



**Shell Petroleum Development Company of Nigeria Limited Operator
for the NNPC/Shell/NAOC/TEPNG Joint Venture**

**ENVIRONMENTAL IMPACT ASSESSMENT
(EIA) OF THE PROPOSED EA/EJA FIELD
FURTHER OIL DEVELOPMENT PROJECT,
OFFSHORE IN BAYELSA STATE**

FINAL REPORT

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List Of Abbreviations and Acronyms

°C	-	Degree Celsius
µg	-	Microgram
µm	-	Micrometre
A.I	-	Abundance Index
AAS	-	Atomic Absorption Spectrophotometer
ABCMS	-	Activity Based Cost Models
ADT	-	Asset Data Template
ALARP	-	As Low as Reasonably Practicable
APHA	-	American Public Health Association
API	-	American Petroleum Institute.
ARP	-	Asset Reference Planning
BAP	-	Biodiversity Action Plan
Bara	-	Bar atmosphere
Barg	-	Bar gauge
BAT	-	Best Available Technology
BCG	-	Bacillus Calmette Guerin
BDL	-	Below Detectable Limit
BH	-	Borehole
BHA	-	Bottom-Hole Assembly
BOD ₅	-	Five-day Biochemical Oxygen Demand
BOGT	-	Bonny Oil and Gas Terminal
BOP	-	Blow Out Preventer
BOPD	-	Barrels of Oil Per Day
Bscf	-	Billion standard cubic feet
Ca	-	Calcium
ca	-	circa
CAPEX	-	Capital Expenditure
CASHES	-	Community Affairs, Safety, Health, Environment and Security
CBO	-	Community-Based Organisations
CCR	-	Central Control Room
CCTV	-	Closed Circuit Television
CDC	-	Community Development Committee
CDP	-	Community Development Project
CEIA	-	Cumulative Environmental Impact Assessment
Cfu	-	Colony forming units
Cfu/g	-	Colony forming units/gramme
Cfu/ml	-	Colony forming units/millilitre
CIMCI	-	Community Integrated Management of Childhood Illnesses
Cl ⁻	-	Chloride ion

cm	-	Centimetre
CO	-	Carbon monoxide (Carbon II Oxide)
Co	-	Cobalt
CO ₂	-	Carbon Dioxide (Carbon IV Oxide)
COD	-	Chemical Oxygen Demand
CORPS	-	Community Resource Persons
CPCC	-	Central Production Control Centre
CPF	-	Central Processing Facility
CPR	-	Contraceptive Prevalence Rate
Cr	-	Chromium
CRA	-	Corrosion Resistant Alloy
dB(A)	-	Decibel
DDC	-	Defensive Driving Courses
DEM 1&2	-	Design and Engineering Manual 1 & 2
DEP	-	Design and Engineering Practice
DG	-	Decision Gate
DG3	-	Decision Gate 3
DO	-	Dissolved Oxygen
DPR	-	Department of Petroleum Resources
DPT	-	Diphtheria Pertussis Tetanus
DRB	-	Decision Review Board
DS	-	Dissolved solids
DSO	-	Domestic Supply Obligation
E& P	-	Exploration and Production
E.A	-	Exchangeable Acidity
EA	-	Environmental Assessment
EC	-	Electrical Conductivity
EC	-	Energy Components
EGASPIN	-	Environmental Guidelines and Standards for the Petroleum Industry in Nigeria
EGP	-	External Gravel Pack
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
EMS	-	Environmental Management System
ENVHRA	-	Environmental and Human Health Research Association
EP	-	Extraction Procedure
EPA	-	Environmental Protection Agency
EPC	-	Engineering, Procurement and Construction
EPI	-	Expanded Programme on Immunization
EPIC	-	Engineering Procurement, Installation & Commission

ESD	-	Emergency Shut Down
ESP	-	Emergency Shut-Down Procedure
F&G	-	Fire and Gas
FAO	-	Food and Agricultural Organization
FDP	-	Field Development Project
Fe	-	Iron
FEED	-	Front End Engineering Design
FEPA	-	Federal Environmental Protection Agency
FGD	-	Focus Group Discussion
FGDM	-	Fire & Gas Detection Mapping
FLB	-	Field Logistics Base
FLKO	-	Flare Liquid Knock Out
FMENV	-	Federal Ministry of Environment
FOD	-	Further Oil Development
FOT	-	Federal Ocean Terminal (FOT)
FPSO	-	Floating Production, Storage and Offloading
FTO	-	Freedom to Operate
FYIP	-	Forcados-Yokiri Integrated Project
g	-	Gramme
GMoU	-	Global Memorandum of Understanding
GPS	-	Global Positioning System
GSG &EE	-	Green House Gas and Energy Efficiency
GWDP	-	Global Well Delivery Process
H ₂ S	-	Hydrogen Sulphide
Ha	-	Hectare
HAART	-	Highly Active Antiretroviral Therapy
HAZID	-	Hazard identification
HAZOP	-	Hazard and Operability
HC	-	Hydrocarbon
HC-DP	-	Hydrocarbon Dew pointing
HEMP	-	Hazard and effect management process
HET/B	-	Heterotrophic bacteria
HFE	-	Human Factors Engineering
HIA	-	Health Impact Assessment
HIV/AIDS	-	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
HP	-	High Pressure
Hr	-	Hour
HRA	-	Health Risk Assessment
HSE	-	Health, Safety and Environment

