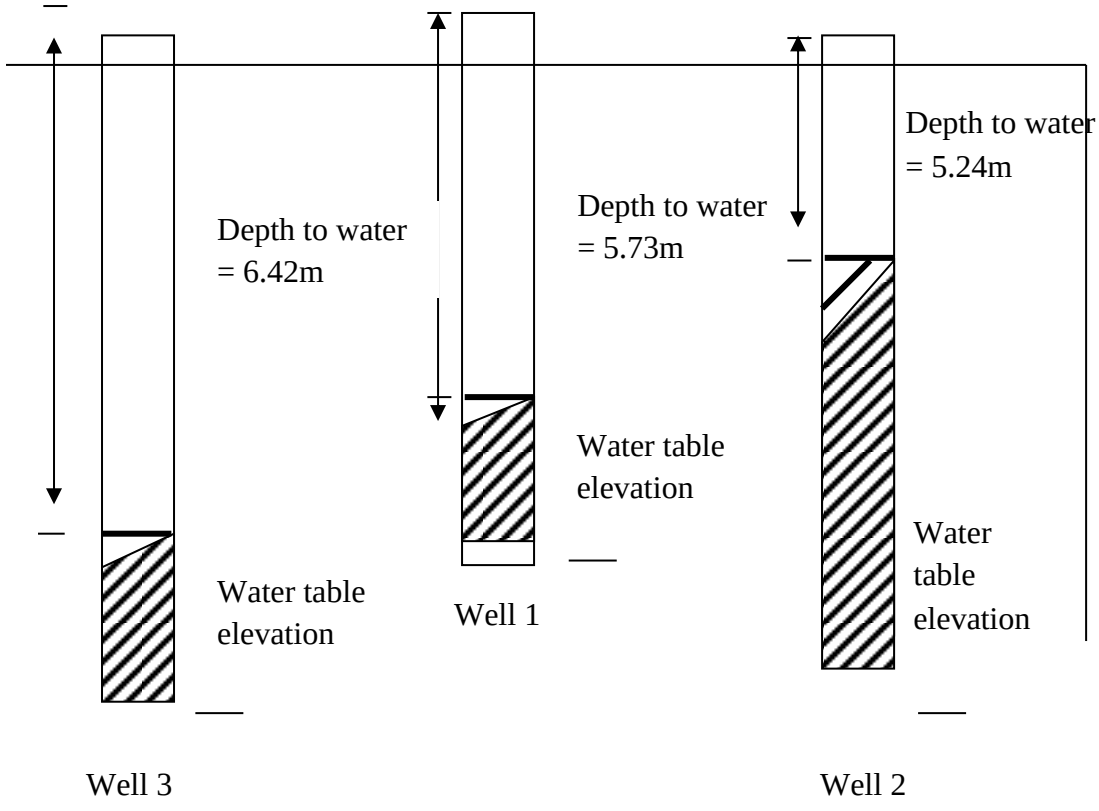


Fig. 4.3: Borehole Lithologic Logs for the Study

4.8.3: Ground Water Quality

Physicochemical Characteristics of Ground Water

The chemistry of groundwater varies depending on the nature of the subsoils and rocks that it passes through (Daly, 1994). Groundwater is usually considered pure and potable as it undergoes a filtering and cleaning process through a subsoil cover and rock medium that surface waters do not have. However, this does not guarantee groundwater purity. Problems can arise either due to the natural conditions in the ground or pollution by human activities. The physicochemical characteristics of the groundwater in Agbada Field are presented in Tables 5a and 5b of Appendix III.

Temperature

The temperature of the groundwater from the study area was slightly warm, with values ranging from 27.00 – 29.70^{0}C during the wet season and 28.00 – 30.60^{0}C during the dry season. These temperature values compared well and corroborated the report of the NDES (2002) on groundwater temperatures of the Niger Delta to be warm with a range of 25.8 – 30.5^{o}C.

Total Dissolved Solid (TDS)/ Total Suspended solid (TSS)

Total Dissolved Solid (TDS) of water is the difference between the total solid (TS) and the suspended solid (SS). Result shows that Total Dissolved Solid (TDS) ranged from 22.80-72.00 mg/l during the wet season and 62.10 – 94.00 mg/l during the dry season. The level of total suspended solids varied between 0.04-0.15mg/l and 0.04 – 1.38 mg/l for the wet and dry seasons respectively. The values for the total dissolved solids were below the regulatory limit of 500 mg/l GEMS, 1992.

Conductivity

Conductivity is the ability of a solution to allow the electrical current flow through it. The conductivity of a solution is dependent on the number and type of ions in that solution. The conductivity in water is proportional to the concentration of dissolved solids, mostly inorganic salts. The higher the salinity of water the higher the conductivity value (Kiely, 1998). The conductivity level ranged from 0.09-0.10 µS/cm and 0.03 – 0.07 µS/cm for wet and dry seasons, respectively.

pH

The pH of most mineral waters is 6 to 9 and unless there are natural or anthropogenic influences adding acidity or basicity, the pH of water remains reasonable constant (Kiely, 1998). The pH of groundwater depends largely on the types of rock/soil from which acid/alkaline compounds erode. The pH of the groundwater of Agbada field ranged from 6.43 – 8.95 and 6.30 – 7.30 for wet and dry seasons, respectively.

Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD)

The COD concentration in the groundwater sample ranged from 26.50-31.00mg/l and 21.70 – 28.10mg/l for wet and dry seasons respectively while the BOD values ranged from 8.50-9.40mg/l and 4.37 – 5.00mg/l for wet and dry seasons, respectively. The FMEnv regulatory limit for COD is <75mg/l.

Total Hydrocarbon (THC)

Total hydrocarbon (THC) causes taste and odour problems in groundwater. The THC of ground water in the project area ranged from 0.30 – 1.30mg/l for the wet season while the dry season value ranged from 0.12 – 1.32 mg/l. The THC concentration of the groundwater at the time of the study is below the permissible DPR and FMEnv levels of 10mg/l.

Nutrients

Nutrients include the ionic forms (NO^-_3, SO_4^{2}, and PO_4^{2-}) and utilization forms of nitrogen, sulphur and phosphorus respectively. Nitrate (NO_3^-) is one of the most common identified groundwater contaminant. It is highly mobile and under wet conditions is easily leached out of the rooting zone, through soil and permeable subsoil. NO_3^- is a good indication of contamination by fertilizer and waste organic matter. The consumption of nitrate rich water by children may give rise to a condition known as methaemoglobinaemia, also called blue

boy syndrome (Kiely, 1998). Sulphate (SO_4^{2-}) is also a good indicator of contamination by fertilizer and waste organic matter.

The concentration of nitrate (NO_3^-) in groundwater from the study area ranged from 7.26 – 8.73 mg/l, phosphate levels varied from 0.06 – 0.12mg/l while Sulphate (SO_4^{2-}) ranged from 1.02 mg/l to 2.11mg/l for wet season. In the dry season, the concentrations of the nutrients ranged from 5.77 – 6.68mg/l, 0.07mg/l and 1.41 – 1.79mg/l for nitrate, phosphate and sulphate, respectively. The values of nitrate and sulphate were also found to be below their respective compliance limits (10 mg/l and 400 mg/l). The chloride values ranged from 10.00 – 12.00mg/l and 14.00 – 30.00mg/l for wet and dry seasons, respectively. This was below the regulatory requirements (250 mg/l). The concentration of ammonia ranged between 0.21-0.25mg/l and 0.20 – 0.32 mg/l for wet and dry seasons, respectively in the groundwater samples.

Total Hardness

Hard water is water that has high mineral content, mainly of calcium and magnesium ions (Ca^{2+}, Mg^{2+}) and possibly other dissolved metals, bicarbonates and sulphates. Hard water is beneficial to health; it helps to build strong bones and teeth. In addition, it gives a pleasant taste. Conversely, very high levels can be a nuisance, resulting in soap wastage as it does not lather easily and causes scale formation in Kettles, pipes and boilers. The hardness of the groundwater from the project area ranged from 8.00 mg/l to 20.00 mg/l in wet season while the dry season values ranged from 4.00 to 12.00 mg/l. These values were far below the regulatory limit of 500 mg/l.

Heavy Metal in Groundwater

Concerns about heavy metals in groundwater bother on toxicity, bioaccumulation and hazards to human health (GEMS 1992). The heavy metals concentration in boreholes water of the study area is presented in **Tables 5a and 5b of Appendix III**. The following concentrations were recorded during the wet season: Lead – 0.005-0.008mg/l, Iron – 0.20 – 0.75 mg/l, Zinc – 0.09-0.11 mg/l, Nickel – 0.03-0.03 mg/l, Copper – 0.002 – 0.004 mg/l, Cadmium – 0.002 – 0.004 mg/l. Chromium, mercury, Arsenic, and Vanadium were below detection limits.

In the dry season, the heavy metal concentrations recorded ranged as follows: Lead – 0.001-0.003mg/l, Iron – 0.06 – 0.43 mg/l, Zinc – 0.03-0.06 mg/l, Nickel – 0.68-1.02 mg/l, Copper – 0.56 – 1.05 mg/l, Cadmium – 0.001 – 0.003 mg/l. Chromium, Mercury and Arsenic were mostly below detection limits.

Groundwater Microbiology

The results of Total Heterotrophic bacterial Count (THB), Hydrocarbon Utilizing Bacteria (HUB), Total Fungi Count and Hydrocarbon Utilizing Fungi for the ground water samples collected within the project area are presented in **Table 5 of Appendix III.** The results showed that in the wet season, the THBC of groundwater ranged from $0.1 \times 10^2 – 0.2 \times 10^2$ (cfu/ml) and HUB ranged from 0 to 0.8×10^2. The Total Fungal Counts (THFC) for

groundwater ranged from 0.1 x 10^2 – 0.4 x 10^2. HUF range was between 0 and 0.7 x 10^2. Total coliform ranged from 0.0 – 0.3 x 10^2 cfu/ml.

In the dry season, THBC of groundwater ranged from 2.0 x 10^2 – 8.0 x 10^2 (cfu/ml) and HUB ranged from 0 to 3.0 x 10^2. The Total Fungal Counts (THFC) for groundwater ranged from 3.0 x 10^2 – 5.0 x 10^2. HUF range was between 0.0 and 3.0 x 10^2. Total coliform ranged from 2.50 – 4.00 x 10^2 cfu/ml.

4.9: Vegetation

The study area has relatively flat topography and is presently a mosaic of farmlands, secondary forests at varying stages of re-growth and remnant lowland tropical moist forests (freshwater swamp and dry-land rainforests). Vegetation in most of the study area would be classified as the oil palm variant. This is indicative of (dry-land) lowland rain forest that is undergoing active regeneration. Such areas have been long under cultivation with the oil palm (*Elaeis guineensis*) being the dominant emergent canopy species.

4.9.1: Structure and Floristic Composition

VEG Transect 1

The vegetation in this location comprised farmlands (cassava) and forest re-growth of approximately 3 years. Oil palms were the main growing canopy species, with a frequency of 38.1%. The secondary nature of the vegetation was further indicated by the occurrence of forest species such as *Anthocleista vogelii* and *Ceiba pentandra.* The mean height of the five tallest trees (excluding palms) was 13m, further signifying that trees of timber stature were lacking. Species composition and species diversity index (1.67) were low. The dominant ground cover species included *Aspilia africana, Chromolaena odorata, Sida acuta, Costus afer* and *Panicum maximum.* Table 4.5 presents the forest data for the area and Plate 4.1 shows ground cover species at the transect.

Table 4.5: Forest data summary in the SPDC project area (VGT 1)

Sample area (40m x 40m)	0.16 ha
Number of species in transect	8
Number of families in transect	8
Stand density (trees/0.16 ha)	21
Number of trees/ ha	131.3
Palm density (number/ 0.16 ha)	8
Number of palms/ ha	50
Palm frequency of occurrence (%)	38.1
Mean height, five tallest trees in transect (m)*	13.0

***** *Exclusive of palms*

Plate 4.1: Ground cover species at transect 1

VEG Transect 2

The predominant vegetation type is the transition secondary forest (approximately of 3- 4 years duration). The complex structure (physiognomy) and species richness of the natural vegetation has been largely eliminated. Trees of timber size were lacking, suggesting that the area has been disturbed in the recent past (about 20- 30 years). Oil palm (*Elaeis guineensis*) (**Plate 4.2**), with a frequency of 37.5 %, was the dominant emergent canopy species. The secondary nature of the vegetation was further indicated by low species diversity index (1.41), low height of the tallest trees (11m) and the presence of lowland forest species such as *Anthocleista vogelii, Alstonia boonei* and *Ceiba pentandra.* The common shrubs included *Alchornia cordifolia, Ficus exasperate, Manniophyton fulvum* and *Baphia nitida.* The ground vegetation was dominated by a variety of shrubs, herbs and weeds including *Aspilia africana, Ageratum conyzoides, Panicum maximum, Sida acuta, Ipomoea involucrata, Costus afer, Schrankia leptocarpa, Heliotropium indicum and Pankia sp.* Table 4.6 presents the forest data for the area.

Table 4.6: Forest data summary in the SPDC project area (VGT 2)

Sample area (40m x 40m)	0.16 ha
Number of species in transect	8
Number of families in transect	7
Stand density (trees/0.16 ha)	16
Number of trees/ ha	100
Palm density (number/ 0.16 ha)	6
Number of palms/ ha	37.5
Palm frequency of occurrence (%)	37.5
Mean height, five tallest trees in transect (m)*	11.0

***** *Exclusive of palms*

Plate 4.2: Oil palm (*Elaeis guineensis*) as emergent canopies

4.9.2: Plant tissue analysis

The levels of essential elements in plant tissues from the study area were within the usual concentrations found in higher plant tissues (**Table 4.7**). Heavy metal concentrations in representative plant species from the study area were also within the usual range of such elements in plant tissues. The observed values are adequate to sustain maximum plant growth. Furthermore, results indicate that plants in the study area were essentially free of heavy metals contamination.

Table 4.7: Mean concentrations of heavy metals in foliage of plant species in the area

	Parameter (mg/Kg dry weight)							
Sample code	**Fe**	**Zn**	**Cr**	**Mn**	**Mg**	**Cd**	**Ni**	**Pb**
Alchornia cordifolia	83.75	ND	<0.10	25	659.7	0.06	0.05	0.01
Anthocleista vogelii	189.1	21	<0.10	37.8	670	0.07	0.07	0.01
Manihot esculenta)	166.5	28	<0.10	ND	700	0.06	0.03	0.02
Elaeis guineensis	164.5	nd	<0.10	ND	690.0	0.07	0.06	0.01
*Minimum values for maximum plant growth (mg/kg)	100	20	Toxic even in Low concs.	20	200	Toxic even in low concs.	Toxic even in low concs.	Toxic even in low concs.

ND= not determined

4.9.3: Plant pathological studies

Generally vegetation was luxuriant with no obvious signs of stress. Leaf spots were the dominant disease symptoms on the foliage of unhealthy plants. *Fusarium, Aspergillus* and *Penicillium* spp were the pathogens with the highest relative incidence.

4.9.4: Economic crops

The major farm crop found in the project was *Manihot esculenta* (cassava). Trees that offer non-timber forest products (barks, fruits, roots etc) that play roles in traditional medicine and nutrition included *Elaeis guineensis* (oil palm), *Raphia vinifera* (wine palm), *Musanga cercropioides, Costus afer, Alchornia cordifolia* and *Harungana madagascariensis* (blood tree). Plant species with utilitarian values are presented in Table 4.8.

Table 4.8: plant species with potential utilitarian benefits in the project area

Species	**Uses**
Harungana madagascariensis	Bark decoction used as blood tonic.
Alchornia cordifolia	Treatment of foot rot (*Taenia paedis*)
Costus afer	Extract used as medicine for insect bites
Dalbergia spp	Extract used for malaria cure
Alstonia boonei	Soap making, cooking oil
Musanga cercropioides	Wine and alcohol production
Elaies guineensis	Extract used as medicine for jaundice
Raphia hookeri	Fruits edible, decoction used to treat gonorrhea, diarrhea and sore throat.
Ipomoea involucrata	Plant medicine
Spondias mombin	Plant medicine
Hevea brasiliensis	Latex used as rubber

4.10: Wildlife

The wildlife resources have been grouped under the following major headings: mammals (primates, small mammals), avifauna, reptiles and amphibians. All the four classes of vertebrates were found in the study area. The mammals and avifauna were the dominant groups. The mammalian species included some primates (*Cercopithecus mona*) and some rodents (small mammals) like *Thryonomys swinderianus* (cane rat), *Protoxerus strangeri* (forest tree squirrel) and *Atherurus africanus sp* (brush tailed porcupine).

The avifauna included guinea fowls weaver birds (*Plesiositagra cucullatus*.), hawks (*Polyboroides radiatus*) and kites (*Milvus nigrans*). The avifauna were typically forest species. Herpetofaunal species (amphibians) included lizards and snakes. The snakes included vipers (*Bitis gabonica*), black cobra (*Naja melanoleuca*) and python (*Python*

regius). Some of the mammalian (*Cercopithecus mona*) and reptilian (*Python regius*) species occurring in the area are threatened or endangered and international trade is either absolutely prohibited or require licenses (Decree 11, 1985). A checklist of the wildlife is shown on Appendix III.

4.11: Conservation Status of study area

The tree species diversity (Shannon Wiener) indices for the proposed project area were very low and ranged from 0.93 to 1.99. Ordinarily the index could be higher than 4.0 in particularly diverse areas. These and other dendrometric indices suggested that trees of timber size/value were lacking and that the study community is of recent origin or affected by recent changes (i.e. past 30-40 years). Preferred height classes (of economic value) might have been selectively removed, contributing to the poor species composition.

Some of the mammalian (*Cercopithecus mona*) and reptilian (*Crocodylus niloticus*) species occurring in the area are threatened or endangered and international trade is either absolutely prohibited or requiring licenses **(**Decree 11, 1985; NEST, 1991). These species would be considered as rare by virtue of their limited distribution. The conservation status of small mammals is considered satisfactory (survival not threatened). The small mammals have naturally high fecundity as well as adaptability to changing habitat conditions (Happold, 1987). Most of the other vertebrate wildlife encountered would, however, be characterized as rare (and therefore vulnerable).

The only chance of survival of representative habitat and species assemblages in this eco-region lies in the continued protection and expansion of the remnant lowland swamp forests. Further fragmentation of these forests should be avoided as they form part of wildlife migration routes. Therefore, any future development should conserve the remnant swamp forests in view of the fragile nature of the vegetation. Such a conservation area would serve as *in situ* gene banks and have an additional positive effect on the conservation of fauna. (IUCN 1992, 1994).

4.12: Socioeconomic Survey

4.12.1: Consultation

The key objective of the consultation is to notify the stakeholders of the nature, scale and timing of the proposed project, thereby eliminating any fears or apprehensions. Secondly, it facilitates information gathering between SPDC and other stakeholders. This two-way communication enables SPDC to learn from its stakeholders and neighbours and avoid misunderstandings about the project. Consultation also provides a mechanism by which stakeholders will be carried along all through the project's lifetime, as well as a forum of addressing community's concerns, issues and needs.

Consultation equally helps the proponent learn through the input of local knowledge, enhance the acceptability of the projects, limit unrealistic expectations and focus on the delivery of benefits.

Throughout the lifespan of the project, SPDC shall maintain effective communications with authorities and other relevant stakeholders. The intention of this is to:

- avoid conflicts by addressing issues promptly;
- ensure that fears and apprehensions about the nature, extent and impact of the operation have been addressed; and
- avoid any misunderstanding about the development.

SPDC will make the draft EIA available to the regulatory agencies (DPR and FME). The document will also be made available to public for comments through the regulatory agencies. One of the stages of consultation was carried out in the Scoping Workshop organized for all the communities likely to be impacted by the proposed project. The workshop was held on 26th March 2008 in Port Harcourt.

Detailed activities of the project were discussed at the workshop and the communities raised issues and concerns based on the following themes: Project impacts, stakeholders likely to be affected, sensitive/vulnerable environmental components that could be impacted as well as measures to enhance beneficial impacts and reduce/eliminate identified adverse impacts. All these were collated and integrated into the Terms of Reference for this study. Another stage of consultation was done by the Community Relations Department of SPDC and involved paying homage to the selected communities, and informing them of the proposed project and the visit of the impact assessment consultants for the EIA studies. The last stage was during the focus group discussions held with the various groups at the community level. During the consultations, the consultants explained the scope and justification of the project and took note of the people's fears, impressions and expectations concerning the proposed project.

Future Consultations

SPDC shall continue to consult with the Regulatory Agencies, the host communities, all stakeholders concerned with or likely to be affected by the project at all stages of project development. The consultations will be sustained throughout the lifespan of the proposed project. **Plates 5.1 – 5.5** show sessions during the consultation exercise for proposed Agbada Field Development project.

Plate 5.1: The Chief Christian Emerengwa of Omunike Omunobo and some community members

Plate 5.2: Team with Dr. Eric C. Amadi of Rumuijima Eledo Rukpokwu and community members

Plate 5.3: Team with Chief Charles O. . Nyemachi of Rumuluwada Eledo Rukpokwu

Plate 5.4: Group photograph with Chief L. I. Oobo of Elikpokwodu Rukpokwu

Plate 5.5: Team with Chief (Capt.) Elechi Amadi (Rtd) (3rd from left – standing, 1st row) and some Mbodo Aluu Community Elders

4.12.2: Socio-Economic Survey

The socio-economic survey for the proposed Agbada Field Development project centers on six (6) communities from two (2) Local Government Areas LGAs in Rivers State. The Local Government Areas are Obio Akpor and Ikwere LGAs. Table 4.9 presents a list of the sampled communities and their LGAs.

Table 4.9: Sampled Communities and their LGAs

S/N	Community	LGA
1	Omuoda Aluu	Ikwere
2	Mbodo Aluu	Ikwere
3	Omunike Omunoba	Ikwere
4	Omuigwe Aluu	Ikwere
5	Rumujima Eledo Rukpokwu	Obio Akpor
6	Elikpokwodu Rukpokwu	Obio Akpor

4.12.3: Study Approach / Design

A combination of several data collection techniques was adopted in the socio-economic survey in order to achieve the objectives of the study. The methods below were combined and adopted at varying degrees for the different communities:

- Questionnaire interview
- Focus Group Discussion (FGD)
- Consultations/Key informants information (KI)
- Participant observation and estimation.

Data was collected on various socio-economic parameters and were analyzed using different appropriate tools. Some of these analytical techniques for demographics are presented below:

Two population projection models were used, (linear and exponential) to project - from available base year statistics the population of the communities.

a) *Linear Extrapolation Model*

$$P_n = P_0 + P_0na \quad \text{.....(1)}$$

Where:
P_0 = the base year population,
a = some fixed percentage of the base population (growth rate), and
n = time elapsed in years.

b) *Exponential Growth Model*

$$P_n = P_0 (1 + r)^n \quad \text{..... (2)}$$

Source: Palmore and Gardner, 1983

Where:
P_0 = base year population;
r = rate of growth (-annual growth rate) and
n = time period in years.

(c) Age Dependency Ratio:

The age-dependency ratio is the ratio of persons in the "dependent" ages (generally under age 15 and over age 64) to 100 persons in the "economically productive" ages (15-64 years) in a population.

The *Dependency Ratio* is given by the formula:

$$\frac{\text{-Number. of Persons Under 18 or Over 64}}{\text{-Number. of Persons 18-64 yrs old}} \times 100 \quad \text{.....(3)}$$

(d) Gender Ratio:
The sex ratio is the ratio of males to females in a given population, usually expressed as the number of males for every 100 females.
The *Sex Ratio* is expressed as:

$$\frac{\text{-Number. of Males}}{\text{-Number. of Females}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Source: Haupt and Kane, 2004

The - survey involved sampling households within the community using a set of questionnaire. The study was to cover two LGAs namely Ikwere and Obio Akpor. Table 4.10 presents the communities sampled and the total number of questionnaires filled. The number of questionnaires filled was proportional to the size of the community based on the 1991 national census - data.

Table 4.10: Communities Sampled and total number of Questionnaires filled

S/N	Communities	Local Government Area	No of filled Questionnaires			
			Informants	Households	Social Groups	Total
1.	Mbodo Aluu	Ikwere	35	5	4	44
2.	Omuigwe Aluu	Ikwere	33	4	6	43
3.	Omuoda Aluu	Ikwere	35	3	2	40
4.	Omunike Omunobo	Ikwere	45	3	5	53
5.	Rumujima Eledo Rukpokwu	Obio Akpor	40	5	5	50
6.	Elikpokwodu Rukpokwu	Obio Akpor	51	3	3	57
Total						**287**

4.12.4: People, Governance and Hierarchical structure

The observations showed that the people around the study area are spread over two LGAs: namely Ikwerre and Obio Akpor. The indigenous language spoken by locals in the study area is Ikwere. There were strong similarities in - culture, tradition, beliefs and taboos -of the communities studied. The Chieftaincy and Traditional hierarchical structure was - the same in all communities involved in this study. A village head who is lower in hierarchy than the clan head heads each community. The clan head is in turn lower than the paramount ruler. Within the community, the leaders of the various groups with which they have affiliation govern the people. One of such is the Community Development Council (CDC). This council is a strong

body in the area usually headed by a committed member of the community with a sense of development of the community. The youths - have a leader who coordinates their affairs in - the community. The youth president was a common title used for their leader - and -is a rallying point for the youths. - The youth President is subject to the elders -who regard him as a driving force behind the authority of the elders and chiefs. - The youth president, elders, and chiefs ensure smooth running and administration of the communities. Figure 4.4 illustrates the line of power in the communities.

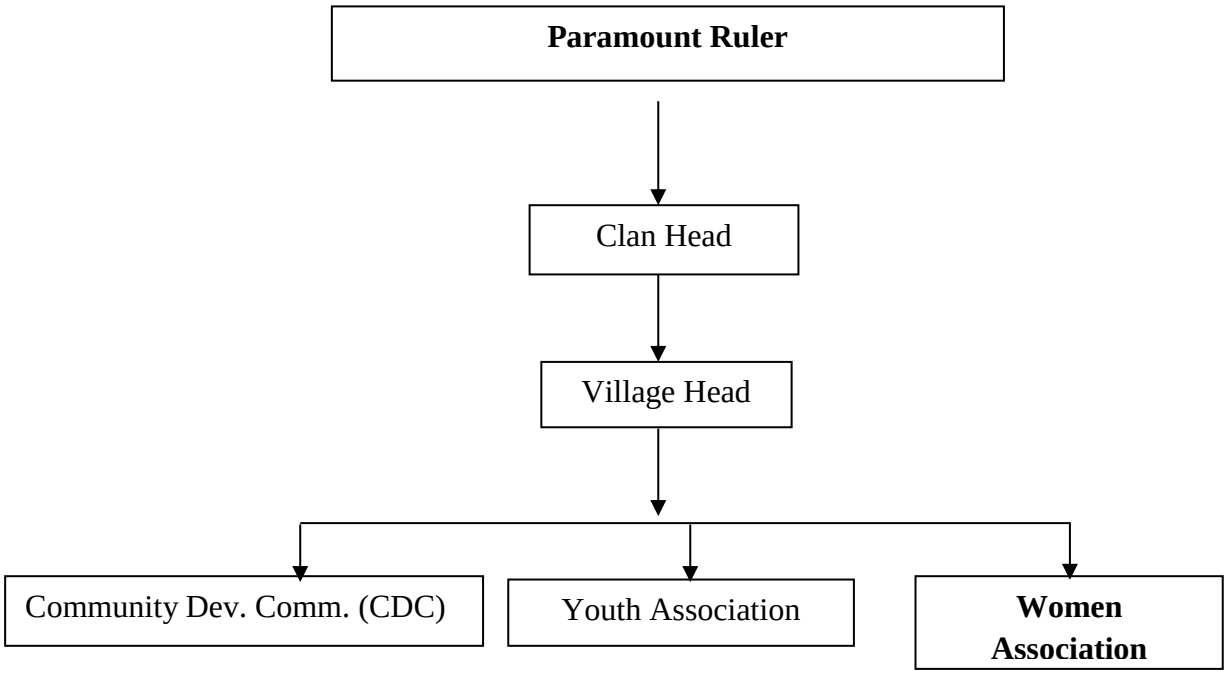


Figure 4.4: Administrative structure of Communities in the Study Area

Age grades were also found in some communities while in others they were not organized and developed. The Chieftaincy succession was found to vary among the sampled communities. The unique case however was the case of selection by the ancestors speaking through a soothsayer in Akpor Kingdom. The traditional administration works side by side and in collaboration with the government administration as the Federal, State and Local Governments function to maintain- the rule of law in all the communities.

4.12.5: Settlement History

History shows that people from the communities sampled during the study came from diverse stocks. Nonetheless, many of the communities are related to one another as some of them are of the same stock of the children of Apara, Evo and Akpor. Eledo who is the father of the Eledo group of communities in Rukpokwu is the sixth son of Apara. The children of Apara form the Obio group that is part of Obio-Akpor. These are said to have come from the Akaloka tribe in the old Bendel State. The people of Omunike and Omonoba, on the other hand are believed to have migrated from the ancient Benin Empire. The Akpor people on the other hand say that documentary evidence exist to prove that they did not migrate from

anywhere, this implies that they were created in their present location. It could also mean that the people have been in the location for so long that they have lost track of where they migrated.

4.12.6: Land ownership/acquisition

Three levels of land ownership exist in the sampled communities viz: community, family and individual ownerships. All the communities sampled had the three options as presented in Table 4.11. Land belonged to either families or communities. Communally owned lands are allocated to individuals and to families for use.

Table 4.11: Distribution of - Land Ownership by sampled communities

S/NO	Communities	Land ownership pattern
1.	Rumujima Eledo Rukpokwu	Individual, Family, Communal
2.	Elikpokwodu Rukpokwu	Individual, Family, Communal
3.	Mbodo Aluu	Individual, Family, Communal
4.	Omuigwe Aluu	Individual, Family, Communal
5.	Omuoda Aluu	Individual, Family, Communal
6.	Omunike Omunoba	Individual, Family, Communal

4.12.7: Settlement Pattern

Land availability and urbanization to an extent, determine the settlement pattern. All the sampled communities had compact nucleated linear settlements (Table 4.12). This was made by the pressure of urbanization on people to build houses linearly along marked roads on the available land. Houses built were close to one another (nucleated) and accommodated households with hardly any spaces between compounds. Some of the communities were more densely populated than others.

Table 4.12 Distribution of communities by type of Settlement

S/NO	Communities	Settlement pattern
1	Rumujima Eledo Rukpokwu	Nucleated linear
2	Elikpokwodu Rukpokwu	Nucleated linear
3	Mbodo Aluu	Nucleated linear
4	Omuigwe Aluu	Nucleated linear
5	Omuoda Aluu	Nucleated linear
6	Omunike Omunoba	Nucleated linear

4.12.8: Major Language

Table 4.13 shows that Ikwere is the indigeneous language spoken in the study area. The ancestral relationship of the people permitted the speaking of Ikwere language in the area. Among the non indigenous residents in the area, the Ibos were in majority in most of the communities. The Yorubas were also in good number and so were the Ibibios and Annangs from Akwa Ibom State. Present in the area also were people from Edo and Delta States. Table 4.13 also gives the major non-indigenous residents in all the sampled communities in order of prevalence. The Ibos are the major non-indigenous group in most of the sampled communities.

Table 4.13: Distribution of sampled communities by language spoken

S/N	Communities	Indigeneous Language spoken	Major non indigenous - language in order of prevalence
1	Mbodo Aluu	Ikwere	Ibos,Ibibios,Yorubas,
2	Omuigwe Aluu	Ikwere	Ibos,Ibibios,Yorubas,Tiv
3	Omuoda Aluu	Ikwere	Ibos,Ibibios,Yorubas,Tiv
4	Omunike Omunoba	Ikwere	Ibos,Yorubs,Edos,Ibibios
5	Rumujima Eledo Rukpokwu	Ikwere	Ibos,Ibibios,Yorubas,Hausa
6	Elikpokwodu Rukpokwu	Ikwere	Yorubas,Ibos,Ibibio

4.12.9: Population structure and distribution

2006 population figures for the Ikwere and Obio Akpor Local Government areas were projected to the 2009 using both the linear and exponential population growth at a rate 2.8% per annum. The total expected population in the local governments to be affected by the project under the linear projection was 709,494 while the exponential projection was 711,047 people. The population figures are presented in Table 4.14.

Table 4.14: Population of Males and Females in 2006 Projected to 2009 in the sampled Obio Akpor and Ikwere LGAs

S/N	Local Government Areas	Males (2006)	Females (2006)	Total (2006)	Total (2009) Linear	Total (2009) Exponential
1	Obio Akpor	244,875	219,914	464,789	503,831	504,934
2	Ikwere	101,080	88,646	189,726	205,663	206,113
Total		**345,955**	**308,560**	**654,515**	**709,494**	**711,047**

Source: NPC, 2007

Population Structure

The population structure analyses the content of the population in terms of sex and age groups. The population of the sampled local government areas was based on 2006 census by the National Population Commission. The community figures were not available yet, at the time of the study. The analysis of sex ratios of the sampled local government areas is presented in Table 4.15.

Table 4.15: Sex and dependency ratios of communities

S/N	Local Government Areas	Sex ratio
1.	Ikwere	114
2.	Obio Akpor	111

Source: Computed from 2006 census figures.

The age-sex distribution of the sampled communities shows that there were more people in the lower age brackets and less in the older age brackets see table 4.16. There was also a good proportion of the working age group in the population. When this happens, the dependency ratio is low as many working age adults work to take care of the dependents who are either in the lower ages (0-18years) and the older population that can no longer work (65 years and above). The distribution of the age groups by sex gives a pyramid structure presented in Table 4.16 and Figure 4.5. This indicates that the younger age classes were more in number than the older age classes giving a pyramidal shape.

Table 4.16 presents the age distribution in the area

Age Group	**Population**	
	Male	**Female**
0 - 4	850	830
5 - 9	720	730
10 – 14	680	715
15 – 19	450	450
20 – 24	430	410
25 – 29	400	410
30 – 34	360	370
35 – 39	300	308
40 – 44	230	225
45 – 49	218	210
50 – 54	115	118
55 – 59	80	86
60 – 64	40	50
65+	20	40

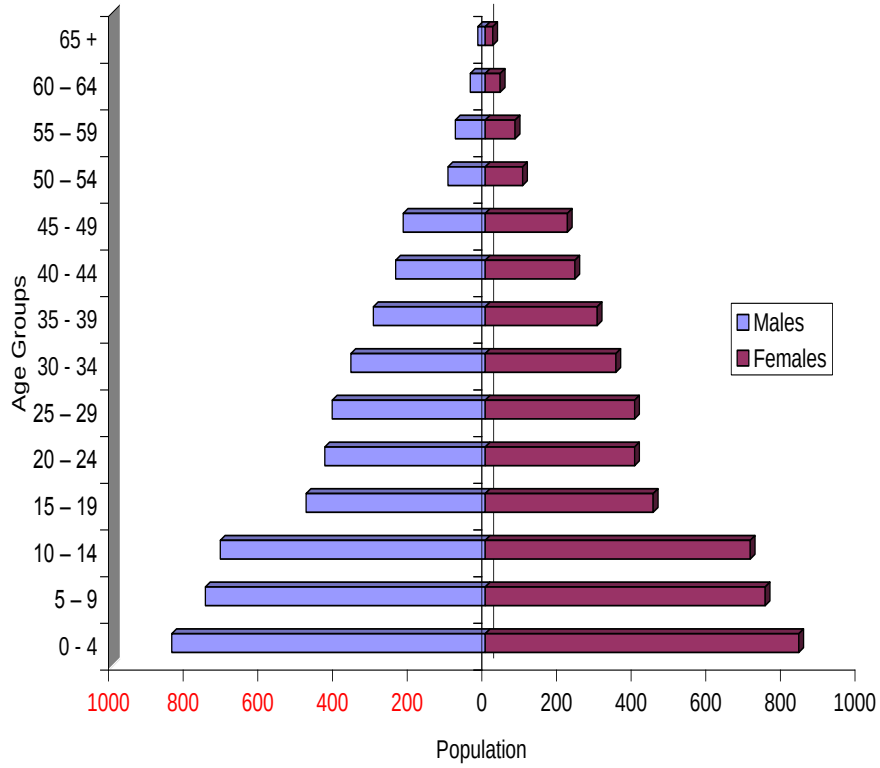


Figure 4.5: Distribution of Age groups and Sex in the study area

4.12.10: Infrastructures and Services

The level of infrastructural development in the communities sampled varied very slightly from place to place as most of the communities were either rural (Mbodo Aluu, Omuigwe Aluu, Omuoda Aluu) or semi urban (Omunike Omunobo, Rumujima Eledo Rukpokwu, Elikpokwodu Rukpokwu).

Roads and Transporting

The major roads leading to the communities (Mbodo Aluu Omuigwe Aluu Omuoda Aluu Omunike Omunoba Rumujima Eledo Rukpokwu Elikpokwodu Rukpokwu) are tarred. However within the communities, the roads were all earth roads some were in a state of disrepair. The means of transport used was a function of where the individual wanted to visit and how far the place was from his/her domicile. Motorbikes were used for short distances while buses were used for longer distances.

Telecommunication

Telecommunication services in the study area are provided by the global satellite for mobile communication (GSM) operators namely MTN, Zain, Globacom, etc. The quality of network signal was observed to reduce significantly as one moves away from the urban areas towards the rural areas.

Availability of infrastructure generally influences living standards and level of urbanization. The level of infrastructure determines whether a community is urban, semi urban or rural.

Education

The distribution of respondents by level of education attained is presented in Table 4.17 and shows respondents attaining similar levels of education in the area. The trend shows that 50% of the respondents had secondary education, many of the respondents (14%) attained tertiary education. The communities had at least a primary school or shared one with some neighbouring communities. Plates 4.3 and 4.4 show some schools in the study area.

Table 4.17: Distribution of Communities by Educational Level of Respondents

S/N	Communities	Number of Respondents	No formal education	Primary education	Secondary education	Tertiary education
1.	Mbodo Aluu	35	10	15	60	15
2.	Omuigwe Aluu	33	15	22	52	11
3.	Omuoda Aluu	35	10	20	57	13
4.	Omunike Omunoba	45	18	21	50	20
5.	Rumujima Eledo Rukpokwu	40	17	22	43	18
6.	Elikpokwodu Rukpokwu	51	22	19	46	13

Plate 4.3: A secondary school at recess during the survey at Rukpokwu

Plate 4.4: State Primary School 1, Aluu

Acquisition of formal education could have influence on income potential of people since better educated people stand better chance of being placed on jobs that attract higher income.

Housing

The structure and types of houses in the communities are good indicators of the income level of the households. The least house quality were the houses with mud walls and thatch roof, this is followed by mud walls and corrugated iron roofing sheets. The next classes of houses were those made of mud walls plastered with cement and corrugated iron roofing sheets, while the class with the highest quality was those made of cement block walls with corrugated iron roofing sheets. The housing types found in the communities in the study area were mostly cement blocks with corrugated iron roofing sheets. A few of the houses were mud walls plastered with cement in the semi urban communities sampled. The proportions of the housing types in the community are presented in Table 4.18. In the community, the proportion of the housing types gave an indication as to whether the community is urban, semi urban or rural.

Table 4.18: Housing type in the study area

S/NO	L.G.A.	Community	Major Housing Type
1	Ikwere	Mbodo Aluu	Semi-temporary
2	Ikwere	Omuigwe Aluu	Permanent
3	Ikwere	Omuoda Aluu	Permanent
4	Ikwere	Omunike Omunobo	Semi-temporary
5	Obio Akpor	Rumujima Eledo Rukpokwu	Permanent
6	Obio Akpor	Elikpokwodu Rukpokwu	Permanent

Temporal – houses made with wood and thatch or corrugated iron roofing sheets
Semi-temporal – houses made with mud and thatch or corrugated iron roofing sheets
Permanent – houses made with cement blocks and corrugated iron roofing sheets

4.12.11: Local Economy

The economy of the sampled locations can be said to be mostly private sector driven. The people were mostly self-employed or employed outside government establishments, as the government establishments could not employ the large population available. Trading was a major occupation as many families were involved in one form of trading or the other. The demand for a wide variety of tradesmen and skilled workers in the area had given room to the growth of large business concerns in the area. There are welders, furniture makers, food processors, etc. that have developed at different levels operating in the area.

Farming was still the traditional occupation of the people but with urbanization and oil exploration, most of the farmlands have been taken up and are currently used as residential or industrial areas. The people now have to farm on marginal lands in the outskirts of the town. Their produce are mostly for subsistence and only the excess of family needs is offered for sale. The other category of people is involved in trade, buying wares from major markets and retailing the goods to community members. The presence of artisans of all types within the sampled communities gave indication of diversity of the economy as the demand for these services were the driving force for their supply.

The agricultural sector dominated the proportion of those involved in other economic ventures. The crops grown were similar in all sampled communities and were mostly made up of mixture of food crops in the farms and some tree crops around the compounds. Common food crops grown in the area include Cassava, Coco yam, yam, maize and vegetables while tree crops include oil palm Mango, Orange, etc.

Occupational Distribution

The distribution of occupational groups available in the communities are presented is Table 4.19. The types of occupational groups found was a function of the level of urbanization. Type of community influences the demand for certain services. In rural communities, most people are farmers while in urban communities; there is a wider range of employment due to enlarged demand. The distribution shows that farming was a major occupation but we had a good distribution of other forms of occupational groups in all the communities.

Table 4.19: Distribution of Sampled Households by Occupational groups in - Ikwerre and Obio Akpor LGAs of Rivers State

S/N	Communities	Number of Respondents	Farming (%)	Trading (%)	Fishing (%)	Civil service (%)	Artisan (%)
1.	Mbodo Aluu	35	25	18	27	15	15
2.	Omuigwe Aluu	33	23	20	25	15	15
3.	Omuoda Aluu	35	20	21	23	20	16
4.	Omunike Omunoba	45	27	19	21	12	21
5.	Rumujima Eledo Rukpokwu	40	24	21	19	19	17
6.	Elikpokwodu Rukpokwu	51	24	18	25	17	16

Income Distribution

The distribution of income levels in the sampled communities is presented in Table 4.20.