HSES MS	-	Health, Safety, Environment and Security Management System
HSES	-	Health, Safety, Environment and Security
HSM	-	Hazards and Sensitivities Matrix
HSSE	-	Health, Safety, Security, Environment
HUB	-	Hydrocarbon Utilizing Bacteria
HUF	-	Hydrocarbon utilizing fungi
HYD/B	-	Hydrocarbon degrading bacteria
IFC	-	International Finance Corporation
IMR	-	Infant Mortality Rate
IOGP	-	Integrated Oil and Gas Development Project
IPF	-	Instrumented Protective Function
IPSC	-	Integrated Production System Capacity
ISO	-	International Standard Organization
ITCZ	-	Inter Tropical Convergent Zone
ITD	-	Inter-Tropical-Discontinuity
ITNs	-	Insecticide-Treated Nets
IUCN	-	International Union for Conservation of Nature
IVMS	-	In-vehicle Monitoring System
JMP	-	Joint Monitoring Programme
JT-LTS	-	Joule Thomson- Low Temperature Separation System
K	-	Potassium
Kg	-	Kilogram
Km	-	Kilometre
Km ²	-	Square Kilometre
L	-	Litre
LGAs	-	Local Government Areas
LIRA	-	Logistics & Infrastructure Resource Assessment
LLI	-	Long Lead Items
LLINs	-	Long Lasting Insecticidal Nets
LP	-	Low Pressure
M	-	meter
MDG-4	-	Millennium Development Goals - 4
MDGs	-	Millennium Development Goals
Meq	-	Milli-equivalent
Mg	-	Magnesium
mg	-	Milligramme
mg/kg	-	Milligramme per kilogramme
mg/l	-	Milligramme per litre
MICS	-	Multiple Indicator Cluster Surveys
MJR	-	Maintenance Job Routines

ml	-	Millilitre
mm	-	Millimetre
MMscf/d	-	Million Standard Cubic Feet Per Day
Mn	-	Manganese
MPN	-	Most Probable Number
MPP	-	Micro Project Programme
N	-	North
NA	-	Not applicable
Na	-	Sodium
NACA	-	National Action Committee on AIDS
NAG	-	Non Associated Gas
NAPIMS	-	National Petroleum Investment Management Services
NBS	-	National Bureau of Statistics
NCDMB	-	Nigerian content development and management board
NCHS	-	National Centre for Health Statistics
ND	-	Not Detected
NDHS	-	National Disease and Health Survey
NE	-	North East
NEGAS	-	National Environmental Guidelines and Standards
NFA	-	No Further Action
NGO	-	Non-Governmental Organization
Ni	-	Nickel
NISER	-	Nigerian Social and Economic Research
NISS	-	Nutrition information and Surveillance Systems
NLNG	-	Nigeria Liquefied Natural Gas
N-NH ₄	-	Ammonium Nitrogen
N-NO ₂	-	Nitrite Nitrogen
N-NO ₃	-	Nitrate Nitrogen
NNPC	-	Nigeria National Petroleum Corporation
NO _x	-	Nitrogen Oxides
NPC	-	National Population Commission
NTF	-	Non-timber Forest Products
NTU	-	Nephelometric Turbidity Unit
NW	-	North West
OCC	-	Operations Control Centre
OGGS	-	Offshore Gas Gathering System
OH	-	Occupational Health
OML	-	Oil Mining Lease
OMPADEC	-	Oil Mineral Producing Areas Development Commission
OMS	-	Operation Management System

ORP	-	Opportunity Realization Process
ORS	-	Opportunity Realization Standards
PA	-	Public Affairs
PAC	-	Project Advisory Committee
PAEAS/PAGA	-	Public Address and Emergency Alarm System
PAH	-	Polycyclic Aromatic Hydrocarbon
PARs	-	Pre-Assembled Pipe-Racks
PAS	-	Process Automation System
PAUs	-	Pre-Assembled Units
Pb	-	Lead
Pc	-	Protective capacity
PCBs	-	Poly Chlorinated Biphenyls
PFR	-	Peak Flow Rate
PFS	-	Process Flow Scheme
pH	-	Hydrogen ion concentration
PHC	-	Primary Health Centre
PMS	-	Project Management System
PO	-	Purchase Order
POBM	-	Pseudo Oil Based Mud
POPM	-	Process Operating Procedure Manual
PPE	-	Personal Protective Equipment
ppm	-	Parts per million
PR	-	Public Relation
PSD	-	Particle Size Distribution
psi	-	Pounds per square inch
PtA	-	Project to Assist
PTF	-	Primary Treatment Facility
PTS	-	Permission to Survey
PTW	-	Permit to Work
QA	-	Quality Assurance
QM	-	Quality Management
Qu	-	Quality of Life
R	-	Correlation Coefficient
RAM	-	Risk Assessment Matrix
RoW	-	Right of Way
RPE	-	Respiratory Protection Equipment
RTAs	-	Road Traffic Accidents
RTIs	-	Respiratory Tract Infections
S	-	South
SACA	-	State Action Committee on AIDS

SAFOB	-	Safety & Operability Study
SAP	-	Systems Application Program
SAU	-	Supplier Assembled Units
SCD	-	Sustainable Community Development
SCE	-	Safety Critical Equipment
SCHO	-	Senior Community Health Officer
SCiN	-	Shell Companies in Nigeria
SD	-	Sustainable Development
SD	-	Standard Deviation
SE	-	South East
SECC	-	Survival and Early Child Care
SEPCiN	-	Shell Companies in Nigeria
SGBP	-	Shell Group Statement of General Business Principles
SHOC	-	Safe Handling of Chemicals
SIA	-	Social Impact Assessment
SIEP	-	Shell International Exploration and Production
SIPM	-	Shell International Petroleum Maatschappij, B.V
SMI	-	Safe Motherhood Initiatives
SO ₂	-	Sulphur dioxide
SO ₄ ²⁻	-	Sulphate ion
SO _x	-	Oxides of Sulphur
SP	-	Social Performance
sp	-	species (Sing.)
SPDC	-	Shell Petroleum Development Company of Nigeria Limited
SPM	-	Suspended particulate matter
Spp	-	Species (Pl.)
SPU	-	Supplier Packaged Units
SSAGS+	-	Southern Swamp Associated Gas Solution Plus Project
SS	-	Suspended solids
SSS	-	Single String Single
SSSIV	-	Sub-Surface Safety Isolation Valve
STDWS	-	Short Term Drilling & Work over Sequence
STIs	-	Sexually Transmissible Infections
SW	-	South West
SWL	-	Soil Water Level
SYMP	-	Soft yoke mooring platform
TB	-	tuberculosis
TBA	-	Traditional Birth Attendants
TDS	-	Total Dissolved Solids
TDU	-	Thermal Desorption Unit

TEG	-	Tri-ethylene glycol
TF	-	Total Fungi
THB	-	Total Heterotrophic Bacteria
THC	-	Total hydrocarbon
TOC	-	Total Organic Carbon
TOR	-	Terms of Reference
TP	-	Technology & Projects
Tscf	-	Trillion cubic of gas
TSD	-	two-string dual
TSS	-	Total Suspended Solids
TT	-	Tetanus Toxoid
TVP	-	True Vapour Pressure
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environment Programme
UNESCO	-	United Nations Education, Scientific, Cultural Organization
UNFPA	-	United Nations Population Fund
UNICEF	-	United Nations Children Education Fund
UOC	-	Unit Operating Cost
UR	-	Ultimate Recovery
USDA	-	United States Department of Agriculture
USEPA	-	United States Environmental Protection Agency
V	-	Vanadium
VAR	-	Value Assurance Review
VAR3	-	Value Assurance Review- 3
VCT	-	Voluntary Counselling and Testing
VES	-	Vertical Electrical Sounding
VOCs	-	Volatile Organic Compounds
W	-	West
WDG	-	Waste Disposal Guidelines
WFS	-	Well Functional Specification
WH	-	Well Head
WHO	-	World Health Organization
WQI	-	Water Quality Index
Zn	-	Zinc

Executive Summary

ES 1.0: Background Information

The Shell Petroleum Development Company of Nigeria (SPDC) conducted an Environmental Impact Assessment (EIA) for EA Further Oil Development (FOD). The project targets the development of oil contingent resource including appraisal opportunities in the EA and EJA fields. FOD opportunity was identified in the 1999 pre-production Field Development Plan (FDP) as Phase 2. Phase 1 is already on stream since December, 2002. The FDP also identified EJA deep exploration as an upside for future development in a success case. The EA FOD Project is to maximise production in EA and EJA fields. The project aims to develop 70.5 MMstb of discovered oil resources.

ES 2.0: Objectives of the EIA

The objectives of the EIA are to:

- Acquire baseline data of the environment as well as the socio-economic and health conditions of the neighbouring communities;
- Use the baseline data to describe and characterise the study area;
- Identify the environmental sensitivities of the project area;
- Determine and evaluate the potential impacts of the proposed project activities on the identified environmental sensitivities and the interactions between the sensitivities;
- Recommend appropriate mitigation measures; and
- Develop an Environmental Management Plan (EMP) and Monitoring Plan.

ES 3.0: Legal and Regulatory Framework

International Laws and standards guiding environmental management in Nigeria include but not limited to the following:

- International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines 1996
- World Bank Guidelines on Environmental Assessment, 1991
- 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
- Environmental Impact Assessment Act CAP E12 LFN 2004.
- Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, 2002 Department of Petroleum Resources (DPR)
- Department of Petroleum Resources (DPR) Mineral Oils Safety Regulations 1997
- FEPA EIA Procedural Guidelines, 1995
- S.I.8 - National Environmental Protection (Effluent Limitation) Regulation 1991

- S.I.9 – National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes Regulation), 1991.
- Bayelsa State Environment and Development Planning Authority Edict 1998;
- Public Health Law-CAP103 of the Laws of Eastern Nigeria 1963
- Bayelsa State Land Use (Environmental Degradation/Protection) Charge Law 2005
- Bayelsa State Forestry Law 1998.