Table 4.20: Distribution of Respondents by income classes in Naira per month

COMMUNITIES		MONTHLY INCOME OF HOUSEHOLDS (NAIRA)							
-	Number of Respondents	1,000 – 10,000	10,001 – 20,000	20,001 – 30,000	30,001 - 40,000	40,001 – 50,000	50,001 – 60,000	60,001 – 70,000	Above 70,000
Mbodo Aluu	35	21	18	15	11	10	8	9	9
Omuigwe Aluu	33	17	16	15	14	11	12	9	6
Omuoda Aluu	35	16	15	17	10	13	9	10	10
Omunike Omunoba	45	16	16	14	14	13	10	11	6
Rumujima Eledo Rukpokwu	40	20	18	14	15	13	8	4	8
Elikpokwodu Rukpokwu	51	20	14	12	10	13	12	13	6

The money income level –supports household consumption expenditure. The money income level in the sampled communities were relatively similar. These could be attributed to the relative proximity of the communities to Port Harcourt town were many respondents worked. The money income level of a household determines liquidity status as to whether the household can support itself with at least daily one-dollar expenditure or less. This helps to rank their poverty level. Poverty status of households could as well be determined with indices like ownership of properties (land, cars, etc.), quality of living apartments, access to potable drinking water, access to good health care, and level of nutrition.

Markets and marketing:

Markets in the area function either every 3, 5 or 8 days in a week. There are also daily markets in many of the communities. The markets that hold every 5 days, or 3 days or 8 days assemble daily for business at relatively lower scale than the designated market days. On business days, inhabitants of the various communities and other stakeholders bring their wares to the market for sale and in the course of doing that interact with fellow participants. Market days in these communities were not only days for income generation but days in which special meals are prepared and eaten with some merriment. They are thus occasions for economic exchange of goods and services and for social interactions.

4.12.12: Lifestyle Culture

Taboos, Sacred Places and Festivals

Urbanization has affected the level at which the communities adhered to traditional norms. Communities with a high proportion of visitors found it difficult to enforce traditional laws and taboos. Christianity also had reduced the beliefs and adherence to traditional taboos in most of the communities. The communities visited had several common beliefs and taboos that were common especially given their common origin. It was common for instance that people were forbidden from having sex in the bush or on the floor. It was found to be the most common taboo across the communities.

The King of Akpor kingdom does not see any corpse; he does not share his plates, cup or stool with any other human being. Violation of this traditions and rules demands offering sacrifices to atone for the deed before the person involved can be freed. Otherwise, violations often resulted in illnesses and finally death. In Aluu, sacred sites include, Minita, Obizor, Odunai, and Ngara. Apart from having sex in the bush, it is also a strong taboo for a woman to climb a tree in Aluu. The traditional dances and masquerades in the area are many and varied. The common ones were the *eregbu* dance, *arungu*, *egelege*, others include *ogumabiri*, *egbukele*, *mkpa*, *obini*, etc. These dances feature during merry making and general celebrations in the communities.

Religion

There were three main religions to which inhabitants belong in the sampled communities. These are Christianity, Islam and African Traditional Religion. Christianity was the most popular amongst the people as most of the people -worshipped their creator in churches of different denominations. The most common denomination was the Anglican Church (Plate 4.5), which is seen as the traditional church of the people of Rivers State.

Plate 4.5: One of the churches in the study area

Church worship was observed to be mostly on Sunday mornings. The Muslims were the minority of the population of religious group. Most Muslims in the areas were residents from either the Hausa or Yoruba speaking areas of the country. The indigenes that are Muslims were very few and not common in several communities. One Mosque at Rukpokwu served Muslims from several communities in the study area.

Inhabitants practicing African Traditional Religion in some instance combined it with Christianity. The adherents to traditional religion maintain the community shrines and sacred places. It was noted that most communities had denounced or remained very cold with value to the shrines – on basis of their adherence to Christianity.

Recreational Facilities

Create a Table to show number, type, provider/year of provision and use status of recreational facilities as seen in your survey of the area. Recreational facilities were grossly lacking inspite of a great need for them in Obio Akpor and Ikwerre Local Government areas. The youth make use of school fields to play football and other games. Wrestling contests also entertain spectators in the school fields. People were observed relaxing with draft boards and other indoor games. Other recreational facilities in the area included ply grounds and town hall/Civic Centers. The civic centers were not equipped and were calling for refurbishing attention to enable them serve their purposes.

4.12.13: Peoples' Perceptions, Fears and Expectations of the Project

Perceptions

The people's perception of the proposed project was discussed in each of the FGDs and the perceptions were quite similar to those recorded for such projects in the past. There were several complains, requests and views expressed by the communities concerning the operations of SPDC in the area. One of the complaint was that the rent paid by SPDC on acquired land had not been reviewed since the early 1980s and this makes the rent value very little, unreasonable, and unfashionable.

On the other hand, concerning the project being proposed, the surveyed communities - pledged to cooperate with SPDC to ensure the project goes on successfully. All the sampled communities said they desired development and would like to see development around their respective communities.

Fears

The fears of the people in the communities visited were based on their experiences of previous developments. Amongst other fears, some community members expressed some doubts about the sincerity of SPDC as regards the proposed project. The fears expressed were listed from community to community and summarized follows:

- destruction of farm land;
- inadequate compensation for land take;
- reduced crop yields;
- deleterious effect of noise on humans (children and babies in particular) and wild life
- destruction of roads during the operations;
- disruption of traffic on roads during movement of equipment and personnel;
- possible fire outbreaks at the well heads;
- deleterious effect of gas flaring.

Expectations and Needs of Communities

The expectations and needs of the people were gathered in each community during the FGDs. The needs of the people were listed in order of priority for each of the communities. - Creating and restoring water drainage and repair of bad roads were prominent among the needs of the inhabitants.- - Some communities lacked good drinking water while others had no schools and/or health centre. These formed the basis for - prioritization of community needs during the survey. A summary of the needs of the people in the sampled communities is presented in Table 4.21.

Table 4.21: Summary of Community Needs

S/N	Community Needs	Number Needed
1	Repair of Community Roads	10
2	Water drainage repairs	20
3	Provision of Employment	45
4	Equipping the Health Centers	-
5	Provision of Portable water	20
6	Granting of Scholarships	-
7	Provision of Electricity	-
8	Provide/equip Schools	-
9	Provision of moderrn Market	6
10	Provision of Town hall	6
11	Pay Homage to Chiefs	-

4.13: Health Profile

A wide range of economic factors determines health and well-being of individuals and communities. They include social and environmental conditions as well as factors like family history and access to health services (Taylor and Plaair-Stephen, 2002). According to Dorland's Medical Dictionary 2007, and Park, 2005, health is defined as a state of optimal physical, mental, and social well-being and not merely the absence of disease. Countries under the umbrella of the World Health Organization are working towards prevention of diseases, promotion of health and improvement of the quality of life of individuals and groups or communities.

4.13.1: Health Infrastructure

An inventory of health care facilities in the study areas shows inadequate provision of government health facilities in the communities. There were private clinics in the area and patent medicine stores. Private medical clinics and patent medical stores are providing healthcare at high prices forcing residents to patronize University of Port Harcourt Teaching Hospital (UPTH).

Survey records show that only three health centers were seen in the communities studied (Table 4.22). The health centres in the area, included, Community Health Center, Mbodo Aluu – (SPDC provided), Bon Maria Clinic, Rukpokwu and Patfare Clinic, Rukpokwu which are both privately owned. At Aluu, only one health care center (Plate 4.6) serves all the communities in the area and this health center lack equipment as well as qualified personnel. Serious cases of ailments and accidents were taken to the University of Port Harcourt teaching Hospital.

Plate 4.6: A health care center at Aluu

The patent medicine stores (Plate 4.7) served for the purchase of drugs and for treatment of minor injuries. These stores are relatively small in size and have limited range of drugs in stock. Some members of the communities were satisfied patronizing these stores whilst a greater part says they do so on ground of no better alternative. Table 4.22 presents a record of health facilities in the study area.

Plate 4.7: A Patent medicine store in the study area

Table 4.22: Inventory of Health Care Facilities /Personnel in Study Area

Community	LGA	Types of facility	Personnel			Lab	Services
			Doctors	Nurses	Attendants		
Mbodo-Aluu	Ikwere	None	None	None	None	None	None
Omuoda-Aluu	Ikwere	None	None	None	None	None	None
Omoigwe-Aluu	Ikwere	Health center (1)	None	11	None	None	Antenatal care, out patient
Omunike Omunobo	Ikwere	None	None	None	None	None	None
Eledo-Rukpokwu	Obio Akpor	None	None	None	None	None	None
Elikpowodu Rukpokwu	Obio Akpor	Health center (1)	None	1	None	None	Antenatal care, out patient

4.13.2: Housing and Environment

In order to study the role environment plays in health and disease, the environment may be categorized into three: biological physical and social. It is of utmost importance to manage all the factors in the environment which may have harmful effects on the physical development as well as health and survival of the inhabitants. (Gupta and Mahajan, 2007). Most houses in the sampled communities were built with cement and roofed with corrugated iron sheets. Some of the rooms are poorly ventilated, and share sanitary conveniences. Exhausts fumes and noise from power generators pollute not only the rooms but also the immediate compounds.

4.13.3 Disease Prevalence

Table 4.23 shows disease prevalence in the areas of study. Malaria and typhoid fever ranked highest with prevalence of 99% and 80% respectively, respiratory infections 50%, measles 5%. Diarrhea diseases were surprisingly low, being about 4%. Hypertension and diabetes had high prevalence too (72%, and 64% respectively).

Table 4.23: Prevalence of Diseases in Study Area

COMMUNITY	NUMBER OF RESPONDENTS	MALARIA	TYPHOID FEVER	HYPERTENSION	DIABETES	RESPIRATORY INFECTIONS
Ikwere LGA						
a) Mbodo-Aluu	30	30	26	24	23	16
b) Omuoda-Aluu	33	33	23	27	22	16

COMMUNITY	NUMBER OF RESPONDENTS	MALARIA	TYPHOID FEVER	HYPERTENSION	DIABETES	RESPIRATORY INFECTIONS
Omoigwe-Aluu	35	30	26	20	18	17
Omunike-Omunnobo	33	30	27	26	20	16
Obio –AkporLGA						
a) Eledo-Rukpokwu	30	30		25	18	16
b)Elikpokwodu-Rukpokwu n	30	27	20	23	18	18

4.13.4: Availability of Potable Water

It is desirable to make - potable water available to all communities members for proper health and cleanliness (Gupta and Mahajan, 2007). All the respondents in the communities' sampled use water from borehole, none use stream water and rain water. Out of the 100% that use borehole water, only 5% treat the water before usage, and about 2% boil their water before drinking.

4.13.5: Lifestyle

The lifestyle has serious social, economic and public health implications and contributes to the overall health and well-being of the people. People's indulgence in alcohol consumption and cigarette smoking in the study area were examined. Focus Group Discussion (FGD) suggested moderate alcohol consumption and low cigarette smoking.

4.13.6: Immunization coverage

Report shows that Immunization of children was carried out in the communities. These include BCG (Bacillus, Calmette, Gueerin), OPV (Oral Polio Virus), and DPT (Diphtheria, Pertusis, Tetanus). Effective enlightenment campaign by government in the communities was responsible for the high immunization status observed in the sampled communities. Health care personnel carrying out immunization were also reported to be regular to the communities during rounds of immunization-.

4.13.7: Nutrition

Good nutrition is an important index in enhancing resistance to infections. Individual responses to questionnaires and oral interview revealed that the commonly consumed food rich in carbohydrates (garri, plantain, yam, rice and other forms of cassava other than garri). Few of the respondents in the communities took seafood and fishes regularly instead beef was more consumed than the sea foods. Vegetables such as fluted pumpkin, bitter leaves and fruits such as banana, paw-paw and so on form sources of micro nutrients.

The nutrition conditions of children under 5 (2 – 4 years) were not left out but were determined by anthropometric method. This included measurement of weight, height, head and upper arm circumference. They were equally examined for indications of anaemia, muscle wasting, jaundice and skin lesions. Majority (89.5%) of the children examined appeared adequately nourished while 3.4% were anaemic and 9.1% had skin lesions.

CHAPTER FIVE
ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

5.1: Introduction

All major public and private projects that might significantly affect the status of the environment require impact assessment. It is proposed to provide reasonable predictions of the possible consequences of policy decisions on perceived receptors and thus, to permit wiser choices among alternative courses of action. The potential impacts of the various project activities of the proposed field development project by SPDC on the environment are assessed in this chapter.

SPDC in pursuance of its environmental policy and in compliance with relevant national and international laws and conventions, and acceptable industry standards embarked on this impact assessment prior to the commencement of the project. This EIA study is intended to predict, identify, interpret and communicate the impacts of the various phases of the project on the environment of the proposed project. **Fig. 5.1** illustrates the stepwise approach adapted for this assessment.

The objectives of this Impact Assessment are:

- To establish the significant potential impacts of the proposed project activities on the environment;
- To evaluate alternatives for environmental impact that could lead to sustainable development; and
- To incorporate the recommendations of the EIA into the decision making process of the field development project.

A screening and scoping exercise were carried-out in accordance with FMEnv and DPR specifications and guidelines in order to achieve the above objectives.

5.2: Principles of Impact Prediction and Evaluation

A sound methodological framework should form the basis of impact prediction and evaluation irrespective of the impact and the technique used in analyzing it. The principles include:

- The overall prediction and evaluation process
- Choice of prediction technique
- Criteria for evaluating significance
- The design of mitigation measures
- Indirect impacts, long range impacts and uncertainty

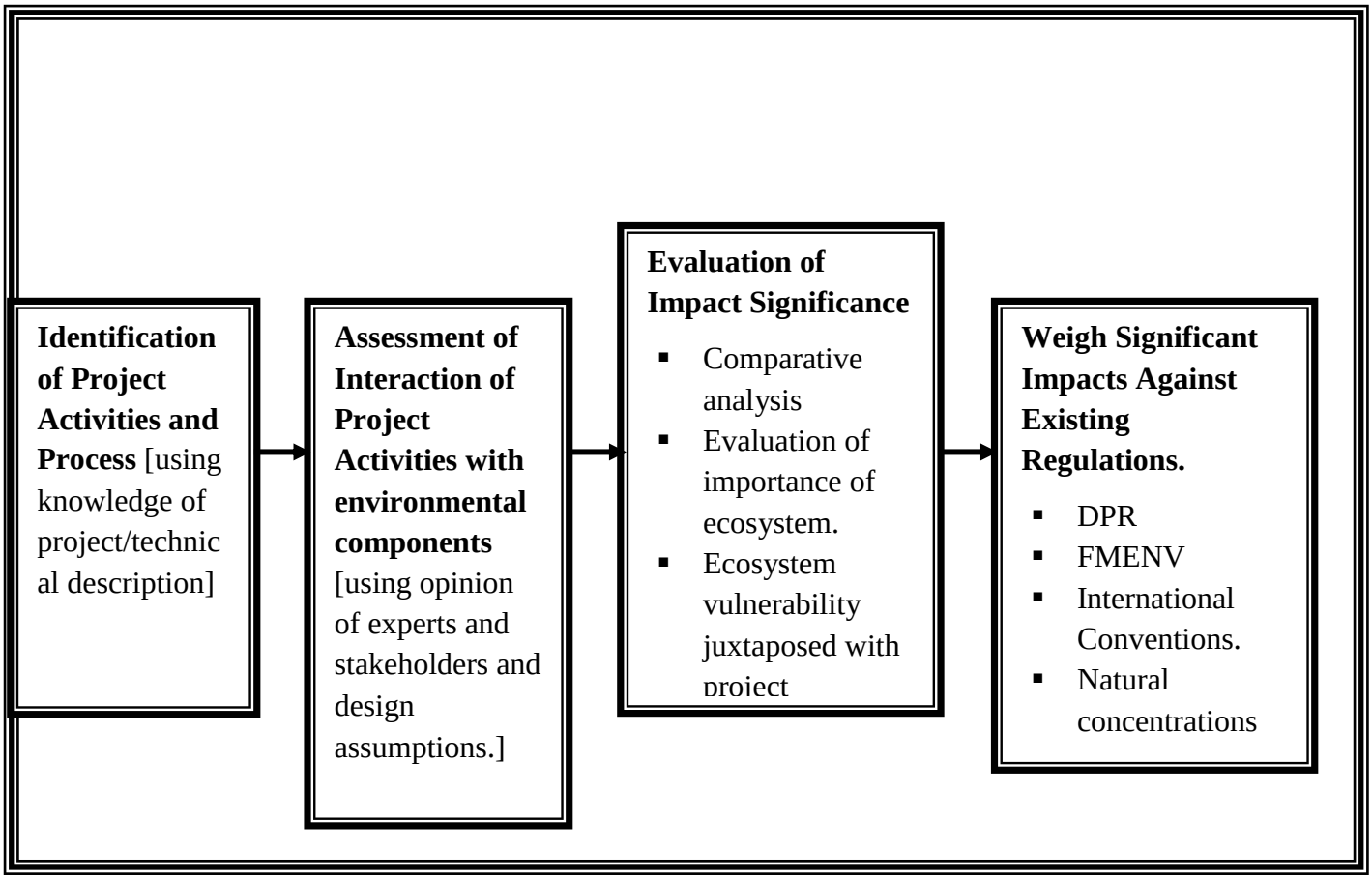


Fig. 5.1: Schematic Representation of Potential Impact Assessment Approach

5.3: Impact Assessment Methodology

There are several approaches and techniques developed for evaluating potential impacts of any project on the environment. Some of which were developed in the early 1970s and lean heavily upon approaches used in other spheres of environmental management (Wathern, 1986). The Overlays techniques (McHarg, 1968); Leopold matrix (Leopold *et al*., 1971); Battelle Environmental Evaluation System (Dee *et al*., 1973) and Peterson Matrix (Peterson *et al*., 1974) are among the most widely used methods for impact assessment. Conversely, in this study, the ISO 14001 guideline (method) is used for the impact prediction and evaluation.

5.4: Screening and Scoping of the Potential Impacts

It has become necessary to undertake an early and open process for determining the scope of issues to be addressed and for identifying the significant issues relating to a proposed action. It is important that the effective screening of actions take place in all environmental assessment systems without which, unnecessarily large numbers of actions would be assessed and some actions with significant adverse impacts may be overlooked. The determination of whether or not an environmental assessment is to be prepared for a particular action should

hinge upon the likely significance of its environmental impacts. Lee and George (2000) identified two broad approaches to the identification of such action and they include:
The assemblage of a list of actions, accompanying thresholds and criteria (which may include locational characteristics) to assist in determining which actions should be assessed, and the establishment of a procedure which may include the preparation of a preliminary or intermediate environmental assessment report for the case by case (discretionary) determination of which actions should be assessed. The rationale for screening the likely significant potential impacts of the proposed project on the environmental components, characteristics and indicators are derived from the following:

- Status of the baseline of the environment;
- Findings of other EIA studies on similar projects;
- Knowledge of the project activities, equipment types, layout of the project facilities;
- Experience on similar project; and
- Series of expert group discussions and meetings.

The potential impacts scoping involves identifications of interactions between project activities and environmental impacts indicators. This stage of the impact assessment process indicates whether an impact is beneficial or adverse. The majority of the adverse effects will originate from the pipeline installation. Most of these impacts are predicted to be short-term and shall cease with the completion of the project while impacts from operational phase are expected to be long-term.

The environmental impact indicators are defined and adopted so as to identify potential environment impacts. The Impact indicators are the easily observable environmental components, which readily indicate changes. **Table 5.1** presents the impact indicators used for this study**.**

Table 5.1: Environmental Components and Potential Impact Indicator

Environmental components	**Impact Indicators**
Climate	Temperature, Rainfall, Relative humidity, Wind speed and direction
Air Quality	SPM, NO_x, SO_x, Cl_2, CO, H_2S, VOC, NH_3 etc
Soil Characteristics	Physicochemical and microbiological characteristics of the soil
Ground water characteristics	Dissolved and suspended Solids; Turbidity and Toxicity, BOD, COD, pH, temperature, electrical conductivity, THC
Ecology	Species diversity, Abundance, Productivity, Yield.
Socio-economics/Health	Needs and concern of host communities, perception on the proposed project /Health risks, Population, Education level, income level, Disease prevalence, mortality rate Waste streams, handling, treatment and disposal etc

5.5: Impact Identification

Impact Prediction Methodology

Table 5.2 presents the ISO 14001 guidelines used for the impact prediction and evaluation of this proposed field development project. This makes room for interactive and descriptive analysis of relationships between the proposed project activities and the various environmental components (biophysical, health and social). The criteria adopted for the evaluation of the identified impacts are as follows:

- Adverse/Beneficial (A/B)
- Duration (D)
- Legal / regulatory requirement (L)
- Risk Factor (R)
- Frequency of occurrence (F)
- Importance of impact on affected environmental components (I) and
- Public perception / interest (P)

The various criteria were weighted on a scale of 0 – 5 as follows:

- Adverse/Beneficial (A/B)
  - A – Adverse
  - B - Beneficial

Duration (D)
ST – Short term (<6 months)
LT – long term (>6 months)

Legal/Regulatory Requirements (L)
0 – No legal/regulatory requirement
3 – legal/regulatory requirement present
5 – Permit required

Risk Factor (R)
0 – No Risk
1 – Low Risk Factor
3 - Intermediate risk factor
5 – High Risk Factor

Frequency of Impact (F)
1 – Low Frequency
3 – Intermediate Frequency
5 – High Frequency

Importance (I)
1 – Low Importance
3 – Intermediate Importance
5 – High importance

Public Interest/Perception (P)
1 – Low
3 – Intermediate
5 – High

The basis for rating the level of significance of the impact as either 'high', 'medium' or 'low' is as follows:
High significance (L+R+F+I+P) ≥ 15 or (F+I) > 6 or P =5
Medium significance (L+R+F+I+P) ≥ 8 but < 15
Low significance (L+R+F+I+P) < 8

The impact assessment and ranking for the Field Development Project activities are presented in **Table 5.2.**

Table 5.2: Characterization/Evaluation of Potential Impacts of the Proposed Agbada Field Development Project

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
Pre-mobilization Phase	**Land acquisitions and claims settlement**	Community protest over compensations, land disputes, wrong landowner identification, leadership tussles	A	ST	3	1	3	3	3	6	13	Medium Significance
Mobilization Phase	Transport of Equipment and Personnel to Site	Workplace accidents / incidents during loading and offloading of materials / equipment	A	LT	0	5	1	1	1	6	8	Medium
		Interference with other public and private transport t activities	A	ST	0	1	1	3	3	4	8	Medium Significance
		Risk of road accident	A	ST	0	3	1	5	2	6	11	Medium Significance
		Traffic jam on local roads due to movement of heavy duty truck	A	ST	3	1	3	3	3	6	13	Medium significance

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
		Noise/Vibration from trucks	A	ST	3	3	1	5	1	6	13	Medium significance
		Pollution - spillage / leakage of fuel or lube oil onto land during transportation	A	ST	3	3	1	3	3	6	13	Medium significance
		Emission of atmospheric pollutants from machineries and vehicle exhaust.	A	ST	0	1	5	3	3	6	12	Medium significance
		Accidents from use of forklifts, cranes etc. used to move materials and equipment	A	LT	0	5	1	5	2	6	13	Medium significance
		Creation of employment opportunities	B	ST	0	0	3	5	5	8	13	High significance

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
		Reduction in aesthetic and recreational value of drilling site	A	ST	0	1	3	3	3	6	10	Medium significance
		Movement of large number of persons to the area	A	ST	0	1	3	5	5	8	14	High significance
		Incidence of STDs, marriage breakages, abortions	A	LT	0	3	1	5	5	6	14	High significance
		Increased noise levels	A	ST	3	1	1	3	3	4	11	Medium significance
Site Preparation / Construction and drilling Phase	Vegetation Clearing and Removal of Topsoil, rehabilitation of campsite, drilling of well	Recruitment of Local labour/ generation of economic activities	B	ST	0	0	3	5	5	8	13	High significance
		Alteration of land use pattern and loss of arable lands	A	LT	0	3	3	5	5	8	16	High significance

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
	Laying of pipelines, transportation of materials, Trenching/excavation along ROW,Welding,Coating of pipes, Backfilling, Pressure testing	Loss of biodiversity (floral and faunal) including loss of plants of economic value along pipeline ROW	A	LT	3	1	3	3	5	6	15	High significance
		Fragmentation of habitats; Disruption of wildlife migration routes	A	LT	3	1	3	3	3	6	13	Medium significance
		Employment of locals as skilled and unskilled labour	B	ST	3	1	1	5	5	6	15	High significance
		Introduction of new and alien disease by movement of workers to the site	A	LT	0	5	3	5	1	8	14	High significance
		Infringing social and cultural taboos by workers	A	ST	0	5	3	3	5	6	16	High significance
		Emission of atmospheric pollutants	A	ST	3	3	3	3	3	6	15	High significance
		Constant lighting	A	LT	5	5	5	5	5	10	25	High significance

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
		Igniting by welding flames, red-hot metals or flying sparks causing fires/explosion and injury/loss of lives	A	LT	0	5	1	5	1	6	12	Medium significance
		Possible pollution of ground water due to drilling activities	A	ST	3	5	1	3	3	4	15	High Significance
		Localized increase in baseline concentration of physicochemical parameters of the environment from routine discharge of spent mud, drill cuttings/mud, chemicals, sewage etc	A	ST	3	1	3	3	3	6	13	Medium Significance
		Increase in noise levels	A	ST	3	3	3	3	3	6	15	High significance
		Invasion of ROW by exotic species	A	LT	0	3	1	3	5	4	12	Medium Significance
		Alteration of natural drainage patterns	A	LT	3	3	3	3	3	6	15	High significance
		Soil erosion and run off from pipeline ROW	A	LT	3	5	3	5	3	8	19	High significance

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
		Obstruction of traffic by construction equipment at road crossing	A	LT	0	1	1	3	3	4	8	Low significance
		Personnel injury from welding burns	A	MT	3	1	3	3	1	6	11	Medium significance
		Personnel injury/death resulting from malfunction and mal-operation excavator/cranes	A	LT	0	5	3	5	3	8	16	High significance
		Possible Kidnap of construction workers	A	LT	0	5	3	5	3	8	16	High significance
Operations Phase		Noise from the use of operation engines and motors	A	LT	3	1	5	1	3	6	13	Medium significance
		Water/Soil pollution, resulting from disposal of pigging waste	A	LT	3	5	3	5	3	8	19	High significance
		Employment of locals and subsequent stimulation of local and national economy	B	LT	0	5	5	5	5	10	20	High significance
		Community development programmes	B	LT	0	5	5	5	5	10	20	High significance
		Atmospheric pollution from gas leaks	A	ST	3	5	1	5	3	6	17	High significance

Project Phase	Project activity	Description of Impact	IMPACT RANKING CRITERIA								
			A/B	D	L	R	F	I	P	F+I	L+R+F+I+P	Overall Ranking
		Continuous lighting	A	LT	5	5	5	5	5	10	25	High significance
		Possible Kidnap of construction workers	A	LT	0	5	3	5	3	8	16	High significance
		Outbreak of fire due to equipment failure or sabotage	A	ST	0	5	1	5	3	6	14	Medium Significance
Decommissioning and Abandonment Phase	Decommissioning and Abandonment	Destruction of the ecosystem of the area	A	LT	3	3	1	5	3	6	15	High significance
		Injuries from abandoned heavy metals/ buried pipes in the environment	A	LT	3	3	3	5	5	8	19	High significance
		Pollution / contamination of the affected environment	A	LT	3	5	3	5	3	8	19	High significance
		Hydrocarbon leak from the abandoned wellhead and pipelines	A	LT	3	5	3	5	3	8	19	High significance
		Availability of land for alternative use by locals	B	LT	3	0	3	5	5	8	16	High significance
		Abandoned wells as potential hazards to humans and animals in the area	A	LT	3	3	3	5	3	8	17	High significance

CHAPTER SIX
MITIGATION MEASURES

6.1: General

This chapter presents the measures and alternatives developed to mitigate the significant negative impacts of all phases of the proposed Agbada Field Development Project (FDP). Equally stated here are details of the control technology and compliance with health and safety hazards requirements including a table showing potential impacts of the proposed project with proffered mitigation measures. Mitigation measures for the identified potential and associated impacts of the project were proffered in order to minimize the impacts of the proposed Project on the environmental components of the project area. Enhancement, Reduction, Avoidance and Compensation were some of the approaches employed for mitigation measures.

6.2: Process Monitoring and Control Technology

The process control and shut down systems shall be made safe with minimum operator intervention. This shall be considered as a key part of mitigation measures for the proposed project. All other equipment/installations shall also be according to specifications in line with SPDC policies and standards. In accordance to regulations (Mineral Oil Safety Regulations of 1995), emergency shutdown system checks shall be done at six-monthly interval to ensure integrity while wellhead checks shall be done weekly.

6.3: Equipment Selection

A major determinant for rig selection is SPDC's drive to reduce impact on the environment. A land drilling rig that meets the minimum requirements (as specified in chapter three) shall be used for this project to reduce potential impacts to as low as reasonably practicable (ALARP). New flow lines shall be designed to withstand maximum closed-in tubing head pressure (CITHP) attainable in the network, according to the standard flow line design philosophy. This shall be done along existing right of way in order not to further impact on the environment.

6.4: Safeguarding Systems

In high-risk areas like transfer pumps, generators etc, fire detection systems shall be provided in line with the company policy. In addition, fire hydrants and portable fire extinguishers shall be placed at strategic locations to fight small developing fires. In the occurrence of an uncontrollable fire outbreak, personnel shall be evacuated according to laid down evacuation procedures. The two levels of shut down systems namely Emergency shutdown system and Operational shutdown system shall be maintained in the facility.

6.5: Instrumentation

Instrumentation will be designed for remote status monitoring, calibration and configuration. Reliability of the instruments will allow for no failure maintenance.

6.6: Impact Mitigation Measures

The proffered mitigation measures for the identified impacts are presented in **Table 7.1**. These measures are predictable to eliminate or reduce to the barest minimum the potential and associated impacts of the proposed project.

Table 6.1 Impacts and Mitigation

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
Pre-mobilization	**Land acquisitions and settlement of claims**	Community agitation over compensations, land disputes, wrong landowner identification, leadership tussles	SPDC shall ensure • Identification of all legacy issues and applicable stakeholders • Adequate consultations are carried out for Stakeholder (Communities, Govt., NGOs, CBOs, land owners, etc.) • Compensations/rent for land is paid to identified owners as agreed.
Mobilization	Transport of personnel and equipment to site	Workplace accidents/incidents during loading and offloading of materials/equipment	SPDC shall ensure • Use of competent personnel, trained in basic HSE awareness • Safety briefings/inductions are carried out daily before work commences • Use of adequate PPE

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Traffic jam on local roads as a result of movement of heavy truck. Risk of road traffic accidents causing injury/death of personnel and/or loss of assets	SPDC shall ensure: • Maintenance of vehicles at optimal operating condition to avoid break down and obstruction of roads. • Application of effective journey management • All vehicles are pre-mobilized • Compliance with visible warning signs on roads and vehicle • Defensive driving course for SPDC and contractor drivers • Enforcement of vehicle monitoring device/SPDC journey management policy/night driving/alcohol policy • First aid training for work force is conducted and provision of first aid boxes in operational vehicles
Mobilization …contd	Transport of personnel and equipment to site …contd	Noise/Vibration from trucks	SPDC shall ensure that: • Periodic maintenance of Vehicles are carried out to retain noise levels within acceptable limits • Noise is reduced by restricting movement to daytime.
		Pollution due to spillage/leakage of fuel or lube oil on land during transportation	SPDC shall ensure that vehicles are regularly maintained and checked for leaks
Mobilization …contd	Transport of personnel and equipment to site	Emission of atmospheric pollutants from exhaust	SPDC shall ensure the use of vehicles with pre-mobilization certificates only.

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
	…contd	Movement of large number of persons to the area	SPDC shall ensure that: • All logistics arrangements are put in place to avoid prolonged journey time. • Host communities are employed
		Reduction in aesthetic and recreational value of drilling site.	• SPDC shall ensure new infrastructural facilities are provided and maintenance of the existing ones in the area. • Excavation and other activities that may result in the alteration of the landscape and condition of the land cover shall be closely monitored and if possible avoided
		Creation of employment opportunities	SPDC shall ensure that: • At least 60% of the workforce are employed from the host communities • Prompt communication of employment policy are made to host communities during meetings • Compliance with MoU signed with communities as regards labour engagement
		Socio-cultural conflicts between the workers and members of host communities	SPDC shall ensure that: • Adequate consultation with community leaders are carried out and maintained • Cordial and good working relationship are established with the local communities • Liaison with host community leaders at inception to educate workers on the cultural norms of the area is done

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Incidence of STDs, marriage breakages, abortions, theft etc.	SPDC shall ensure: • all personnel are screened for communicable diseases before mobilization and equally maintain regular medical check for all staff • health and safety awareness course for all personnel is conducted • social awareness campaign for workers and members of host communities are carried out as well as encouraging abstinence/safe sex
Site Preparation/constr-uction and Drilling Phase	Vegetation Clearing; removal of topsoil; Construction of generator platform, ancillary facilities such as perimeter drains and oil traps and rehabilitation of campsite	Recruitment of Local labour/ generation of economic activities	SPDC shall ensure the employment of locals
		Alteration of land use pattern and loss of arable lands	SPDC shall ensure that vegetation clearing activities are reduced to the barest minimum required.
Site Preparation/construction and Drilling Phase	Vegetation Clearing; removal of topsoil; Construction of generator platform, ancillary facilities such as perimeter	Loss of biodiversity (floral and faunal) including loss of plants of economic value along pipeline ROW	SPDC shall ensure that re-vegetation of cleared areas that are not required during operation are carried out.

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
…contd	drains and oil traps and rehabilitation of campsite …contd	Fragmentation of habitats; disruption of wildlife migration routes	SPDC shall ensure the utilization of the existing ROWs to avoid habitat disturbances and losses of ecological species.
		Threat to health of workers e.g. snake bites, insect stings. Injuries etc.	SPDC shall ensure • HSE briefings and awareness talk on potential for contact with wildlife are carried out daily before work commencement • Availability of fully equipped first aid boxes on site at all times as well as a functional site clinic • Availability of trained First aiders • Appropriate use of PPEs is enforced • Provision of Anti-venom is on site to ease snakebites and insect stings. • Communication of MEDEVAC procedures to personnel
		Introduction and spread of diseases by movement of workers to the site	SPDC shall ensure that: • all personnel are screened for communicable diseases before mobilization and regular medical check for all staff is maintained • a health and safety awareness course for all personnel is carried out • social awareness campaign for workers is conducted • encourage abstinence/safe sex

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Infringing social and cultural taboos by workers	SPDC shall ensure that: • all personnel are briefed with acceptable social behaviours and taboos of the host community.
		Constant lighting	SPDC shall ensure • the communities are informed before time of the activities that are likely to increase periods of lighting • worksites are not close to human settlement. Half a kilometer away would be ideal
Site Preparation/construction and Drilling Phase …contd	Vegetation Clearing; removal of topsoil; Construction of generator platform, ancillary facilities such as perimeter drains and oil traps and rehabilitation of campsite …contd	Igniting by welding flames, red-hot metals or flying sparks causing fires/explosion and injury/loss of lives	SPDC shall ensure • HSE briefings are conducted daily prior to work commencement • Strategic positioning of fire fighting equipment, manned by trained personnel.
		Possible pollution of ground water due to drilling activities	SPDC shall ensure • Ground water monitoring practice will be sustained

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Localized increase in baseline concentration of physicochemical parameters of the environment from routine discharge of spent mud, drill cuttings/mud chemicals, sewage etc	SPDC shall ensure • Supervision of all activities and put in place all logistics arrangement that will guarantee least adverse interference with the environment that will warrant localized increase in baseline concentration of physicochemical parameters. • Installation of waste water detention pond and waste water treatment systems in order to dilute effluent from these activities before discharging it to surface drainage system
		Increase in noise levels	SPDC shall ensure • the communities are informed in advance of likely increase in noise level during trenching • exposure to high noise equipment is restricted to the recommended 8-hour a day limit (90dbA) • Strict enforcement of use of earmuffs for all employees using high noise equipment/ machinery in high noise zones. • Prohibition of night operations • Construction of Sound proof walls around stationary power generating walls

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Alteration of natural drainage patterns	SPDC shall ensure • Utilization of existing access road to avoid more environmental destruction. • Maintenance of existing facility access road and construction of culverts where necessary to ensure flood control.
		Soil erosion off from pipeline ROW	SPDC shall ensure drainage systems are opened up around the project areas for flood control
		Obstruction of traffic by construction equipment at road crossing	SPDC shall ensure • Placement of caution signs at appropriate locations • Engagement and use of traffic control wardens
		Personnel injury from welding burns	SPDC shall ensure • Provision and enforcement of the use of PPE for all workers • Only competent and certified welders/ personnel are used
		Personnel injury/death resulting from malfunction and mal-operation excavator/cranes	SPDC shall ensure • Proper maintenance and adequate calibration of equipment before usage • Equipment operation shall be by competent personnel with years of experience in excavator/crane safety.

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Possible kidnap of construction workers	SPDC shall ensure that: • Strict enforcement of security procedures and continuous improvement based on updated risk information; • An ongoing cordial relationship with the stakeholder communities is maintained.
Operations & Maintenance	**Material transport**	Noise from the use of operation engines and motors	SPDC shall • ensure exposure to high noise equipment is restricted to the recommended 8-hour a day limit • use of earmuffs in high noise zones and for all employees using high noise equipment/ machinery is enforced.
		Disturbance/ interference with transportation system and general way of life of locals	SPDC shall • ensure that movement of personnel and materials is not carried out during peak traffic periods. • Enlighten its workers to respect the traditions and beliefs of locals and avoid interactions where possible. • Employ a good number of youths from the hos communities.
		Possible kidnap of workers	SPDC shall: • Ensure strict enforcement of security procedures and continuous improvement based on updated risk information • Sustain ongoing cordial relationship with the host communities

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
		Outbreak of fire due to equipment failure or sabotage	SPDC shall ensure • Strategic placement of alarms/extinguishers within all operational facilities. • Suitable maintenance and calibration of equipment before usage • Competent personnel operate equipment • HSE training and job hazard analysis shall be carried out to ascertain that all staff observes safety rules at work places.
Decommissioning and Abandonment Phase	**Decommissioning and Abandonment**	Destruction of the ecosystem of the area	SPDC shall • Embark on effective remediation and restoration of the environment • that native species are employed in restoration activities
		Injuries from abandoned heavy metals/ buried pipes in the environment	SPDC shall ensure • Provision and enforcement of the use of PPE for all workers • Only competent and certified welders/ • adequate calibration of equipment before usage • Equipment operation shall be by competent personnel with years of experience in excavator/crane safety.
		Pollution / contamination of the affected environment	SPDC shall ensure • Ground water monitoring practice will besustained • Supervision of all activities and put in place all logistics arrangement that will guarantee least adverse

Project Phase	Project Activities	Description of Impacts	Proffered Mitigation Measures
			interference with the environment that will warrant localized increase in baseline concentration of physicochemical parameters. • Installation of waste water detention pond and waste water treatment systems in order to dilute effluent from these activities before discharging it to surface drainage system
		Hydrocarbon leak from the abandoned wellhead and pipelines	SPDC shall ensure • that appropriate containment (drip pans) and clean up procedures are adopted • best engineering of pipeline design, construction and installation. Design to incorporate auto leak detection for pipelines. • effective gas leak monitoring programme for the pipelines
		Availability of land for alternative use by locals	SPDC shall ensure • that native species are employed in restoration activities
		Abandoned wells as potential hazards to humans and animals in the area	SPDC shall ensure • Where abandonment will lead to poor aesthetics, the structures. shall be removed

CHAPTER SEVEN
ENVIRONMENTAL MANGEMENT PLAN

7.1: General

The World Bank (1999) defines Environmental Management Plan (EMP) as the set of mitigation, monitoring and institutionalized measures that must be ensured during the implementation and operation of a project to eliminate adverse environmental and social impacts or at least reduce them to acceptable levels.

The EMP outlines strategies and procedures for ensuring that mitigation measures prescribed in an EIA are implemented at all phases of the project development. In addition to this function, the EMP may also be used to ensure compliance with statutory requirements, corporate safety and environmental policies. In line with SPDC HSE policy of best environmental practice, the EMP of the Agbada Field Development Project has been designed to comply with regulatory specifications.

7.2: The Objectives of EMP

The objectives are to:

- Demonstrate that a systematic procedure ensuring that all project activities are executed in compliance with applicable legislations and SPDC policies on Health, Safety, Environment, Security and Community Relations have been established for the project.
- Show that mitigation measures for all impacts and effects have been established and should be maintained throughout the project's life cycle, so that impact risk level will remain ALARP
- Demonstrate that emergency response measures will be in place. This will ensure that adequate responses in case of emergency have been established for the project; and
- Present an effective monitoring plan that shall be used for assuring the effectiveness of mitigation measures proffered and for identifying unforeseen impacts arising during project implementation.

7.3: Management Organization

SPDC shall ensure that environmental commitments are not ignored during the life cycle of the project. It shall put in place a responsibility and training schedule on environmental matters. Issues on the environment shall be a line responsibility where all personnel are accountable at all levels. Top management shall be saddled with ensuring that all environmental considerations are incorporated into the project implementation.

An Environmental Monitoring Team (EMT) shall be appointed for effective execution of the EIA and its management plan. The team shall comprise project team representatives, HSE and Security departments. The EMT shall communicate with contractors, engineers, quality assurance officers, supervisors and relevant departments on environmental issues at a specified period. The team shall be a focal point for all environmental issues as regards

detailed design and monitoring of construction, drilling, workover and completion of wells, laying of flow and pipeline networks, operation, decommissioning, restoration of sites and abandonment of the project.

7.4: Implementation of Mitigation Measures

The mitigation measures for impacts presented in chapter five of this report have been drafted into an EMP. It specifies detailed action plan with roles and responsibility for their implementation. EMT shall ensure that all the mitigation measures proposed to cater for the significant negative impacts as well as enhancement measures for positive impacts are implemented.

7.5: Transport operations

SPDC shall manage all transportation operations in line with the following guidelines in order to avert accidents/incidents.

Pre-mobilization of Vehicles:

Pre-mobilization shall be conducted for all vehicles which shall used for transportation of equipment, materials and personnel shall be pre-mobilized. This shall be done to ascertain that the vehicles are okay for the operations. The exercise shall equally ensure that the drivers and their assistants have the necessary proficiencies which the job requires. Pre-mobilization exercise is equally an avenue to establish that a job hazard analysis (JHA) for the project has been carried out as well as adoption of all recommended mitigation measures.

Journey Management Plan:

The contractor shall collaborate with the HSE and Security team leaders of SPDC to manage the day to day transportation needs in conformity with SPDC's standards. Journey management shall include the following:

- Planning takes place before traveling
- Distances traveled are minimized
- Unnecessary journeys are avoided
- Right vehicle and right driver for the job are selected
- The safest times and routes are selected
- No night driving unless absolutely necessary and waiver obtained.