ES 4.0: Project Location

EA and EJA fields are shallow offshore fields located in the south-eastern section of OML 79 about 90km southeast of Warri and 15km from the mouth of the Dodo River in Bayelsa State at a water depth range of 13 to 30m. EA and EJA fields were developed using a floating production, storage and offloading (FPSO) called “Sea Eagle” as the main facility processing fluids from the drilling platforms. Oil is evacuated by tanker and produced gas is exported through the offshore gas gathering system (OGGS) to Bonny NLNG plant.

ES 5.0: Proposed Project Scope

The EA FOD project scope comprises of 3 work over wells, 15 new wells to be drilled from existing wellhead platform, and 5 new wells in a new platform. The Well distribution are as follows: 6 Wells from DP-J (Eja field), 4 Wells from DP-B (EA field), 5 Wells from DP-C (EA field) and 3 wells from DP-A (EA field). Other activities include the installation of well hook-up piping system and ancillaries, well control systems, process automation, instrumentation, control, safeguarding and gas-lift piping. Existing infrastructure comprising evacuation pipelines and umbilical (composite electrical & fibre optic cables) from existing platforms to the Sea Eagle FPSO including processing facilities on the Sea Eagle FPSO are sufficient to support this development.

ES 6.0: Need for the Project

The EA Further oil development will achieve three main objectives:

- Develop the remaining oil and gas resources of the EA/Eja field and realise the financial benefits to the partners;
- Further contribute to the Nigerian Economy; and sustain the employment of staff and the development of infrastructure through a targeted community development programme as contained in the Social performance plan of the EA/Eja field; and
- Since it will extend the EA production, the EA Asset team will have the opportunity to keep on developing the skills and capabilities of local staff to international standards, as is already been done through short term deployment.

ES 7.0: Value of the Project

The value of the project may be judged by its positive impact on economy, improved quality of life and quality of atmospheric environment, as follows:

- **Economy:** Full field development will enhance oil production and purposeful utilization of associated gas via existing OGGs pipeline to NLNG, and foreign exchange earnings from the sale of oil and gas, are positive signs of real development.
- **Quality of life:** Enhance the opportunities contained in the Social Performance Plan, as already being done by the EA Asset team, to improve quality of life of the neighbouring communities.
- The main driver for the EA FOD project is full field development implementation of the 1999 pre-production FDP. This will address the production decline in the EA/EJA fields, utilize the available ullage in the Sea Eagle FPSO and thus reduce the unit operating cost of the facility.

ES 8.0: Envisaged Sustainability

Economic Sustainability

The EA/Ejafield have proven reserves of oil and gas. Drilled reserves in the phase one have economically and commercially supported the operations of the Sea Eagle, with the export of oil through tankers and gas to NLNG via the OGGs Riser platform (RPA).

Technical Sustainability

The EA FOD Project is technically sustainable because of SPDC's track record of strict adherence to Nigerian National (and International) engineering codes and standards. Only proven technologies that are economically viable with minimal environmental, social and health impacts shall be utilised in the execution of the project.

Environmental Sustainability

The aim is to ensure that current use of the environment and its natural resources does not damage prospects for use by future generations. SPDC shall comply with all statutory regulations and its own corporate guidelines on Environmental Sustainability, whilst continuously striving towards performance improvement.

Social Sustainability

The EA and EJA FOD projects will attract a lot of improvements in the social wellbeing of communities neighbouring the project area. Some category of jobs including some sub-contracting services shall be employed from the communities, resulting in financial upliftment and reduction in the number of unemployed youths that presently besiege the Niger Delta Region. This project will also attract contribution to the already existing Global Memorandum of Understanding (GMOU) between SPDC and the communities.

Project Alternatives

Option 1: Chase the barrel": This option considers only validated wells that can be drilled from available slots in existing platforms without the need for construction of a new Platform. The

scope of this option is to drill a total of 15 new wells from available slots in existing platforms and carry out 3 recompletions on existing wells.

Option 2: Minimum CAPEX“: This option targets 3 recompletions plus wells with recoverable volumes of at least 2MMstb and drillable from existing platforms. Only 10 new wells met this criterion.

Option 3: Maximum Recovery”: This option targets drilling of all validated 20 new wells and 3 recompletions. This option encapsulates the full implementation of Option 1 and in addition recommends construction of a new Platform in EA to drill the remaining 5 new wells which could not be drilled from the existing platforms.

Option 4: Minimum CAPEX + Optimized Development”: This option desires to carry out 3 recompletions and drill all identified wells with recovery cut-off of 2MMstb per well. A total of 12 wells met this criterion and this option also requires construction of a new Platform in EA to host the two extra wells that could not be drilled from existing platforms.

Option 5: Maximum Production + Maximum CAPEX + EJA Deep”: Option 5 scope consists of drilling a total of 23 new wells and 3 recompletions as follows: 15 new wells from existing platforms, 5 new wells from new platform in EA and 3 new wells from new platform in EJA. The new platform in EJA will be constructed in the event of the EJA deep exploration/appraisal success. This element is currently notional and considered an upside that would be matured after drilling the exploration/appraisal well.

The selected concept for EA FOD project is **Option 3** –Maximum Recovery. This option includes optimal lifecycle development of the field. The development proposes a total of 20 new wells and 3 recompletions.

Surface Facilities Options

The option identified for the Ullage Fill Concept entails developing the EA/EJA fields and evacuating the produced reservoir fluids via new infrastructure to the Sea Eagle FPSO. For the Alternative HC Evacuation Concept, two options were identified, namely; FPSO Re-deployment and No FPSO option.

ES 9.0: Project Objectives

The main business drivers for the EA Further Oil Development project include:

- Achieving full field development (i.e. maximizing/ultimate recovery from the discovered wells);
- Improving cash flow from operating asset and contribute to SPDC growth aspiration;
- Utilizing the available ullage in the FPSO to maximize asset utilization;

- Reducing the unit operating cost by increasing the production in the field; and
- Testing the EJA Deep exploration scope with circa 20MMstb (2U) potential upside.

Proposed Project Activities

The activities to be carried out for the project include: route survey for pipelines, site preparation for the new wellhead platform, transportation of wellhead platform from fabrication base to site and well drilling. Other infrastructure include: well hook-up for the 15 wells from the existing platforms, civil works related infrastructure for the new platform, pipe welding, coating and testing. Thereafter the pipeline will be commissioned; personnel and equipment demobilized.

ES 10.0: Decommissioning/Abandonment

The No Further Activity (NFA) of the EA/Eja field is currently 2022, and with this project it shall extend to 2027. The Sea Eagle shall be taken out of service then, and all other facilities shall be decommissioned in line with SPDC decommissioning plan and standard offshore practice.

ES 11.0: Waste Management

Wastes from the drilling and flowline construction shall be managed in accordance with the current SPDC waste management policy and other regulatory requirements. The strategy for waste management will include: waste segregation at source, reduction, recycling, reuse, treatment of toxic and hazardous wastes to make them innocuous before disposal. Waste streams envisaged from the project activities include but not limited to the following: Oil in cuttings and cement returns, scrap metals, plastics, Waste oil and domestic sewage.

ES 12.0: Project schedule

Planned Well hookup (first oil) is scheduled for Q3 2016. Details of the project activities and associated timelines are presented in Section 3.15 (Chapter 3).

ES 13.0: Description of the Existing Environment

Climate and Meteorology

The project area is located within the equatorial belt that experiences rainfall for most of the year. There are basically two seasons: rainy and dry, though sporadic rain occurs even during the dry season. Ambient air temperatures of the area were relatively moderate with a mean value of 26.9°C. Long term wind distribution data shows that the wind blows generally from the south-westerly (SW/S/W) most times. Wind velocities recorded during the two seasons varied from 4.80-7.20m/s and 0.5-2.60m/s for wet and dry seasons, respectively. Annual relative humidity for the project area was high all year round at an average of 78.5%, which is typical of equatorial climate. The mean cloud cover in the area was 6.5 oktas and clouds were at maximum both at night and day.

Air Quality

Sulphur oxides, nitrogen oxides and VOC were generally below the detection limits of the respective measuring equipment and thus could all be described as practically absent around the EA area for both seasons. There were no seasonal variations in the levels of these parameters. Also, zero concentrations of these air pollutants were recorded at each of the control points, thus, reflecting proper environmental management. SPM levels within the study area varied from 0.16 - 0.71 $\mu\text{g}/\text{m}^3$ with a mean value of $0.56 \pm 0.25 \mu\text{g}/\text{m}^3$ for wet season while values ranging from 0.09-0.22 $\mu\text{g}/\text{m}^3$ (mean value of $0.15 \pm 0.05 \mu\text{g}/\text{m}^3$) were recorded in the dry season.

Noise

Noise levels recorded at the study area in the dry season varied from 44.3 - 47.4 dB(A) with 45.1 dB(A) as average, while the wet season recorded values ranging from 44.90-48.3 dB(A) with a mean value of 49.0 dB(A). The average values obtained for the two seasons were significantly lower than the allowable DPR/WHO set limit of 80 dB(A). The sources of noise include: movement of supply and security vessels, production process in the Sea Eagle FPSO.

Aquatic Studies

Surface Water Physico-chemistry

The results of the water quality for the dry and wet seasons revealed conditions that are within the normal ranges for off shore oceanic environment. The water of the study area had a dry season temperature range of 26.6 -30.0°C for both the study area and control, while the range for the wet season was 26.3 – 32.7°C for both study area and control. The water was colourless in both study area and control stations during the dry and wet seasons. The turbidity and total suspended solids of the water were low for both seasons in the study area and the control points. The total dissolved solids in the study area ranged from 15240 – 33780 mg/l in the dry season and 17870 – 32140 mg/l in the wet season, typical of high TDS values in natural sea waters. The Electrical Conductivity (EC) was expectedly high. The water was slightly alkaline with a pH range of 7.05 – 8.08 (dry season) and a range of 7.51 – 7.92 (wet season) which compared very well with the control values in both seasons. These pH ranges are typical of normal sea water (7.5-8.5).