7.6: Prevention of Accidents/incidents:

Developed Job Hazard Analysis (JHA) and written work instructions (WIs) shall be implemented in order to prevent workplace accidents and incidents during the proposed project. The HSE and Security team leaders have the responsibility of ensuring that JHA for all HSE critical activities is carried out. Written and explicit work instructions from such activities shall be developed.

Observance of standards, operations/maintenance codes and specifications as required by law

as well as SPDC HSE guidelines shall form the bedrock for the implementation of the proposed project. Nonetheless, emergency situations could still occur as a result of equipment failure, weather, negligence and/or sabotage. An emergency plan shall be in operation so as to support other containment systems set to cater for such occurrences. As a minimum, the contingency plans that shall apply to both SPDC and contractors shall address the following emergency situations.

- Fires and explosions
- Serious injury or illness
- Spills and blow outs
- Weather related disasters
- Vehicle mishaps

The HSE and Security team leaders shall ensure that sufficient security arrangement for the project is provided for and that host communities are carried along in the plans.

7.7: Training and Awareness:

The project management shall establish, maintain and operate a training and awareness programme on health, safety and environmental issues in order to determine proficiency and consciousness amongst SPDC personnel and Contractor staff. Additional attention shall be given to the locals in the contractors' teams. Accident emergency practices, basic first aid, and the use of personal protective equipment and so on shall make up the components of the training. Environmental induction course and subsequent refresher course concerning the work shall be organized. Periodic review of the training and awareness programme shall be conducted by top management and shall embrace but not limited to the following aspects:

- HSE induction course
- Emergency response drill
- Community interaction and relations management
- Basic first aid for first aiders
- Defensive driving
- Permit to work system
- Fire fighting
- HSE on site

Successful participants shall receive certificates of attendance. SPDC shall equally carry out HSE awareness campaign for the host communities and the general public with the intention of notifying them of the potential impacts and hazards associated with its operations as well as the proper response to accidents/incidents. There shall be public awareness campaigns performed from time to time and the actions documented for audit.

7.8: Maintenance Programme

The maintenance officer for the project shall put a comprehensive maintenance programme for all equipment and machines in place. The schedule for the maintenance shall be planned to comply with the manufacturer's specification for each of the equipment. A maintenance logbook which shall be regularly audited by HSE and security team leaders shall be in operation. The state of maintenance of the equipment and machines (last and next service dates) shall be proper and clearly displayed at visible points on each equipment and machine.

7.9: Construction guidelines

- **Site Preparation/Clearance**

Site preparation/clearance works shall be carried out within defined borders and only when necessary. To make for safe operations, the acceptable time lapse between site clearing and commencement of construction operations shall be shortened as much as possible. Excess cleared areas shall be restored with indigenous topsoil and vegetation.

- **Use of public rights of way**

Transportation, construction and drilling works shall be executed in such a manner that will minimize traffic disruption. Nonetheless, blockage of public highways or roads can be done if safety in operations demands that it be done. Before this action is approved and carried out, SPDC Agbada Field development project manager would have arranged for temporary traffic control and diversion. Dumping or storage of litter/debris, tools and equipment in public or private highways and roads shall not be allowed. Contractors shall come up with plans on how roads shall be cleared to ensure that roads are kept clear, safe and passable.

- **Archaeological/Heritage sites**

Contractors and SPDC personnel working at the sites shall preserve the Preservation of the cultural heritage of the host communities shall be the responsibility of Contractors and SPDC personnel working at the sites. All known existing sites of heritage or cultural value shall be isolated and avoided. If the need arises that any such site be moved, SPDC shall consult with the affected community before relocation.

- **Health and safety of workers**

Hazard and effects management process (HEMP) shall be developed and applied throughout the project development. This shall consist of IACR approach of identifying, assessing and controlling hazards and putting in place measures to recover from the consequences of hazards if the controls fail. Operations at all work sites shall be subject to government, industry and SPDC HSE policies and guidelines. All facilities shall equally be designed to enhance safety planning and activities shall be executed within the confines of relevant legislation and stakeholders' interest.

For effective management of project activities, careful planning along with application of relevant HSE policies shall be included. The relevant HSE policies shall include the following:

- Use of permit to work (PTW)
- Job hazard analysis and toolbox meeting
- Use of PPEs in designated hazard areas
- Prohibition of alcohols during work hours and at work sites and facilities
- Prohibition of use of petrol engines for operations
- Regular emergency drills
- Prohibition of smoking in fire hazard areas.

- **Emergency Response**

Measures shall be put in place to take care of emergency situations and this shall be in line with the following International Association of Geophysical Contractors (IAGC) guidelines and relevant SPDC procedures:

- Medevac (IAGC 1991).
- Man lost procedure (IAGC 1991).
- Fire protection and fire procedures (IAGC 1991).
- Evacuation or abandonment procedures (IAGC 1991).

The entire emergency measures applicable to the proposed project shall be carried out on a regular basis as long as the conditions do not pose a hazard to the safety of the crew. Details of these drills shall be documented, showing the time taken to secure personnel. During operations, fire fighting and associated facilities shall be inspected and tested on a periodic basis to verify inventory and function.

- **Waste Management Guidelines**

The handling, storage and disposal of all wastes generated during the life span of the project shall be in accordance with the regulations of FMEnv, DPR and other national and international environmental agencies as well as SPDC approved waste management guidelines. The approach used in wastes handling, storage and disposal is dependent on the nature of the waste. Waste management guidelines consider the nature of all wastes that will be generated during the lifetime of the proposed project. These standards are binding on all staff and contractors involved in the proposed project with respect to the:

- emission or release of pollutant exhaust and/or fugitive gases;
- discharge or spill of untreated effluent on land and in the rivers;
- discharge of solid wastes on land and in the rivers; and
- generation of noise and vibration.

Waste Handling

Wastes shall be well defined at source (Table 7.**1**). The definition transmitted along with the waste to the final disposal points. SPDC personnel and Contractors shall define and document all wastes generated at work. Essential information that must be provided, as minimum, for adequate definition of wastes include:

- waste type identification;

- proper waste categorization;
- waste segregation information; and
- recommended management practices.

Waste Minimization

Waste minimization entails reduction to the greatest extent possible of the volume or toxicity of waste materials. The four principles of waste minimization process; recycle, reduce, reuse and recover, shall be adopted as applicable. Opportunities to achieve significant waste reduction during this proposed project are functions of activity level, age, depreciation and maintenance level of facilities and operating equipment. As much as possible, excavated materials shall be used for landscaping or other remedial works. In addition, all drill mud, oils, hydraulic fluids, oily sump water, etc. shall be treated before disposal.

Waste Segregation

For useful implementation of suitable waste disposal methods, wastes shall be segregated at source into clearly designated bins positioned at strategic locations to be defined in the field.

Waste Disposal Protocol

All wastes shall be cleared regularly from the site and disposed off at SPDC or Government designated areas and facilities. Instructions on material safety data sheet (MSDS) shall be strictly adhered to and shall form the basis for the disposal of wastes related to such products. Wastes in transit shall be accompanied and tracked by consignment notes. The consignment shall contain the following information as a minimum:

- date of dispatch;
- description of waste;
- waste quantity/container type;
- consignee name and means of transportation; and
- confirmation of actual disposal (time and date).

Table 7.1: Expected types of Waste Streams from the FDP Project

S/No	**Waste Types**	**Classification**	**Management Options/Methods**
1.	Domestic wastes	Non-hazardous	Move to Government.-approved dump sites at East-West road, location road in Mgbuoba, Elekohia, Abuloma and Wimpy for disposal
		Hazardous	Move to re-cycling depot at Shell I.A in Port Harcourt
2	Sanitary waste	Grey water	Well-engineered soak-away system at the NAG plant location
		Black water	Well-engineered soak-away system at the NAG plant location
3.	Drill cuttings	Top hole cuttings	Wash and subject to land farming
		Synthetic mud	Transport the Thermal Desorption Unit at

S/No	**Waste Types**	**Classification**	**Management Options/Methods**
		cuttings	Onne, Rivers state.
4.	Waste fluids	Spent mud	Transport the Thermal Desorption Unit at Onne, Rivers state.
		Deck wash-offs	Re-inject in FMEnv/DPR approved injection wells
		Storm water	Re-inject in FMEnv/DPR approved injection wells
5.	Work over fluids	Brine, inhibited water, etc.	Re-inject in FMEnv/DPR approved injection wells
6.	Construction waste	Pipe off-cuts, metal scraps, etc	Move to the SPDC Industrial Area (I.A.) Waste Dumpsite for segregation and subsequent move to Metal Recycling Depot.
7.	Vegetation	Non-Hazardous	Allow for turn to mulch for use by community members or move to government approved dumpsite for disposal. Do not burn.
8.	Paper	Non-Hazardous	Move to I.A. Waste Dumpsite for segregation and subsequent move to paper mill for recycling.

All waste generated from the proposed Agbada Field development project shall be managed according to SPDC waste management principles.

7.10: Spills

Standard techniques and technologies to prevent and minimise the risk of spills shall be incorporated into the proposed project. All flowlines would be constructed to standard sizing and rating. Flowlines shall also be protected against corrosion using deep well cathodic protection device. Flowlines and equipment inspections/maintenance strategies necessary to ensure that spills are minimised shall also be put in place. Emergency procedures and spill response tools shall be developed. Adequate processes and procedures shall be put in place to regularly conduct drills to test spill contingencies and to record, report and investigate all spills. Results of investigations would be fed back to identify actions to minimise the chance of recurrence and to continuously improve performance. Annual targets would be set for reducing the volume of spill and the number of incidents.

7.11: Gaseous Emissions (CO_2, CH_4, SOx, NOx, H_2S, VOCs including BTEX)

Pollution prevention and reduction will be fully considered in facility and process design in the proposed project. The source of emissions would be from operational flaring. Volume of operational gas flared would be recorded in order to estimate quantities of gas components in view of greenhouse effect. Operational control would ensure quantities of gaseous components are within regulatory limits and set targets. Emissions shall be measured and targets set for continuous improvement. Noise reduction from source would be achieved through the use of electric driven pumps and soundproof generators. All relief systems shall

be designed as to be piped to the flare to eliminate venting. Gaseous emissions monitoring would be carried out regularly and values checked against regulatory limits as we strive towards zero flaring.

7.12: Decommissioning and Abandonment Plan

At the completion of the proposed project, SPDC shall follow regulatory standard procedures for decommissioning. A decommissioning team shall plan and implement the guidelines for decommissioning to ensure that the best and practicable methods available to clean up the project site have been used. The following activities are involved in decommissioning/abandonment:

- Demolition and site clean up
- Disposal of wastes; and
- Final site review.

7.13: Remediation Plans After Decommissioning /Abandonment / Closure

The statutory (National) regulations cited in Chapter 1 of this report require the operator of a field to rehabilitate the area to be relinquished to the satisfaction of the DPR/FMEnv. The biological objective, amongst others, of any such rehabilitation programme is to ensure that an ecologically functional system to enable satisfactory plant growth is achieved. In line with this and company standards, SPDC shall put in place a policy to carry out a restoration programme at the end of project's economic life. In carrying out this programme, the following shall be considered.

(i) Subsurface abandonment – the objective here shall be to isolate formations and prevent fluid migration. Basically, this will involve cementing a large section of the borehole and cutting and removal of casing below cellar depth;

(ii) Surface facilities abandonment here, all redundant surface facilities and concrete shall be removed by SPDC. After removal, the facility shall be cleaned and disposed off by land filling at a suitable location with regards to regulatory guidelines. There are no established markets for scraps around here so it may not be in SPDC's interest to recycle the metals as scraps. The concrete slabs removed from locations may be used as landfill materials in designated sites. Underground pipelines shall be cleaned, filled with water and left in place, as is the practice in the industry.

(iii) Field restoration upon completion (suspension or abandonment), all excavation shall be filled. Beyond this, the procedures to be applied in the restoration of cleared areas shall be the subject of a detailed integrated study.

This study shall utilize the services of ecological and hydrological specialists who will assist in determining strategies for site restoration. The goal of the study shall be a detailed field-specific restoration plan. The success of any restoration process is measured by the similarity

of the vegetation on the restored land to that of its surroundings. However, this success is a manifestation of the reinstatement of the physical, chemical and hydrological characteristics of the soil, bearing in mind that the single most significant factor, which will likely inhibit re-vegetation, is compaction / cementing of soil surface. The ripping apart of the compacted / cemented areas will be a major key to a successful restoration programme. The restoration operations will take intensive management for a number of years to ensure success.

7.14: Environmental Audit

Environmental audit shall be conducted on the site before mobilization and during operations. The audit process shall be used to check the predictions in the EIA as well as assess the environmental performance during the operation phase of the project development. This will demonstrate that environmental protection and management procedures as specified in the EIA are implemented. Environmental audit shall be conducted on the site before mobilization and during operations. The audit process shall be used to check the predictions in the EIA as well as assess the environmental performance during the operation phase of the project development. This will demonstrate that environmental protection and management procedures as specified in the EIA are implemented.

7.15: Environmental Monitoring Plan

The objective of monitoring shall be to identify any unexpected changes to the biophysical, health and social environment brought about by the Agbada Field Development Project. Baseline information against which development and post development impacts and mitigation measures can be measured and compared has been established. SPDC shall ensure that deviations from the baseline beyond reasonable limits shall trigger corrective actions so that monitoring becomes a dynamic activity as opposed to passive collection of data.

To ensure that the mitigation measures outlined in Chapter Six of this report are carried out as required, a comprehensive listing of the mitigation measures that SPDC and the contractor shall implement in the course of the proposed project, timing and monitoring programme for ensuring full implementation of the actions are outlined in **Table 7.2.** The relevant regulatory bodies (FMEnv/DPR) shall also be consulted at all phases of the implementation of the monitoring programme. Table 7.3: shows monitoring programme for environmental components.

Table 7.2: Environmental Management Plan for Implementation of Mitigation Measures

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
Premobilization phase									
Temporary land use for base camp or use of an existing camp facility	Community agitations over compensations, land disputes, wrong landowner identification, leadership tussles, etc	High	SPDC shall ensure: • All relevant stakeholders and legacy issues are identified • Stakeholders (communities, Govt., NGOs, CBOs, land owners, etc.) are adequately consulted and relevant issues discussed • Agreed compensation / rent for land are paid to identified owners	Low	SPDC field development Team and Contractor	Pre-mobilisation and during operations	Community / other stakeholder engagement reports	Quartely	SPDC Project Manager
Mobilization phase									
Transportation of equipment, personnel and materials to site	Workplace accidents / incidents during loading and offloading of materials / equipment	Medium	SPDC shall ensure: • Use competent personnel trained in basic HSE awareness in all operations • Safety briefings / inductions are carried out prior to	Low	SPDC Field development Team and Contractor	During mobilization / project execution	Site HSE report Reports of induction meetings PPE Issuing register	Daily / Weekly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			commencement of work • Adequate use of PPE						
	Increased usage of roads with risks of accidents leading to injury / death of personnel and loss of assets	Medium	SPDC shall ensure: • Effective journey management is implemented to limit the amount of traffic • Regular maintenance / checks of vehicles Relevant personnel undergo driving training and certification before mobilisation • Compliance with • Warning signs are established where required • Night driving is prohibited • Adequate PPE are used	Low	SPDC Field development Team and Contractor	During mobilisation / project execution	Inventory of approved journey management forms DEP certificates Vehicle certification reports In-vehicle monitoring system checks / reports. Personnel driving certificates Reports of all training sessions	Daily / Weekly / Monthly	SPDC Project Manager
	Nuisance (noise, vibration etc) from trucks, etc	Medium	SPDC shall ensure: • Periodic maintenance of vehicles are carried out to maintain noise levels within	Low	SPDC Field development Team and Contractor	During mobilisation / project execution	Equipment maintenance report Camp site noise mapping Journey	Weekly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			acceptable limits • Movement is limited to day time to reduce nuisance issues				management records		
	Pollution - spillage / leakage of fuel or lube oil onto land during transportation	Medium	SPDC shall ensure: • Vehicles are regularly maintained and checked for leaks	Low	SPDC Field development Team and Contractor	During mobilisation / acquisition campaign	Community engagement reports Equipment maintenance report	Monthly	SPDC Project Manager
	Creation of opportunities for employment	Beneficial	SPDC shall ensure workers are advised on judicious use of income	Beneficial	SPDC Field development Team and Contractor	Prior to mobilisation and during operations	Employment records and community engagement reports	Prior to mobilisation and during operations	SPDC Project Manager
	Conflicts / community agitations over employment issues	Medium	SPDC shall ensure: • At least 60% of the unskilled workforce are hired from the host communities during the project construction phase • Prompt communication of employment policy are made to host communities during meetings • Compliance with MOU signed with communities as	Low	SPDC Field development Team and Contractor	Prior to mobilisation and during project execution Pre-recruitment	Employment records and community engagement reports	Prior to mobilisation and during operations	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			regards labour engagement						
	Increased rate of social vices (theft, prostitution, etc) within the communities due to population increase	High	SPDC shall ensure social / health awareness campaigns are carried out for workers and members of host communities	Medium	SPDC Field development Team and Contractor	During project execution	Community engagement reports Reports on awareness campaign sessions	Monthly	SPDC Project Manager
	Socio-cultural conflicts between the workers and members of host communities	High	SPDC shall ensure: • Adequate consultation with community leaders are carried out and maintained • Cordial and good working relationship are established with the local communities • Liaison with host community leaders at inception to educate workers on the cultural norms of the area	Medium	SPDC Field development Team and contractor	During project execution	Community engagement reports Reports on awareness campaign sessions	Monthly	SPDC Project Manager
Construction phase									
Camp Site Preparation • Vegetation clearing	Work place accidents and incidents leading to injury and	Medium	SPDC shall ensure: • All personnel are inducted to comply with work	Low	SPDC Field development Team	During site preparation	Pep talks / tool box meetings records Incident reports	Daily / Weekly / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
• Construction of generator platform, ancillary facilities such as perimeter drains and oil traps; rehabilitation of camps and associated facilities	death		procedures e.g. buddy system • All personnel are provided with appropriate PPE • Competent first aiders and first aid facilities are provided on site • MEDEVAC procedures are communicated to personnel		and Contractor		Induction report Number of existing old camp sites used		
Camp Site Preparation • Vegetation clearing • Construction of generator platform, ancillary facilities such as perimeter drains and oil traps; rehabilitation of camps and associated facilities … cont'd	Risk of wildlife (bees, snakes, scorpions, wasps, etc.) attack on personnel / contact with poisonous plants leading to injury and death	Medium	SPDC shall ensure: • HSE briefings and awareness talk on potential for contact with wildlife is conducted prior to work. • All personnel are inducted to comply with work procedures e.g. buddy system • All personnel are provided with appropriate PPE • Competent designated first aiders and first aid facilities are provided on site	Low	SPDC Field development Team and Contractor	During site preparation	Pep talks / tool box meetings records Health records Induction report Number of existing old camp sites used Incident reports	Daily / Weekly / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			• Emergency drills are planned and complied with • MEDEVAC procedures are communicated to personnel						
	Increase in Noise level	Medium	SPDC shall ensure that: • HSE policy of wearing ear muffs/plug are enforced at all camp sites • Site construction are done within the shortest possible time • Night operations are prohibited • Machinery with low noise levels shall be used • Workers with hearing impairment are deployed to other areas of activity with reduced noise level	Low	SPDC Field development Team and Contractor	During construction	Compliance monitoring report Site inspection report Pre-employment medical report	Daily / Weekly	SPDC Project Manager
Camp Site Preparation • Vegetation clearing	Increase in financial flow resulting in: social vices, (drug	High	SPDC shall ensure that: • Awareness campaigns are	Low	SPDC Field development Team	During construction	Community engagement report Health Report	Weekly / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
• Construction of generator platform, ancillary facilities such as perimeter drains and oil traps; rehabilitation of camps and associated facilities … cont'd	abuse, exposure to HIV/AIDS, unwanted pregnancies, violence, etc), boom and bust phenomenon associated with temporary labour contracts etc.		carried out against HIV/AIDS, drug and alcohol abuse • Implementation / enforcement of the company's HSE and other policies (security, alcohol and drug, etc) at the site • Workers are advised on judicious use of income		and Contractor				
	Increased financial flow due to compensations leading to improved standard of living	Beneficial	SPDC shall ensure that: • Workers are advised on judicious use of income • Adequate and prompt payment of compensations as per OPTS rates	Beneficial	SPDC Field development Team and Contractor	Prior to mobilisation	Community / other stakeholder engagement reports	During project activities	SPDC Project Manager
	Littering / environmental pollution from poor handling of wastes	Medium	SPDC shall ensure that: • Segregation of solid wastes is appropriately carried out and liquid effluents are treated, and analysed to meet	Low	SPDC Field development Team and Contractor	Daily / Weekly / Monthly	Equipment maintenance log Site inspection report Compliance monitoring report	Weekly / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			regulatory requirements / specifications • All solid/liquid wastes are disposed in compliance with SPDC waste management standards and procedures (Govt. / SPDC approved site in Port Harcourt, etc) • Scheduled periodic maintenance of equipment and vehicles are enforced to reduce exhaust emissions				Waste generated / disposal management data Sewage / grey water analysis report		
Camping and accommodation of workers	Risk of fire and explosion from storage of fuel for power generating units	Medium	SPDC shall ensure that: • "No smoking" signs are posted within the vicinity of fuel storage areas • Provision of functional fire extinguishers at strategic point around the facility and train	Low	SPDC Field development Team and Contractor	During project execution	Site inspection report Site HSE report	Daily / Weekly / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			personnel in its use • Activation of emergency response procedure when required						
	Groundwater pollution from discharge of sewage / sanitary wastes into septic tanks / pits	Medium	SPDC shall ensure that: • Checks are carried out to ensure septic tank / pit designs meet regulatory requirements • Groundwater monitoring boreholes are drilled and monitored at area susceptible to groundwater pollution. • Proper treatment before evacuation / discharge of sewage to govt. approved sites	Low	SPDC Field development Team and Contractor	During tenure of project	Pre-mobilisation / site check reports Site inspection report/Groundwater monitoring. Sewage / grey water analysis report	monthly groundwater monitoring.	SPDC Project Manager
	Public nuisance / wildlife scare from generator noise	Medium	SPDC shall ensure that: • generators with low noise capacity are used • periodic	Low	SPDC Field development Team and Contractor	During tenure of project	Camp noise mapping report Community engagement report	During tenure of project	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			maintenance of generators are Scheduled and implemented • mufflers are used to further reduce generator noise				Personnel complaints		
Camping and accommodation of workers … cont'd	Risk of attack, hostage situation, theft and robbery leading to loss of belongings and possible injury / death	Medium	SPDC shall ensure: • Armed security operatives are stationed around the camp • Use of T-card system for access control within the camp • Periodic consultations with communities • Use of SREM	Medium	SPDC Field development Team and Contractor	Mobilization and construction.	Community engagement report Security report Movement records SREM	Daily / Weekly / Monthly	SPDC Project Manager
	Increase in financial flow due to increased opportunities for supply of food and other items by indigenes	Beneficial	SPDC shall ensure indigenous contractors are used	Beneficial	SPDC Field development Team and Contractor	Mobilization/ Construction	Community engagement report	Weekly	SPDC Project Manager
Well Drilling	Localised increase in baseline concentration of physicochemical parameters of the environment from	High	SPDC shall ensure: • Drilling waste and other chemicals shall be collected and managed in line with SPDC waste	Medium	SPDC well operations Team and Contractor	During drilling	• Compliance monitoring report. • Waste consignment note.	Weekly / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
	discharge of spent mud, drill cuttings/mud, chemicals, sewage etc.		management plan and regulatory requirements and standards. • activate her waste management plan						
Well Drilling	Pollution of surface/groundwater from chemicals, waste materials, including spent mud, oily waste water, additives, etc	High	SPDC shall ensure: • Drilling waste and other chemicals shall be collected in such a manner as to avoid surface water contamination. Thereafter, the wastes shall be managed in line with SPDC waste management plan • wastes generated are managed in accordance with regulatory requirements and standard practices. • Implementation of ground water monitoring • Drill cuttings and spent mud wil be transported to TDU at Onne Rivers State	Medium	SPDC well operations Team and Contractor	During/after drilling	Site inspection report/Groundwater monitoring report/and waste consignment note. MSDS	Daily / Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
Pipeline laying	Destruction of vegetation resulting in loss/alteration of wildlife habitat, medicinal, economic and food materials and reduction of biodiversity	Medium	SPDC shall ensure: • Trees of >30cm girth are not cut / felled • Clearing is limited to minimum required for work and line width does not exceed 1m • Fair compensations are paid for loss of economic plants • Mangrove re-vegetation of cleared line is undertaken after the project work	Low	SPDC Field development Team and Contractor	During Pipeline laying	Site inspection report Community engagement and assessment report	Daily / Weekly / Monthly	SPDC Project Manager
	Ecosystem fragmentation leading to increased access to hunting and logging activities	Medium	SPDC shall ensure: • Line cutting is limited to specifications required for work • Hunting by crew members is prohibited • Camp sites are restored to normal conditions as practicable • Carry out awareness campaign on the	Low	SPDC Field development Team and Contractor	During Pipeline laying	Site report and community engagement report	Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			adverse effects of hunting and logging						
	Work place accidents and incidents (e.g. machete cuts, etc)	Medium	SPDC shall ensure: • Use of trained personnel only • Use of appropriate PPE • HSE briefing prior to work are Conducted • Strict adherence to work procedures • Work tools are in good condition	Low	SPDC Field development Team and Contractor	During Pipeline laying	Inspections (audits) / daily field reports Line inspection reports Incident / Unsafe Acts, Unsafe conditions, etc. reports	Daily / Weekly / Monthly	SPDC Project Manager
Pipeline laying … cont'd	Risk of encroachment into sensitive locations, property, sacred sites, public utilities, etc. leading to strife	Medium	SPDC shall ensure: • Scouting is done by contact personnel to identify sacred areas and conservation areas within the communities in order to avoid interference • Strict adherence to guidelines given by contact personnel and survey crews are enforced • Fair compensations are	Low	SPDC Field development Team and Contractor	During pipeline laying	Contact personnel report / community engagement report	Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
			paid for certified damaged property as per OPTS rates						
	Third party agitation over damage to property, encroachment and compensations	High	SPDC shall ensure: • Identification of appropriate beneficiaries of damaged property and evaluate the loss • Consultation with the relevant communities and property owners • Prompt payment of fair compensation when liable	Low	SPDC Field development Team and Contractor	After Pipeline laying	Site inspection report Community engagement report	Monthly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
	Wildlife attack leading to personnel injury and death	Medium	SPDC shall ensure: • All work crew use appropriate PPE • Safety briefing are conducted prior to work • Availability of trained bee fighters as well as pre-employment inductions against bee attacks before commencement of work • Activation of MEDEVAC plan, when needed	Low	SPDC Field development Team and Contractor	During Pipeline laying	Site inspection report Incident report	Daily / Weekly	SPDC Project Manager
Decommissionning and Abandonmennt									
Transportation of equipment, personnel and materials from site	Workplace accidents / incidents during loading and offloading of materials / equipment	Medium	SPDC shall ensure: • Use of competent personnel trained in basic HSE awareness in all operations • Safety briefings / inductions are carried out prior to commencement of work • Adequate use of PPE	Low	SPDC field development Team and Contractor	During mobilisation / project execution	Site HSE report Reports of induction meetings	Daily / Weekly	SPDC Project Manager
	Increased usage	Medium	SPDC shall ensure:	Low	SPDC	During mobilization	Inventory of	Daily /	SPDC

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
	of roads with risks of accidents leading to injury / death of personnel and loss of assets		• Effective journey management is implemented to limit the amount of traffic • Regular maintenance / checks of vehicles • Relevant personnel undergo driving training and certification before mobilisation • Compliance with speed and load limits are enforced • Warning signs are established where required • Night driving is prohibited		field development Team and Contractor	/ project execution	approved journey management forms Vehicle certification reports In-vehicle monitoring system checks / reports. Personnel driving certificates Reports of all training sessions	Weekly / Monthly	Project Manager
Transportation of equipment, personnel and materials from site …. cont'd	Risk of armed attacks leading to hostage situations / injury / death of personnel	High	SPDC shall ensure: • Security operatives (Mopol etc) accompany vehicles uring routine and non-routine trips • Adequate consultations are carried out with stakeholders	Medium	SPDC field development Team and Contractor	During mobilisation / project execution	Site inspection report Community engagement report Security reports	Daily / Weekly	SPDC Project Manager

Project Activities	Impact	Rating Before Mitigation	Description of mitigation	Residual Impact Rating	Action Party	Timing	Parameters for monitoring	Monitoring Frequency	Responsible Party
Transportation of equipment, personnel and materials from site …. cont'd			• Use of SREM						
	Nuisance (noise, vibration, etc.) from trucks	Medium	SPDC shall ensure: • Periodic maintenance of vehicles are carried out to maintain noise levels within acceptable limits • Movement is limited to day time to reduce nuisance issues	Low	SPDC field development Team and Contractor	During mobilisation / project execution	Equipment maintenance report Camp site noise mapping Journey management records	Weekly	SPDC Project Manager
	Pollution - spillage / leakage of fuel or lube oil onto land during transportation	Medium	SPDC shall ensure: • Vehicles are regularly maintained and checked for leaks	Low	SPDC field development Team and Contractor	During mobilisation / acquisition campaign	Site inspection and community engagement reports Equipment maintenance report	Monthly	SPDC Project Manager
✓ Removal of structures ✓ Restoration of site	Litter of environment with base camp rubbles, line pegs, markers, etc	Medium	SPDC shall ensure enforcement of responsible waste handling from cradle to grave in line with the company's and regulatory requirements	Low	SPDC field development Team and Contractor	During facilities decommissioning	Community engagement report Waste generated / disposal management data	End of the project	SPDC Project Manager
	Increased opportunity for employment and contracting resulting in increased income level	Beneficial	SPDC shall ensure: • Indigenous contractors are used	Beneficial	SPDC field development Team and Contractor	During site restoration	Community engagement report Site restoration certificate	End of the project	SPDC Project Manager

Table 7.3: Environmental Monitoring Plan for the Agbada Non Associated Gas (NAG) (PRE-MOBILIZATION AND CONSTRUCTION PHASE)

Environmental component	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME				Responsibility
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method	
Groundwater	EGASPIN Appendix V-1 page 108: Limits for Substances and characteristic affecting the acceptability of water for domestic use (WHO standards)	Total solids: 1500mg/l p H: 6.5 – 9.2 Mineral Oil: 0.3mg/l Chloride as Cl: 600mg/l Copper: 1.5mg/l Iron: 1.0mg/l Zinc: 15mg/l Sulphate: 400mg/l Total Hardness: 500mg/l Calcium: 200mg/l Magnesium: 150mg/l Manganese: 0.5mg/l Colour: 50units Coliform: 0MPN/100ml	Physico-chemical parameters (pH, TDS, Mineral Oil, Phenolic compounds, Salinity as Chloride, Copper, Iron, Zinc, Sulphate, Total Hardness, Calcium, Magnesium, Manganese, Anionic detergents, Colour, Odour, Taste	Monitor one (1) borehole within 200 m radius around the NAG wells taking recognizance of the direction of groundwater flow.	Quarterly	Sample collection and analysis in an external approved laboratory.	SPDC Project Manager
Air Quality	EGASPIN: National Air quality Guidelines for maximum exposure	Daily average/mean CO = 10ppm Total SPM: 60 - 90µg/m^3 SO_2 = 100 – 150 µg/m^3 NO_2 = 150 µg/m^3 Noise: 90dB(A)	CO, Total SPM, SO_2, NO_2, Noise, VOC, H_2S, Ozone, Cadmium, Chromium, Lead, NH_3, Atmospheric temperature, Relative humidity, Wind speed, Wind direction, Pressure, Wind turbulence, Sun Radiation	Meteorology, Air quality and noise measurements shall be sampled 200m away from the NAG wells along the direction of the prevailing wind.	Weekly	Portable Environmental sensor meters	SPDC Project Manager/FMEnv/DPR
Vegetation/ Wildlife	Food and Agricultural Organization : Conservation Agriculture (2007)	25% Forest cover	Noise levels, Records of wildlife kill, or sighting of wildlife	Around the vegetation ecotypes in the project area	Annually during construction and thereafter.	Standard methods as recommended by FMEnv, WHO, World Bank, UNEP and DPR; Direct Observation	SPDC Project Manager/FMEnv/DPR

Environmental component	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME				Responsibility
	Regulation/ Standard	**Requirements/ Limits**	**Parameters to be monitored**	**Sampling Location**	**Frequency**	**Data collection method**	
Community health and safety	National/ WHO standards IFC/World Bank	Available safe water/ pers/day (< 20l/ pers/day) Access to safe water (Rural communities (65%) Urban Access to latrine (63% (National average, 2003) Access to improved sanitation (National average, 30-48%) Malaria prevalence (21.0% national average (MICS4) Prevalence of fever in under 5s (National Av. 10.3% (NDHS,2003) Infant mortality rate (11.3/ 1000 live births National target by 2011 (NEEDS 2)	• % access to safe water (new water provision) • faecal coliforms count in water • % use of insecticide treated nets, • % children under five with high fever, • % children under five treated with proper anti-malaria, diarrhoea prevalence • No of health awareness sessions • Waste management • Sexual health prevalence	Communities water sources	Quarterly	• Field survey • Secondary clinic data collation	SPDC Project Manager/FMEnv/DPR

CHAPTER EIGHT
CONCLUSION

The status and sensitivities of the various ecological and socio-economic components of the project environment have been carefully established and assessed through literature research, field sampling and measurements/testing within the proposed project area, using a multi-disciplinary team of experts. The interactions of the various ecological and socio-economic components of the existing environment with the known activities of the proposed project were used along with other source references to identify, characterise and evaluate the potential and associated impacts. Mitigation measures were subsequently developed for adverse impacts based on industry best practice, available technology and HSE considerations.

Consultations with the project communities, regulatory authorities and other stakeholders have been carried out and shall continue through-out the project lifecycle. The impact assessment of the proposed Agbada Field Development Project indicated that it would impact positively on the socio-economic life of the people by way of semiskilled and unskilled employment and provision of social amenities. Subsequent production of gas in the area will impact positively on the national, State and local economy as well as on the revenue base of the project proponents. The environmental benefits of a reduction in gas flaring are also enormous. The proposed project will also contribute to significant socio-economic development within the host communities and result in long term economic empowerment for the indigenes, residents and other professionals. These would be by way of skilled, semiskilled and unskilled employment opportunities, and award of contract for supplies and services etc.

The potential adverse impacts of the proposed project on ground water, air quality, vegetation and socio-economics/health, are localised and can be significantly controlled. Also, the EMP developed shall ensure that the procedures for managing the adverse impacts of the proposed project and the implementation of the environmental and social commitments are developed and maintained throughout the project lifecycle. It will therefore form the basis for the actual project implementation. The proposed project can thus be executed within the ambit of sustainable development.

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APPENDICES
Appendix 1

The Shell Petroleum Development Company of Nigeria Limited
Operator of the NNPC/Shell/TEPNG/Agip

TERMS OF REFERENCE (ToR)

FOR THE

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

OF

AGBADA FIELD DEVELOPMENT PROJECT

May 2008

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LIST OF ACRONYMS

AGG	Associated Gas Gathering
ALARP	As Low As Reasonably Possible
Bopd	Barrels of Oil Per day
CBO	Community-Based Organization
CD	Community Development
CITES	Control of International Trade in Endangered Species
DPR	Department of Petroleum Resources
EGASPIN	Environmental Guidelines & Standards for the Oil Industry in Nigeria
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESH	Environment, Social and Health
ESHIA	Environment, Social and Health Impact Assessment
ESHMP	Environmental, Social and Health Management Plan
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussion
FMEH & UD	Federal Ministry of Environment, Housing & Urban Development
GEM	Gender Empowerment Measure
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HDI	Human Development Index
HIA	Health Impact Assessment
HPI	Human Poverty Index
HRA	Health Risk Assessment
HSE	Health, Safety and Environment
HSE-MS	Health, Safety and Environment Management System
IFC	International Finance Corporation
LTO	License to Operate
MEDEVAC	Medical Evacuation
MMscf/d	Million Standard Cubic Feet of Gas per Day
MoU	Memorandum of Understanding
NGO	Non-Governmental Organization
NIWA	National Inland Waterways Authority
OML	Oil Mining Lease
OPTS	Oil Producers Trade Section
PAC	Project Advisory Committee
PIA	Post Impact Assessment
QA/QC	Quality Assurance / Quality Control
QRA	Qualitative Risk Assessment
SCD	Sustainable Community Development
SIA	Social Impact Assessment
SMART	Specific, Measurable, Achievable, Realistic and Time-Bound
SPDC	Shell Petroleum Development Company of Nigeria

STOIIP	Stock Tank Oil Initially in Place
ToR	Terms of Reference

1.0: INTRODUCTION

The Agbada field is located in the Eastern Land Area operation of Shell Petroleum Development Company (SPDC) in OML 17 situated approximately 16 km North-East of Port Harcourt in Rivers State. The field was discovered in 1960 by the Agbada-1 well and has a Stock Tank Oil Initially in Place (STOIIP) of 1.5 Billion barrels. To date sixty-four (64) wells have been drilled in the field and some 18 percent of its original oil in place to date has been produced. Significant recoverable oil volumes remain in the field, which have not been developed. Current field production stands at around 28,000 bopd and 9.6MMscf/d gas production, which is processed and sold to the domestic market. There is 90Mbopd capacity in the field's two flow stations while Agbada Associated Gas Gathering (AGG) was commissioned with a capacity of 68MMscf/d. The field has been further divided into two oil fields, Agbada 1 and Agbada 2, for administrative purposes.

A Field Review/ Field Development Plan was carried out in 2004 to identify and develop Non Associated Gas (NAG) reserves to accommodate the expected demand increase in the Eastern Domestic Gas market. The plan is to drill four (4) NAG wells into the G6000, G8000 or G4000 reservoirs. Furthermore a Field Review/ Field Development Plan was carried out in 2007 to identify and further develop oil reserves in order to maximize economic recovery of hydrocarbons, grow reserves base, increase production and keep the existing facilities full. To achieve this, a plan has been put in place to drill four (4) oil wells into the E4000 and E8000 reservoirs.

In line with statutory requirements for the conduct of Environmental Impact Assessment of the proposed Agbada FDP, a Scoping Workshop was held on the 26th of March 2008 to which various stakeholders were invited as follows:

- Department of Petroleum Resources (DPR)
- Regulators - Federal Ministry of Environment Housing and Urban Development (FMEH & UD), Abuja
- Rivers State Ministry of Environment
- Representatives of River State Ministry of Health,
- Representatives of Rivers State Ministry of Local Government and Chieftaincy Affairs,
- SPDC
- EIA Consultants
- Representatives of stakeholder communities relevant to the project.

The aim of the workshop was to present the project to the stakeholders and obtain their issues and concerns that would guide the EIA study and decision-making process for the project. Stakeholders were made to express their perceptions and expectations, identify potential impacts (adverse and beneficial), propose measures to mitigate the negative and enhance the positive impacts from the proposed project.

This Terms of Reference (ToR) highlights the various issues raised during the scoping workshop. It is developed in an integrated manner to include the scope of work for biophysical, social and health Impact Assessments. This is in compliance with the regulatory requirements and the SPDC EIA process, which aims at giving equal coverage to the biophysical, social and health aspects of the environment. The purpose of the Terms of Reference is to define the study boundary and scope for the proposed Agbada Field Development Project.

1.1: Executing Arrangements.

SPDC is responsible for the preparation of the EIA, which shall conform to the approved DPR, FMEH & UD guidelines and regulations as well as the SPDC EIA Process Manual. SPDC intends to carry out the EIA through a contractual arrangement with accredited EIA consultants.

1.2: Objectives of the EIA

The objectives of the EIA study are to:

- Determine the baseline conditions of the environment (biophysical, socio-economic and health).
- Determine and evaluate the potential impacts of the proposed project activities on the biophysical environment of the area.
- Identify and evaluate the potential socio-economic effects of the project on the communities including impacts on cultural properties, social infrastructures, natural resources and lifestyles / values.
- Identify and evaluate health impacts that may result from the different phases of the project.
- Develop cost-effective mitigation measures and appropriate Environmental Management Plan (EMP) for sustainable development.

1.3: Institutional and Legislative Framework

Environmental Impact Assessment in Nigeria is regulated by Federal, State and Local Government legislation and the proposed EIA shall conform to these guidelines as well as relevant international guidelines / conventions including those of the World Bank / IFC. The regulatory framework is outlined below:

1.3.1: Federal Regulations/Guidelines

- The Environmental Impact Assessment (EIA) Act No. 86 of 1992.
- Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for Petroleum industry in Nigerian, (EGASPIN) 2002 Guidelines
- Department of Petroleum Resources (DPR) Mineral Oils and Safety Regulations 1997
- FEPA EIA Procedural Guidelines, 1995
- FEPA EIA Sectoral Guidelines (Oil and Gas), 1995
- Revised National Policy on Environment - 1995
- S.I.8 - National Environmental Protection (Effluent Limitations) Regulations of 1991

- S.I.9 – National Environmental Protection (Pollution Abatement in Industries and Facilities Generation Wastes)
- S.I.15 – National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations of 1991
- The Petroleum Act No. 51 of 1969
- Endangered Species Control Act of 1985
- Land Use Act of 1978
- National Inland Waterways Authority (NIWA) Act 13 of 1997
- Factory Act 1992
- Revised National Health Policy - 2004
- National Health Act 2005
- National Guidelines and Standards for Environmental Protection 1991

1.3.2: State Regulations

- Rivers State Environmental Protection Agency Law No. 2 of 1994
- Rivers State Private Health and Allied Establishments Authority Law, 2001
- Rivers State Public Health Law, 1999
- Public Health Law – CAP 103 of the Laws of Eastern Nigeria, 1963

1.3.3: Relevant International Conventions and Guidelines

- International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines 1996
- World Bank Guidelines on Environmental Assessment, 1991
- World Bank Operational Directive 4.00, Annex A: "Environmental Assessment"
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.
- Convention on Biological Diversity (Rio Summit) 1992
- Convention Concerning the Protection of the World Cultural and Natural Heritage Sites (World Heritage Convention) 1978.
- Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal 1989.
- United Nations Framework Convention on Climate Change 1994
- Convention to Regulate International Trade in Endangered Species of Fauna and Flora (CITES) 1973

2.0: PROJECT ACTIVITY DESCRIPTION

Project Objectives

The objectives of the project are as follows:

1. Supply a plateau gas rate of about 100 MMscfd to supplement the gas supply to the Eastern Domestic Gas network.
2. Achieve flares down at Agbada 2 Flowstation by gathering surge vessel gas.
3. Optimise the ultimate recovery of oil and gas from all reservoirs developed.
4. Increase booked reserves

5. Maximise implementation of Sustainable Development initiatives in the operational area covered by the project.

The Project Location

The planned Agbada Field development Project is located in Etche, Ikwerre and Obio-Akpor Local Government Areas of Rivers State within the Niger Delta area of Nigeria (Figs. 1, 2 and 3).