The Dissolved Oxygen (DO) observed in the study area had a range of 3.93 – 4.78 mg/l while it was 4.23 – 4.97 mg/l in the control areas during the dry season. The wet season had a concentration range of 7.33 – 8.85 mg/l while the control points had a range of 7.53 – 8.29 mg/l. The BOD and the COD observed during the dry season of the study area including the control showed that they were far below the DPR limits of 30 mg/l and 10 mg/l respectively. The same trend was observed in the wet season. Alkalinity levels observed in this study for the dry season were 80 – 195.99 mg/l while for the wet season it was 56.4 – 199.9 mg/l. These levels were comparable to the values obtained for the controls during the dry and wet seasons.

Salinity which expresses the salt content of water was high, and varied from 13.50 to 33.19 % for the dry season and 29.32 – 36.15 % for the wet season. The water was oligotrophic (low in nutrients like nitrates and phosphates). The low level of nitrate and phosphate indicates low level of anthropogenic biological pollution and organic decomposition and mineralization since all the wastes generated are segregated and sent to Industrial Area in Port Harcourt for recycling or given to a third party contractor for treatment. Unpolluted waters generally contain low concentration of phosphate, usually less than 1.0 mg/L. From the results for cations, calcium has a range of 610 – 873 mg/l while magnesium has concentration of 65.51 – 305 mg/l in the dry season survey. Natural waters contain very small quantities of several essential metals including Iron (Fe), Cadmium (Cd), Chromium (Cr), Lead (Pb), Copper (Cu), Nickel (Ni), Vanadium (V), Zinc (Zn), Manganese (Mn) and Mercury (Hg). The heavy metal concentrations in the surface water of the study area were low in all the stations during the dry and wet season and do not pose any pollution threat. Barium which is normally present in produce water was not detected in the surface water. Among the heavy metals analysed, only Zinc, Total Iron and Copper were detected at trace levels. These metals were however not detected during the EIA study but this difference is however statistically insignificant.

The Total Petroleum Hydrocarbons in the surface water were very low (<0.0010 – 0.0080 mg/l) in the study area during the dry season. The wet season had a range of 0.000 – 0.0040 mg/l. Polycyclic Aromatic Hydrocarbons (PAHs) and BTEX were however not detected during the dry and wet season surveys.

Surface Water Microbiology

Total heterotrophic bacteria (THB) in the surface water ranged from 0.04 – 0.49 x 10³ cfu/ml in the dry season and 0.5 – 0.97 x 10³ cfu/ml in the wet season. The THB population in the control sites was 0.14 – 0.32 x 10³ cfu/ml in the dry season and 0.5 – 0.97 x 10³ cfu/ml in the wet season. Hydrocarbon Utilizing Bacteria (HUB) was in the range of 0.02 – 0.09 x 10² cfu/ml in the dry season and 0.16 – 0.56 x 10² cfu/ml in the wet season, whereas there was no growth in both controls. Hence, HUB account for 10% of the heterotrophic population.

Total fungi (TF) in the water was in the same range of 0.04 – 0.23 x 10³ cfu/ml in the dry season and 0.55 -0.96 10³ cfu/ml in the wet season.

Sediment physicochemical characteristics

In the dry season, temperature of sediment varied between 25.1⁰C and 28.20⁰C and in the wet season, between 26.2⁰C and 27.8⁰C. In the dry season, pH of sediments fluctuated from 6.12 (slightly acidic) to pH 7.81 (slightly alkaline). In the wet season, the sediment was slightly alkaline and pH values fluctuated between 7.24 and 7.73. The electrical conductivity of sediment in the dry season indicated significant spatial variation from 95067µS/cm) to 89010µS/cm. Chloride levels in sediment varied from 1799-4998mg/kg in the dry season and 1063-4608mg/kg in the wet season. Nitrate concentrations varied between 6.29 and 191.33

mg/kg in the dry season and 3.47-539.92 mg/kg in the wet season. In the control area, nitrate levels varied 36.04-488.57mg/kg in the dry season and 27.85-131mg/kg in the wet season. Phosphate levels ranged from 68.4 to 184.61 mg/kg in the dry season and 104.94 to 361.6 mg/kg in the wet season. Levels of potassium in the sediment varied from 422 to 1992 mg/kg in the dry season and from 1104 to 2126 mg/kg in the wet season. In the dry season, the concentration of calcium in sediment ranged from 1053 to 2463 mg/kg and in the wet season, this variable ranged from 116.20 to 892.6 mg/kg. Magnesium concentration in sediment ranged from 18.75 to 182.00 mg/kg and 447 to 1782 mg/kg and in the dry and wet seasons respectively.