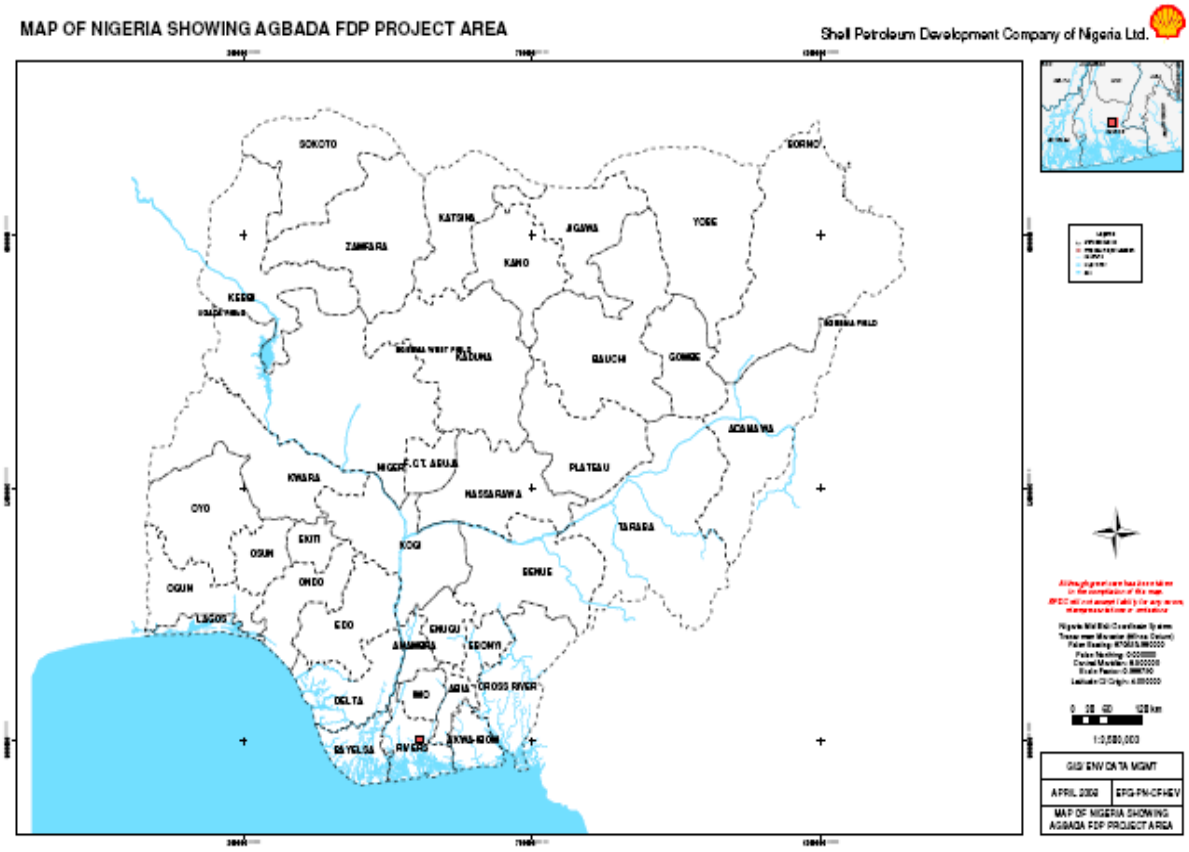


Fig. 1: Map of Nigeria Showing the Proposed Project Location

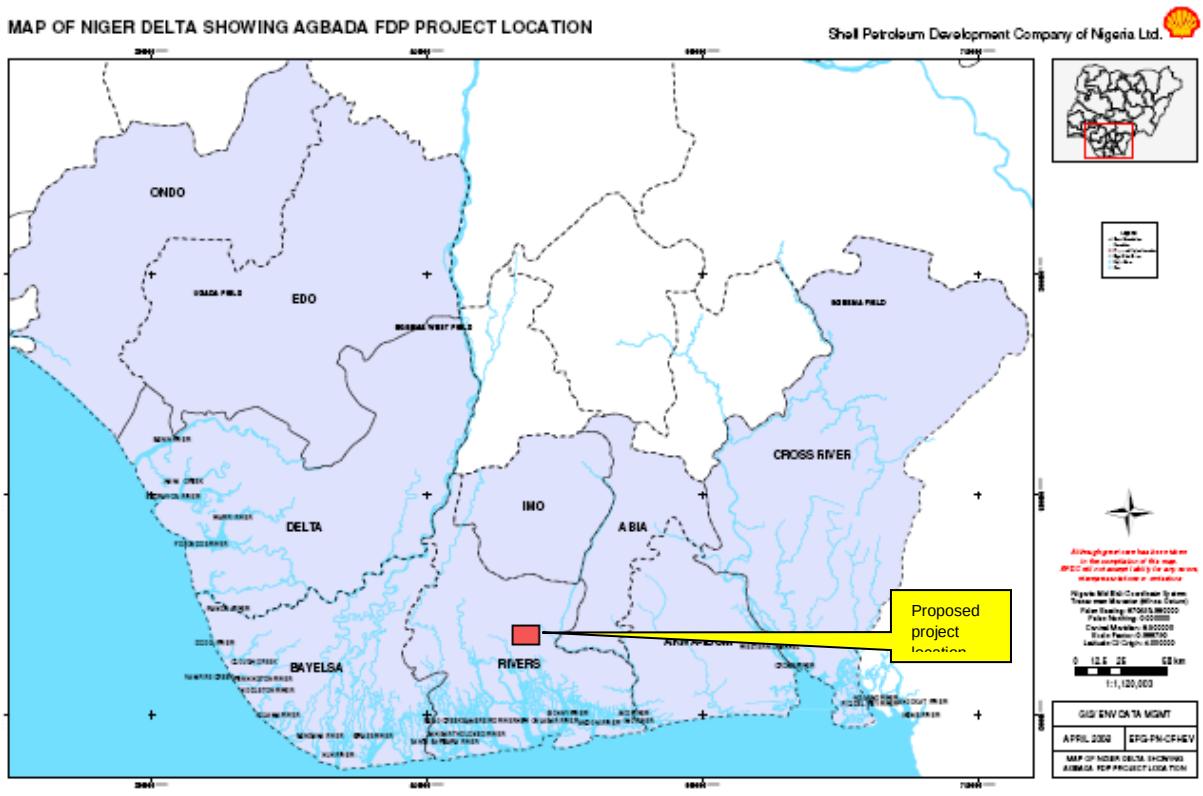


Fig. 2: Map of the Niger Delta showing the proposed Agbada FDP Location

The Agbada field, which is further subdivided into two subfields consists of two flow stations namely Agbada 1 and Agbada 2, wells and flowlines; which are hosted by several communities in Ikwerre, Obio - Akpor and Etche Local Government Areas of Rivers State. However, the proposed EIA surface area coverage extends beyond the immediate vicinity of the flow stations, lines and wells. The Agbada FDP EIA study area covers five-kilometre radius of each of the flow stations. This includes the proposed NAG plant, a two kilometre radius of the wells and two kilometre buffer zone on either side of the flowline Right of Way (ROW) for transporting gas from Agbada 1 to Agbada 2 as shown in Figure 3.

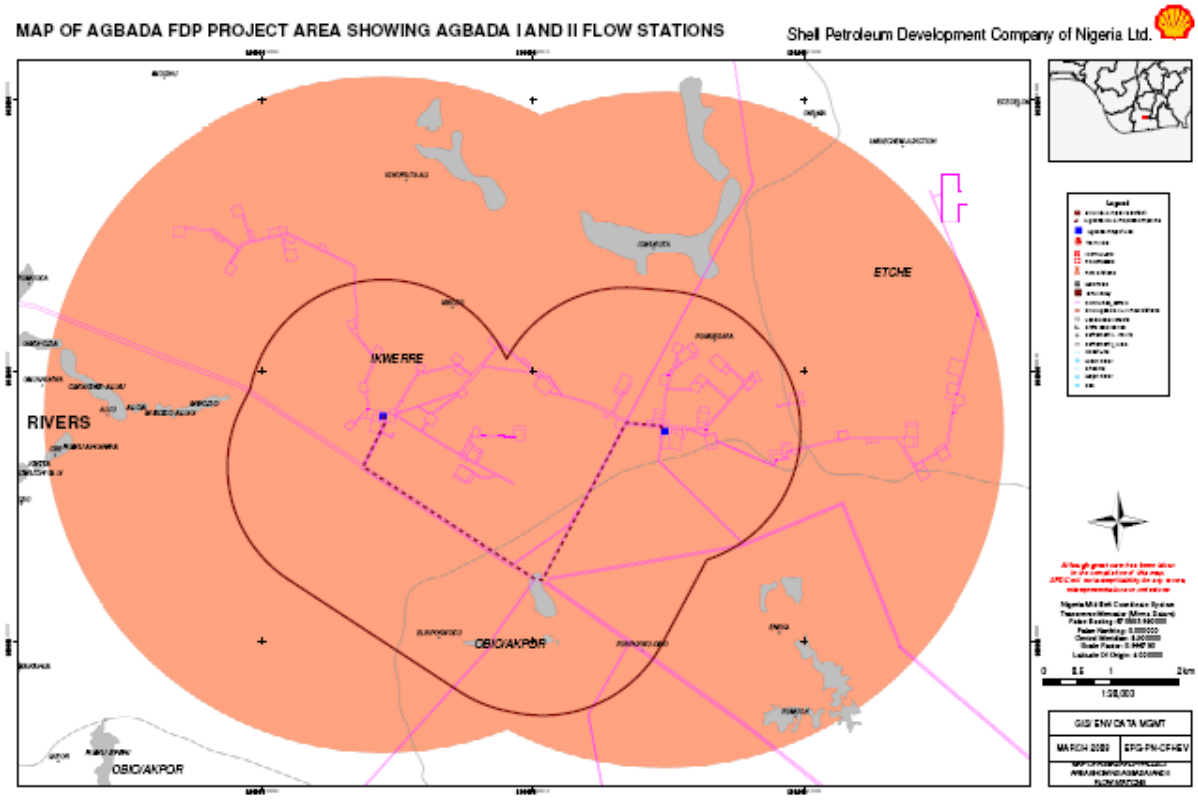


Fig. 3: Map of the Proposed Agbada FDP location with the overlapping EIA study boundary (in brown highlight)

Satellite imagery (Fig. 4) of the area shows that the predominant land cover consists of mainly secondary vegetation and fallow farm lands undergoing varying degrees of successional changes with sparse vegetation. Relics of primary forest occur occasionally. Also visible on the satellite imagery are areas of urban industrial developments.

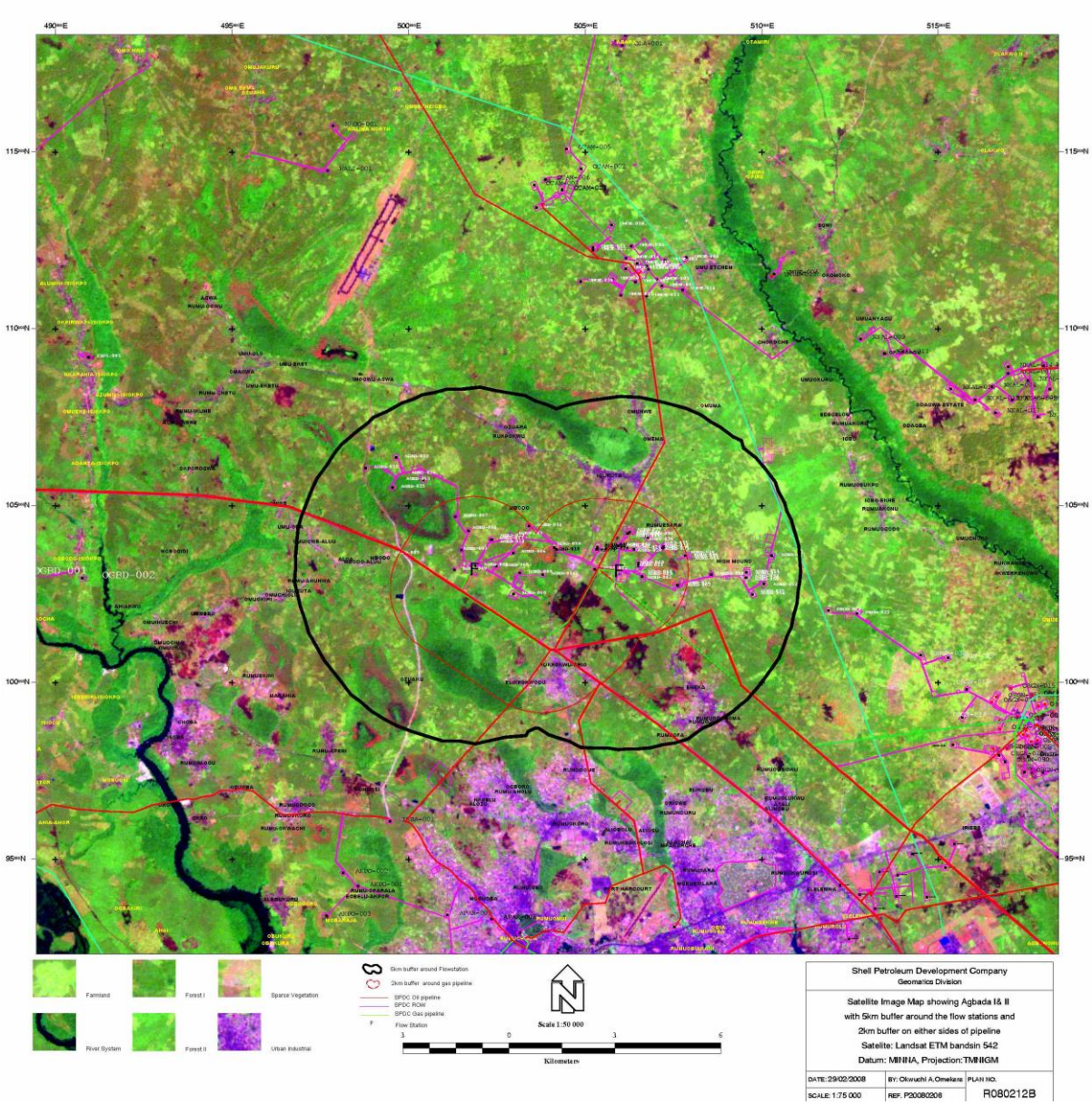


Fig. 4: Satellite Imagery of the proposed Agbada FDP location (with the EIA study boundary)

2.3 Nature of the Project

The development concepts that are considered involve the following:

- Install 120 MMscf/d NAG processing plant at Agbada-2 Flowstation.
- Install 1 MMscf/d AG compressor to gather surge vessel gas at Agbada-2 Flowstation.
- Drill 3 NAG and 2 oil wells and hook-up.
- Lay 2 No. 8" x 8km NAG flowline from wells at Agbada-1 to NAG plant at Agbada-2.
- Lay 1 No. 8" x 0.5km NAG flowline to connect well to already laid 8" flowline.
- Lay 2 No. 4" x 5km oil flowlines from well location to Flowstation

Details of the flowlines scope are shown in **Table 1.0**

Table 1: Agbada FDP Flowlines Scope

S/N	Field	Flowlines	Status	RoW Width
1	Agbada (NAG)	2 Nos. 8 x 8 km (gas) 1 Nos. 8" x .5 km(gas)	On existing RoW On existing RoW	15m
2	Agbada (OIL)	2 Nos. 4" x 5km (oil)	On existing RoW	15m

2.1 Project Activities

Based on the nature of the project as indicated earlier, the activities come under the following categories:

Pre-construction

- Survey
- Pre-mobilisation and inspection
- Mobilisation of equipment and workforce to site
- Well Location preparation (Land clearing, sand-filling etc)
- Construction of camps sites, lay-down areas, access roads and other civil works

Drilling/Workover

- Rig move
- Well Drilling
- Well Completion and testing
- Hook up

Construction

Flowline Execution

- Excavation and trenching
- Flowline laying
- Welding and coating
- Radiography
- Hydrotesting of flowlines
- Backfilling

Facilities

- NAG plant (dehydration, fuel gas) installation.
- AG booster compressors (surge vessel gas) installation
- Tie-ins

Commissioning and Operations

- Operation of NAG, AG and associated facilities
- Operation of wells and manifolds
- Maintenance of flowline RoW

Decommissioning and Abandonment

- Demobilization
- Excavation
- Removal of facilities
- Restoration

The primary considerations in the selection of project sites and adopted technology include the following:

- Impact on and benefit to the local communities
- Impact on environment sensitivities
- Minimal land take
- Capital cost impacts
- Operability of the plant and facilities
- Distance to oil and gas reserves
- Location of current facilities and production operations
- Safety
- Impact on schedule to First gas

Specific details of the activities under these categories are as follow:

2.1.1 Pre-construction

Pre-construction activities shall involve minimal land acquisition; topographic surveys and soil investigation; vegetation clearing; earth works (e.g. sandfilling); and construction of slabs (for cellar, generator, chemicals etc), access road, and campsite/storage areas for Drilling. For Flowlines, they include: route selection and survey; material selection; pre-mobilization inspection and mobilization; pegging and fencing; route clearing; probing for existing facilities; and construction of access road, and campsite/storage areas.

Minimal Land Acquisition

A feasibility study for the re-use of existing locations has been undertaken in order to minimize land take. The aim is to use drilling slots on already acquired land. However, where an existing well location is found unsuitable for the drilling, additional land may be acquired as the need arises. In addition, cluster-drilling strategy will be adopted for the project to minimize land take and other impacts on the environment.

Well Locations Preparations

Single well pads will be designed for both oil and gas wells. Each location will be surfaced with asphalt to prevent groundwater and soil contamination. In addition, pits will be constructed to capture surface run-off. The pads will be graded so that rainfall on the active portions of the pad will be directed into the pit.

Sizes of the well locations are estimated to be approximately 60 x 110 m for one-wellhead location. Exact dimensions for each well pad will depend on surface constraints that may impact construction of individual locations. Well site construction is typically completed over 12 months in a seasonally flooded terrain like Agbada.

Access Roads Preparations

There are existing access roads to the existing and proposed well sites. However these roads shall be maintained in good conditions during the course of the project.

Flowline Design

Flowlines have been designed according to the relevant regulations, codes, and standards as summarized below:

- Guidelines & Procedure for the Construction, Operation & Maintenance of Oil & Gas Flowlines (1990)
- Oil and Gas Flowline Regulation (1995)
- Oil Flowlines Act, 1956, Cap 338, Vol XIX P.12363
- Primary Codes and Standards
- Standard Flowline and Flowline Design Package (ENGL/21/34/01)

- Shell Group Flowline Engineering DEP (31.40.00.10-Gen)
- ASME B31.4 - Liquid Transportation Systems for Hydrocarbons & other Liquids (Applicable to the Oil Export Flowline)
- ASME B31.8 - Gas Transmission & Distribution Piping System (Applicable to the NAG flowlines)

The design life for the various categories of flowlines has been established to ensure the integrity of the flowlines and bulklines throughout their operating life. The applicable design life is given as follows:

- ❖ NAG bulklines and flowlines - 30 years
- ❖ Bulklines and flowlines - 20 years

Route Selection and Survey

Routes for the flowlines will be selected and surveyed to ensure consistency with the philosophy of shortest possible distance between start and end points with environmental, social, economic and technical considerations. This is to reduce the exposure of communities to potential hazards associated with high-pressure flowlines, and the risk of third party interference.

Materials Selection

Materials of appropriate grades will be selected for the flowlines to ensure the highest integrity to withstand the anticipated pressure and environmental conditions without risk of failure. All the NAG flowlines shall be of carbon steel.

All the flowlines shall be coated with three-layer polyethylene (PE) anti-corrosion coating. Coating shall be carried out in a pipe coating yard before transportation to the site. Line pipes, fittings and other flowline construction accessories shall be transported and stored in such a manner as not to impact on the integrity of the materials.

Pre-mobilisation Inspection and Mobilisation

Prior to mobilisation, SPDC shall carry out pre-mobilisation inspection of all items/personnel to be mobilised to site. All equipment and personnel mobilised to site shall be certified fit for purpose and approved by SPDC before deployment to site. Key construction equipment to be mobilised include: Back hoe, Side boom, Prime mover, Trailer, Self loading truck, Crane, Crew bus, 4WD truck, Welding sets, Flushing pumps, Hydro testing unit, Generators, Compressors, Bending Machine, Grit blasting unit, Oxy acetylene torch, Line up clamps, Cold cutter, X-ray units, Thrust boring machine, etc. The contractor shall mobilise all necessary personnel, materials and equipment to site after setting up of the Project Advisory Committee (PAC), resolving community issues and obtaining necessary approvals.

Survey and Staking of Flowline Routes

Survey shall be carried out to re-establish and clearly mark out boundaries of the permanent RoW and temporary working strip required for construction activities. For example, a single

flowline route will be approximately 25 m wide (15 m for the permanent RoW and 10 m for the temporary strip). The temporary strip will be re-vegetated and restored to the landowners after construction activities.

During Front End Engineering Design (FEED), keen attention will be given to reduction in land take and minimization of environmental footprint. In this regard, where technically feasible, multiple flowlines will be routed through a common corridor, and may or may not be installed in the same trench.

Probing for existing flowlines
Flowlines shall be identified and located using drawings and pipe detectors. Manual excavations at appropriate intervals shall confirm exact positions. Inspection of each flowline shall be carried out and a permanent mark placed on all exposed lines to indicate which are to be replaced and which are to be left in place.

Clearing
The working width shall be cleared of trees and hedges. Ditches shall be flumed by installing pipes and ramped over with subsoil to give a continuous running track through the fields. Top soil shall then be stripped across the working area and stored at one side.

Site preparations
The pre-construction activities for site preparations include:

- Setting up of Site Camp, including preparation of lay down and work areas, storage facility for construction materials and fittings, messing facilities, accommodation facilities, offices, workshops, temporary access roads, etc.
- Civil works, including foundations, bund walls, drains, culverts, roads.
- Loading, transportation and offloading of equipment and materials, using cranes, forklifts, self-loaders, trailers, including Self-Propelled Multiwheel Trailers (SPMT).
- Welding, installation and painting of pipe rack segments.
- Assembling, welding, installation and painting of piping on pipe supports and/or pipe racks.
- Installation of equipment skids, packages and modules, comprising installation of utility systems

The manpower requirements for construction works is estimated to peak at 90 persons during the site preparation phase and about 200 persons during the EPIC phase. The manning level is expected to peak at about 10 persons during the normal operations phase.

2.1.2 Drilling

The scope for the drilling activities is as follows:

- Drill 3 NAG and hook-up.
- Drill 2 oil wells and hook up

Drilling shall be done using a land rig for surface hole, intermediate and production drilling. Water-based drilling mud will be used for the top-hole sections while pseudo oil based mud shall be used for the intermediate and deeper sections. The expected wastes include drilling mud, drill cuttings and spent chemicals.

Well Design Concepts

For NAG wells the design shall be a conventional vertical (or slightly deviated) well with a 4 1/2" completion, utilising existing experience and standard well construction equipment and materials. The concept selection for the oil wells is a conventional horizontal or deviated well with a 4-1/2" completion. A generic sketch of the base case NAG well design and the base case Oil well design are illustrated in Figures 5 and 6 respectively

Drilling Process

The wells will be drilled using water based mud system from surface to 13-3/8" or 9-5/8" casing depth at $\pm$ 6,000 ft. Thereafter, Pseudo Oil Based Mud (POBM) will be used to drill to total depth (10,000 ftss) i.e. the lower section of the hole (below surface casing depth). The two mud systems will be salvaged for re-use. Approximately 160 m^3 of drill cuttings is expected to be generated from each drilling operation. Spud (Gel Suspension) mud contains bentonite, polymer additives (e.g. CMC HV) and KCl (shale inhibitors).

Drilling a well is achieved by making up the bottom-hole assembly (BHA) below pipes. Rotating this assembly generates formation cuttings. During this operation, a special fluid (drilling mud) is continuously pumped through the pipe and comes out of the drilling bit. The mud carries the drilled cuttings through the annular space between the drill string and the hole to surface.

The mud shall be tested/checked regularly (every 15 minutes on site) to ensure that the properties and weight are in order. The primary safeguard against a blow out is the pressure exerted by the drilling mud. The secondary control is the equipment referred to as Blow Out Preventer (BOP) with surface safety valves. This equipment shall be used to close in a well at the slightest detection of formation fluid ingress/flow into the well bore (mud system).

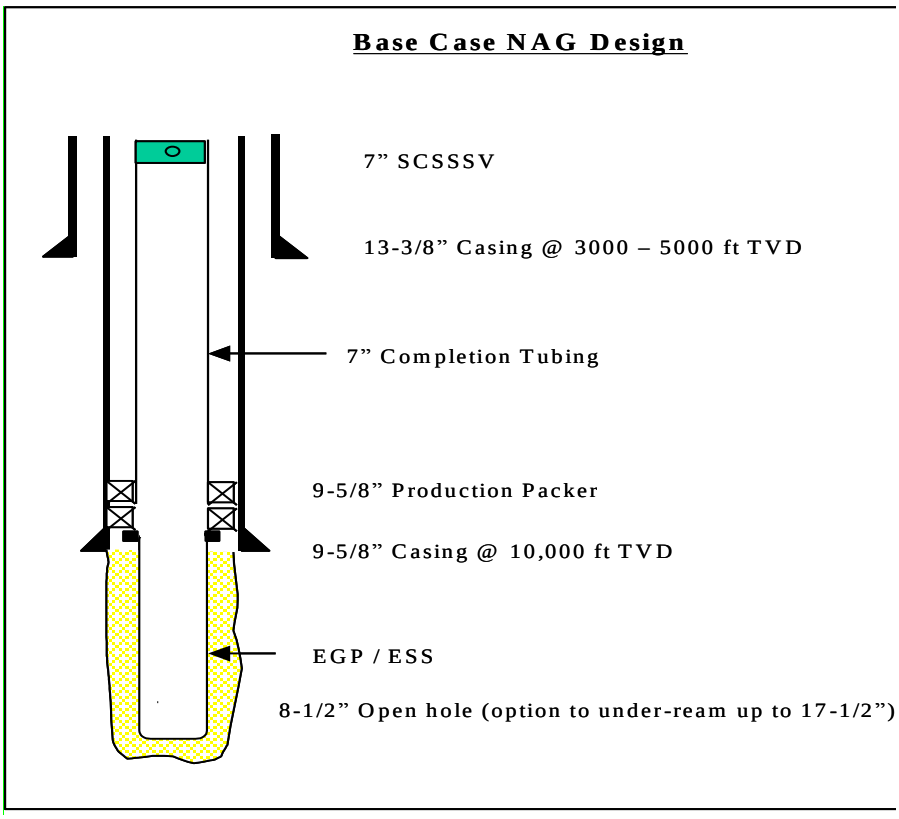


Figure 5: NAG Well Design

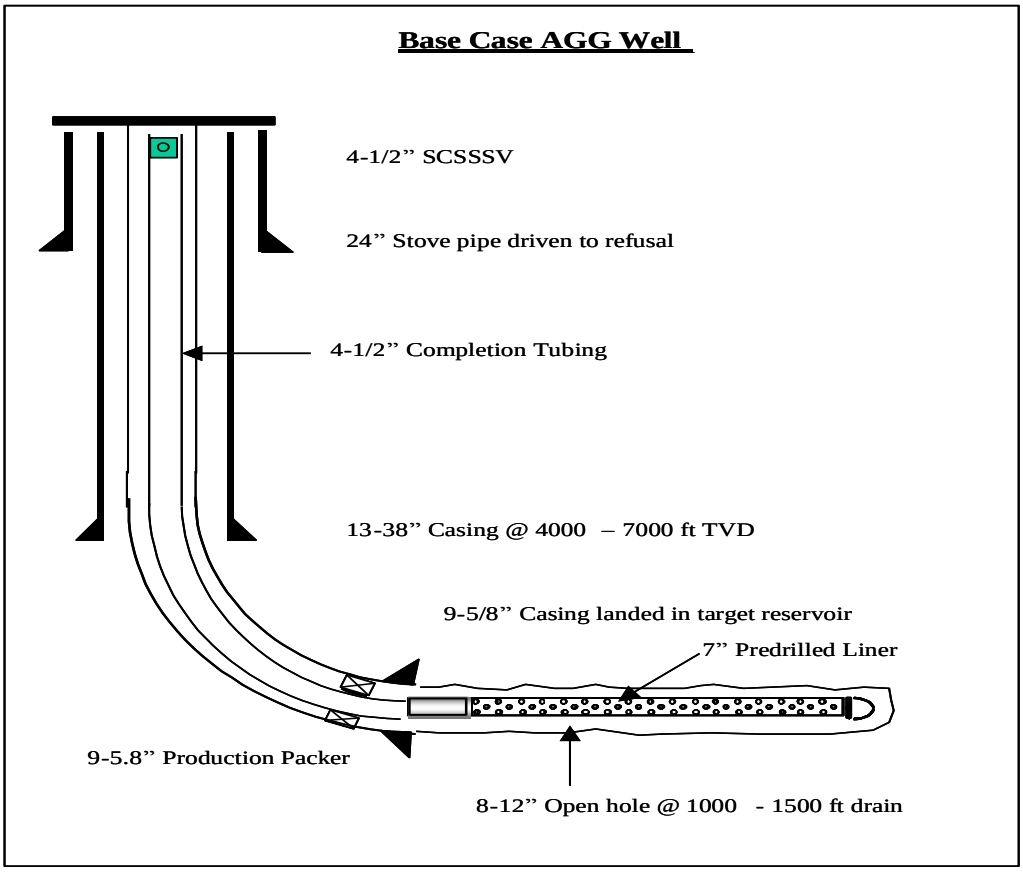


Figure 6: Base case Design for Oil Well

Drilling Wastes

The wastes that will be generated during the drilling operations include:

- Drill cuttings
- Spent drilling mud and completion fluids
- Drilling effluents (waste water)
- Cementing waste
- Rig wash (Detergent) water

The drilling waste management principles in this project will focus on waste minimization and recycling. Wastewater shall be treated/flocculated and used for building new mud and also for the rig and equipment washing. The wastewater and drilled cuttings from the drilling operations will be channelled into waste pits. A pay loader shall be used to scoop out the drilling waste from the waste pit into cutting skips. The cuttings will be mixed with water to form slurry and taken to a Thermal Desorption Unit (TDU) Onne in compliance with FMEH&UD/DPR directives.

Associated Wastes

Discarded consumables include unused drilling chemicals, chemical/material bags, scrap metals used in constructions etc, will be trucked to SPDC facility for recycling. A strict inventory control of all chemicals in use shall be maintained. All chemicals, lubricating oils and fuels will be stored in containers and safely placed in a sheltered area on the rig. Appropriate Safe Handling of Chemicals (SHOC) cards will be provided for every chemical on board the rig for the safety of personnel and the environment. International standard in-built biological sewage treatment plants shall be put in place to manage human waste expected from the rig personnel who are not expected to exceed one hundred (100).

2.1.3 Flowlines Construction

The gas wells are within 8km of the proposed NAG facility location. Flowlines will be constructed from the wells to the proposed NAG facility. The flowlines will be installed with pigging facilities. The pigging facilities shall consist of an outgoing pig launcher and an incoming pig receiver.

The flowline construction shall include the following specific activities:

- Welding, installation and painting of pipe supports.
- Assembling, welding, installation and painting of pipes

The overall flowline scope of Agbada FDP requires the construction of flowlines of 4” and 8” by approximately 26km cumulative. The flowline material is predominantly carbon steel. A summary of the flowlines list for the project is given in Table 2.

TABLE 2 : Agbada FDP Flowlines Summary

From	**To**	**Fluid**	Length (Km)	Flow Rate MMScfd	Pipeline Size (inches)	Pipeline Inlet Pressure (bars)	Arrival Pressure (bars)	**Material**	ANSI Rating / Design Pressure
Well 09	Agbada 2 (GHF)	Wet Gas	8	100	8	115	110	Carbon Steel	1500
Well 09	Agbada 2 (GHF)	Wet Gas	8	100	8	115	110	Carbon Steel	1500
Well 09	Existing pipeline Via Agbada 1	Wet Gas	0.5	100	8	115	115	Carbon Steel	1500
Well 04	Agbada 1	Oil	5	6Mbpd	4	14	13	Carbon Steel	600
Well 06	Agbada 1	Oil	5	6Mbpd	4	14	13	Carbon Steel	600

Trenching

A trench, 0.3 - 0.6 m wider than the pipe diameter and deep enough to provide minimum cover, will be excavated for the flowline burial. Where the flowlines cross major roads the option of trust-boring will be considered.

Stringing and bending

Stringing and bending involves the handling and positioning of flow lines or joints on wooden skids along a line parallel on one side of the trench in preparation to welding into a continuous flowline. Strung pipes shall be provided with caps at both joint ends to keep the joint free from dirt and extraneous materials. Where the flowline changes direction, factory manufactured bends will be used or, if the change in direction is less severe, bends will be fabricated at site. As much as possible, deviations will be achieved via elastic bending.

Welding

Before welding, each item shall be visually inspected to ensure that the integrity and general condition of the pipes and fittings have not been compromised during transportation and storage, that they are clean internally and that the ends are correctly prepared for welding. Welding of the joints shall be in accordance with sections 21, 25 and 34 of Shell's construction specifications.

Inspection testing and NDT of welds (Radiography)
Quality assurance and control of the weld shall be achieved by visual inspection and radiographic inspection. All radiography films will be processed and interpreted on site to facilitate quick repairs of defective welds.

Lowering-in and Backfilling
The welded pipe shall be lowered gently into the ditch without subjecting the line to any stress. The pipes will conform to the ditch and substantially supported by the ditch bottom. Initial backfilling shall be carried out by installation of soft material (medium sand bed) to obtain a soft surround for the installed pipe. The material shall be free of stones, rocks, timber, roots, debris and any other material, which may damage the pipe coating. The sand bed shall have a minimum depth of 150 mm. After the trench has been backfilled, the material shall be tamped down as much as possible and the finish surface levelled with the adjacent grounds.

Cathodic Protection
Permanent cathodic protection (CP) facilities shall be installed to protect all flowlines. Protection source shall be from deep well ground bed installed at the flowstations and any other locations to be determined during the design. All CP materials and installations shall conform to the relevant International Standard Construction Specifications (ISCS).

2.1.4 Commissioning and Operations

Operation of NAG Plant and AG Booster Compressor and Associated Facilities
A NAG Plant and an AG Booster compressor will be installed at Agbada-2 flowstation Station. Liquids from the NAG plant shall be piped to the existing flowstations and a dehydration system will be installed for gas conditioning.

Operation of wells and flowlines
Pre-commissioning and commissioning activities for flowlines shall include:

- Thorough cleaning and flushing of the internals of the system piping to ensure no debris.
- Draining, blowing out and drying of piping systems.
- Installation and removal of temporary blinds used for isolation and testing of joints.
- Hydro testing, pneumatic testing, leak testing to full system pressure, strength or other non-destructive testing of all pressure containing parts of the system.
- Testing of all electrical system.
- Calibration and testing of all instruments including those installed on packages or skids.
- Testing of power and instrument cables (continuity tests).
- Electrical and instrumentation loop checks.
- Testing of set points and action of alarm and shutdown devices.
- Full operational testing of all communication systems.
- Checking to ensure that safety equipment is installed, charged and fully functional.
- Pre-commissioning of systems including service and potable water.

- Effluent and drainage, fire protection, instrument air, blow down and interconnecting lines.
- Installation and checking of hazardous area equipment in accordance
- with the requirements of the certification.
- Operating areas to be cleared of debris and construction equipment.
- Completion and submission of appropriate test sheets and documentation.
- Purging of the entire facilities including the flowlines with Nitrogen.
- Full simulation of all systems and sub-systems necessary for the
- introduction of hydrocarbons;
- Complete cause and effect checks including commissioning of all safety
- detection systems like fire detection, smoke detection, gas detection,
- public address system, manual alarm/call points.
- Full emergency shutdown system test.

Cleaning, Testing, De-watering and Drying of all flowline and manifold sections will be carried out. Flowlines will be cleaned using flush water with brush and bi-directional pigs. Caliper pig inspection of the flowline will be run to identify positions of features such as bends, kinks and ovality. Defects observed would be rectified. Baseline Intelligent Pig (IP) inspection of the flowlines will be carried to identify any base case anomalies and provide a fingerprint for comparison with subsequent IP inspections.

Hydrostatic pressure testing shall be carried out on all flowlines to determine the structural integrity of the constructed flowlines. Water shall be the testing medium. Water used shall be lab-tested to prove that it will not damage the flowline integrity during testing or the environment during disposal.

The new line shall be de-watered immediately after pressure testing using compressed air and foam pig. All water recovered from the line shall be tested and treated (where necessary), and sent to Bonny Terminal for further treatment to meet regulatory limits before disposal into Bonny River.

Gas flowlines shall be dried, when required, to prevent internal corrosion due to presence of water. Drying methods include nitrogen or air-drying with pigs, glycol or methanol swabbing, and vacuum drying.

2.1.5 Decommissioning and Abandonment

The decommissioning of the project facilities shall involve these main activities:

- Determining the regulatory requirements
- Evolving a community involvement strategy
- Establishing future land use objectives
- Determining objectives of the mothballing plan
- Determining remediation requirements
- Determining reclamation objectives
- Developing a HSE plan

Table 3: The decommissioning plan for the facilities proposed for the Agbada FDP:

Facilities	Decommissioning
Wells	Leave potable water wells as agreed with local authorities; isolate production interval to prevent communication between aquifers of different nature or salinity; isolate from the surface; plug and abandon downhole according to applicable DPR guidelines; place surface cement plug below the cellar to allow removal of surface components; backfill to surface.
Production, processing and utility facilities including remote oil and NAG manifolds, vessels, heaters, coolers, glycol contactor, regeneration system, storage tanks, pumps, compressors, generators including all piping, instrument and electric cables/tubing and fencing.	Purge and clean to remove lubricants, residues, etc; reuse, recycle or scrap redundant equipment such as generators, compressors, etc.
Flowlines	Purge and flush with water to remove residues; remove or plug and abandon below grade lines.
Redundant buried structures, foundations and cables.	Purge and clean to remove residues; abandon in place or remove completely according to proposed end land use.
Concrete and steel structures including concrete foundations, wellhead cellars, skid foundations and telecom masts, gratings, buildings (including workshops, offices, houses, etc.) and bridges.	Remove steel structures for reuse or recycling; remove wellhead cellar to 1 m below soil surface; remove concrete foundations and slabs down to soil level (unless abandoned in place for future use); break up concrete slabs at ground level into 1 m^2 to allow vegetation to re-grow through the fissures or remove completely according to proposed end land use; remove buildings or leave in place for reuse; provide access controls for physical structures remaining on-site, that are unsafe or hazardous to humans or animals.
Earthworks such as roads, quarries, asphalt covered areas and walls.	Reach agreement with local authorities & communities for use of usable assets such as roads, remove asphalt for remediation and/or land filling; level mounds and dispose of waste rock; remove and recycle or reuse gravel (if clean); decompact subsoils and re-establish vegetation.

All wastes generated in the course of project execution will be handled in line with existing statutory and SPDC Waste Management guidelines.

2.5 Project Schedule

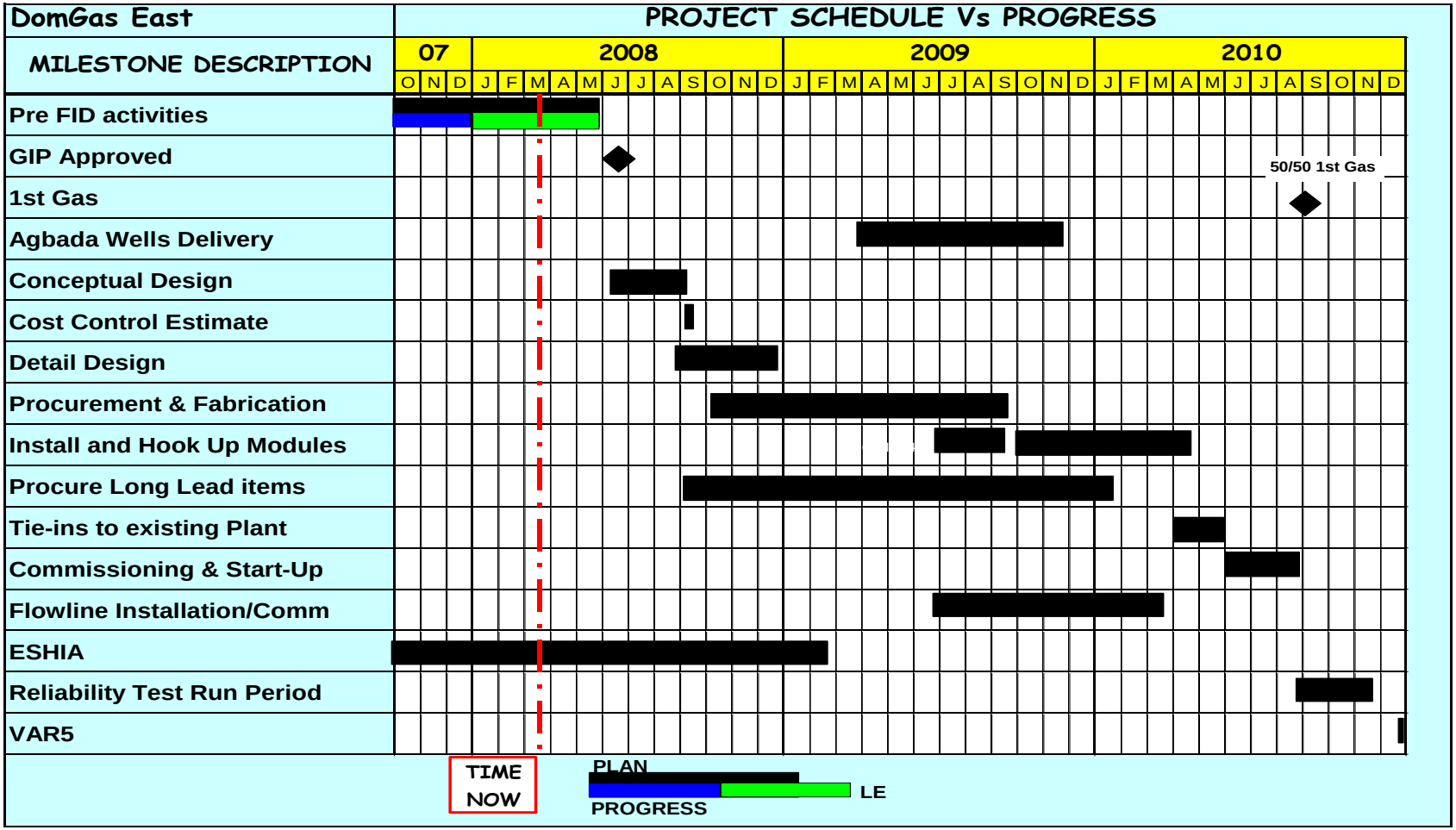


Fig. 7: Project Schedule

3.0: THE TERMS OF REFERENCE (TOR)

The specific objective of the ToR is to provide a framework for achieving the overall objectives of the EIA. Other objectives include:

- ✓ Outlining the general scope of the EIA study including the overall data requirements for the proposed project and the affected environment.
- ✓ Defining the relevant framework of the legal and administrative requirements for the proposed project.
- ✓ Defining the procedures and protocols for identification and assessment of associated and potential impacts, and for selection of appropriate mitigation (prevention, recovery, control) measures for such impacts; and
- ✓ Defining the elements expected to be included in the Environmental Management Plan (EMP).

3.1: Scope of Work / EIA Scope

This Scope of Work defines the objectives, methodology, deliverables, applicable standards, and other execution information for the conduct of the EIA. It covers all the activities that constitute the Agbada FDP and outlines the techniques and methodologies to be used in generating data including the description of the data sources. The EIA scope covers the following broad task categories:

i. Review of regulatory requirements
ii. Baseline data acquisition
    - Literature review
    - Field work
    - Laboratory and data analyses
iii. Consultation/Stakeholder engagement
iv. Evaluation and prediction of potential impacts
v. Determination of appropriate mitigation measures
vi. Environmental management plan
vii. Report preparation

The scope of work incorporates the issues and concerns that arose from the Scoping Workshop and (attached as Appendix 2) as well as the experience and professional judgements of consultants and regulators from similar projects. The detailed scope for each of the environmental components is presented as follows:

3.1.1: Review of Regulatory Requirements

The EIA shall review the applicable environmental regulatory framework for the project both at the national, state and local government levels as well as outline the applicability of international environmental regulations as they relate to the conduct oil filed development.

The review shall include, but not limited to, the regulatory framework outlined in Section 1.3 above.

Baseline Data Acquisition
Literature Review

Biophysical

Review relevant DPR and FMEH & UD approved EIA reports and previous baseline studies for the proposed project area, as well as other available literature on Niger Delta ecology. The review shall focus on:

- Defining the spatial boundaries of the study.
- Identifying data gaps, if any, in the previous environmental studies, in order to enable proper characterisation of the environmental components.
- Establishing the conservation status of the area and its relationship to any protected areas in the country.
- Obtaining relevant secondary data on regional environmental features from local and national agencies (Nigerian Meteorological Agency, Nigerian Institute for Oceanography and Marine Research, etc).

Social

- Identifying and obtaining all relevant data from government agencies (such as National Population Commission, Federal Office of Statistics, Police authorities and National Orientation Agency), Regulators, SPDC, Reports, Journals, etc.

- Establishing baseline data on the project area, including its people, culture, tradition, and local governance, trend of population change, geographical area, activity systems, infrastructure, archaeological and historical artifacts, traffic analysis and potential impacts of the project.

- Identifying all stakeholders including national and international authorities, non-Governmental organisations (NGOs), community based organisations (CBOs), local/ state government authorities, regulators, community leaders and groups that could be involved in the project and state the basis of their involvement.

Health

- Identifying and obtaining all relevant data on the health conditions of the communities over time from Rivers State Ministry of Health and private health institutions in the study area.

- Determining the population and disease trend over time in the study communities from the National Population Commission, State Ministry of Health, and Bureau of National Statistics.

- Collating information on health budget, local health situation, policies and programmes, regulations and conflicting goals/priorities.

- Establishing history of any health issues in the study communities.
- Determining effects of seasonal changes on the health of the people from the Public Health Department of Rivers State Ministry of Health.
- Identifying necessary minimum health requirements and standards.

The baseline conditions for biophysical, social and health parameters will be determined through fieldwork, laboratory and data analyses.

Field Data Acquisition

In addition to the air / water quality and soil monitoring data being collected for the Agbada 1 and 2 fields on weekly and monthly basis for the past two years, a two season data gathering shall be embarked upon as detailed below.

Biophysical

The fieldwork for data gathering will involve determination of relevant environmental parameters under appropriate quality control/quality assurance measures. The status of the environmental parameters / components and indices that should be established during the baseline data acquisition are outlined in Table 4

Table 4: Data Requirements and Environmental Indicators (Biophysical Aspect)

Environmental Component	Environmental Aspect	Data Acquisition	Potential Environmental Impact Indicator
Climate/ Meteorology	Microclimate/Regional Climatic features	*In situ* measurement, secondary data	Temperature, Rainfall, Relative humidity, Wind direction and speed and their local effects.
Air Quality	Local and Regional	*In situ* / laboratory analysis	Particulate, NO_x, SO_x, CO_2, CO, VOC, H_2S Heavy metals (Fe, Cd, Cr, Pb, Ni, V, Zn)
Noise	Local	*In situ* measurement	Ambient noise level dB (A), communication interference.
Surface Rain Water Characteristics	Physicochemical Features	*In situ* measurements, Composite samples for laboratory analysis	Colour, alkalinity, TDS, TSS, Turbidity, EC, THC, pH, DO, Redox potential, BOD_5, COD, Oil & Grease, Anions/Cations, NH_4^+, NO_3, NO_2, PO_4, SO_4, SiO_2, Na, K, Ca, Mn, Mg, Heavy metals (Fe, Cd, Cr, Ni, V, Pb, Zn, Hg).
Surface Rain /Portable Water Characteristics	Microbiology	Composite samples for laboratory analysis	Total heterotrophic bacteria, fungi, Total hydrocarbon degrading bacteria and fungi, total and faecal coliforms.
	Water Use	Direct observation/ Interviews	Traditional use of rivers and water bodies (navigation, sand mining, food processing, aquaculture, domestic uses etc)

Table 4: Data Requirements and Environmental Indicators (Biophysical Aspect) contd.

Environmental Component	Environmental Aspect	Data Acquisition	Potential Environmental Impact Indicator
Ground Water Characteristics	Physicochemical Features	*In situ* / laboratory analysis	Colour, odour, alkalinity, TDS, TSS, Turbidity, EC, THC, DO, pH, Redox potential, BOD_5, COD, Oil & Grease, Anions/Cations, NH_4+, NO_3, NO_2, PO_4, SO_4, SiO_2, Na, K, Ca, Mn, Mg, Heavy metals (Fe, Cd, Cr, Ni, V, Pb, Zn, Hg).
	Microbiology	Composite samples for laboratory analysis	Total heterotrophic bacteria, fungi, Total hydrocarbon degrading bacteria and fungi, total and faecal coliforms.
	Groundwater dynamics	*In situ*	Static Water Level (SWL), Flow direction/ Flow Rate.
Ground Water Characteristics	Hydrogeology	Laboratory analysis, secondary data sources	Stratigraphy, Aquifer characteristics
Geology	Local and Regional	Secondary data, laboratory analysis	Regional geology, Stratigraphic/Lithologic properties
Soil	Physical characteristics	*In situ*/ composite auger samples for lab analysis, Soil profile pits	Permeability, porosity, bulk density, texture (grain size), colour,

Table 4: Data Requirements and Environmental Indicators (Biophysical Aspect) contd.

Environmental Component	Environmental Aspect	Data Acquisition	Potential Environmental Impact Indicator
Soil	Chemical characteristics	Composite samples for laboratory analysis	pH, cation exchange capacity (CEC), THC, heavy metals, Soil capability
	Soil microbiology	Composite samples for laboratory analysis	Total heterotrophic bacteria, fungi, Total hydrocarbon degrading bacteria and fungi, total and faecal coliforms
Land Use/Cover	Satellite Imagery of Land cover	Secondary data sources	Land Use types: Recreational, agricultural, industrial, residential, institutional, commercial. Trends and time-lapse mapping.
Bio-diversity: Status and relevant issues	Wildlife	Transect, direct observation, interviews, secondary data sources	Species composition/distribution (vegetation map of locality), seasonality, exploitation methods/level (kill rates/month/year, estimates of wildlife population etc)
	Vegetation	Transect, herbarium studies, tissue analysis	Habitat status, floral composition, density and distribution, vegetation structure, plant pathology
	Conservation	*In situ* observation, interviews, secondary data	Conservation status (rare, threatened and endangered species), conservation areas (forest reserves etc), environmentally sensitive areas – wetlands and swamps), local conservation practices.

Laboratory Analyses

Relevant samples collected during the fieldwork will be analysed for the different parameters as listed in Table 5 below.

Table 5: Sampling and Analytical Specifications/Requirements for Biophysical Samples

S/N	Sample	Sample Type	Analysis	Parameters
1	Soil	Surface (0 –15cm)	Physico-chemical	pH, THC, Percent carbon, Available PO_4-P, Total-N, NH_4+, NO_3, NO_2, Na, K, Ca and Mg, Redox potential, cation exchange capacity, (CEC), conductivity, oil & grease, heavy metals (Fe, Cd, Cr, Pb, Cu, Ni, V and Zn)
		Subsurface (15-30cm)	Soil characterisation / classification,	Texture, grain size analysis, porosity, permeability, bulk density, erosion potential
			Microbiology	Total heterotrophic bacteria and fungi, Total hydrocarbon degrading bacteria and fungi as CFU/g
2.	Surface rain water	Composite	Physico-chemical	Colour, alkalinity, TDS, TSS, Turbidity, EC, THC, pH, DO, Redox potential, BOD_5, COD, Oil & Grease, Anions/Cations, NH_4^+, NO_3, NO_2, PO_4, SO_4, SiO_2, Na, K, Ca, Mn, Mg, Heavy metals (Fe, Cd, Cr, Ni, V, Pb, Zn, Hg).
			Microbiology	Total heterotrophic bacteria and fungi, Total hydrocarbon degrading bacteria and fungi

Table 5: Sampling and Analytical Specifications/Requirements for Biophysical Samples contd.

S/N	Sample	Sample Type	Analysis	Parameters
3.	Ground-water	Composite	Physico-chemical	Temperature, pH, salinity, EC, DO, Turbidity, THC, Redox potential, oil & grease, anions and cations, heavy metals (Fe, Cd, Cr, Pb, Cu, Ni, V and Zn)
			Hydrodynamics	Water table depth, flow direction and rate.
			Microbiology	Total heterotrophic bacteria and fungi, Total hydrocarbon degrading bacteria and fungi
			Hydrogeology	Stratigraphy of the initial underground layers.
			Log analysis	Physico-chemical and heavy metal characterisation.
4.	Vegetation	*Transect area	*In situ* study	Vegetation types, floral composition
			Herbarium studies	Sampled /field unidentifiable plant species
			Plants and crops pathological studies	Identification of health conditions, insect pests, fungi, bacteria and viral disease of crops around the field and associated villages, farmlands or plantations, plant tissue analysis
5.	Wildlife	Transect/ Visual observation	Mammals, reptiles, birds, amphibians and invertebrates	Diversity, distribution, density, conservation status, formal/traditional conservation practices, wildlife exploitation methods.
6.	Air Quality		Physico-chemical	SO_x, NO_x, VOC/HC, Particulates, CO, CO_2, N_2O, NH_3, soot

* The width and length of transect shall be determined by the nature and type of terrain and field topographical status.

The limit to the number of transects shall be dependent on features of interest.

Sample Locations and Numbers (Biophysical)

Soil samples shall be arranged along the flowline corridor, near the wells and NAG plant and by the settlements in such a manner as to cover the entire area. Sampling locations for other environmental parameters such as vegetation and ground water characteristics have been chosen with due reference to land cover features of the area.

Table 6: Sampling Points and Coordinates

Samples Pt	XFIELD	YFIELD
Soil Sample		
SS1	510030.036	105134.962
SS2	508090.888	99274.900
SS3	507153.279	104580.920
SS4	505682.936	105071.034
SS5	505491.152	102407.370
SS6	504979.728	101107.501
SS7	502997.962	100212.510
SS8	501762.022	101469.760
SS9	502294.755	102769.628
SS10	503765.098	102663.081
SS11	505110.126	103218.267
SS12	500227.751	102492.607
SS13	497628.015	104261.280
SS14	502145.590	107628.152
SS15	501953.806	104367.827
SS16	505832.101	104197.352
SS17	504766.635	99828.943
SS18	509305.519	99722.396
Vegetation Sample		
Samples	XFIELD	YFIELD
Veg1	501514.296	104712.165
Veg2	509753.015	105156.271
Air Quality		
Samples	XFIELD	YFIELD
AQ1	497287.066	102833.556
AQ2	504361.758	100596.078
AQ3	501932.496	104410.445
AQ4	506386.143	106243.046
AQ5	507302.444	103515.454
Borehole		
Samples	XFIELD	YFIELD

BH1	501971.980	103161.838
BH2	505816.384	103055.419
BH3	504093.718	101099.961
Profile Pit		
Samples	XFIELD	YFIELD
PP1	502294.755	103771.166
PP2	507046.732	103600.691
Rain Water Samples		
Samples	XFIELD	YFIELD
RWS1	501485.001	103131.886
RWS2	505661.627	103110.577

SS = Soil Samples; **BH** = Boreholes; **VEG** = Vegetation Transects; **AQ** = Air Quality; **RWS =** Rain Water Sample; **WS/SD** = Water Samples/Sediment; **PP** = Soil Profile Pits

Geographical coordinates for the various biophysical parameters are provided in Table 6 and mapped in Fig. 8. Table 4 shows summary of sampling requirements for biophysical environmental parameters.

Table 7: Sampling Requirements for Biophysical Parameters

S/No	Parameter	No. of Samples
1.	Soil (surface, deep)	18
2.	Soil Profile Pits	2
3.	Air Quality (out door)	5
4.	Vegetation transects	2
5.	Surface Rain Water	2
6.	Groundwater	3
7.	Noise level measurements	5

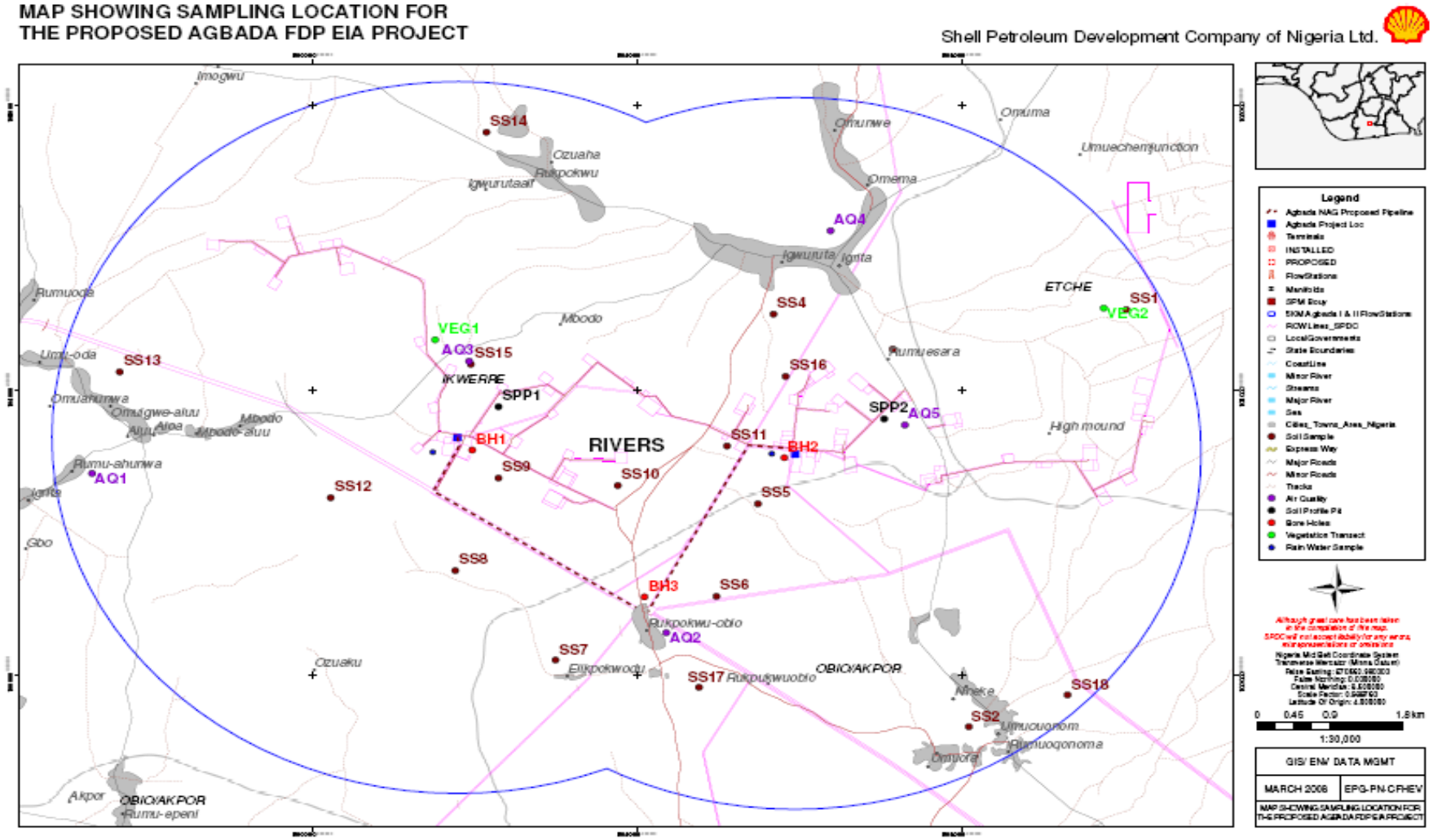


Fig 8: Proposed Sampling Locations for Various Biophysical Environmental Parameters

Social

The fieldwork will involve gathering of socio-economic and socio-cultural data using interview schedules, questionnaire administration, Focus Group Discussion (FGD) and key informants. The relevant communities identified in the project area which shall be covered in the social impact assessment, have been listed in Table 8. Photographic and video documentation of pertinent socio-economic attributes shall also be obtained.

Table 8: List of Study Communities in the Agbada FDP Study Area

S/N	COMMUNITIES	LGA	STATE
1	Omuoda-Aluu	Ikwerre	Rivers
2	Elikpokwodu-Rukpokwu	Obio/Akpor	Rivers
3	Agboga-Igwuruta	Ikwerre	Rivers
4	Omuohia-Igwuruta	Ikwerre	Rivers
5	Omoluta-Igwurutali	Ikwerre	Rivers
6	Mbodo-Aluu	Ikwerre	Rivers
7	Omummah-Igwuruta	Ikwerre	Rivers
8	Omuigwe-Aluu	Ikwerre	Rivers
9	Omunwei-Igwuruta	Ikwerre	Rivers
10	Eledo-Rukpokwu	Obio/Akpor	Rivers
11	Rukpokwu	Obio/Akpor	Rivers
12	Rumuesara-Eneka	Obio/Akpor	Rivers
13	Umuokwa-Etche	Etche	Rivers
14	Rumuoji-Eneka	Obio/Akpor	Rivers
15	Rumuowha-Eneka	Obio/Akpor	Rivers
16	Omuike-Aluu	Ikwerre	Rivers
17	Omunike-Omunobo	Ikwerre	Rivers
18	Omuchi	Ikwerre	Rivers
19	Omueke-Igwuruta	Ikwerre	Rivers
20	Umuokoji-Igwuruta	Ikwerre	Rivers
21	Rumujima-Rukpokwu	Obio/Akpor	Rivers

Social data and information to be collected from the identified communities are detailed in Table 9.

Table 9: Socio-Economic Data Parameters

S/N	Social Features	Variables
1	Demography	Population size and distribution (age, gender, ethnic groupings, population density, dependency and sex ratio), marital status, educational attainment, primary and secondary school drop out rates, history and trend of migration, net enrolment ratios for primary and secondary schools, etc.
2	Livelihood	Income distribution and consumption patterns, employment status, occupation, occupational mobility and adjustment, poverty profile, land use and tenure system, and other economic activities.
3	Social Infrastructure	Major means of transport; educational institutions, water supply, electricity, communication, recreational facilities, waste management facilities, housing (type, pattern and quality), etc.

Table 9: Socio-Economic Data Parametres contd.

S/N	Social Features	Variables
4	Cultural Properties	Value system, social norms, location and spatial distribution of historical sites, archaeological artefacts, shrines, sacred forests/scenic areas; religion, plants/animal species of cultural value, festivals, marriage practices, cultural calendar, etc.
5	Natural Resources and Land Use	Values and use of natural resources including rights over private, rental, common ownership and access to resources – especially with respect to women; local conservation practices (closed seasons/closed locations), etc.
6	Perception of the project	Perception of associated project risks and impacts on quality of life, rating of relationship with SPDC, pleasure/displeasure with proposed project, expectations, etc.
7	The role of women and children	Rights and privileges, contribution to socio-economic development; activity systems and political organization, women trafficking, child labour, etc.
8	Social Structure and Organisation	Settlement history, ethnic groups, social organization and traditional governance – power and authority structure; history of conflicts and their resolution including the role of women
9	Vehicular Traffic	Vehicular volume count, origin and destination survey

S/N	Social Features	Variables
	Analysis	

Health

The fieldwork will involve *in situ* determination, study of health determinants and conditions in the communities. The fieldwork data gathering approach will be via:

- Oral Interviews
- Physical observation
- Focus group discussion (FGD)
- Administration of questionnaires
- Environmental sample collection (potable water, air quality-indoor/out door, soil with emphasis on bio-chemical contaminants like parasites, heavy metals etc)

The following health data that is detailed in Table 10 shall be acquired:

Table 10: Health Data Parameters

S/N	Health Parameters	Data Requirements
1	Demographic profile of the Communities	Population, age-sex distribution, migration pattern, occupation, religion, marital status, educational attainment, Fertility rate, Crude Birth Rate (CBR), life expectancy.
2	Morbidity/Mortality Patterns	Pattern of morbidity and mortality in the area; computation of crude death rate (CDR); age-specific death rate (infant mortality rate, under 5 mortality rate, maternal mortality rate), etc

Table 10: Health Data Parameters Contds.

S/N	Health Parameters	Data Requirements
3	Healthcare facilities	Inventory of existing healthcare facilities and the types/ quality of services rendered; health programs available and their providers etc. Qualifications, experience and competence of local health professionals; availability of Medical Emergency Response Facilities (MEDEVAC)
5	Maternal and Child Health	Maternal mortality rate; <5 mortality rate; Immunization Status; number, distribution and patronage of traditional birth attendants
6	Knowledge, Attitude	Behaviour/Lifestyle that could influence Health (e.g. Substance abuse, reproductive health

S/N	Health Parameters	Data Requirements
	Practices and behaviour,	behaviour; health care seeking behaviour (traditional medicine utilisation, spiritual healing, etc) Key household practices e.g. personal hygiene, intake of proteinous food like egg, meat, etc by children.
7	Environmental health factors	Water supply, sanitation, housing, waste management practices (disposal of human and domestic wastes), noise levels, air quality (indoor and outdoor) and levels of radioactivity

Consultation/Stakeholder Engagement

The relevant stakeholders have been engaged during the scoping exercise. Consultation is a continuous process that spans the life cycle of the project. Stakeholder engagement shall be encouraged at various phases of the EIA process (Preparation of Terms of Reference, fieldwork, laboratory analysis, open fora, etc). Prior to field data gathering, project proponent and consultant should undertake a reconnaissance exercise/community entry formalities as part of the consultation process.

Evaluation and Prediction of Potential Impacts

From all facets of data gathering and analysis, the EIA shall identify the associated and potential impacts of the proposed project, specifically covering the following:

- Identification and prediction of potential environmental, social and health impacts associated with the various phases of the project:
  - Pre-consruction,
  - Drilling/Workover,
  - Construction,
  - Commissioning and operations,
  - Decommissioning and abandonment,

The assessment should distinguish between significant positive and negative impacts, direct/indirect, immediate, short and long term impacts, which are unavoidable and irreversible. As much as possible, impacts shall be described quantitatively in terms of environmental costs and benefits explaining any uncertainties and deficiencies associated with impact predictions

Targeting on the valued ecosystem resources of the considered area of influence

- Quantification, evaluation and prediction of the significance of the identified impacts using appropriate models and indicators [air dispersion models, Human Development Index (HDI), Human Poverty Index (HPI), Gender Empowerment Measure (GEM) etc.)]

- Comprehensive risk analysis covering all aspects of project activity on environmental components – biophysical, socio-economic and health status of project area.
- Evaluation and prediction of the cumulative impacts of project activities on the environment

Determination of Appropriate Mitigation Measures

The proposed mitigation measures shall be SMART (Specific, Measurable, Achievable, Realistic and Time-based). Mitigation measures proposed should include:

- Recommendations on feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels.
- Suggestion of strategies to enhance beneficial impacts of the project.
- Determination of the residual impacts.
- Evaluation of the effectiveness of any mitigation measures identified.
- Provision of a comprehensive and detailed plan covering mitigation of impacts.

The mitigation plan should include the following:

a) Strategies to manage all environmental, social and health issues to ALARP (as low as reasonably practicable).

b) Strategies to establish communication and trust of the stakeholders.

c) Action Plan for implementing appropriate mitigation strategies in a tabular format to address:

- Impacts
- Prevention
- Reduction
- Enhancement

Environmental Management Plan (EMP)

The EMP shall be prepared and reported as a stand-alone chapter as outlined in the FMEH & UD`s EIA Procedural Guidelines and DPR`s EGASPIN (revised edition 2002) under the following sub-headings to cover all the stages of the life-cycle of the project:

- Project activities and their Impacts
- Proposed mitigation measures
- Rating before and after mitigation
- Scope of monitoring
- Parameters to be monitored and frequency of monitoring
- Methodology
- Monitoring schedule
- Responsible and action parties

The EMP shall therefore:-

- Identify and discuss the management and/or implementation of commitments to stakeholders, as identified during the Stakeholders Scoping Workshop exercise and other consultation procedures identified in the report.
- Discuss how to implement the mitigation measures, as identified in the report.
- Design and implement appropriate post-EIA monitoring process according to the identified schedule for implementation.
- Confirm the availability of budget for implementation measures and monitoring.
- Put in place a system for obtaining all necessary regulatory approvals for all the aspects of the project from the start to de-commissioning.
- Propose appropriate waste management plans to include management and disposal of wastes throughout the lifecycle.

Report Preparation
The EIA report of the proposed project shall be in the format laid down by the Department of Petroleum Resources and Federal Ministry of Environment, Housing and Urban Development as outlined below:

- Title Page
- Table of Contents
- List of Tables
- List of Figures
- List of Maps
- List of Plates
- List of Acronyms and Abbreviations
- List of Preparers
- Acknowledgement
- Executive Summary

Chapter One – Introduction: - Background information, Administrative and Legal framework, Terms of reference, Declaration

Chapter Two – Project Justification: - Project background, project objectives, need for the project, value of the project, envisaged sustainability, alternatives considered (including no project alternative), development options considered, site selection.

Chapter Three - Project Description: - Type of project, scope, location, material input/output and by-products, waste generation, technical layout and process, operation and maintenance, schedule.

Chapter Four – Description of the biophysical, socio-economic and health environment - Study approach, literature review, baseline data acquisition method and quality assurance/ quality control, geographical location, field data, climatic conditions, air quality, noise level, vegetation cover characteristics, land use and landscape pattern, ecologically

sensitive areas, terrestrial fauna and wildlife, soil studies, aquatic studies including hydrobiology and fisheries, ground water resources, social, economic and health studies, prediction of changes in the baseline condition without the development in place.

Chapter Five – Consultation, - Identification of stakeholders, consultation with regulators, consultation with communities, community concerns and observations, and Participatory Rural Appraisal (PRA).

Chapter Six, - Associated and Potential Environmental Impacts, - Scoping, impact prediction methodology, impacts of project activities (site clearing, dredging, construction, transportation, excavation, sand filling, etc), impacts on resource utilisation, process impacts (operation), short term/long term impacts, reversible/irreversible impacts, cumulative impacts, direct/indirect impacts, adverse/beneficial impacts, risk assessment (HAZOP, HAZID, QRA), social impacts, health impacts, etc.

Chapter Seven, - Mitigation Measures and Alternatives, - Control technology, compensation, alternative site, alternative route or location, compliance with health and safety hazards requirements.

Chapter Eight, - Environmental Management and Community Development Plans, - Guidelines for specific project activities, emergency response procedures, mitigation plan, costing of alternatives and budget requirements, monitoring program (scope, parameters, frequency, location, methodology), auditing and inspection procedures, waste handling procedures, training program, roles and responsibilities.

Chapter Nine, - Conclusions and Recommendations
References
Appendices

4.0 CONSULTING TEAM

A competent consulting team accredited by DPR, FMEH&UD and Rivers State Authorities shall be engaged by SPDC to prepare the EIA report.

4.1 Deliverables

1. Program for field studies
2. EIA specific program for stakeholder consultation.
3. Defined SIA/HIA programme that meets EIA requirements
4. Environmental Management Plan (EMP) that is/or can be integrated within HSE Cases and ISO 14001
5. Field Reports
6. EIA Draft Report.
7. EIA Final Report.

Appendix 2
List of Participants

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Chf. Ogbonda. J.	Omagwe Aluu	Ikwerre	[signature]
2	Mr. Samuel Nwachukwu	Omuigwe Aluu	Ikwerre LGA.	[signature]
3	Chief Blessing Nnotuka	Umuakuru	Etche	[signature]
4	Mr. [illegible]	Umuakuru	Etche	[signature]
5	CHIEF FRANCIS OPURUM	RUMUCHIOLU - EGBEKA	OBIO/AKPOR	[signature]
6	HON. EMEKA MBATA	RUMUCHIOLU - EGBEKA	OBIO/AKPOR	[signature]
7	Chief O.N. ICHEMUDO	RUMUAGHOLU	OBIO/AKPOR	[signature]
8	Chief K.N.W. [illegible]	RUMUAGHOLU	OBIO/AKPOR	[signature]
9	Mr Bathram Ogbondah	Omumah Igwuruta	KELGA	[signature]
10	Gladson Ikengah	Omumah Igwuruta	KELGA	[signature]
11	Comr. [illegible]	Omumah Igwuruta	KELGA	[signature]
12	Edwin Nwagu	Omumah Igwuruta	KELGA	[signature]
13	Emmanuel E. Ejekwu	Elioparanwo (Rumuokoro)	Obio/Akpor	[signature]
14	Engr. Mbata Shadrach	Elioparanwo (Rumuokoro)	~	[signature]
15	Mr Napoleon [illegible]	Rumuigbo Rukpokwu	OBALGA	[signature]
16	Sir Ovy Ezeoru			[signature]
17	MR WILLIAMS SAMUEL	UMUOKWA	ETCHE LOCAL GOVT.	[signature]
18	Awale Julius	UMUOKWA	ETCHE	[signature]
19	Nwe, Innocent I.	Igwuruta - Ali (Omademe)	KELGA	[signature]
20	NNODI CHARLES	IGWURUTA ALI OMUOLOF	Kelga	[signature]
21	HON SHEDRACK ONU	EGWI	ETCHE	[signature]
22	Francis CHOKO	EGWI	ETCHE	[signature]

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Chief James Amadi	OMAGWA	IKWERRE	
2	" " Samuel Ovalolepu	" "	" "	
3	Thankgod Amadi	AGBOGA	" "	
4	Kenneth Onwucheku	" "	" "	
5	Chief Emma N Frank	Rumuofu Rukpokwu	OBIO/AKPOR	
6	Mr. Asonye Sabinus	Rumuapu, Rukpokwu	Obio/Akpor	
7	Emmanuel Nwafor	Umuakonu - Etche	ETCHE	
8	Hycinth Nwoson	" "	" "	
9	HRH Ap Gabriel Chuku	RUMUOWHA ESHIRA	Obio/AKPOR	
10	MR. Emmanuel Oroku	" "	" "	
11	Samuel A Nwafor	Chokota Etche	Etche LGA	
12	Morrison Amadi	" "	" "	
13	Kevin Amanye I	RUMUOSI	OBIO/AKPOR LGA	
14	Wagbara David	Rumuosi	"	
15	ICHELLA BEN	RUMUOKPARALI	OBIO/AKPOR LGA	
16	Comrade Godwin Wonda	Mgbagidi	Ikwerre	
17	Johnson Wehale	✓	—	
18	Chief J. A. Amadi	Elele Rukpokwu	Obio Akpor	
19	" Charles O. A. Nyemadi	" "	"	
20	BARR. O'AMAI JOHN NGUBO	OKOMOKO ETCHE	ETCHE LGA	
21	AZUBUIKE GODWIN	OKONALAKU/ETCHE	ETCHE LGA	
22	Elder Abulems Okeh	Rumuesara Eneka	OBALGA	
23	Nyong Robinson A Chuks	✓	—	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Hon Olumdah Igwe	Nkpogwu Rebisi	PHLGA	
2	Deele Chizie. G.	Nkpogwu Rebisi	PHLGA	
3	JUSTICE N. EREH	OMUODA – ALUU	(IKLGA)	
4	Okemadu A. S.	Omuoda – Aluu	KELGA	
5	Chief. F. C. Nwoechi	Umuanyagu	ELGA	
6	Mr Titus Nwoke	Umuanyagu	Etche	
7	CHIEF MATHIAS ANIEB AMADI	Rumuahlogu	OBIO/AKPOR	
8	Azubuike Nwanu	✓	✓	
9	C. A. J. Chinwo	Rumuekham, Oroigwe	"	
10	Peace Owhonda	✓	✓	
11.	EZE (DR.) J. A. UTCHAY (J.P)	ELIMGBU, OROIGWE	OBIO/AKPOR	
12.	UTCHAY SILVERLINE	= =	=	
13.	SUNNY WORLU, ESQ.	RUMUODOMAYA	✓	
14	MR. FRIDAY E. EKWE	✓ ✓	✓	
15	HON L. C. IGWE	CHOBA COMMUNITY	OBIO/AKPOR	
16	DR. H. N. OZURU	CHOBA COMMUNITY	✓	
17	MR. DANIEL I. OGBONDA	ALAKAHIA	OBIO/AKPOR	
18	MR. VINCENT CHUKWU	✓	✓	
19	Mr Joseph Onwumah	OKORAGU	ETCHE	
20	Suleiman Nwaogazi	✓	✓	
21	HON BRAVE WORDU	Eliohia	PHALGA	
22	GIDEY OLUM	✓	✓	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Benjamin C. Wobidi	Rumuodukwu Eneka	Obio/Akpor	
2	Chidi Owhonda	R ✓	✓	
3	Thankgod Chuku	Omuchiohu-Ahu	Ikwerre	
4	Chigozie Wosu	Omuchiohu Aluu	Ikwerre	
5	Humphery Nwoku	Omuokoji	Ikwerre	
6	Chinedu Kingsley	Omuokoji	Ikwerre	
7	Innocent A. Ogbonna	Rumuokurushi-Eneka	Obio/Akpor	
8	Goodluck Orlum	✓	✓	
9	Kelvin Agbam	Umuechem	ETCHE	
10	Echegeru Jonathan	Umuechem	Etche	
11	Nwokeji John N.	Omuoke-Igwuruta	IKWERRE	
12	Ierry Joe Olucha	Omuoke Igwuruta	✓	
13	Chief E.A. Gabriel	Aguruwoji Omagwa	Ikwerre	
14	Henry Ikpo	Aguruwoji Omagwa	✓	
15	CHF. John Oluo	Umuogodo Igbo-Etche	ETCHE LGA.	
16	Mr. Emmanuel Nwaogbu	Umuogodo Igbo-Etche	Etche LGA	
17	Agoronu Woke	Mgbuchi Rukpokwu	Obio Akpor	
18	Hanotu Justice	Mgbuchi Rukpokwu	Obio/Akpor	
19	Emmanuel Anyanwu	Umuakuru	ETCHE	
20	August Agbaybum	✓	✓	
21	Festus E. Okere	Umunwaelile	✓	
22	John Onyegosom	✓	✓	

S/N	Name	Community	LGA	Signature
1	ICHELLA, A. BONIFACE	OZUORA – AKPOR	OBIO/AKPOR	
2	Pastor Amadi C.D.	✓	✓	
3	Samuel Kinikanwo	Orueliza Ogwuta	Ikwerre	
4	Christian Amadi	✓	✓	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Bawo E.J. OSIMIRI	RUMUODOGO	EMOHUA	
2	Orfa OBINSOH	✓	✓	
3	[illegible]	[illegible]	[illegible]	
4	Hon Prince [illegible]	[illegible]	[illegible]	
5	TEMPLE WUICHE K.	RUMUBEKWE	OKIO/AKPOR	
6	PROMISE ADELE	RUMUBEKWE	OKIO/AKPOR	
7.	Eze Elijah Okoe	Umuchoke	Etche	
8.	Chidiebere Dickson	✓	✓	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Hon. Chief G.N.J. Agbaraka	ATALI	OBIO/AKPOR	[signature]
2	CHIEF GODPOWER A. AZONWU	ATALI	OBIO/AKPOR	[signature]
3	SUNNY NNADI	ENEKA	OBIO/AKPOR	[signature]
4	GODPOWER OKERE	ENEKA	✓	[signature]
5	HRH Eze A.O. Owhonda	RUMUOKORO	✓	[signature]
6	Chief E. A. Chinda	✓	✓	[signature]
7	Richie O. Worlu	Rukpokwu Comm.	✓	[signature]
8	Hon. Joseph Chidi Outhor	Rukpokwu	Obio/Akpor	[signature]
9	KENNETH OKAM	Rumuoji ENEKA	Obio/Akpor	[signature]
10	Felix Amadi	Rumuekini	Obio/Akpor	[signature]
11	Akandu Clement S.	Rumuekini	✓ ✓	[signature]
12	BETHEL AMADI	OMUIKE Aluu	IKWERRE	[signature]
13	EMMANUEL E. EMENIKE	OMUIKE ALUU	IKWERRE	[signature]
14	JUMBO LONDON	NKPOLU RUMUIGBO	OBIO/AKPOR	[signature]
15	Sunday Akah	Nkpolu Rumuigbo	Obalga	[signature]
19	Chf. Ken. Wabunike	Mbodo – Aluu	Ielga	[signature]
20	Emmanuel Peleus	Mbodo – Aluu	Ikwerre	[signature]
21	E.S. Emenegasi	Omuoke Omuanwoko	Kelga	[signature]
23	Chief C. Emesengwa	✓ ✓	✓	[signature]
24	Nwogu Innocent .M.	Chokocho Community	ELGA	[signature]
25	Chief Nwala Charles .C.	Ch ✓ ✓	✓	[signature]
26				

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Ochuba Auguste	Fed Min of Envt, H&UD, PH	–	
2	EZEOBIA RAPH JOE	VSGP		
3	ESITO SUNNY	CHIEF REIS IDSL/HGNL		
4	TOKY, EMMANUEL	SPDC CAE CCRLE		
5	END-OBONG EKONG	SPDC - CSDS		
6	Nwachukwu, Eunice	SPDC - CFHEV		
7	Obuoforibo George	SPDC SCJ		
8	Miebaka Moses	SPDC CFHEV		
9	Inengite Azibaola K.	SPDC CFHEV		
10	DAVIDS, CALEB	SPDC - CSDS		
11	Anyanwu Victor	SPDC - CFHEV		
12	I.C. Okoro	SPDC		
13	T-T. OMIND	State MOH		
14	Onomuo-Samuel P.J	SPDC, CCRLE		
15	Esabilche Uzezi	SPDC, CCRLE		
16	Bayo Shedrack.	SPDC VSGP		
17	Bernard Osuji	SPDC - VSGP		
18	Ibidoja Karol	SPDC, CFHEV		
19	OLADELE, T-G	RSMENV		
20	MAJOFODUN C.E.(MRS)	DPR - LAGOS		
21	UFONDU, E.D.(MRS)	DPR - PHC		
22	Reuben Jonah	SPDC - VSGP		
23	Isah Sulemana	SPDC - VSGP		

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Prof. Austin Ubuoh	STDL	–	

Appendix 3: Summary of Stakeholders' Input into EIA
Issues and Impacts Identification Table

Project Phase	What aspects of the Project Phase would cause the Impact	Impact	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
Pre-Construction	Land Acquisition	Conflict among landowners Inadequate compensation for acquired land through the continued application of the OPTS rates Loss of regular income due to change in land ownership Loss of income/frustration due to delayed payment of land compensation	Communities	• The community people (families, individuals etc). • Local occupations such as farming, fishing, lumbering, etc	• Adequate and transparent consultation • Improvement on OPTS standard payments should be as at when due. • Timely payment of land compensation
	Site Preparation (Surveying, staking of flowline route, vegetation clearing)	1) Scaring away of wildlife/game animals 2) Air pollution 3) Aquatic life destroyed Contamination of our Rivers and Streams	Community, Environmental NGOs & Activists, Regulators, Universities / Research Institutions	Soil, Flora and Fauna, Air Quality, Surface water	• Communities should be empowered to undertake Animal husbandry livestock farming • Fish pond should be created after the activities • Safety of workers and community to be ensured through use of appropriate PPE. Provision of Bore Holes
Project Phase	**What aspects of the Project**	**IMPACT**	**Which stakeholders are likely to be affected?**	**What are the sensitive or vulnerable**	**What potential measures would you propose to enhance beneficial and reduce /**

Project Phase	What aspects of the Project Phase would cause the Impact	Impact	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
	Phase would cause the Impact			**environmental Components that could be impacted?**	**eliminate adverse impacts?**
	Mobilization (Movement of equipment & personnel to site)	1) Roads may be damaged 2) Increase Accident rates. 3) Increase in population 4) Increase in social vices	Community Company and other road users	Social Amenities / infrastructure Demography Air quality and noise levels increase Community Health	Effect repairs to damaged roads Create awareness Adequate road signs Proper Journey management Use local labour Awareness/Enlightenment campaigns on social and health issues
Construction	ROW Clearing	Loss of Vegetation	Community	Flora and Fauna, Air quality, surface water and aquatic life	Limit clearing to ROW only
	Trench Excavation	- Effect on wildlife from noise and vibration of machinery - Impacts on Air Quality - Enhanced Employment opportunities	Communities Workers, Environmental Activists/NGOs	- Farm land - Vegetation (Economic Trees) - Social life - Community Health Water bodies	Timely Back filling and use of properly serviced machinery to reduce noise /vibration Timing of activity; use of water sprinklers to reduce dust - Put all safety measures in

Project Phase	What aspects of the Project Phase would cause the Impact	Impact	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
					place - Adequate compensation - Use skill personnel specially in the use of technical equipment

Project Phase	What aspects of the Project Phase would cause the Impact	IMPACT	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
Construction (contd.)	Pipe welding, Joint coating, inspection and testing of welds	Radiographic testing of welds operation affects work force	Communities, Workforce	Humans	Adequate compensation Provision of Medical care
	Lowering and backfilling	Air pollution Noise	Communities and Work force	Humans	Use of PPE -Operational Timeliness -Public Enlightenment
	Camp site construction	Loss of Vegetation -Waste generation -Spread of STDs	Communities Work force	Flora and Fauna Environmental health	Routine Medical check of workers Proper waste management

Project Phase	What aspects of the Project Phase would cause the Impact	IMPACT	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
Drilling	• Well locations/Contractors camp site • Drilling of new wells • Laying of new flowlines	• Employment opportunities • Provision of infrastructure/ sustainable development • Creation of subcontractors • Pollution of soil and water • Ozone layer depletion • Increase in prostitution	Communities Workers	Soil - Humans - Water	• Conduct EIA • Proper evacuation of waste materials • Compensation to affected communities

Project Phase	What aspects of the Project Phase would cause the Impact	IMPACT	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
Operation	Operational / maintenance venting and occasional flaring Operational job opportunities	Health Hazards Employment	Communities Work force Communities	Air Humans	Reduce Venting and Flaring to ALARP Employ /Train Communities members as much as possible

Project Phase	What aspects of the Project Phase would cause the Impact	IMPACT	Which stakeholders are likely to be affected?	What are the sensitive or vulnerable environmental Components that could be impacted?	What potential measures would you propose to enhance beneficial and reduce / eliminate adverse impacts?
Decommissioning and Abandonment	Abandonment of NAG plant and associated facilities, Wells, flowlines etc	Health hazards Unemployment Land wastage Waste of resources Waste Generation	Communities	Air , Soil , water, Social life	- Stakeholders should be engaged before decommissioning to agree on plan. - Use of best available technology for decommissioning

APPENDIX 3
METHODOLOGIES FOR BASELINE DATA ACQUISITION

The details of the methodologies adopted for environmental baseline data acquisition for each of the environmental components and the Impact indicators are described below.