Polycyclic Aromatic Hydrocarbon and BTEX were not recorded in the sediment of EA/Eja field. However, TPH levels in sediment of EA/Eja field were generally low and ranged from 0.17-5.14mg/kg in the dry season. Concentrations of TPH in the wet season ranged from 0.008 to 3.11 mg/kg. The total hydrocarbon content (THC) was generally below 5 mg/kg. This indicates that the sediment was not polluted with petroleum hydrocarbon. The following heavy metals; Vanadium, Arsenic, Barium and Mercury were not detected in the sediment in both seasons of the season. Cobalt was similarly below detectable limits of <0.001mg/l in the wet season and ranged from 0.11-1.26mg/l in the dry season. The concentration of Pb varied from 25.15 to 53.34 mg/kg and 14.27 to 33.72 mg/kg for dry and wet seasons respectively. The concentration of Pb and Ni in the wet season was lower than that of the dry season. In the dry season, maximum Ni levels in sediment was highly varied between a minimum value of 56.26 mg/Kg while in the wet season values for this element varied between 2.59 and 24.43 mg/kg. The concentration of Cr in sediment of the study area in the dry season ranged from a minimum of 10.54 to a maximum of 43.2 mg/kg. Minimum Cr level in the sediment in the wet season was 5.04 mg/Kg while maximum value was 21.11 mg/Kg. There are temporal variations in Cr in favour of dry season levels. Similarly, mean concentration of Cr in the dry season was comparable to wet season. These results are generally lower than in previous studies and may indicate a depreciation of this element in sediments within OML 79.

The concentration of Cu in sediment ranged from 4.79 to 18.69 mg/kg in the dry season and 2.49-20.49 mg/kg in the wet season. Zinc (Zn) levels in sediment varied from 10.88 to 87.12-mg/kg in the dry season and 24.09-86.58 mg/kg in the wet season. The concentration of iron (Fe) in sediments of OML 79 fluctuated from 930.4 - 1987 mg/kg in the dry season and 377.97 - 895.08 mg/kg in the wet season. Cadmium (Cd) was also recorded in variable concentrations in the sediment and ranged from 0.81 mg/kg to 8.32 in the dry season and <0.005-4.16 mg/kg in the wet season. In the dry season, cobalt (Co) was recorded in the sediment in all the stations in concentrations ranging from 0.11 to 1.26 mg/kg. In the rainy season, this element was not detected (<0.001 mg/kg) in the sediment indicating seasonal variation.

Sediment Microbiology

Total Heterotrophic Bacteria (THB) ranged from $0.96 - 2.99 \times 10^4$ cfu/g in the wet season and $1.02 - 1.83 \times 10^4$ cfu/g in the dry season. The THB population recorded for the project site sediments was similar to that of the controls in both seasons. THB was $1.59 - 2.01 \times 10^4$ cfu/g for the wet season control and $2.33 - 3.06 \times 10^4$ cfu/g for the dry season control. Hydrocarbon utilizing bacteria (HUB) in the sediments ranged from $0.02 - 7.66 \times 10^2$ cfu/g in the wet season and $0.45 - 6.82 \times 10^2$ cfu/g in the dry season, where there was no significant growth in the control samples for both seasons. HUB accounted for about 1% of the heterotrophic bacteria population. Total Fungi (TF) population was in the same range as THB. It ranged from $0.86 - 2.8 \times 10^4$ cfu/g in the wet season and $1.00 - 1.75 \times 10^4$ cfu/g in the dry season. Hydrocarbon utilizing fungi (HUF) ranged from $0.01 - 5.34 \times 10^2$ cfu/g in the wet season and $0.11 - 2.1 \times 10^2$ cfu/g in the dry season. Hydrocarbon Utilizing Fungi was 1% of the total fungi population.

Phytoplankton

In both seasons, the recorded major families of phytoplankton were Five (5); namely Baccillariophyceae, Cyanophyceae, Chlorophyceae and these contributed 57%, 21% and 11% respectively. Other divisions of phytoplankton include Euglenophyceae and Dinophyceae.

Zooplankton

The identified zooplankton fauna were categorized into crustaceans, rotifers, the larvae of molluscs and pisces. In the dry season, copepod crustaceans were the dominant zooplankton and contributed 50% while rotifers were the second dominant zooplankton with respect to density and constituted 22% of the total zooplankton count. The relative abundance of Cladocera and decapod crustaceans in the dry season was 11% and 17% respectively. In the wet season, the dominant zooplankton were copepods which constituted 47% of the zooplankton while rotifers were the second dominant group constituting 23% of the total zooplankton haul and members of this group included *Brachionus calyciflorus* (5.08%), *Lecane bulla* (5.04%) and *Filinia longiseta* (3.37%).