Topography

The topography represents the features of the study area such as the position of rivers, roads as well as the general landscape. The location maps were studied by team members and based on the maps; sampling stations were established across the study area. Sample stations and coordinates are presented in table A.

Table A: Sampling Stations and Coordinates

Soil Sample (Auger Boring)

Station	Coord. (North) m	Coord. (East) m	Location
SS1	103585.359	513401.165	
SS2	99052.319	508609.471	
SS3	98236.942	499600.956	
SS4	105885.169	505506.547	
SS5	101580.451	504507.819	
SS6	101066.188	505058.198	
SS7	100577.709	503704.443	
SS8	101688.754	502804.162	
SS9	103687.038	502167.84	
SS10	104078.828	502794.204	
SS11	103521.188	504854.197	
SS12	103128.392	497988.478	
SS13	103577.409	497780.011	Mbodo-Aluu
SS14	107913.339	501207.058	
SS15	104198.093	501691.439	
SS16	103893.444	505979.631	
SS17	98202.931	507902.003	
SS18	99626.754	508619.971	
Vegetation Transect Co-ordinates			
Station	**Coord. (North) m**	**Coord. (East) m**	**Location**
VEG6	103433.36	501600.328	
VEG10	103779.596	507439.803	
Rain Water Samples			
Station	**Coord. (North) m**	**Coord. (East) m**	**Location**
RWS1	103362.292	501778.872	Agbada-1 F/stn

Station	**Coord. (North) m**	**Coord. (East) m**	**Location**
RWS2	103358.116	506020.117	Agbada-2 F/stn
Profile Pit Coordinates			
Station	**Coord. (North) m**	**Coord. (East) m**	**Location**
PF1	102708.379	501589.42	Agbada-1 F/stn
PF2	99748.27	507840.689	Rumuchiolu-Eneka
Boreholes Coordinates			
Station	**Coord. (North) m**	**Coord. (East) m**	**Location**
BH1	103340.908	501726.443	Agbada-1 F/stn
BH2	100945.468	504096.589	Nkpoku manifold
BH3	103076.422	505798.164	Agbada-2 F/stn
Air Quality Coordinates			
Station	**Coord. (North) m**	**Coord. (East) m**	**Location**
AQ1	103433.36	501600.328	
AQ2	106100.994	506523.758	Igwuruta
AQ3	103779.596	507439.803	
AQ4	102860.264	497044.994	Umu-ahunwa Aluu
AQ5	112650.203	494880.88	Rumu-ogwu
Economic/Social/Health Quality & Infrastructures' Coordinates			
Station	**Coord. (North) m**	**Coord. (East) m**	**Location/Description**
Rukpokwu	100395.135	504292.549	Rukpokwu Portable Water
	100450.341	504332.729	Rukpokwu Mosque
	100453.302	504382.035	Rukpokwu Shrine
	100219.843	504375.348	Rukpokwu Church
	100140.2	504273.488	Rukpokwu School
Omuigwe	104316.558	496999.132	Omuigwe Indoor Air Quality
	103411.299	497872.056	Omuigwe Church & School
	104095.024	497143.424	Omuigwe Town Hall
Mbodo	103512.579	499228.016	Mbodo-Aluu Hall

Climate/Meteorology

Meteorological information namely wind speed, wind direction, humidity and temperature were acquired during the fieldwork from predetermined locations within the proposed project area. The measurements of the various meteorological parameters were carried out using portable *in situ* equipment. The information obtained was supported with data from the Port Harcourt Zone of the Nigeria Meteorological Agency.

The entire study area was traversed using a vehicle and in most cases by foot. The distribution and pattern of the physical features defining the terrain in the project area was the basis of landscape description and assessment. Physiographic or land system approach was used to identify the units forming the terrain.

Air Quality

A total of five air quality-sampling stations were established in the study area. The sampling stations were established based on upwind and downwind directions. The measurements of the various air quality parameters were carried out using *in situ* equipment (Digital Gas monitors).

Plate A: Air quality measurement during the field exercise

TABLE B: ENVIRONMENTAL COMPONENTS AND IMPACTS INDICATORS

S/NO	ENVIRONMENTAL COMPONENTS	ENVIRONMENTAL IMPACT INDICATORS
1.	Relief / Topography & Hydrology	Drainage / Discharge, Hydrologic balance, soilation, erosion, topography.
2.	Air Quality, Climate and Meteorology	SPM, NOx, SOx, CO_2, CO, NH_3VOC, etc., Wind speed & direction, Relative humidity, Rainfall, cloud, etc
3.	**Geology / Hydrogeology**	Borehole drilling for Stratigraphical / Lithologic characteristics, ground water level, direction and quality (Physicochemical and microbiological characteristics).
4.	**Soil, Agriculture & Land Use**	Soil type and structure, physico-chemical and microbiological characteristic land use types; recreational, industrial, agricultural, residential, institutional and commercial. Species checklist, characterization of plant pollution, taxonomy, diversity and productivity load, locations and characteristics.
5.	Vegetation / Forestry	Identification of types and economic importance of trees in the study area.
6.	Wildlife	Identification of wildlife types, parks, estimate population, behavioral pattern and habitat requirement; endangered species and ecological interactions.
7.	Noise / Vibration / Radiation	Ambient noise level, exposure limits of impulsive and persistent noise generated in the environment, the proximity of noise sources to human and ecological habitants; day and night disturbance, hearing loss communication interference.

S/NO	ENVIRONMENTAL COMPONENTS	ENVIRONMENTAL IMPACT INDICATORS
8.	Health Risk Assessment	Health risks, public health and medical services, water supply and demand, analysis of medical records.
9.	Community / Socio-Economic Impact Assessment	Needs and concern of host communities, Data on settlement, man-made features, socio-economic / historical rites, population, income, recreational facilities, social organizations and institutions, occupation and employment structure, culture, heritage, etc.
0.	Waste Management	Waste streams, handling, treatment and disposal, etc.

Noise and Vibration

Noise levels were measured at the same locations where air quality parameters were taken using a sound indicator model Cs 15C decibel noise meter. Readings were taken after allowing the meter to stabilize at each point. The range of the noise level was noted and the true mean computed.

Plate B: Noise Measurement during the study

Hydrogeology

Ground water quality was studied by sampling water boreholes drilled in the study area. Water samples were collected from the boreholes. *In-situ* measurements were also taken for temperature, conductivity, pH, Total dissolved solids (TDS), turbidity, salinity and dissolved oxygen (DO) of the groundwater.

Plate C: One of the boreholes being drilled

Land Use

Land use study was conducted by undertaking a walk-through of the entire study area. Observations were made of land cover/land use systems, crops and built up areas.

Vegetation/Forestry

Vegetation sampling was undertaken in designated sampling loations (VEG 1 and VEG 2). At both sampling location, plants were identified from 20m x 20m quadrats. Unidentified plants were collected for mounting and identification later in the University of Calabar herbarium. For each station information on habitat, vegetation structure and species was recorded. Habitat data include vegetation description, latitude, longitude and signs of wildlife. Vegetation structure (biomass stratification) is described in terms of heights of plants, which have grouped into ground layer (less than 2 m), shrub layer (2-5 m) and tree layer (more than 5m). A pair of binoculars (Model: Helios Fieldmaster 8 x 40) was employed to aid field identification of tall trees. Dendrometric parameters recorded included height (m) and diameter (cm) of trees. Abundance of herbaceous genera is expressed semi-quantitatively (dominant, frequent, occasional, rare) (Pryor, 1981). On this basis a species having a wide distribution with many stands would be classified as a common, abundant, widespread species. Alternatively, a species may have a similarly wide distribution but with very few stands and would be classified as an infrequent, restricted or occasional species. Species of limited geographic distribution and with a few stands are classified as rare. Some species are considered rare where little is known about their distribution. Features of ecological interest will be recorded with a digital camera (Sony DCR- TRV 340).

Vegetation was also observed for any health defects. Samples of diseased plants were taken in polythene bags to the laboratory for analysis. Samples of diseased plants were examined microscopically and cultured on Agar plates using the surface spreading plate technique. Fungal and bacterial pathogens were identified microscopically using such features as cultural morphology and pigmentation.

Foliar samples from representative plant species were used for tissue analysis. Samples were cut up and dried, for 48 hours, to constant weight in an oven at 70 ^{o}C. The dried tissue sample was ground into a fine powder and 0.5 g digested by boiling in 10 ml of a 1:2 mixture of nitric and hydrochloric acids in a fume hood. The resulting solution was diluted to 50 ml with distilled water, filtered and the chemical composition analyzed by atomic absorption spectrophotometry.

Plate D: Vegetation sample being collected for further studies

Table C: Infection indices for different levels of disease severity

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

At each sampling location evidence of wildlife presence was also studied. This was in the form of direct evidence (sighting or sale of bounties) or indirect evidence (e.g. Burrows, faecal droppings, sloughed skin or the calls of various animals).

Wildlife/Biodiversity

The wildlife study cuts across the entire field. Methodology of sample collection includes:

* Visual observation and documentation of their droppings
* Oral discussions with natives of the study area
* Tree beating, purpose mark, feathers, shells etc.
* **Observation of bush meat in the local markets.**

Information on available species and relative abundance was obtained through oral interview and discussion with artisanal hunters and indigenes. The key parameters of study are the:

- Species composition/abundance
- Reproduction method
- Feeding method
- Wildlife habitat

Soil Studies

Thirty-six soil samples were collected from the study area. Samples were collected at 0 – 15 and 15 – 30cm depths for Laboratory analysis. The result of analysis provides the basis for determining the fertility status of the soil and possible fertilizer recommendation for the crops grown. Core soil samples were also taken for studies on water transmission through the profile and bulk density (Bd). The soil samples were packed in polyethylene bags and properly labeled. The samples would be processed, sieved through a 2mm mesh before physicochemical analysis in the laboratory.

Plate E: Soil Sampling using an Auger

Plate F: A soil profile pit dug during the field exercise

Socio Economic Assessment

In the communities, the study groups included the paramount rulers and members of the council of chiefs, youth groups, women groups, community - based organizations, economic subgroups (e.g. hunters, Trader, farmers etc), the community development committees etc.

The socioeconomic survey adopted a combination of several data collection tools to gather information on the social and economic characteristics of the people. These include:

a. Questionnaire interview
b. Focus group discussions (FGD)
c. Key informants interview
d. Participant observation and estimation

There was a high degree of homogeneity both within and between communities sampled. The analysis was therefore taken together as one and where differences were noticed, this was pointed out to distinguish the communities. The survey covered communities in four (Ikwerre, Etche, and Obio Akpor) Local Government Areas of Rivers State.

Plate G: Traditional sharing of kola-nuts at Omuahunwo Aluu community

Plate H: Focus group discussion with women group in the study area

Consultations

The consultation exercise involved an explanation of the proposed field development project and the mission of the consultants as well as introduction of the team members to the village chiefs and council members. The consultation process was very similar in the communities visited.

Health Survey

The communities of the study area regarding the proposed project were surveyed for baseline health situation and availability of health services.

The following techniques were adopted for the study:

- Focus group discussions and community consultations
- Community health surveys through interviews and administration of questionnaires,
- On the spot observation and visual appraisal,
- Use of relevant health center statistics, and
- Experience and professional judgment of the consultant.

Questionnaires were distributed to literate members of the host communities. Those who were not literate were interviewed.

Water and Sediment Chemistry

Total Dissolved Solid (TDS)

Total Dissolved Solid was measured using Nyron calibrated TDS meter with range of 0-100,000ppm.

Conductivity

Conductivity was measured using Hach conductivity meter in □s/cm.

pH:

The pH was measured with Ele pH meter.

Turbidity

Turbidity measurement was carried out *in situ* with Hach turbidity with sensitivity of 0-1000 NTU

Chloride

Chloride was measured titrimetrically (Argentometric Method) in slightly alkaline solution with silver nitrate ($AgNO_3$) solution in the presence of potassium chromate as indicator (APHA, 1975). Prior to sample analyses the silver nitrate is standardized with sodium chloride.

Oil and Grease

Oil and grease in water was measured, after pre-extracting 100 ml sample with 10.0 ml carbon tetrachloride, using a Horiba Oil Content Analyzer (OCMA-200, range 0-100 ppm).

Total Suspended Solid

100ml of sample was filtered through a pre-weighted filter paper using Buckner flask and suction pump. The filter paper was dried in an oven at about 103^0c – 105^0c for 1 hour and coked in a dessicator. The TSS was then calculated after reweighing.

Dissolved Oxygen

Dissolved Oxygen was measured in-situ using YS1 model 54A oxygen meter.

Biochemical Oxygen Demand

A known volume of the sample was treated with dilution water containing nutrients to one litre mark and the initial DO recorded. Some portion of the diluted sample was incubated for 5 days at 20^0C. The final DO was measured after the incubation. The initial DO minus final DO and divided by the dilution decimal fraction gave the BOD result in mg/l.

Chemical Oxygen Demand

The sample (50ml) and standardized dichromate solution in a 5% by volume sulphuric acid/silver sulphate is refluxed for a 2-hour digestion period. Excess dichromate, after the digestion period, is titrated with a standard ferrous ammonium sulphate solution, using ortho-phenanthroline ferrous complex as indicator.

Total Hydrocarbon Content

The spectrophotometric method was adopted using SPEC-20 genesys for measuring oil and grease. This involved extraction of the oil and grease from 500ml of sample with 50ml of xylene in a separatory flask. The extract was measured at 500nm using 10mm unit path length.

Total Hardness

Total hardness was determined by EDTA Titrimetric method using Eriochrome Black T as indicator. EBT was added to a portion of the sample at a pH of 10.0+0.1 and titrated with EDTA solution to blue coloured end point.

Sulphate

The turbidimetric method was used for measuring the concentration of sulphate in a portion of the sample. The sulphate reacts with Barium ion in the presence of sodium chloride – hydrochloric acid solution containing glycerol and ethyl alcohol. The turbidity so developed was measured at 450nm.

Phosphate

Ascorbic acid reduction method was adopted in determining the phosphate concentration in the sample. Ammonuim molybdate and antimous potassium tartrate react with orthophosphate to form an antimony phosphate-molybdate complex. The complex is reduced with ascorbic acid to form a deep-colored, blue molybdeuum complex. The colour intensity is proportional to the phosphate concentration, which is measured at a wavelength of 880nm using 25mm cell.

Nitrate

Brucine method was used for nitrate concentration determination in the sample. The reaction between nitrate and brucine produces a yellow colour that is used for colorimetric estimation of nitrate. The intensity of colour is proportional to the nitrate concentration and measured at a wavelength of 410nm using 25mm cell.

Heavy Metals

Heavy Metals concentrations were determined using Unican Atomic Absorption Spectrophotometer (AAS). The concentrations of the metals were recorded by aspirating the filtered samples directly with no chemical pretreatment.

Ammonium

Nesslerization method was used for measuring ammonia concentration. 50ml samples or a portion diluted to 50ml with ammonia-free water treated with nessler reagent and allow the reaction to proceed for at least 10min after addition of nessler reagent. The concentration was measured photometrically at a wavelength of 425nm.

Soil Analysis*(Soil mechanical analysis (percentage sand, silt and clay)*

Hydrometer method was used to determine the percentage of sand, silt and clay in the air-dried soil sample. 51.0 of silt sieved sample was treated with 5% sodium hexametaphosphate along with 100ml of distilled water. The mixture was stirred severally and allowed to settle in a glass cylinder and soil hydrometer was immediately placed into the suspension.

Total Organic Carbon (Walkley Black)

1g of sample was weighed each into a 250ml standard volumetric flask. A known volume of standard solution of potassium dichromate was added accurately followed by the addition of a known volume of concentrated sulphuric acid. The sample and reagents were immediately mixed and the content allowed to stand for 30 minutes. The contents after 30 minutes were diluted with 100ml each of distilled water. Three to four drops of Ferroin indicator was added and titrated against a standard solution of ferrous sulphate. A blank titration was carried out in the same manner (but without soil). Results obtained were then calculated for total organic carbon.

Bulk Density – core method (Vomocil)

A core, 10cm long, 8cm internal diameter was used to collect core sample. The core sample was oven-dried at 105^0C to a constant weight. Bulk density was obtained from mass-volume relationship.

Particle Density – Pycnometer method (Blake, 1965)

Air-dried, 2mm sieved soil sample was used for the determination. The sample was boiled with distilled water to remove air in the pycnometer bottle. Boiled and cooled distilled water was added to the content of the bottle after cooling. The bottle and content were weighed. The particle density of the soil was calculated as the

ratio of the total mass of the solid particles to their total volume excluding pore spaces between particles.

Total porosity (Vomocil)
This was calculated from particle and bulk densities.

Alkaline/Alkaline – earth Metals (Na, k, Ca & Mg)
5g of sample was extracted with three times ammonium acetate buffer solution. The entire extract was made up to a known volume and used to analyze for Na and K using a flame photometer (Corning 410) and AAS model 320 was used to measure calcium and magnesium.

Cation exchangeable Capacity (CEC)
This was obtained from the summation of the results obtained from Na, K, Ca, Mg and exchangeable acidity. Results were expressed in Meq/100g.

Moisture Content
The homogenate was mixed with a spoon for at least 20s, especially taking care to scrape the walls and the bottom. About four grams of sediment was added accurately to the petri dish. Drying at 105^0C was carried out until constant weight was obtained. The fraction of dry sediment in the sample was then determined.

Heavy Metals: Dutch Standard Methods Draft NVN 5770 (leaching), draft NEN 6426 (metals, exclusive mercury), NEN 6449 (Mercury)

Sample Extraction: The physical condition of the sample was noted together with the odour detected. Approximately 5g of soil was placed in a Teflon pressure vessel, a mixture of 18ml hydrochloric acid and 6ml nitric acid was added. The vessel was heated for 150 minutes till 180^oC. The sample was cooled for 30 minutes. The extract was filtered over a paper and added up to 100ml with de-ionised water.

***Sample Analysis*:** Samples were analysed for Ni, V, Pb, Fe, Cr, Zn, Cd, Mn and Cu using the AAS-flame technique (ASTM – D1886, E885, D3559, D2972, D1068, D1687, D3223, D3651, D1687, D3557, D3866 respectively.

pH/Conductivity (Electrometric)
20g of sieved air dried soil sample was treated with 20ml of distilled water and allowed to stand for 30 minutes and stirred occasionally with glass rod. Calibrated Ele pH meter

was used to measure the pH and a Hach conductivity meter for conductivity measurement.

Chloride

A known weight of soil was measured and soaked in a known volume of water with an occasional stirring. A known volume of extract was then analyzed by Mohr's method using direct titration against standard silver nitrate, with potassium chromate as the indicator. The results obtained was then used to calculate for chloride.

Available Phosphate

Bray No.1 method was adopted, 1g of air-dried soil sample was treated with 7ml of the extracting solution and centrifuged for 15 minutes. 2ml of the clear supernatant was treated with 2ml of ammonium molybdate solution and 1ml of stannous chloride. % transmittance was measured after 5 minutes at a wavelength of 660nm.

Total Hydrocarbon Carbon (THC)

5g of air-dried soil sample was soxhlet-extracted with distilled xylene for 3 hours. The extract was made up to a known volume after cooling and the absorbance measured at 420nm. Results obtained were compared with reference calibration curve, which was prepared using crude oil.

Nitrate

5g of air-dried soil sample was treated with activated carbon and extracting solution. 1ml aliquot of the soil extract was transferred to a vial and treated with brucine reagent and conc. Sulphuric acid and mixed with 2ml of distilled water added and contents allowed to set for 15mins and transmittance measured with spectronic – 20 Genesys at 470nm.

Microbiological Analysis

Preparation procedure

The glasswares were sterilized in hot oven at 160ºC for 1 hour and media in the autoclave at 121ºC, 15 Pascal for 15 minutes. The bench was swabbed with absolute ethanol. 0.85% normal saline was prepared and used for serial dilution of the samples (9ml normal saline + 1ml sample or 1g sample in 9ml normal saline for soil and sediment samples.

Total Heterotrophic Bacteria Count (THBC) APHA 9215B

28g of nutrient agar media was dissolved in 1litre of distilled water. The media was sterilized in the auto-clave at 121ºC and 15 Pascal for 15minutes and allowed to cool to

47ºC and poured into sterilized petri dishes. The surface of the poured media was flamed with Bunsen burner flame allowed to solidify.

The surface of the media was dried in the hot air oven at 40ºC for 5minutes and the sample was inoculated using pour plate method and incubated at 37ºC in Incubator for 24 hours. The colonies in the plate were counted and the total heterotrophic bacteria recorded.

Total Heterotrophic Fungal Count (THFC) APHA 9610C

65g of Sabouraud Glucose Agar media was dissolved in 1litre of distilled water and the media sterilized in the autoclave at 121ºC and 15Pascal for 15 minutes. The media was allowed to cool to 47ºC and chloramphenicol capsule was added into the media and stirred to mix (this chloramphenicol is used to prevent the growth of bacteria. The media was poured into sterilized petri dishes and the surface of the poured media was flamed and allowed to solidify. The surface of the solidify media was dried in the hot air oven at 40ºC for 5 minutes. The sample was inoculated using pour plate method and incubated at 20ºC in Incubator for 48 hours. The colonies in the plate were counted and the total number of hetero-tropic fungi recorded.

Hydrocarbon Utilizing Bacteria Count (HUBC) APHA 9215C

The following reagents were weighed out : 0.42g of $MgSO_4.7H_2O$, 6.28g of KCl 1.25g of KH2(PO_4), 0.83g of K_2HPO_4, 0.42g of NH_4NO_3, 10-20g of NaCl, 15g of Agar-Agar and dissolved in 1litre of distilled water. The media was sterilized in the auto-clave at 121ºC and 15 Pascal for 15 minutes and allowed to cool to 47ºC. The media was poured into sterilized petri dishes. The surface of the poured media flamed with Bunsen burner and allows to solidify. The surface of the media was dried in the hot air oven at 40ºC for 5minutes. The sample was inoculated using pour plate method and incubated at 37ºC in incubator for 14days. The colonies in the plate were counted and the total number of hydrocarbon utilizing bacteria recorded.

Note: Before incubation, one-quarter size of Watman filter paper was soaked in crude oil and placed on the cover of the petri dish and the plate inverted while incubating

Hydrocarbon Utilizing Fungi Count (HUFC) APHA 9610C

The following reagents were weighed out; 0.42g of $MgSO_4.7H_2O$, 6.28g of KCl 1.25g of $KH_2(PO_4)$, 0.83g of K_2HPO_4, 0.42g of NH_4NO_3, 10-20g of NaCl 15g of Agar-Agar dissolve all these in 1litre of distilled water. The media was sterilized in the auto-clave at 121ºC and 15 Pascal for 15 minutes and allowed to cool to 47ºC. 250mg of chloramphenicol capsule was added into 1litre of the media and stirred to mix (this chloramphenicol prevent the growth of bacteria) The media was poured in sterilized petri

dishes, the surface of the poured media. Flamed with Bunsen burner and allowed to solidify. The surface of the media dried in hot air oven at 40ºC for 5 minutes. The sample was inoculated using pour plate method and incubated at 20-25ºC for 14 days. The colonies in the plate were counted and the total number of hydrocarbon utilizing fungi recorded.

Note: before incubation one- quarter size of watman filter paper was soaked in crude oil and placed on the cover of the petri dishes and the plate inverted while incubating. The media is called mineral salt media. Samples from offshore have high salt content and media for HUB and HUF are salt media, hence the need to acidify the media. The acidification help to raise the pH of media for bacteria and fungi growth. This is done by adding 0.1ml of H_2SO_4 to the media.

Total Coliform Count APHA 9215B

48.5g of MacConkey agar media was dissolved in 1litre of distilled water.
The media was sterilized in the auto-clave at 121ºC and 15 Pascal for 15minutes and allowed to cool to 47ºC. The media was poured into sterilized petri dishes and the surface of the poured media flamed and allowed to solidify. The surface of the media was dried in the hot air oven at 40ºC for 5minutes. The sample was inoculated using pour plate method and incubated 37ºC in Incubator for 24 hours for bacteria. The colonies in the plate were counted and the total number of coliform recorded.

Quality Assurance/Control Measures Adopted for the Sampling

Sample Collection

Standard procedure adopted for sample collection involved:

- Obtaining a representative portion of the material concerned, and which represents the conditions existing at the point taken and time of sampling.
- Samples were of sufficient volume to permit reproducibility of testing requisites for the desired objectives.
- Samples were preserved prior to analysis in a manner that safeguards against change in the particular constituents or properties to be examined.
- Contact with any material other than the original container was avoided to prevent possible contamination or alteration on the sample quality.
- Before obtaining water sample, containers were rinsed out two to three times with the seawater being collected.
- Sample containers were made of materials that cannot be contaminated. The containers were cleaned thoroughly to remove all extraneous surface dirt before use. These included glass bottles and metal containers with cap for hydrocarbon

oil and grease analysis, rigid and collapsible plastic containers of polyethylene for others.

Sample Labeling

Adhesive sample label were affixed onto each sample bottle or container. The following information was written in an indelible marker on the label.

- Sample number.
- Date and time of sampling.
- Point of sampling
- Types and quantity of preservatives added.
- Signature of sampler.

Sample Storage & Transport

As required, all samples were suitably contained to preserve their quality during transportation from field to the laboratory. Samples were stored in appropriate containers and stored in the vessel freezers.

Sample Custody

Samples were placed immediately in a cooling box and transported to the laboratory. Sample handling and preservation conformed to DPR standards as shown in Table D.

Table D: Recommended Preservatives and Sample Storage

S/N	PARAMETER	REQUIRED (ML)	CONTAINER	PRESERVATION	MAXIMUM HOLDING PERIOD
1.	PH	35	P,G	Cool, 4 ^{0}C Det. On site	6 hours
2.	Electrical Conductivity	100	P,G	Cool, 4 ^{0}C	24 hours
3.	Colour	50	P,G	Cool, 4 ^{0}C	24 hours
4.	Odour	200	G, only	Cool, 4 ^{0}C	24 hours
5.	Turbidity	100	P,G	Cool, 4 ^{0}C	7 days
6.	Total Dissolved Solids (TDS)	50	-	Filter on site cool 4 ^{0}C	24 hours
7.	Total Suspended Solid	50	-	**Filter on site**	6 months
8.	Total Hardness	100	P,G	Cool, 4 ^{0}CHNO_3 To pH <2	7 days

S/N	PARAMETER	REQUIRED (ML)	CONTAINER	PRESERVATION	MAXIMUM HOLDING PERIOD
9.	Acidity and alkalinity	100	P,G	Cool, 4 ^{0}C	24 hours
10.	Salinity as Cl	50	P,G	None required	7 days
11.	Chemical Oxygen Demand	50	P,G	2ml H_2SO_4 per litre	7 days
12.	Biochemical Oxygen Demand (BOD)	1,000	P,G	Refrigeration at 4 ^{0}C	6 hours
13.	Surfactants as (MBAS)	250	P,G	Cool, 4 ^{0}C	24 hours
14.	Dissolved Oxygen (DO)	300	G, only	Det. On site	No holding
15.	Ammonia	400	P,G	Cool, 4 ^{0}C H_2SO_4 or pH<2	24 hours
16.	Oil and Grease	1,000	G, only	Cool, 4 ^{0}C H_2SO_4 or pH<2	24 hours
17.	Nitrate NO_3	100	P,G	Cool, 4 ^{0}C H_2SO_4 or pH<2	24 hours
18.	Sulphate (SO_2/4)	50	P,G	Cool, 4 ^{0}C	7 days
19.	Carbonate (CO_3) free CO_2 & HCO_3	-	P,G	-	-
20.	Cyanides	500	P,G	Cool, 4 ^{0}C NaOH to pH 12	24 hours
21.	Phosphorous	-	-	40mg, $HgCL_2$ per litre 4^{0}C	7 days
22.	**Phenolics**	500	G, only	Cool, 4 ^{0}C H_2SO_4 or pH< 41.g $CuSO_4$/ litre	24 hours
23.	Chromium	100	P,G	HNO_3 to pH<2	-
24.	Arsenic	100	P,G	HNO_3 to pH<2	6 months
25.	Cadmium	100	P,G	HNO_3 to pH<2	6 months
26.	Cobalt	-	P,G	HNO_3 to pH<2	6 months
27.	Copper	-	P,G	HNO_3 to pH<2	6 months
28.	Iron	-	P,G	HNO_3 to pH<2	6 months

S/N	PARAMETER	REQUIRED (ML)	CONTAINER	PRESERVATION	MAXIMUM HOLDING PERIOD
29.	Mercury	100	P,G	Filter, HNO_3 to pH<2	38 days (GLASS)
	Lead	100	P,G	HNO_3 to pH<2	6 months
30.	Nickel	100	P,G	HNO_3 to pH<2	6 months
31.	Zinc	100	P,G	HNO_3 to pH<2	6 months
32.	Vanadium	100	P,G	HNO_3 to pH<2	6 months
33.	Calcium	100	P,G	None required	6 months
34.	Magnesium	100	P,G		6 months

P = Plastic, G = Glass

Source: Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN, 2002), by the Department of Petroleum Resources, Lagos.

Quality Assurance Measures Adopted for Equipment

The following were carried out to ensure that the equipment is in good condition for generation of quality data:

- Field instruments were fully calibrated/standardized and cross-checked before use and from time to time when in use. This entailed establishing instruments/equipment operating conditions (supplied by the manufacturer, and the response validation.
- Instrument calibration technique, the validation technique and the results were recorded in the instrument log.
- All instruments were calibrated after each service or repair

Data Review, Validation and Verification

Data Verification was done at several points of the collection and analysis process. Field data sheets were carefully kept and inspected daily. Data from instrumental and titrimetric measurements were used to calculate the concentration of the various analytes, using standardized formula. Data, which do not fall within the expected range, (especially in relation to water sample) were noted. Laboratory data for wet chemistry were subjected to analysis to draw attention to the station whose values fell outside the observed range. Such stations were subjected to further scrutiny during data analysis so as to provide explanation for the values

Data Analysis and Reporting

Data Storage and Treatment

The data obtained from the study locations were analysed using appropriate statistics to bring out the salient points and trends on each location and to establish relationship (s) between the stations.

Data Evaluation

Raw data obtained from instrumental and titrimetric measurements were used in calculating the concentration of the various analyses, using standardized formula. Outliers were identified and deleted from the replicate data before calculation of mean concentrations.

APPENDIX 4

Table 1a: Meteorological and Ambient Air Quality for Wet Season

Sampling point	NO_2 ppm	SO_2 ppm	H_2S ppm	CO ppm	CH_4 ppm	NH_3 ppm	VOC ppm	SPM $\mu g/m^3$	R/H %	TEMP ^oC	WS m/s	WD
AQ 2 25/10/2008	1.00	<0.01	<0.01	4.00	<0.01	<0.01	<0.01	27.00	92.00	26.60	0.60	NE
AQ 3 27/10/2008	0.70	<0.01	0.30	4.00	<0.01	<0.01	<0.01	23.00	69.30	33.60	0.20	SW
AQ1 28/10/2008	0.60	<0.01	<0.01	19.00	<0.01	<0.01	<0.01	25.20	68.20	32.90	0.20	SW
AQ 4 30/10/2008	0.80	<0.01	<0.01	13.00	<0.01	<0.01	0.03	24.90	81.30	32.10	1.00	SW
AQ 5 2/11/2008	0.90	0.03	0.10	6.00	<0.01	<0.01	<0.01	20.50	69.00	32.80	0.50	NE

Table 1b: Meteorological and Air Quality

Sampling point	NO_2 ppm	SO_2 ppm	H_2S ppm	CO ppm	CH_4 ppm	NH_3 ppm	VOC ppm	SPM $\mu g/m^3$	R/H %	TEMP ^oC	WS m/s	WD
AQ 2 26/01/2009	1.30	<0.01	0.02	8.20	<0.01	<0.01	<0.01	36.00	56.00	32.00	0.00	SW
AQ 5 27/01/2009	0.90	0.03	<0.01	7.00	<0.01	<0.01	<0.01	30.40	51.40	28.30	0.50	SW
AQ 3 27/01/2009	1.70	<0.01	0.04	4.00	<0.01	<0.01	<0.01	30.00	58.50	34.30	0.50	SW
AQ 1 28/01/2009	1.30	<0.01	<0.01	3.00	<0.01	<0.01	<0.01	32.20	58.20	29.50	0.00	SW
AQ 4 28/01/2009	1.90	0.01	0.01	1.80	<0.01	<0.01	<0.01	33.00	53.00	31.00	1.80	SW

Table 2a: Noise Values for wet season

SAMPLING POINT	**NOISE dB(A)** **1st Reading**	**NOISE dB(A)** **2nd Reading**
NSS 2	43.70	42.90
NSS 3	57.70	55.40
NSS 1	50.00	49.30
NSS 4	52.00	50.90
NSS 5	68.60	59.00

Table 2b: Noise Values for dry season

S/N	SAMPLING POINT	NOISE dB(A) 1st	NOISE dB(A) 2nd
1.	NSS 2	56.40	54.70
2.	NSS 5	61.50	50.40
3.	NSS 3	33.60	40.00
4.	NSS 1	37.40	35.90
5.	NSS4	59.30	59.80

Table 3a	**Diversity and relative abundance of plant species in Agbada**								
ID_Point	**Species**	**Common name**	**Family**	**Count**	**Trees (>4 m height)**	**Shrubs (0.5 to 4 m height)**	**Trees (>4 m height) (%)**	**Height (m)**	**Stem diameter (cm)**
VEG 1	**Trees/shrubs**								
	Elaeis guineensis	Oil palm tree	Arecaceae	8	8	0	38.1	20	30.5
	Alstonia booneii	Stoolwood	Apocynaceae	1	1	0	4.8	7	12.5
	Ceiba pentandra	Silk cotton	Bombacaceae	1	1	0	4.8	20	45.5
	Anthocleista vogelii	Cabbage tree	Potaliaceae	1	1	0	4.8	15	38
	Bambusa vulgaris	Bamboo	Bambusae	3	3	0	14.3	10	11.4
	Mallotus oppositifolius		Euphorbiaceae	5	5	0	23.8	5	7.6
	Anthonotha macrophylla		Caesalpiniceae	2	0	2	_	_	_
	Vitex doniana	Black plum	Verbenaceae	2	2	0	9.5	7	12.7
	Herbs/Weeds								
	Eleusine indica	Bull grass	Poaceae	Common					
	Sporobolus pyramidalis	Cat's tailgrass	Poaceae	Common					
	Panicum maximum	Guinea grass	Poaceae	Common					
	Eragrostus tremula		Poaceae	Common					
	Costus afer	Bush cane	Costaceae	Common					
	Smilax kraussiana	W. African sarsaparilla	Smilacaceae	Rare					
	Sida acuta	Broomweed	Malvaceae	Occasional					

Table 3a	**Diversity and relative abundance of plant species in Agbada**								
ID_Point	**Species**	**Common name**	**Family**	**Count**	**Trees (>4 m height)**	**Shrubs (0.5 to 4 m height)**	**Trees (>4 m height) (%)**	**Height (m)**	**Stem diameter (cm)**
	Urena lobata	Cadillo	Malvaceae	Common					
	Commelina benghalensis	Wandering Jew	Commelinaceae	Rare					
	Aspilia africana	haemorrhage plant	Asteraceae	Occasional					
	Emilia coccinea	False tassle flower	Asteraceae	Occasional					
	Chromolaena odorata	Siam weed	Asteraceae	Common					
	Mimosa pudica	Sensitive plant	Mimosaceae	Occasional					
	Crotolaria retusa	Rattlebox	Papilionaceae	Occasional					
	Ipomoea involucrata	Cover crop	Convolvulaceae	Occasional					
	Phyllanthus amarus		Euphorbiaceae	Rare					
	Pandiaka heudelotii		Amaranthaceae	Abundant					
VEG 2	**Trees/shrubs**								
	Elaeis guineensis	Oil palm tree	Arecaceae	6	6	0	37.5	18	30.5
	Alchornia cordifolia	Christmas bush	Euphorbiaceae	6	4	2	25	5	6.5
	Manniophyton fulvum		Euphorbiaceae	2	0	2	_	_	_
	Anthocleista vogelii	Cabbage tree	Potaliaceae	1	1	0	6.3	15	17.5
	Ceiba pentandra	Silk cotton	Bombacaceae	1	1	0	6.3	10	19.3
	Baphia nitida	Cam wood	Papilionaceae	2	0	2	_	_	_
	Bambusa vulgaris	Bamboo	Bambusae	6	4	2	25	10	10.5

Table 3a	**Diversity and relative abundance of plant species in Agbada**								
ID_Point	**Species**	**Common name**	**Family**	**Count**	**Trees (>4 m height)**	**Shrubs (0.5 to 4 m height)**	**Trees (>4 m height) (%)**	**Height (m)**	**Stem diameter (cm)**
	Ficus exasoerata	Sandpaper tree	Moraceae	2	0	2	_	_	_
	Herbs/Weeds								
	Eleusine indica	Bull grass	Poaceae	Common					
	Panicum maximum	Guinea grass	Poaceae	Abundant					
	Paspalum conjugatum	Sour grass	Poaceae	Common					
	Sporobolus pyramidalis	Cat's tail	Poaceae	Common					
	Mimosa pudica	Sensitive plant	Mimosaceae	Common					
	Schrankia leptocarpa		Mimosaceae	Rare					
	Chromolaena odorata	Siam weed	Asteraceae	Common					
	Aspilia africana	Haemorrhage plant	Asteraceae	Occasional					
	Ageratum conyzioides	Goat weed	Asteraceae	Common					
	Sida acuta	Broomweed	Malvaceae	Occasional					
	Urena lobata	Cadillo	Malvaceae	Common					
	Costus afer	Bush cane	Costaceae	Common					
	Calapogonium mucunoides	Cover crop	Fabaceae	Common					
	Ipomoea involucrata	Cover crop	Convolvulaceae	Common					
	Cyperus rotundus	Nut sedge	Cyperaceae	Common					
	Heliotropium indicum	Turnsole	Boraginaceae	Common					
	Borreria ocymoides	Eczema plant	Rubiaceae	Occasional					

Table 3a	Diversity and relative abundance of plant species in Agbada								
ID_Point	**Species**	**Common name**	**Family**	**Count**	**Trees (>4 m height)**	**Shrubs (0.5 to 4 m height)**	**Trees (>4 m height) (%)**	**Height (m)**	**Stem diameter (cm)**
	Pandiaka heudelotii		Amaranthaceae	Abundant					

Table 3b: Checklist of wildlife species identified in the Agbada project area

Class	Family	Species	Common name	Detection Method	Habitat	DECREE 11/1985	NARESCON/ Biodiversity***
Mammalia	Cercopithecidae	*Cercopithecus mona***	Mona monkey	SH	Forest		Threatened
	Muridae	*Cricetonys gambianus*	Giant rat	BU	Forest		Satisfactory
	Muridae	*Rattus rattus*	Common rat	DS	House/ Garden		Satisfactory
	Bovidae	*Tragelaphus scriptus*	Bush buck	SH	Forest		Satisfactory
	Bovidae	*Cephalophus maxwelli*	Maxwell duiker	SH	Forest		Endangered
	Bovidae	*Neotragus batesi*	Dwarf antelope	SH	Forest		Threatened
	Sciuridae	*Protoxerus strangeri*	Giant forest tree squirrel	DS	Forest		Satisfactory
	Thryonomidae	*Atherurus africanus*	Brush tailed porcupine	SH	Forest		Threatened
	Thryonomidae	*Thryonomys*	Cane rat	DS	Forest		Satisfactory

Class	Family	Species	Common name	Detection Method	Habitat	DECREE 11/1985	NARESCON/ Biodiversity***
		swinderianus					
	Canidae	*Lycaon pictus*	Hunting dog	SH	House/ Forest		Endangered
	Chiroptera	*Pteropus sp*	Fruit bat	DS	Forest		Satisfactory
Reptilia	Agamidae	*Agamma agamma*	Common lizard	DS	House/ Garden		Satisfactory
	Boidae	*Naja melanoleuca*	Black cobra	SH	Forest/ Swamp		Satisfactory
	Viperidae	*Bitis gabonica*		SH	Forest		Rare
	Veranidae	*Veranus exanthematicus*	Monitor lizard	SH	Forest/Garden		Endangered
	Pythonidae	*Python regius**	Royal python	DS	Forest/swamp		Endangered
Amphibia	Bufonidae	*Bufo regularis*	Toads	DS	Forest/ Garden		Satisfactory
	Ranidae	*Dicroglosus occipitalis*	Frogs	DS	Forest/ Garden		Satisfactory
	Ranidae	*Rana temporalis*	Frogs	DS	Forest/ Garden		Satisfactory
Aves	Accipitridae	*Necrosyrtes monarchus*	Common vulture	DS	Garden/ Road sides		Satisfactory

Class	Family	Species	Common name	Detection Method	Habitat	DECREE 11/1985	NARESCON/ Biodiversity***
	Accipitridae	*Milvus nigrans*	Black kite	SH	River bank/ pond sides		Satisfactory
		Accipiter erythropus	Chicken Hawk	DS	Forest/ Garden		Endangered
		Crinifer piscator	Plantain eater	DS	Forest		Satisfactory
	Corvidae	*Corvus albus*	Pied crow	DS	Forest/road sides		Satisfactory
	Ardeidae	*Ardeola ibis*	Cattle egret	DS	Garden/ Road sides		Endangered
		Pycnomonus barbatus	Common garden bulbul	DS	Garden/ Road sides		Satisfactory
	Ploceidae	*Plesiositagra cucullatus*	Weaver birds	DS	Garden/ Road sides		Satisfactory
	Bucerotidae	*Polyboroides radiatus*	Carrier hawk	DS	Garden/ Road sides		Satisfactory
		Strix wordfordii	African hood owl	SH	Garden/ Road sides		Satisfactory
		Hirundo nigrita	Swallow	DS	Forest/road sides		Satisfactory
	*****International trade is absolutely prohibited	****** International trade requires licence	***First National Biodiversity Report (2006)				

Table 4a: Physico-chemical and Microbiology Characteristics of Soil for wet season

PARAMETERS	**SS1 (0-15)cm**	**SS1 (15-30)cm**	**SS2 (0-15)cm**	**SS2 (15-30)cm**	**SS3 (0-15)cm**	**SS3 (15-30)cm**	**SS4 (0-15)cm**	**SS4 (15-30)cm**	**SS5 (0-15)cm**	**SS5 (15-30)cm**	**SS6 (0-15)cm**	**SS6 (15-30)cm**	**SS7 (0-15)cm**	**SS7 (15-30)cm**	**SS8 (0-15)cm**	**SS8 (15-30)cm**
pH	5.85	5.72	6.87	6.44	6.32	6.21	6.44	6.23	6.85	6.45	6.54	6.44	6.55	6.17	6.45	6.48
Conductivity (µS/cm)	50.0	50.0	48.0	47.0	40.0	40.0	18.0	18.0	20.0	20.0	58.1	58.0	60.0	60.0	57.0	57.0
TOC (%)	3.76	3.12	3.76	3.08	3.98	3.23	4.66	4.08	4.58	4.33	3.76	3.04	4.27	3.56	4.50	3.90
Moisture Content(%)	12.23	12.87	14.87	13.80	13.23	14.89	16.94	12.34	13.87	12.87	12.98	12.33	13.76	12.98	12.80	10.34
Bulk density	3.76	3.56	3.67	3.46	3.43	3.40	3.45	3.34	3.49	3.23	3.67	3.45	3.56	3.23	3.45	3.31
Porosity (%)	33.67	32.54	32.45	32.25	33.55	32.19	33.25	32.89	33.10	32.13	32.56	32.26	33.33	32.67	33.34	32.58
Chloride(mg/kg)	3.2	1.2	26.2	22.6	0.1	0.8	27.2	24.8	26.6	24.4	24.8	24.4	25.8	23.6	26.9	24.4
CEC (meq/100g)	3.66	2.30	4.88	3.98	3.41	3.15	3.58	3.34	3.45	3.12	3.76	3.56	3.56	2.66	3.89	2.98
Phosphate(mg/kg)	0.08	0.06	0.07	0.08	0.08	0.07	0.10	0.09	0.07	0.07	0.08	0.08	0.07	0.06	0.09	0.08
Sulphate(mg/kg)	2.32	2.53	3.67	3.15	2.96	3.36	2.00	2.03	2.67	2.74	3.36	5.12	2.59	2.94	2.66	2.83
Nitrate(mg/kg)	12.62	8.14	13.98	13.75	6.90	7.31	9.33	9.69	10.60	12.17	10.39	10.69	10.87	11.41	10.51	11.76
Calcium(mg/kg)	0.42	0.40	30.21	30.00	2.06	2.00	25.52	25.12	31.12	30.42	34.62	33.41	37.20	36.10	40.10	39.80
Sodium (mg/kg)	439	435	369	364	298	294	355	351	371	369	370	366	368	362	378.0	374
Potassium(mg/kg)	26.33	18.30	12.30	12.00	25.67	19.10	13.60	13.20	13.40	12.30	24.30	18.60	26.40	23.30	25.00	23.00
Lead (mg/kg)	0.07	0.02	0.98	0.78	0.06	0.01	0.76	0.70	0.89	0.85	0.55	0.44	0.56	0.34	0.34	0.23
Nickel(mg/kg)	7.1	6.9	7.9	7.3	8.0	7.6	7.6	7.1	8.0	7.4	7.7	7.1	7.6	7.2	7.8	7.3
Chromium(mg/kg)	17.30	17.00	17.80	17.30	18.60	18.20	17.90	17.30	18.50	18.10	18.90	18.20	19.70	19.10	20.70	20.10
Zinc(mg/kg)	7.06	6.86	0.67	0.56	7.16	7.09	0.89	0.40	0.87	0.66	0.56	0.45	0.76	0.65	0.98	0.88
Cadmium(mg/kg)	0.46	0.42	0.48	0.43	0.54	0.50	0.45	0.42	0.49	0.45	0.46	0.41	0.47	0.42	0.45	0.41
Iron(mg/kg)	92.03	90.12	45.78	42.56	61.31	59.12	101.23	106.98	78.31	73.90	43.89	41.23	35.56	32.67	39.56	36.76
Manganese(mg/kg)	10.30	10.00	42.10	39.60	9.10	8.90	39.20	37.80	41.30	39.20	43.00	40.40	45.00	41.20	46.5	42.00
Vanadium(mg/kg)	0.02	0.03	0.07	0.06	0.05	0.03	0.16	0.07	0.14	0.09	0.12	0.08	0.06	0.03	0.09	0.07
Copper	6.45	6.13	5.78	5.49	5.65	5.57	5.88	5.56	6.15	5.99	5.78	5.44	5.65	5.43	6.25	6.11
THC(mg/kg)	0.92	0.71	0.87	0.66	0.78	0.60	0.34	0.28	0.78	0.54	1.07	0.73	1.23	0.89	0.98	0.76
Oil &Grease (mg/kg)	1.23	0.67	0.76	0.54	0.82	0.54	0.13	0.55	0.34	0.65	0.78	0.66	0.89	0.56	1.43	0.78
Hydrogen Sulphide (mg/kg)	1.45	0.85	1.45	1.23	1.59	4.34	1.76	1.23	1.44	1.33	3.23	3.67	4.54	3.54	1.53	0.87
Available Water Holding Capacity (%)	23.19	23.34	22.32	22.38	23.31	23.35	22.43	22.46	22.43	22.48	22.45	22.55	22.56	22.61	22.34	22.43
THBC (x102cfu/g)	1.2	0.8	0.7	0.4	1.4	0.9	0.8	0.4	0.9	0.4	0.4	0.3	0.6	0.3	0.5	0.3
HUB (x102cfu/g)	0.3	0.2	0.2	0.1	0.3	0.1	0.1	NG	0.3	0.2	0.3	0.1	0.2	NG	0.1	NG

PARAMETERS	SS1 (0-15)cm	SS1 (15-30)cm	SS2 (0-15)cm	SS2 (15-30)cm	SS3 (0-15)cm	SS3 (15-30)cm	SS4 (0-15)cm	SS4 (15-30)cm	SS5 (0-15)cm	SS5 (15-30)cm	SS6 (0-15)cm	SS6 (15-30)cm	SS7 (0-15)cm	SS7 (15-30)cm	SS8 (0-15)cm	SS8 (15-30)cm
THF (x102cfu/g)	0.7	0.4	0.3	0.2	0.4	0.1	0.2	0.1	0.4	0.1	0.4	0.2	0.2	0.1	0.3	0.1
HUF (x102cfu/g)	0.3	0.1	0.3	NG	0.3	0.1	NG	NG	0.2	0.1	0.1	NG	0.2	NG	0.3	0.1

Table 4a: Physico-chemical and Microbiology Characteristics of Soil for wet season (cont'd)

PARAMETERS	SS9 (0-15)cm	SS9 (15-30)cm	SS10 (0-15)cm	SS10 (15-30)cm	SS11 (0-15)cm	SS11 (15-30)cm	SS12 (0-15)cm	SS12 (15-30)cm	SS13 (0-15)	SS13 (15-30)cm	SS14 (0-15)cm	SS14 (15-30)cm	SS15 (0-15)cm	SS15 (15-30)cm	SS16 (0-15)cm	SS16 (15-30)cm
pH	6.54	6.67	6.77	6.55	6.78	6.77	5.9	5.7	6.80	6.60	6.89	6.65	5.8	5.7	6.70	6.60
Conductivity	20.0	20.0	30.0	30.0	20.0	20.0	60.0	60.0	60.0	60.0	20.0	20.0	35.0	35.0	50.0	50.0
TOC (mg/kg)	4.35	3.25	4.28	3.12	4.67	4.44	4.63	3.28	4.55	3.65	4.56	3.45	4.53	3.32	3.88	3.09
Moisture Content(%)	14.89	15.65	15.10	15.87	12.98	12.45	12.88	13.98	13.23	13.89	15.24	15.67	13.23	14.78	17.67	17.98
Bulk density	3.67	3.34	3.76	3.45	3.67	3.54	3.65	3.45	3.92	3.67	3.56	3.34	3.67	3.56	3.68	3.34
Porosity	32.56	32.26	33.43	32.67	32.82	32.48	33.25	32.99	33.05	32.23	33.23	32.78	32.64	32.35	33.01	32.26
Chloride(mg/kg)	1.6	1.0	0.7	0.4	25.8	24.6	27.2	23.3	26.7	24.2	1.6	0.9	25.4	23.1	26.6	24.4
CEC (meq/100g)	3.76	3.55	3.69	2.36	3.67	3.41	3.68	3.14	3.65	3.10	3.66	2.30	3.77	3.23	3.78	3.45
Phosphate (mg/kg)	0.07	0.08	0.08	0.07	0.08	0.08	0.07	0.08	0.11	0.19	0.09	0.07	0.06	0.08	0.08	0.07
Sulphate (mg/kg)	3.92	4.51	3.36	4..32	18.81	18.99	11.74	11.54	2.85	3.00	2.11	2.37	2.91	3.07	2.03	2.13
Nitrate (mg/kg)	10.07	10..37	10.75	10.91	9.69	9.20	9.06	9.69	13.08	14.43	9.24	9.69	9.69	10.37	9.20	9.92
Calcium(mg/kg)	1.04	1.01	1.23	1.12	29.67	27.12	23.50	21.30	1.23	1.20	22.12	20.31	19.08	18.90	0.98	0.93
Sodium(mg/kg)	164	161	155	150	359	352	334	330	452	448	128	123	321	318	470	468
Potassium(mg/kg)	13.50	10.30	13.10	11.20	14.50	13.40	24.60	17.10	26.20	18.40	12.00	9.00	24.15	19.30	23.50	28.30
Lead(mg/kg)	0.65	0.23	0.52	0.32	0.56	0.45	0.08	0.04	0.09	0.04	0.45	0.31	0.09	0.05	0.09	0.04
Nickel(mg/kg)	7.6	7.1	7.5	7.0	8.2	7.5	8.5	7.9	6.4	6.0	7.8	7.3	8.4	8.0	8.3	8.0
Chromium(mg/kg)	19.20	18.90	19.00	18.80	19.80	19.30	20.30	19.40	15.70	15.30	18.90	18.30	22.90	22.10	24.30	23.80
Zinc(mg/kg)	5.86	5.32	5.62	4.90	0.55	0.43	0.87	0.46	3.23	3.05	5.46	5.08	0.53	0.42	9.87	9.10
Cadmium(mg/kg)	0.52	0.47	0.45	0.42	0.47	0.42	0.68	0.64	0.56	0.50	0.47	0.42	0.67	0.61	0.67	0.61
Iron(mg/kg)	52.75	50.05	56.15	53.50	120.78	115.76	63.89	60.38	67.56	64.21	111.24	109.67	66.49	60.12	148.23	145.47
Manganese(mg/kg)	15.90	15.30	15.70	15.10	42.10	40.30	13.00	12.60	14.20	13.50	38.90	36.70	12.80	12.10	34.30	30.10
Vanadium(mg/kg)	0.04	0.03	0.06	0.05	0.16	0.05	0.04	0.05	0.06	0.05	0.05	0.04	0.05	0.03	0.04	0.05
Copper(mg/kg)	5.78	5.49	5.78	5.44	5.78	5.63	5.78	5.59	6.12	5.89	5.65	5.43	5.79	5.66	5.65	5.42
THC(mg/kg)	1.02	0.71	1.09	0.84	0.45	0.43	0.38	0.30	0.72	0.49	0.91	0.69	0.51	0.47	0.36	0.29

PARAMETERS	**SS9 (0-15)cm**	**SS9 (15-30)cm**	**SS10 (0-15)cm**	**SS10 (15-30)cm**	**SS11 (0-15)cm**	**SS11 (15-30)cm**	**SS12 (0-15)cm**	**SS12 (15-30)cm**	**SS13 (0-15)**	**SS13 (15-30)cm**	**SS14 (0-15)cm**	**SS14 (15-30)cm**	**SS15 (0-15)cm**	**SS15 (15-30)cm**	**SS16 (0-15)cm**	**SS16 (15-30)cm**
Oil Grease(mg/kg)	0.87	0.64	0.90	0.56	0.43	0.44	0.15	0.58	0.37	0.68	1.12	0.88	0.33	0.54	0.15	0.51
HydrogenSulphide(mg/kg)	1.37	0.78	1.20	0.87	1.78	0.98	1.67	1.34	1.53	1.37	1.54	0.98	1.72	0.93	1.68	1.18
Available Water Holding Capacity (%)	19.52	19.66	19.41	19.56	22.38	22.40	23.44	23.47	22.23	22.25	19.45	19.48	23.34	23.40	22.42	22.45
THBC (x102cfu/g)	1.3	1.1	1.0	0.9	0.7	0.3	0.7	0.3	1.4	0.9	1.2	1.1	0.9	0.5	1.3	0.8
HUB (x102cfu/g)	0.3	1	2	1	2	NG	1	NG	2	1	4	2	NG	NG	NG	NG
THF (x102cfu/g)	0.5	0.2	0.6	0.3	0.3	0.2	0.3	0.1	1.5	1.0	0.8	0.5	0.4	0.1	0.7	0.2
HUF (x102cfu/g)	0.3	0.2	0.2	0.1	NG	NG	0.1	NG	0.3	0.2	0.3	0.1	0.2	0.1	NG	NG

Table 4a: Physico-chemical and Microbiology Characteristics of for wet season Soil (cont'd)

PARAMETERS	**SS17 (0-15)cm**	**SS17 (15-30)cm**	**SS18 (0-15)cm**	**SS18 (15-30)cm**
pH	6.32	6.34	6.02	6.00
conductivity	30.0	30.0	25.0	25.0
TOC	4.21	3.25	4.56	3.67
Moisture Content	12.23	13.98	12.34	14.37
Bulk density	3.67	3.56	3.65	3.46
Porosity	33.10	32.13	32.82	32.48
Chloride(mg/kg)	4.2	3.0	2.8	5.2
CEC	3.45	3.00	3.73	3.43
Phosphate	0.09	0.07	0.08	0.08
Sulphate	4.10	4.96	11.36	9.92
Nitrate	7.76	8.20	8.16	7.89
Calcium	1.97	1.94	2.10	1.89
Sodium	291	289	290	287
Potassium	24.50	17.30	25.12	19.37
Lead	0.07	0.03	0.09	0.03
Nickel	7.9	7.4	7.6	7.1
Chromium	18.80	18.10	17.60	17.10
Zinc	6.52	6.16	6.54	6.21
Cadmium	0.49	0.45	0.51	0.48
Iron	53.24	50.74	112.45	109.32
Manganese	9.60	9.10	9.70	9.10
Vanadium	0.06	0.07	0.05	0.04
Copper	6.02	5.87	5.69	5.64
THC	0.79	0.44	0.43	0.47
Oil & Grease	0.38	0.68	0.46	0.46
Hydrogen Sulphide	1.24	1.37	1.88	0.95
Available Water Holding Capacity	23.26	23.35	23.14	23.20

PARAMETERS	SS17 (0-15)cm	SS17 (15-30)cm	SS18 (0-15)cm	SS18 (15-30)cm
THBC (x102cfu/g)	1.3	0.7	1.2	1.0
HUB (x102cfu/g)	NG	NG	0.2	NG
THF (x102cfu/g)	0.3	0.1	0.5	0.1
HUF (x102cfu/g)	NG	NG	0.1	NG

Table 4b: Physico-chemical and microbiology characteristics of soil for dry season

PARAMETERS	SS1 (0-15)cm	SS1 (15-30)cm	SS2 (0-15)cm	SS2 (15-30)cm	SS3 (0-15)cm	SS3 (15-30)cm	SS4 (0-15)cm	SS4 (15-30)cm	SS5 (0-15)cm	SS5 (15-30)cm	SS6 (0-15)cm	SS6 (15-30)cm	SS7 (0-15)cm	SS7 (15-30)cm	SS8 (0-15)cm	SS8 (15-30)cm
pH	5.4	5.7	6.4	6.7	6.1	6.5	6.3	6.8	5.9	6.3	5.6	5.9	6.3	6.7	6.2	6.6
Conductivity (µS/cm)	17.0	17.0	18.0	18.0	16.0	16.0	17.0	17.0	18.0	18.0	15.0	15.0	58.0	58.0	50.0	50.0
TOC (%)	2.34	2.19	1.84	1.76	2.50	2.00	2.15	2.07	2.33	2.19	1.88	1.72	1.52	1.32	0.70	0.56
Moisture Content (%)	10.30	9.87	12.31	12.09	11.23	10.97	15.45	10.25	11.34	10.32	10.34	9.89	12.45	11.32	12.23	10.12
Bulk density	2.95	2.91	2.93	2.90	2.89	2.86	2.85	**2.80**	2.95	2.87	2.93	2.92	2.87	2.84	2.88	2.83
Porosity (%)	30.92	30.09	31.23	30.67	30.78	30.32	31.12	30.12	31.23	30.65	32.01	31.67	31.68	31.03	31.09	30.87
Chloride(mg/kg)	12.75	12.43	12.70	12.43	7.52	7.10	8.88	8.45	10.65	10.34	14.20	13.90	14.20	13.80	25.12	23.10
CEC (meq/100g)	3.23	2.01	4.12	3.65	3.13	3.00	3.23	3.12	3.21	3.09	3.45	3.27	3.24	2.32	3.65	2.56
Phosphate(mg/kg)	0.18	0.51	0.57	0.55	0.52	0.51	0.55	0.54	0.35	0.33	0.42	0.38	0.48	0.43	0.40	0.38
Sulphate(mg/kg)	2.37	2.27	2.45	2.37	4.14	4.10	2.98	2.94	22.69	20.85	3.30	2.88	3.07	3.02	3.26	3.20
Nitrate(mg/kg)	7.14	6.41	5.67	6.40	4.12	3.89	4.21	3.85	4.07	3.30	2.88	3.07	3.02	3.26	3.20	2.98
Calcium(mg/kg)	0.37	0.33	29.4	28.00	1.97	1.90	23.00	22.90	30.49	29.89	32.90	31.78	34.00	33.41	38.41	37.49
Sodium (mg/kg)	42.1	41.8	34.9	33.8	28.5	27.8	34.1	33.9	36.1	35.3	36.5	35.9	34.6	34.1	36.4	35.8
Potassium(mg/k	22.15	16.37	11.40	11.20	23.40	18.70	12.10	12.50	12.10	11.80	22.20	16.34	24.10	21.20	23.00	21.00

PARAMETERS	**SS1 (0-15)cm**	**SS1 (15-30)cm**	**SS2 (0-15)cm**	**SS2 (15-30)cm**	**SS3 (0-15)cm**	**SS3 (15-30)cm**	**SS4 (0-15)cm**	**SS4 (15-30)cm**	**SS5 (0-15)cm**	**SS5 (15-30)cm**	**SS6 (0-15)cm**	**SS6 (15-30)cm**	**SS7 (0-15)cm**	**SS7 (15-30)cm**	**SS8 (0-15)cm**	**SS8 (15-30)cm**
g)																
Lead (mg/kg)	0.04	0.01	0.89	0.65	0.04	0.01	0.70	0.64	0.78	0.74	0.48	0.40	0.49	0.30	0.30	0.20
Nickel(mg/kg)	6.7	6.0	6.9	6.4	7.50	7.10	7.00	6.80	7.50	7.00	7.20	6.90	7.10	6.80	7.20	6.90
Chromium(mg/kg)	16.70	16.30	17.20	16.90	18.20	17.79	17.30	16.80	18.10	17.80	18.30	17.80	19.10	18.80	20.10	17.00
Zinc(mg/kg)	6.80	6.45	0.59	0.48	7.01	6.80	0.78	0.38	0.81	0.60	0.51	0.41	0.70	0.60	0.98	0.80
Cadmium(mg/kg)	0.42	0.38	0.43	0.39	0.46	0.43	9.41	0.39	0.44	0.40	0.41	0.38	0.42	0.39	0.41	0.38
Iron(mg/kg)	88.70	87.00	41.68	40.19	56.00	56.09	99.21	102.12	72.13	70.50	40.12	39.10	32.2	31.20	33.00	30.14
Manganese(mg/kg)	9.70	9.20	39.80	36.70	7.80	7.10	35.70	34.60	39.40	37.00	40.20	38.10	41.00	39.80	42.30	40.10
Vanadium(mg/kg)	0.02	0.02	0.05	0.04	0.03	0.02	0.01	0.05	0.11	0.07	0.09	0.06	0.04	0.01	0.07	0.05
Copper	6.12	5.89	5.43	5.12	5.25	5.19	5.45	5.31	5.97	5.58	5.47	5.21	5.39	5.23	5.92	5.81
THC(mg/kg)	0.85	0.65	0.81	0.61	0.72	0.52	0.28	0.22	0.71	0.47	0.99	0.70	1.09	0.83	0.93	0.71
Oil &Grease (mg/kg)	1.10	0.58	0.71	0.50	0.75	0.49	0.10	0.48	0.31	0.61	0.71	0.61	0.81	0.51	1.20	0.72
Hydrogen Sulphide (mg/kg)	1.24	0.62	1.21	1.10	1.33	2.94	1.42	1.09	1.21	1.10	3.12	3.41	4.22	3.29	1.28	0.71
Available Water Holding Capacity (%)	20.81	20.86	20.12	21.15	20.23	21.38	20.13	20.28	19.95	20.21	20.05	20.15	19.87	20.31	21.09	21.87
THBC(x102cfu/g)	1.0	0.6	0.5	0.3	1.0	0.6	0.5	0.3	0.6	0.2	0.2	0.1	0.4	0.2	0.3	0.1
HUB (x102cfu/g)	0.2	0.1	0.1	0.1	0.2	0	0	0.1	0.1	0.1	0.2	0.1	0.1	0	0.1	0

PARAMETERS	SS1 (0-15)cm	SS1 (15-30)cm	SS2 (0-15)cm	SS2 (15-30)cm	SS3 (0-15)cm	SS3 (15-30)cm	SS4 (0-15)cm	SS4 (15-30)cm	SS5 (0-15)cm	SS5 (15-30)cm	SS6 (0-15)cm	SS6 (15-30)cm	SS7 (0-15)cm	SS7 (15-30)cm	SS8 (0-15)cm	SS8 (15-30)cm
THF (x102cfu/g)	0.5	0.3	0.3	0.1	0.3	0.2	0.1	0.2	0.3	0.1	0.3	0.1	0.2	0.1	0.2	0.1
HUF (x102cfu/g)	0.3	0.2	0.1	0	0.1	0	0	0.1	0.2	0.2	0.1	0.1	0.2	0	0.2	0.1

Table 4b: Physico-chemical and microbiology characteristics of soil for dry season Cont'd

PARAMETERS	SS9 (0-15)cm	SS9 (15-30)cm	SS10 (0-15)cm	SS10 (15-30)cm	SS11 (0-15)cm	SS11 (15-30)cm	SS12 (0-15)cm	SS12 (15-30)cm	SS13 (0-15)	SS13 (15-30)cm	SS14 (0-15)cm	SS14 (15-30)cm	SS15 (0-15)cm	SS15 (15-30)cm	SS16 (0-15)cm	SS16 (15-30)cm
pH	6.0	6.5	6.3	6.7	5.9	6.0	5.6	5.9	6.5	6.8	6.2	6.5	6.0	6.2	6.4	6.7
Conductivity	55.0	55.0	55.0	55.0	30.0	30.0	10.0	10.0	25.0	25.0	50.0	50.0	35.0	35.0	40.0	40.0
TOC (mg/kg)	2.71	2.34	2.69	2.15	1.62	1.54	3.49	2.89	1.52	1.60	2.45	2.65	2.13	2.27	2.30	1.90
Moisture Content(%)	13.43	14.21	14.34	15.23	11.23	10.90	10.98	11.78	12.45	12.21	14.54	14.12	12.09	11.89	15.34	15.65
Bulk density	2.94	2.89	2.87	2.84	2.79	2.74	2.93	2.89	2.87	2.83	2.86	2.81	2.84	2.79	2.88	2.78
Porosity	31.23	30.14	32.31	31.56	30.87	30.12	31.32	30.21	32.09	31.23	31.23	30.56	31.22	30.78	30.78	30.24
Chloride(mg/kg)	18.20	17.75	2.10	1.78	3.55	3.12	5.33	5.06	9.10	8.88	9.00	8.88	38.70	37.30	33.73	31.23
CEC (meq/100g)	3.45	3.24	3.43	2.23	3.45	3.23	3.46	3.09	3.34	2.90	3.32	2.21	3.34	3.12	3.45	3.23
Phosphate (mg/kg)	0.47	0.43	0.47	0.45	0.44	0.43	0.56	0.55	0.54	0.49	0.50	0.46	0.57	0.56	0.47	0.45
Sulphate (mg/kg)	2.98	2.90	4.29	4.03	3.82	3.38	3.33	3.74	3.70	3.39	3.22	4.59	4.56	6.37	6.27	4.61

PARAMETERS	**SS9 (0-15)cm**	**SS9 (15-30)cm**	**SS10 (0-15)cm**	**SS10 (15-30)cm**	**SS11 (0-15)cm**	**SS11 (15-30)cm**	**SS12 (0-15)cm**	**SS12 (15-30)cm**	**SS13 (0-15)**	**SS13 (15-30)cm**	**SS14 (0-15)cm**	**SS14 (15-30)cm**	**SS15 (0-15)cm**	**SS15 (15-30)cm**	**SS16 (0-15)cm**	**SS16 (15-30)cm**
Nitrate (mg/kg)	2.90	4.29	4.03	3.84	3.30	4.12	3.25	3.57	3.39	3.71	3.53	4.53	3.48	4.12	3.62	3.85
Calcium(mg/kg)	1.02	0.98	1.19	1.09	25.78	23.08	20.40	19.95	1.21	1.96	20.17	19.23	18.76	18.30	0,95	0.87
Sodium(mg/kg)	158.0	156.0	150.0	147.0	353.0	348.0	330.0	326.0	447.0	443.0	124.0	119.0	318.0	313.0	4646.0	461.0
Potassium(mg/kg)	12.70	9.86	12.60	10.27	13.58	12.49	21.34	16.91	22.87	17.79	11.51	8.84	22.10	18.48	20.24	26.43
Lead(mg/kg)	0.61	0.20	0.49	0.30	0.47	0.41	0.06	0.02	0.07	0.01	0.42	0.28	0.06	0.03	0.07	0.02
Nickel(mg/kg)	7.20	6.70	7.00	6.50	7.90	7.20	8.10	7.40	6.10	5.60	7.50	6.90	8.10	7.70	8.00	7.60
Chromium(mg/kg)	18.70	18.10	18.50	18.30	19.30	18.83	19.70	19.10	15.20	14.90	18.40	17.80	22.60	21.70	24.00	22.50
Zinc(mg/kg)	5.49	5.13	5.42	4.57	0.47	0.38	0.73	0.41	3.08	2.78	5.21	4.81	0.46	0.37	9.42	8.69
Cadmium(mg/kg)	0.47	0.43	0.42	0.37	0.42	0.36	0.57	0.55	0.51	0.46	0.443	0.38	0.61	0.56	0.61	0.57
Iron(mg/kg)	50.14	48.00	52.48	50.30	115.17	110.48	60.41	56.17	63.14	61.18	105.19	103.14	61.01	55.12	142.19	140.73
Manganese(mg/kg)	13.47	12.90	14.60	13.70	37.70	34.4	10.00	9.70	12.20	11.49	35.24	33.41	11.44	11.12	30.1	28.29
Vanadium(mg/kg)	0.02	0.01	0.04	0.03	0.013	0.03	0.03	0.04	0.04	0.03	0.03	0.02	0.04	0.03	0.02	0.03
Copper(mg/kg)	5.40	5.24	5.51	5.28	5.49	5.41	5.50	5.33	5.89	5.74	5.43	5.27	5.45	5.29	5.42	5.26
THC(mg/kg)	0.97	0.64	101	0.79	0.41	0.38	0.34	0.28	0.68	0.43	0.85	0.61	0.46	0.43	0.32	0.23
Oil Grease(mg/kg)	0.85	0.60	0.84	0.52	0.39	0.35	0.13	0.25	0.35	0.41	0.82	0.59	0.30	0.40	0.13	0.22
Hydrogen Sulphide (mg/kg)	1.25	0.74	1.09	0.82	1.68	0.91	1.49	1.23	1.45	1.24	1.45	0.92	1.66	089	1.49	1.09
Available	19.45	10.56	10.35	19.46	22.25	22.33	22.35	23.38	22.18	22.17	19.34	1945	23.19	23.34	22.27	22.31

PARAMETERS	**SS9 (0-15)cm**	**SS9 (15-30)cm**	**SS10 (0-15)cm**	**SS10 (15-30)cm**	**SS11 (0-15)cm**	**SS11 (15-30)cm**	**SS12 (0-15)cm**	**SS12 (15-30)cm**	**SS13 (0-15)**	**SS13 (15-30)cm**	**SS14 (0-15)cm**	**SS14 (15-30)cm**	**SS15 (0-15)cm**	**SS15 (15-30)cm**	**SS16 (0-15)cm**	**SS16 (15-30)cm**
Water Holding Capacity (%)																
THBC (x102cfu/g)	0.1	1.0	0.7	0.8	0.6	0.4	0.8	0.5	1.2	0.7	1.0	1.3	0.8	0.4	1.4	0.8
HUB (x102cfu/g)	0.3	0.2	0.3	0.1	0.3	0.1	0.2	0	0.3	0.1	0.3	0.1	0.1	0.1	0	0
THF (x102cfu/g)	0.6	0.3	0.4	0.2	0.4	0.3	0.3	0.1	1.2	0.8	0.7	0.3	0.3	0.4	0.8	0.4
HUF (x102cfu/g)	0.2	0.1	0.3	3.1	0.2	0	0.1	0	0.2	0.3	0.4	0.2	0.1	0.1	0	0

Table 4b: Physico-chemical and microbiology characteristics of soil for dry season Cont'd

PARAMETERS	SS17 (0-15)cm	SS17 (15-30)cm	SS18 (0-15)cm	SS18 (15-30)cm
pH	**7.3**	**7.6**	**7.2**	**7.5**
conductivity	**45.0**	**45.0**	**47.0**	**47.0**
TOC	**1.06**	**1.14**	**1.76**	**1.64**
Moisture Content	**11.23**	**12.45**	**10.98**	**13.12**
Bulk density	**2.94**	**2.89**	**2.87**	**2.79**
Porosity	**31.30**	**30.53**	**30.89**	**30.12**
Chloride(mg/kg)	**15.1**	**14.2**	**21.3**	**20.1**
CEC	**3.23**	**2.68**	**3.34**	**3.23**
Phosphate	**0.41**	**0.55**	**0.53**	**0.54**
Sulphate	**4.46**	**3.46**	**3.38**	**3.26**
Nitrate	**2.84**	**4.26**	**3.94**	
Calcium	**1.65**	**1.62**	**1.95**	**1.74**
Sodium	**285**	**281**	**283**	**276**
Potassium	**21.23**	**15.67**	**22.48**	**18.93**
Lead	**0.04**	**0.02**	**0.06**	**0.02**
Nickel	**7.2**	**6.72**	**7.23**	**6.84**
Chromium	**15.34**	**14.98**	**14.56**	**14.23**
Zinc	**6.12**	**5.68**	**6.22**	**6.09**
Cadmium	**0.35**	**0.31**	**0.47**	**0.42**
Iron	**50.21**	**48.23**	**109.34**	**101.32**
Manganese	**9.12**	**9.02**	**9.32**	**9.08**
Vanadium	**0.04**	**0.05**	**0.03**	**0.02**
Copper	**5.91**	**5.73**	**5.41**	**5.23**
THC	**0.59**	**0.36**	**0.38**	**0.39**
Oil & Grease	**0.35**	**0.63**	**0.41**	**0.39**

PARAMETERS	SS17 (0-15)cm	SS17 (15-30)cm	SS18 (0-15)cm	SS18 (15-30)cm
Hydrogen Sulphide	**1.12**	**1.28**	**1.69**	**0.91**
Ava Water Holding Cap. %	**21.34**	**21.43**	**21.12**	**21.19**
THBC(x102cfu/g)	**1.0**	**0.5**	**0.9**	**0.7**
HUB (x102cfu/g)	**0.0**	**0.0**	**0.1**	**0.0**
THF (x102cfu/g)	**0.2**	**0.1**	**0.4**	**0.1**
HUF (x102cfu/g)	**0.0**	**0.0**	**0.1**	**0.0**

Table 5a: Physico-chemical and microbiology characteristics of ground water for wet season

PARAMETER	BH1	BH2	BH3
pH	8.95	8.42	6.43
Temperature (^{o}C)	27.00	29.70	29.50
Dissolved Oxygen (mg/l)	1.40	1.60	1.20
Conductivity (mS/cm)	0.10	0.09	0.09
TDS(mg/l)	22.80	36.30	72.00
Nitrate(mg/l)	8.73	7.26	7.26
Nitrite (mg/l)	6.47	5.38	5.38
Ammonium(mg/l)	0.24	0.21	0.25
Phenols (mg/l)	<0.001	<0.001	<0.001
BOD (mg/l)	8.83	9.40	8.50
Sulphate(mg/l)	2.11	1.02	1.17
Phosphate(mg/l)	0.12	0.06	0.06
THC(mg/l)	0.97	1.30	0.30
Residual Chlorine(mg/l)	11.23	12.34	10.25
Total Hardness(mg/l)	20.00	18.00	8.00

PARAMETER	**BH1**	**BH2**	**BH3**
H_2S(mg/l)	14.00	15.30	12.50
Alkalinity(mg/l)	90.0	0.00	48.0
HCO^-_3(mg/l)	21.96	0.00	11.71
COD	26.50	31.00	30.10
Salinity(mg/l)	19.80	16.50	16.50
Chloride(mg/l)	12.00	10.00	10.00
Manganese(mg/l)	0.04	0.05	0.04
Zinc(mg/l)	0.10	0.11	0.09
Chromium(mg/l)	<0.001	<0.001	<0.001
Lead(mg/l)	0.005	0.008	0.006
Iron (mg/l)	0.75	0.20	0.54
Nickel (mg/l)	0.030	0.032	0.026
Copper (mg/l)	0.002	0.003	0.004
Mercury (mg/l)	<0.001	<0.001	<0.001
Arsenic (mg/l)	<0.001	<0.001	<0.001
Vanadium (mg/l)	<0.001	<0.001	<0.001
Cadmium (mg/l)	0.002	0.002	0.004
TSS (mg/l)	0.04	0.15	0.08
Oil and grease	1.81	2.45	1.97
Microbiology			
THBC($x10^2$cfu/ml)	0.2	0. 2	0.1
HUB ($x10^2$cfu/ml)	0.3	0.8	NG
THF ($x10^2$cfu/ml)	0.2	0.2	0.1
HUF ($x10^2$cfu/ml)	0.7	1.0	NG

PARAMETER	**BH1**	**BH2**	**BH3**
T. Coliform ($x10^2$cfu/ml)	0.3	NG	NG

Table 5b: Physico-chemical and microbiology characteristics of ground water for dry season

PARAMETER	BH1	BH2	BH3
pH	6.3	7.3	7.0
Temperature (^oC)	30.60	30.40	28.00
Dissolved Oxygen (mg/l)	2.20	2.00	2.60
Conductivity (mS/cm)	0.07	0.04	0.03
TDS (mg/l)	73.00	94.00	62.10
BOD (mg/l)	4.80	5.00	4.37
COD (mg/l)	21.70	28.10	26.30
Nitrate(mg/l)	5.77	6.68	5.90
Nitrite (mg/l)	<0.01	<0.01	<0.01
Sulphate(mg/l)	1.41	1.49	1.79
Phosphate(mg/l)	0.07	0.07	0.07
THC(mg/l)	1.32	0.12	0.72
Residual Chlorine(mg/l)	4.25	7.80	5.32
Total hardness(mg/l)	4.00	9.00	12.00
H_2S(mg/l)	33.00	34.00	36.00
Alkalinity(mg/l)	6.00	7.00	5.00
HCO^-_3(mg/l)	7.32	8.54	6.10
Salinity(mg/l)	32.00	48.00	22.40
Chloride(mg/l)	20.00	30.00	14.00
Manganese(mg/l)	0.03	0.03	0.02
Zinc(mg/l)	0.03	0.06	0.04
Chromium(mg/l)	<0.001	<0.001	<0.001

PARAMETER	BH1	BH2	BH3
Lead(mg/l)	0.001	0.001	0.003
Iron (mg/l)	0.43	0.06	0.08
Arsenic	<0.001	<0.001	<0.001
Phenol	<0.001	<0.001	<0.001
Copper(Cu)	1.05	0.95	0.56
Nickel (Ni)	0.68	0.92	1.02
Vanadium(V)	0.010	0.003	0.001
Mercury (Hg)	<0.001	<0.001	<0.001
TSS (mg/l)	1.38	0.04	0.45
Cadmium (mg/l)	0.001	0.003	0.002
Ammonium	0.32	0.24	0.20
Oil and grease	1.87	2.94	2.11
Microbiology			
THBC ($x10^2$cfu/ml)	2.0	5.0	8.0
HUB ($x10^2$cfu/ml)	1.0	3.0	0.0
THFC ($x10^2$cfu/ml)	5.0	3.0	3.0
HUF($x10^2$cfu/ml)	3.0	0.0	0.0
T. Coliform ($x10^2$cfu/ml)	2.50	3.40	4.00

Table 6a: Physico-chemical and Microbiology Characteristics of rain water for wet season

PARAMETER	RW1	RW2
pH	6.18	6.01
Temperature (^{o}C)	32.10	30.40
Dissolved Oxygen (mg/l)	2.20	1.30
Conductivity (mS/cm)	0.03	0.06
TDS(mg/l)	37.1	45.0
Nitrate(mg/l)	7.35	7.58
Nitrite(mg/l)	5.44	5.61
Ammonium(mg/l)	0.09	0.10
Phenols(mg/l)	<0.001	<0.001
BOD (mg/l)	6.80	6.50
Sulphate(mg/l)	1.15	1.22
Phosphate(mg/l)	0.06	0.05
THC(mg/l)	0.84	0.94
Residual Chlorine(mg/l)	12.56	12.41
Total hardness(mg/l)	4.0	10.0
H_2S(mg/l)	13.10	13.40
Alkalinity(mg/l)	40.0	50.0
HCO_3(mg/l)	9.76	12.20
COD (mg/l)	10.50	12.40
Salinity(mg/l)	26.40	16.50
Total Nitrogen	0.03	0.14
Chloride(mg/l)	16.0	10.0
Manganese(mg/l)	0.001	0.002

Zinc(mg/l)	0.08	0.06
Chromium(mg/l)	<0.001	<0.001
Lead(mg/l)	0.007	0.008
Iron (mg/l)	0.20	0.12
Nickel (mg/l)	0.03	0.03
Copper (mg/l)	<0.001	<0.001
Mercury (mg/l)	<0.001	<0.001
Arsenic (mg/l)	<0.001	<0.001
Vanadium (mg/l)	<0.001	<0.001
Cadmium (mg/l)	0.002	0.003
TSS (mg/l)	0.03	0.04
Oil and grease(mg/l)	2.53	2.62
Microbiology		
THBC ($x10^2$cfu/ml)	2.4	1.4
HUB ($x10^2$cfu/ml)	0	0.6
THFC ($x10^2$cfu/ml)	1.2	0.5
HUF ($x10^2$cfu/ml)	0.3	0.5
T. Coliform ($x10^2$cfu/ml)	0.5	0.3

Table 6b: Physico-chemical and Microbiology Characteristics of rain water for dry season

PARAMETER	RW1	RW2
pH	6.02	5.11
Temperature (^{o}C)	31.70	32.30
Dissolved Oxygen (mg/l)	1.90	2.40
Conductivity (mS/cm)	0.02	0.05
TDS(mg/l)	48.40	113.0
Nitrate(mg/l)	6.54	6.36
Nitrite (mg/l)	<0.01	0.01
Sulphate(mg/l)	2.10	1.79
Phosphate(mg/l)	0.08	0.06
THC(mg/l)	0.41	0.53
Residual Chlorine(mg/l)	8.15	7.44
Total hardness(mg/l)	20	5
H_2S(mg/l)	31	30
Alkalinity(mg/l)	5.0	5.0
HCO_3(mg/l)	6.1	6.1
Salinity(mg/l)	19.20	22.40
Total Nitrogen	0.04	0.02
Phenol(mg/l)	<0.001	<0.001
BOD (mg/l)	1.8	2.0
COD (mg/l)	9.30	10.20
Copper (mg/l)	<0.001	<0.001
Nickel (mg/l)	<0.001	<0.001
Vanadium (mg/l)	<0.001	<0.001

PARAMETER	**RW1**	**RW2**
Mercury (mg/l)	<0.001	<0.001
Arsenic (mg/l)	<0.001	<0.001
Chloride(mg/l)	12.0	14.0
Manganese(mg/l)	0.002	0.005
Zinc(mg/l)	0.04	0.08
Chromium(mg/l)	<0.001	<0.001
Lead(mg/l)	0.002	0.004
Iron (mg/l)	0.03	0.07
TSS(mg/l)	0.19	1.0
Cadmium (mg/l)	<0.001	<0.001
Ammonium(mg/l)	0.31	0.34
Oil and grease (mg/l)	2.71	2.84
Microbiology		
THBC ($x10^2$cfu/ml)	4.0	4.5
HUB ($x10^2$cfu/ml)	1.30	0.70
THFC ($x10^2$cfu/ml)	2.70	0.80
HUF ($x10^2$cfu/ml)	1.70	0.0
T. Coliform ($x10^2$cfu/ml)	0.0	3.10

Appendix 5
Participant List of the Scoping Workshop held on the 26th of March 2008

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Chf. Ogbodo J.	Omuigwe Aluu	Ikwerre	
2	Mr. Samuel Nwachukwu	Omuigwe Aluu	Ikwerre LGA.	
3	Chf Blessing Nkoku	Umuakuru	Etche	
4	Mr. Mendel Ouyesa	Umuakuru	Etche	
5	CHIEF FRANCIS OPURUM	RUMUCHIOLU - ENEKA	OBIO/AKPOR	
6	HON. EMEKA MBATA	RUMUCHIOLU - ENEKA	OBIO/AKPOR	
7	Chief O.N. ICHEMUSO	RUMUAGHOLU	OBIO/AKPOR	
8	Chief K.N.W. AMADI	RUMUAGHOLU	OBIO/AKPOR	
9	Mr Bathram Ogbondah	Omumah Igwuruta	KELGA	
10	Gladson Ikengah	Omumah Igwuruta	KELGA	
11	Comr. Ham Worlu	Omumah Igwuruta	KELGA	
12	Edwin Nwagu	Omumah Igwuruta	KELGA	
13	Emmanuel E. Ejekwu	Eliogbolo (Rumuokoro)	Obio/Akpor	
14	Engr. Mbata Shadrach	Eliogbolo (Rumuokoro)	~	
15	Mr Napoleon Amadi	Rumuekpe Rukpokwu	OBALGA	
16	Sir Ovy Ezeoru			
17	MR WILLIAMS SAMUEL	UMUOKWA	ETCHE LOCAL GOVT.	
18	Awale Julius	UMUOKWA	ETCHE	
19	Nwe, Innocent	Igwuruta - Ali (Omuike)	KELGA	
20	NNODI CHARLES	IGWURUTA ALI OMUIKE	Kelga	
21	HON SHEDRACK ONU	EGWI	ETCHE	
22	Francis Choko	EGWI	ETCHE	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Chief James Amadi	OMAGWA	IKWerre	
2	" " Samuel Ovalolepa	" "	" "	
3	Thankgod Amadi	AGBOGA	" "	
4	Kenneth Onwucheku	" "	" "	
5	Chief Emma N Frank	Rumuepa Rukpokwu	Obio/Akpor	
6	Mr. Asonye Sabinus	Rumuepa, Rukpokwu	Obio/Akpor	
7	Emmanuel Nwafor	Umuakonu Etche	Etche	
8	Hycinth Nworgu	"	"	
9	HON Ap Gabriel Chuku	RUMUOWHA ESERA	Obio/AKPOR	
10	MR. Emmanuel Oche	" "	" "	
11	Samuel A. Nwafor	Chokota Etche	Etche LGA	
12	Morrison Amadi	"	"	
13	Kevin Amanye I	RUMUOSI	OBIO/AKPOR LGA	
14	Wagbara David	Rumuosi	"	
15	ICHELLA BEN	RUMUOKPARALI	OBIO/AKPOR LGA	
16	Comrade Godwin Wordu	Mgbagidi	Ikwerre	
17	Johnson Wehale	"	—	
18	Chief J. A. Amadi	Elelo Rukpokwu	Obio Akpor	
19	" Charles O. A. Nyemadu	" "	"	
20	BARR. OTAMIRI JOHN NGUBO	OKOMOKO ETCHE	ETCHE LGA	
21	AZUBUIKE GODWIN	OKOMOKO/ETCHE	ETCHE LGA	
22	Elder Abuldmus Okeh	Rumuesara Eneka	OBALGA	
23	Nwoma Robinson A Chuku	"	—	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Hon Olundah Igwe	Nkpogwu Rebisi	PHLGA	[signature]
2	Dede Chizie G.	Nkpogwu Rebisi	PHLGA	[signature]
3	JUSTICE N. EREH	OMUODA – ALUU	IKELGA	[signature]
4	[illegible] A. S.	OMUODA – ALUU	IKELGA	[signature]
5	Chief F. C. Nwoeche	Umuoyanga	ELGA	[signature]
6	Mr Titus Nwoke	Umuoyanga	Etche	[signature]
7	CHIEF MATHIAS [illegible]	Rumuokwu	OBIO/AKPOR	[signature]
8	Azubuike Nwanu	✓	✓	[signature]
9	C. A. J. Chinwo	Rumuekwhara, Orogwe	"	[signature]
10	Reca Owhonda	✓	✓	[signature]
11.	EZE (DR.) J. A. UTCHAY (JP)	ELIMGBU, ORIGWE	OBIO/AKPOR	[signature]
12.	UTCHAY SILVERLINE	=	=	[signature]
13.	SUNNY WORLU, ESQ.	RUMUODOMAYA	✓	[signature]
14	MR. FRIDAY E. EKWE	✓ ✓	✓	[signature]
15	HON L. C. IGWE	CHOBA COMMUNITY	OBIO/AKPOR	[signature]
16	DR. H. N. OZURU	CHOBA COMMUNITY	✓	[signature]
17	MR. DANIEL I. OGBONNA	ALAKAHIA	OBIO/AKPOR	[signature]
18	MR. VINCENT CHUKWU	✓	✓	[signature]
19	Mr Joseph Otamiri	OKORAGU	ETCHE	[signature]
20	Suleiman Nwogbes	[illegible]	✓	[signature]
21	HON BLAISE WOBO	Elelenwo	PHALGA	[signature]
22	GLORY [illegible]	✓	✓	[signature]

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Benjamin C. Wobidi	Rumuodukwu Eneka	Obio/Akpor	
2	Chidi Owhonda	R. ✓	✓	
3	Thankgod Chuku	Omuchiolu - Aluu	Ikwerre	
4	Chigozi Wosu	Omuchiolu Aluu	Ikwerre	
5	Humphery Woku	Omuokoji	Ikwerre	
6	Chinedu Kingsley	Omuokoji	Ikwerre	
7	Innocent A. Ogbonna	Rumuokwurusi - Eneka	Obio/Akpor	
8	Godwin Onum	✓	✓	
9	Kelvin Agbam	Umuechem	ETCHE	
10	Echezu Jonathan	Umuechem	Etche	
11	Nworgu John'N'	Omuoke - Igwuruta	IKWERRE	
12	Terry Joe Oloche	Omuoke - Igwuruta	✓	
13	Chief E.A. Gabriel	Agwanwosi Omagwa	Ikwerre	
14	Henry Ikpo	Agwanwosi Omagwa	✓	
15	CHF. John Oluo	Umuogodo Igbo-Etche	ETCHE LGA.	
16	Mr. Emmanuel Nwaogbu	Umuogodo Igbo - Etche	Etche LGA	
17	Agoronda Woke	Mgbuchi Rukpokwu	Obio Akpor	
18	Hanotu Justice	Mgbuchi Rukpokwu	Obio/Akpor	
19	Emmanuel Anyanwu	Umuakuru Umuokpu	ETCHE	
20	August Agbaegbu	✓	✓	
21	Festus E. Okere	Umunwaelile	✓	
22	John Onyegorom	✓	✓	

S/N	Name	Community	LGA	Signature
1	ICHELLA, A. BONIFACE	OZUOBA – AKPOR	OBIO/AKPOR	
2	Pastor Amadi C.D.	✓	✓	
3	Samuel Kinikanwo	Omuelia by Nunda	Ikwerre	
4	Christian Amadi	✓	✓	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Barr. E.J. OSIMIRI	RUMUODUGO	EMOHUA	
2.	OFFA OBINNOH Esq.	✓	✓	
3	QUOSIGHE KINGSLEY	RUMUOPIRIKOM	OBIO/AKPOR	
4	PION PRINCE WELI-WORU	RUMUOPIRIKOM	OBIO/AKPOR	
5	TEMPLE WUCHE K.	RUMUOBEKWE	OBIO/AKPOR	
6	PROMISE ADELE	RUMUOBEKWE	OBIO/AKPOR	
7.	Eze Elijah Okoro	Umuchoke	Etche	
8.	Chidiebere Dickson	✓	✓	

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Hon Chief G.N.S Agbaruke	ATALI	OBIO/AKPOR	
2	CHIEF GODPOWER A. AZONWU	ATALI	OBIO/AKPOR	
3	SUNNY NNADI	ENEKA	OBIO/AKPOR	
4	GODPOWER OKEKE	ENEKA	✓	
5	HRH Eze A.O. Owhonda	RUMUOKORO	✓	
6	Chief E. A. Chinda	✓	✓	
7	Richie O'Worlu	Rukpokwu Comm.	✓	
8	Hon. Joseph Chidi Ouhor	Rukpokwu	Obio/Akpor	
9	KENNETH OKAM	Rumuoji ENEKA	Obio/Akpor	
10	Felix Amadi	Rumuekini	Obio/Akpor	
11	Akandu Clement S.	Rumuekini	✓	
12	BETHEL AMADI	OMUIKE Aluu	IKWERRE	
13	EMMANUEL E. EMENIKE	OMUIKE ALUU	IKWERRE	
14	JUMBO LONDON	NKPOLU RUMUIGBO	OBIO/AKPOR	
15	Sunday Akah	Nkpolu Rumuigbo	Obalga	
19	Chf. Ken. Walobunmo	Mbodo - Aluu	Kelga	
20	Emmanuel Peters	Mbodo - Aluu	Ikwerre	
21	ES Amerengwo	Omuoko Omuoko	Kelga	
23	Chief C. Emenigwe	✓	✓	
24	Nwogu Innocent. M.	Chokocho Community	ELGA	
25	Chief Nwala Charles. C.	Ch. ✓	✓	
26				
27				

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Ochuba Augusta	Fed Min of Envt, H & UD, PH	–	
2	EZEOBIE RAH JOE	VSGP		
3	ESITO SUNNY	CHIEF REIS IDSL/NGNL		
4	TOBY EMMANUEL	SPDC CHE CCRLE		
5	END-OBONG EKONG	SPDC – CSDS		
6	Nwachukwu, Eunice	SPDC – CFHEV		
7	Obuoforibo George	SPDC SCJ		
8	Miebaka Moses	SPDC CFHEV		
9	Inengite Azibaola K.	SPDC CFHEV		
10	DAVIDS, CALEB	SPDC – CSDS		
11	Anyanwu Victor	SPDC – CFHEV		
12	I.C. Okoro	SPDC		
13	T-T. OMINO	State MOH		
14	Onomuo-Samuel, P.J	SPDC, CCRLE		
15	Esabilibe Uzezi	SPDC, CCRLE		
16	Bayo Shedrack.	SPDC VSGP		
17	Bernard Osuji	SPDC – VSGP		
18	Ibidoja Kayode	SPDC, CFHEV		
19	BLADELE, T-G	RSMENV		
20	MAJOFODUN C.E. (MR)	DPR – LAGOS		
21	UFONDU, E.D (MRS)	DPR – PHC		
22	Reuben Jonah	SPDC – VSGP		
23	Isah Sulemana	SPDC – VSGP		

Attendance list

EIA Scoping Workshop for Agbada (OML 17) 4D Seismic Survey, Agbada FOD & FDP

S/N	Name	Community	LGA	Signature
1	Prof. Austin Obinkpa	SPDC	–	

Appendix 6

RESPONSE TO FEDRAL MINISTRY OF ENVIRONMENT COMMENTS FOR AGBADA NAG EIA

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
Cover Pages			
1	The cover page should read submitted to Federal Ministry of Environment	Preliminary Pages	Done
2	The status page of the report should be paged	Preliminary Pages	i
3	The report does not have table of contents include Table of contents in the final report	Preliminary Pages	ii to v
4	Page XVIII report preparers: the list of EIA preparers should include individual area of qualification, specialization and study function	Preliminary Pages	Done
5	Page XX acknowledgement: the correct acronym for Federal Ministry of Environment is "'FMEnv" Correct it wherever it is in the report	Preliminary Pages	Done
6	List of Figures, List of Plates, List of Plates, List of appendices have been omitted in the preliminary page of the EIA draft report.	Preliminary Pages	vi to viii
7	Page xvii: On the list of Regulators at field sampling "Housing and Urban Development" should be expunged from the Federal Ministry of Environment. The Ministry no longer has that nomenclature but simply Federal Ministry of Environment	Preliminary Pages	Housing and Urban development has been expunged
8	List of acronyms/abbreviations: some acronyms and abbreviations used in the text were not listed and some listed were wrongly defined. Update list of abbreviations in the final report	Preliminary Pages	ix
9	Correct the wrong paginations that characterized the preliminary pages of this		Done

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	report		
EXECUTIVE SUMMARY			
10	The executive summary should be paged using roman numerals	ES	Done
11	Page 1 ES 1.3 Coordinates of the Project location should be provided	ES	ix
12	Page 1 ES 2 EIA objectives: the EIA Terms of Reference(ToR) should be provided under this section	ES	Done
13	Page 3 Project Justification: The envisaged sustainability should be centered on the technical, economic and environmental sustainability of proposed project and not economic value of the project alone	ES	Technical and environmental sustainability have been included. Page xi.
14	Page ES 3 to 4 Project alternatives: in the executive summary there is no Project alternatives mentioned. What was highlighted is different from Project alternatives.	ES	This has been corrected to Project Development Options. Page xi to xii
15	ES Page 3. On paragraph1 line 7, the DPR Director was quoted as saying that the quantity of Nigeria Gas daily flared was at a minimum of 2.5 billion standard feet of Natural Gas and a daily loss of about US $10. This has not been a stagnant figure over the years. The time this claim was made needs to be stated along.	ES	This statement has been deleted because the figures are no more correct
16	On paragraph 4 line 1 an acronym AG was used, this was not defined in the list of ACRONYMNS and ABBREVIATIONS provided.	ES	Associated Gas (AG). This has now been included in the list of acronyms. Page ix.
17	ES Page 4, Paragraph 4 line 3 under Project description, it was stated that drilling and	ES	Drilling and Completion of 2 NAG wells (W67 and W68). Page xii.

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	completions of two (2) NAG wells and recompletions of one of the wells in 2014.This statement is not coherent technically. Is SPDC planning to drill and complete two new wells and recomplete an old existing one? The final report needs to clarify this.		
18	The foot note numbering style are not consistent with the one applied in the remaining part of the report		This has been removed
19	The information on provided especially on current population and its projection of the affected LGA's are not current	ES	The information on current population has been updated. Page xviii
20	There is gross lack of information on drilling and completion scope as well as on the pipe laying	Included in chapter 3/Section 3.3.3	Information on the drilling and completion scope and pipe laying has been included. Page 24.
21	Drilling: How man strings are we looking for at each of the wells and what are respective Casing sizes viz a viz the drilling bits considered?	Included in chapter 3/Section 3.3.3	Both wells had the following 67/ 68; ➢ 24'' stove pipe - /(354ft) ➢ 10 ¾'' 60.7ppf- /(120ft) ➢ 9 5/8'' 47ppf -/ (11,725ft) Page 24.
22	What are the respective projected well depths?	Included in chapter 3/Section 3.3.3	Projected well depths for W67/68; ➢ /11,774ftah Page 24.
23	What are the Mud alternatives for the respective well s and what are the factors being considered to make a choice?	Included in chapter 3/Section 3.3.3	The well was drilled with POBM and the drill –in fluid across the reservoir was Thixal mud to reduce the reservoir impairment, thereby increasing the production potential. Page 25.
24	How would the mud be handled after the project?	Included in chapter 3/Section 3.3.3	The POBM is recovered and treated for use in other wells by the Mud supplier.

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			Page 36.
25	What type of completion would be embarked upon and what is the justification?	Included in chapter 3/Section 3.3.3	The completion is 4 ½'' 13cr upper completions with external Gravel pack in the sand face. This is to enable 40Mmscf/day gas production
26	Is it going to be single string, dual strings or single selection type of completions?	Included in chapter 3	Single string completion
27	On the pipeline would it just be constructed and the products introduced like that?	Included in chapter 3/Section 3.3.5.8	On completion of pipeline construction, pre-commissioning activities which includes cleaning by introducing swabbing and brushing pigs into lines via the pig traps, hydrotest of pipelines to 1.25 of the design operating pressure using tested potable water, depressurizing and drying of the lines with compressed air-driven high and low density foam pigs in order to remove moisture from the lines to the required dew point of -20^{o}c were all carried out. Thereafter, leak test, purging/preservation of lines with nitrogen and awaiting final commissioning which will involve introducing the products.
28	What grade of pipe does SPDC have in mind and what are the choice considerations?	Included in chapter 3/Section 3.3.5.4	8" PE coated carbon steel pipes (L450/X65 grade) for flow lines and (L360/X52 grade) for 2" corrosion inhibition lines. The choice considerations for the flow lines from design parameters includes; the design well flow rates, NAG production forecast,

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			NAG temperature, pressure and composition.
29	What type of welding procedure to be approved for the construction?	Included in chapter 3/Section 3.3.5.4	The welding procedure specification (WPS) approved for manual welding is in line with ASME B31.8 (Gas transmission and distribution piping systems), DEP 61.40.20.30-Gen (Welding of pipelines and related facilities - amendment/supplement to API 1104), DEP 31.40.00.10-Gen (Pipeline Engineering) and Standard Construction Specification Section 21(Welding).
30	What about the pipeline cleaning and hydrotesting phases?	Included in chapter 3/Section 3.3.5.8	Pipelines were properly cleaned by running air-driven swabbing and brushing pigs in order to ensure the lines were free of debris. Filling of the lines with tested potable water followed and introduction of two swabbing pigs in order to ensure removal of air. On arrival of water filling pigs, flushing continued until an acceptable clean level of the lines were achieved. Water pressure-driven gauging pigs were thereafter introduced and deformity checks carried out upon arrival at the exit point. Thereafter, hydrostatic pressure was applied moderately up to 30% of the test pressure ensuring that the air content in the line does not exceed 0.5% of volumetric capacity and held for 2hours to confirm no pressure loss. On satisfactory completion, pressure was

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			moderately raised to 70% of the test pressure with a maximum pressure of 20bar/hour. After attaining 70% of the specified test pressure, raising of the pressure continued moderately at 15% of the test pressure (or 10bar/hour) until the specified test pressure was achieved. This was held for 2hours and thereafter, the pressure was reduced to 50% of the test pressure at a rate of 20bar/hour for the first hour and later 60bar/hour. This process was repeated in order to achieve the required test pressure. Then the ambient and water in the line temperatures were recorded. After ensuring stabilization of the lines, the chart recorder was now connected and monitored for 24hours with the initial temperature and pressure readings taken. Also, gauge pressure and temperature readings were recorded on hourly basis. On successful completion of the hydrostatic pressure test, the lines were depressurized immediately at a rate of 20bar/hour at first and thereafter 60bar/hour. The specified test pressures used are 1.25 of the design operating pressure for flow lines and 1.5 for piping. Water in the lines was properly discharged into an impermeable containment pit using air-driven high

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			density foam pigs. Drying process followed immediately by introducing low density foam pigs through the pig traps and blowing of the lines continuously with air in order to remove moisture and achieved the required dew point of -20ºC.
31	How will the pipeline be chemically treated?	Included in chapter 3/Section 3.3.5.8	Corrosion inhibitors will be injected continuously via an injection skid at each wellhead to help reduce internal corrosion and extend the lifespan of the flow lines.
32	What measures are in place to handle the effluent following the chemical treatment?	Included in chapter 3/Section 3.3.5.8	The effluent during the chemical treatment will be transferred to the SPDC Produced water system in the Agbada I flowstation for subsequent export to Bonny Terminal
33	All these need to be reported as part of project summary	Included in chapter 3/Section 3.3.5.8	Noted
34	Project alternative should key into the alternative project location, alternative technology(facilities and equipment)" best available technology	Included in chapter 3	This has been done
35	ES page 5 the proposed project scheduled for commissioning by 3rd quarter of 2010 should be revised in line with the current status of the	Included in chapter 3	Project schedule has been updated
36	ES page 5 Environmental Baseline description; the period that both wet and dry seasons were carried out 24th October to 5th November and 26th to 30th January 2009 is more less dry season sample for both season	Chapter 4, page 3 of 10 and Executive summary (ES 5)	October is late rainy season (March to July and September to October) why November is early dry season (November to February)

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
37	ES Page 9 Groundwater; The second paragraph, the unit of conductivity measurement is in some typographical error; it is expected to be microsemen/cm	Chapter 4 (Rain water characteristics) and ES(Ground water)	mS/cm has been corrected to µS/cm
38	The COD of the ground water system shows been stressed	ES5.5/Chapter 4.8.3	The COD concentration in the groundwater sample ranged from 26.50-31.00mg/l and from 21.70 – 28.10mg/l for wet and dry seasons. The regulatory limit for COD is <75mg/l.The COD was within regulatory limits
39	SPDC should carry out a cumulative impact assessment of all the area	ES	Noted
40	ES Page 11 states that the socioeconomic survey covered three LGAs, however four LGAs are listed there. This should be corrected or cross checked	ES 5.8	This has been updated to read two LGAs(Obio Akpor and Ikwere)
41	ES Page 11-wildlife, why study only one vertebrate? are they the only animals within the study area? What about the invertebrates? Herpatofauna species(amphibians) are not lizards and snakes as stated in the last sentence	ES 5.7	The statement has been corrected to read Herpatofauna species (amphibians and reptiles)
42	ES Page 12, Paragraph 3- why was the population figures of all the LGAs not displayed in the Project report	ES5.8	This has been included in the ES and Chapter 4
43	Please recheck your claims that the total population figure in the three LGAs as per the 2006 census is 654,515 so what was your projected figure for these LGAs.	ES 5.8 and Chapter 4.12.8.1	In 2006 Obio-Akpor LGA had an estimated population of 464,789 persons while Ikwerre LGA had a population of 654,515. In 2009 Obio-Akpor LGA had a population of 504,934 persons while Ikwerre had a population of 206,113 persons. In 2015 Obio-Akpor had an

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			estimated population of 512, 927 persons while Ikwerre has an estimated population of 707,653 persons
44	ES page 13 paragraph 1; are there no health centres in the study area	ES 5.9 /Chapter 4.13.1	The Health centers in the area, included, Community Health Center, Mbodo Aluu – (SPDC provided), Bon Maria Clinic, Rukpokwu and Patfare Clinic, Rukpokwu which are both privately owned
45	ES page 14 NEGATIVE IMPACTS; A negative impact not mentioned here is a damage to the road infrastructure as a result of movement of heavy equipment but the mitigation measures was captured in page 15 last bullet	ES 7.2	Damage to the road infrastructure as a result of movement of heavy equipment has been included in the ES
46	The Executive Summary did not capture surface water as one of the study parameters under environmental baseline data		Surface water was not captured because there was no surface water body within the study area (see map of study area)
CHAPTER ONE:INTRODUCTION			
47	Map of Nigeria showing Rivers State was conspicuously missing in this section	2	It has been included
48	River State map showing LGAs was not included	2	It has been included
49	Credible information about the proposed project environment should be stated in this chapter	4	More information about the proposed project environment have been included
50	Page 20 of 21 Structure of the Report; Chapter five(5) which presents the consultation and identification of stakeholders, host communities and regulators should be moved to chapter 4 under socioeconomic status of the	55	Consultation section has been moved to the Social Economics section of Chapter 4.

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	project area		
51	Chapter 5 to chapter 8 should be revised to confirm with EIA report writing format		Chapter 4 has been merged with Chapter 5, so Chapter 6 is now Chapter 5 , Chapter 7 is now Chapter 6 while Chapter 8 is now Chapter 7
52	Chapter 5 described under this section should be merged with chapter 4.		Chapter 4 and 5 have been merged
CHAPTER TWO: PROJECT JUSTIFICATION			
53	Page 1 of 8 on Project justification: Section 2.1 Background line; Line 1 is it Agbada 1 well that discovered the field….. please re-visit the phrase	12	The Agbada field is located in the Eastern Land Area operation of Shell Petroleum Development Company (SPDC) in OML 17 situated approximately 16 km North-East of Port Harcourt in Rivers State. The field was discovered in 1960 by SPDC and to date sixty-six (66) wells have been drilled in the field.
54	On paragraph 2 section 2.2 page 1 of 8, NAFCON was mentioned as one of the target consumers of the product from this project; events have overtaken this; the name of the current and potential consumer needs to be updated in the final report	12	Notore Chemical Industries
55	The envisaged sustainability of the Project should include the following: Technical sustainability; the conceptual design phase should include the optimization of site layout wells and pipeline routes as proposed	12 to 13	This has been included
56	Environmental sustainability; compliance with	Chapter 3 section 3.1. Page 19.	This has been included in Chapter 3 section 3.1

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	design on engineering standard, codes and practices with respect to environmental standards and policies, regulations and procedures should be included.		
57	It should include integration of impact minimization and mitigation measures in to design the design of the project facilities	Chapter 3 section 3.1. Page 19	This has been included in Chapter 3 section 3.1
58	It should include compliance with gaseous emissions effluent discharge and waste disposal regulations.	Chapter 3 section 3.1. Page 19	This has been included in Chapter 3 section 3.1
59	It should identify how best the implementation of an effective contingency and response planning for environmental impacts and accidental events during the operational phase of the project	Chapter 3 section 3.1	This has been included in Chapter 3 section 3.1
60	Project alternatives; A section should be created for project alternatives and this should evolve out of careful consideration of alternative project locations and alternative technology (best available equipment) to be used during construction and operational phases of the project. This differs from project options as used in the report. The revised should consider environmental	13 to 17	This exists in Chapter 2

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	implications of alternatives		
CHAPTER 3 PROJECT DESCRIPTION			
61	Page 1 of 19 the project location lacks coordinates	19	Agbada Field is located in Ikwerre Local Government Area of Rivers State and within SPDC's OML 17. Latitudinal and longitudinal positioning of the Flowstations I and II were found to be 6.58°72'E, 4.56°02'N and 7.00°95'E, 4.55°94'N respectively using a GARMI Global Positioning System (GPS) on the field. Agbada field was the first land-based oil-field in the Eastern Division of SPDC. The two flowstations, Agbada I and II were commissioned in 1960 and 1965 respectively with a combined capacity of 90,000 bbl/d. Agbada I is a single bank flowstation with a nominal capacity of 30,000 bbl/d having 30 flowlines laid to the station while Agbada II is a double bank flowstation with a nominal capacity of 60,000 bbl/d and having 57 flowlines.
62	Figure 3.1 under project location the political map of Rivers state should be updated with conventional geographical features that enhance map reading	19	This has been updated
63	Page 1 of 19-Project location; Identify and mention the host communities in the LGAs where the project will traverse. Each LGA will be highlighted	19	The project centers on six (6) communities from two (2) Local Government Areas LGAs in Rivers State. The Local Government Areas are Obio Akpor and Ikwere LGAs. The

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			communities Omuoda Aluu, Mbodo Aluu, Omunike Omunoba and Omuigwe Aluu in Ikwere LGA and Rumujima Eledo Rukpokwu and Elikpokwodu Rukpokwu in Obio Akpor LGA
64	Page 2 of 19-Table 3.1;" proposed EIA outline coordinates" what exactly is meant by proposed EIA coordinates	Chapter 3.2. Page 20.	The scope of the EIA are within the area with the following co-ordinates below
65	The map in page 3 of 19 should be replaced with a bigger GIS generated map(attached as an appendix) to illustrate the project locations in Rivers State and should be given proper titles with legends and indicate geographical coordinates	Appendix	This has been done
66	Page 4-19 of the report Project activities; Bullet point 12 it was indicated that the component of the project will also involve "laying Nos of 8"x8km flow lines from wells at Agbada 1 to NAG plant at Agbada II. While on the ToR submitted 8"x20km was indicated. What is the correct length of the proposed flowlines?	Chapter 3. Page 23.	The correct length is 2Nos x 8" x 8.15km flow lines (i.e. Total length of both flow lines is 16.3km) from NAG Wells at Agbada-1 to the pig receiver at Agbada-2 NAG plant.
67	Page 4-19 Landtake; It was stated that there will be no additional landtake while under project activities bullet 8 it was indicated that there would be land acquisition and claim settlements. Provide the accurate detail in the revised report	Chapter 3. Page 26.	Pipelines will be buried to a minimum depth of 1.5m at road crossings (i.e. minimum cover between road surface and the top of pipeline).
68	Page 4-19 to page 18 of19; For each project activities, you are expected to list all the	Chapter 3. Page 23	There shall be additional land take (8.9316 hectares) along the RoW

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	environmental disturbances eg air pollution, noise, waste streams etc. SPDC claims there will be no additional land take yet she has proffered mitigation measures for land acquisition. SPDC should clarify this		
69	Page 6, 3.3.3. Drill workers and Completion of Wells; During the drilling exercise SPDC should show how the ground water would be protected as the flow direction is south-westerly	Chapter 3. Page 25.	Ground water will be protected using casing strings as they ensure the isolation of fresh water zones and groundwater inside the well, Casing is further used to transmit flowback fluids from well treatment and is the first line of defense and a second layer of protection for groundwater, We also carry out frequent sampling and laboratory analysis of waters from boreholes drilled within the location to provide a groundwater monitoring array that will enable the setting of an environmental baseline and the ability to study and record groundwater conditions throughout the lifecycle of the operation
70	Page 7, 3.3.4.1 RoW Survey and Bush Clearing; SPDC was not specific at what depth pipeline should be buried at road crossing	Chapter 3. Page 27	Pipeline will buried 3m beneath the road at road crossings
71	Page 10, 3.34.7 Cathodic Protection: this is a device to protect the main carrier pipe. How long should the cathodic pipe last i.e. the sacrificial anode and what method would you use to replace it when it is used up	Chapter 3. Page 29	The sacrificial anode design lifespan is 5years. This would be replaced by a deep ground bed cathodic protection system upon commissioning.

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
72	Page 19 of 19, Section 3.10 Project Schedule: this should be revised to include Project EIA key activities and the current timeline for the Project implementation	Chapter 3. Page 37.	This has been revised
73	This chapter over summarized the description of the Project scope(especially the drilling and completion) while the pipeline construction, handling and treatment facets were not given adequate coverage	Chapter 3, Page 24 to 30	This section has been expanded
CHAPTER 4; DESCRIPTION OF THE EXISTING ENVIRONMNT			
74	Page 1 of 45, section 4.1, Appendix 1 is not in the report as claimed.	Appendix	This (GIS map) has been included
75	Page 1 of 45 to page 5 of 45- on climatic and meteorological data should be revised with NIMET data of at least 30 years. This is necessary as an environment is dynamic as well as to take care of climate change		Information for 30 years not readily available
76	Rainfall data presented in this study depict rainfall trend and represent data for only seven years. No attempt was made to show some historical data of rainfall trend in the study area in the report	Chapter 4. Section 4.3. Page 40.	We could not lay our hands on any recorded historical data specific to Agbada. Closest information was obtained from NIMET Port Harcourt Zone. The area is very close Port Harcourt (2km)
77	Similarly temperature data reflected only the period of field data collection with no historical data presented to reflect changes over time	Chapter 4. Section 4.3. Page 40.	Historical data has been included
78	Two soil profile pits and 36 soil sampling points were presented in the report of soil studies. Mention is not made in the report of the basis for the choice of the number of soil	Chapter 4, section 4.7. Page 43 to 45	Samples were collected at 0 –15 and 15 – 30cm depths within the study area. Soil samples were distributed within the study area along the pipeline RoW, GHF

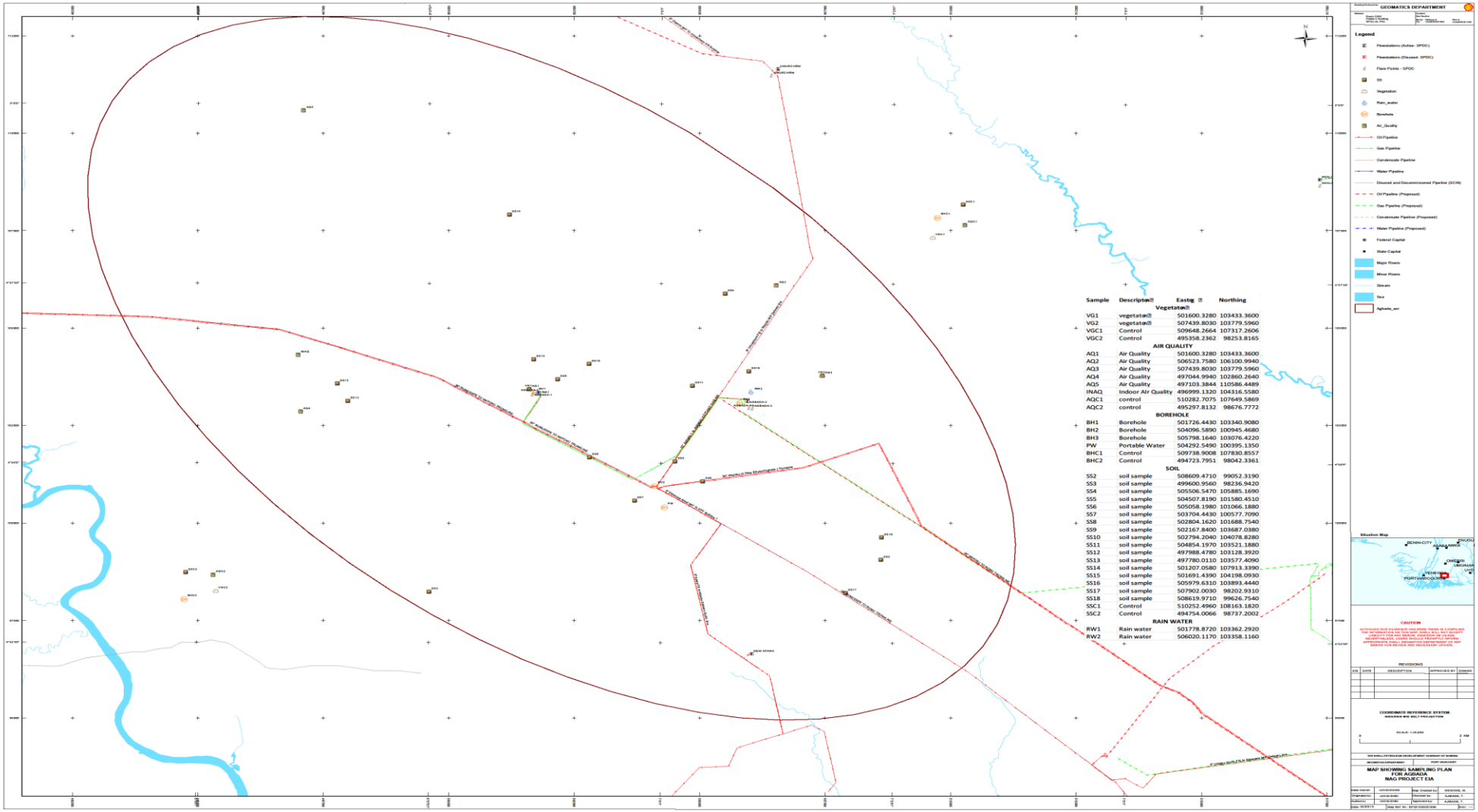
S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	profile pits/sampling points such as physiographic factors, major soil types and land use patterns etc		location and in control stations. There was no record of spills within the area otherwise a soil sampling station would have been located at such a site. Two soil profile pits were located 50m from each of the flow stations (Agbada 1 and Agbada II). The objective of the profile pits was to determine whether the locations of the two Flow stations had a different soil profile
79	Surface water data was omitted in field data acquisition and analysis. This is not acceptable for a study with potential impact on such an important environmental component	Not Available	ToR did not contain samples for surface water because of the absence of surface water (streams, rivers and ponds) within 4km of the study area. As a result rain water samples was collected in the absence of surface water
80	Equally in evaluating the environmental components and potential impact indicators the monitoring program for environmental components identified surface water quality as one of the major components to be monitored. Without a baseline data on surface water quality there will be no basis of the proposed surface water quality monitoring. This omission is a major deficiency in analyzing the potential impact of this project on a key environmental component	Not Available	Impact of Project activities on surface water and mitigation actions to reduce the impact on surface water have been expunged
81	Page 41 of 45 section 4.13; update health status as Health Impact Study of the project location is scanty	Chapter 4.13. Page 73 to 77	This has been updated: The health centres in the area, included, Community Health Center, Mbodo Aluu – (SPDC provided),

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
			Bon Maria Clinic, Rukpokwu and Patfare Clinic, Rukpokwu which are both privately owned.
CHAPTER FIVE: POTENTIAL AND ASSOCIATED IMPACTS			
82	Chapter 5 on consultation should be merged with chapter 4 in line with National EIA reporting format	Chapter 4. Section 4.12.1, Page 55 to 58	This has been done
83	Page 1 of 3 and 3 of 3 evidence of consultation provided is not sufficient. The evidence of consultation in terms of list of participants venue of meeting concerns expressed, list of attendance, signatures and telephone numbers etc	Appendix IV	This has been included in the appendix IV
SOCIOECONOMIC SURVEY(CONSULTATION)			
84	In the report restricted photographs shown are not an adequate representative of pictures for the entire 3 LGAs communities claimed as host of the project		More photographs have been included
CHAPTER SIX IMPACT MITIGATION MEASURES			
85	Table 6.2 and 7.1 of 7 on characterization/evaluation of potential impacts and impacts/mitigation should be harmonized as there is disparity		Mitigation measures were only provided for impacts that had ranking of medium to high significance Table 6.2 and 7.1 have been harmonized. Table 6.2 is now 5.2 and Table 7.1 is now 6.1
CHAPTER SEVEN MITIGATION MEASURES			
86	This chapter on mitigation measures should be moved to chapter six to conform to EIA report format	Chapter 6	This has been done
87	Page 3 of 8 to 8 of 8 Table 7.1project phase ; only proffer mitigation measures for	Chapter 6, Table 6.1	Mitigation measures for decommissioning and abandonment have

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
	premobilization, mobilization, operation and maintenance, while Decommissioning and Abandoned phase ranked high significance in chapter 6, Table 6.2 pages 7 of 11 to 11 of 11. Appropriate mitigation measures should be presented.		been included in Table 6.1 page 9 of 9
88	Page 3 of 8-Impact Mitigation Measure Table 7.1; On land acquisition and claim settlement, 3rd bullet point, it was agreed that compensation /rent for land are paid to identified owners. While in the report it was not fully stated if there will be additional land take	Chapter 3. Page 23	There will be additional land take 8.9316 hectares along the RoW
Page 5 of 8 Construction and Drilling Phase			
89	Fragmentation of habitat is a residual impact. SPDC has in the project location or RoW, that has not been acknowledged, had led to species severance. Has this been researched upon and documented; having in mind the long stay at the location		Noted
90	All correction made in chapter 5 should be incorporated into chapter 7 as would be moved to chapter 6	Chapter 7, Table 7.2	This has been effected
CHAPTER EIGHT ENVIRONMENTAL MANAGEMENT PLAN			
91	Management options for drill cuttings, waste fluids and work over are not specific	Chapter 7, Page 108 to 109	This has been modified to read transport to Thermal Desorption Units(TDS) at Onne in Rivers State for treatment
92	Table 8.1presented expected types of waste streams from FDP but the waste quantification especially for drill cuttings and waste fluids is absent	Chapter 7, Table 7.1	

S/N	FMEnv Comments	Chapter/Section/Page	SPDC Response
93	Since the Rivers State Ministry of Environment Interim Guidelines and Standards on Environmental Pollution Control and Management was not cited and reviewed elements of industrial waste management in the State Principle are not referred to and consulted, SPDC should consider it necessary to replace their operations within the State Government confine or else why would SPDC promise to take some of the waste to the Government approved dumpsites		The Rivers State Ministry of Environment Interim Guidelines and Standards on Environmental Pollution Control and Management has been included in the reference section

Appendix 7
Sampling Map



Sample	Descriptor	Easting	Northing
Vegetation			
VG1	vegetation	501600.3280	103433.3600
VG2	vegetation	507439.8030	103779.5960
VGC1	Control	509648.2664	107317.2606
VGC2	Control	495358.2362	98253.8165
AIR QUALITY			
AQ1	Air Quality	501600.3280	103433.3600
AQ2	Air Quality	506523.7580	106100.9940
AQ3	Air Quality	507439.8030	103779.5960
AQ4	Air Quality	497044.9940	102860.2640
AQ5	Air Quality	497103.3844	110586.4489
INAQ	Indoor Air Quality	496999.1320	104316.5580
AQC1	control	510282.7075	107649.5869
AQC2	control	495297.8132	98676.7772
BOREHOLE			
BH1	Borehole	501726.4430	103340.9080
BH2	Borehole	504096.5890	100945.4680
BH3	Borehole	505798.1640	103076.4220
PW	Portable Water	504292.5490	100395.1350
BHC1	Control	509738.9008	107830.8557
BHC2	Control	494723.7951	98042.3361
SOIL			
SS2	soil sample	508609.4710	99052.3190
SS3	soil sample	499600.9560	98236.9420
SS4	soil sample	505506.5470	105885.1690
SS5	soil sample	504507.8190	101580.4510
SS6	soil sample	505058.1980	101066.1880
SS7	soil sample	503704.4430	100577.7090
SS8	soil sample	502804.1620	101688.7540
SS9	soil sample	502167.8400	103687.0380
SS10	soil sample	502794.2040	104078.8280
SS11	soil sample	504854.1970	103521.1880
SS12	soil sample	497988.4780	103128.3920
SS13	soil sample	497780.0110	103577.4090
SS14	soil sample	501207.0580	107913.3390
SS15	soil sample	501691.4390	104198.0930
SS16	soil sample	505979.6310	103893.4440
SS17	soil sample	507902.0030	98202.9310
SS18	soil sample	508619.9710	99626.7540
SSC1	Control	510252.4960	108163.1820
SSC2	Control	494754.0066	98737.2002
RAIN WATER			
RW1	Rain water	501778.8720	103362.2920
RW2	Rain water	506020.1170	103358.1160