Macrobenthic fauna

In both seasons, nine (9) major taxonomic groupings namely sponges, holothuroidea, polychaetes, echinoderms, molluscs (gastropods and bivalves), arthropods, coelenterates, and crustaceans were encountered. During wet season, gastropod molluscs were the dominant benthos and they constituted 25% of the macro-benthic organisms while crustaceans and polychaetes each constituted 18% of the number of benthos. The gastropods, coelenterates and polychaetes constituted 61% of the total benthos during the dry season with the gastropods contributing 25%, coelenterates 18% and the polychaetes 18%. In the dry season, the gastropod molluscs and polychaetes dominated the benthic population and these contributed 23% each. Bivalve molluscs contributed 18% of the benthos.

Fisheries Studies

A total of twenty-one species of fin fish belonging to eight families were recorded in the area. Five (5) species of crustacean was also reported. These include: croakers (*Pseudolithus*), threadfins (*Galeoides*, *Pentanemus* and *Polydactylus*), soles (*Cynoglossidae*), marine catfish (*Arius*), brackish water catfish (*Chrysichthys*), snapper (*Lutjanus*), grunters (Pomadasyidae), groupers (*Epinephelus*), and the estuarine white shrimp (*Palaemon*). Bonga dominates the pelagic fishery. Fishes are largely exploited by artisan fishers who operate with dug-out wooden canoes which may or may not be motorized. Other fishing gears include long setlines, circling nets and seine nets of different mesh sizes varying between ½", 1", 1½", 2", 2½ and 3" (1.0mm to 5.0mm). Gears measure 6-12m in length and 2-4 meters in width. Nets are manually operated. They are set and allowed to stay for up to one hour before they are removed with the catch. When the net is set and before it is removed another net is also set. Catch rates are seasonally dependent.

Fish tissues analysis shows that the concentration of copper varied from 7.81–16.01 µg/g and this is below the limit in fish flesh. The concentration of lead in all the fish samples were generally below detectable limits in most fish species analysed. Levels of lead ranged from 0.00 to 0.15 µg/g. Lead in all analysed fish species was also below the WHO and FAO limits. Concentrations of Iron (Fe) in the Fish tissue were high with a range of 54.75 to 248.52µg/g. This high value could be due to high iron value in the sediment. Vanadium, Arsenic and Nickel were not detected in any fish sample.

The total hydrocarbon content in the fish samples was generally less than 6.0 mg/kg. The THC recorded was below the GESAMP standard of 25.0mg/kg allowed in food fish for human consumption. There were no detectable traces of BTEX and poly-aromatic hydrocarbons in all the Fish samples.

Geology and Geomorphology

The geology of the EA/Eja Field area consists of sedimentary deposits of the Cenozoic age (about 160 million years) namely Benin, Agbada, and Akata formations. The area is characterized by fairly uniform geomorphology and lacks geological features like mountains, and rock outcrops. The EA/Eja Field is part of a highly faulted NW-SE trending major rollover feature in the SE corner of OML 79 overlying the youngest of the well-developed belts of the Niger delta. The nearest coastlines to the EA concession range from 15-60 km from the Ramos, Dodo to the Pennington River mouths. The area is characterised by fairly uniform geomorphology. Plains and sand beaches are the dominant features of the landscape with some silt and mud in the southern flank.

Hydrogeology

The stratigraphy is uniform in all the boreholes. This comprises of a muddy clayey sand top soil, a saturated silt and sand mélange that grade into silty sand substratum. This makes the aquifer phreatic. Static water levels were in the range of 0 to 0.5 m. Thus the direction of flow is consistent with the surface water flow which is in the south of southwest direction in most locations occupied. Since the environment is subject to tidal flow, the groundwater flow direction will be reversed when the tide is up resulting into a north of north east directional flow.

Groundwater in all the locations and the control point were slightly acidic with range of 5.13 to 6.59. The pH values of all the locations and that of the control were slightly below neutral point (pH = 7). Electrical conductivity (EC) is a direct indication of total dissolved solids and salinity in the water. Higher EC implies higher total dissolved solids (TDS) and salinity. Alkali earth metals exist in trace quantity and pose no hazard to the ground water; however chromium content was slightly above the tolerable limit in all the boreholes and the control. Turbidity was within tolerable limits. Sulphate and phosphate contents were favourable; the two radical's concentrations therefore have no serious impact on the ground water status in all the locations and stations. All the locations are within water quality (regulatory standards) standards for domestic use. With the exception of iron which is above 1.0 mg/l in all the boreholes. Total heterotrophic bacteria counts ranged from 2.59 to 4.13×10^4 cfu/ml. Total fungal counts ranged from 1.15 to 2.08×10^2 cfu/ml.

Hydrography

The hydrography of the region is also influenced by the tides of the Atlantic Ocean and the flood regime of the major rivers (Dodo, Ramos, and Pennington). The area is affected by the Guinean current which flows at a speed in the range of 1.0 – 1.3 knots (0.51 – 0.66m/s) from the west to east direction and is typically a warm current. The sea heights in offshore location show significant direct correlation with wind speed but this relationship is affected by water depth. The Nigerian coast has high intensity wave action. The waves have a long fetch and are generated by the prevailing S-SW winds. These winds originate in storm centres far out in the Atlantic. Typical wave energies are 4-80 kJ per metre of crest. The S-SW waves strike the shore obliquely and generate strong long shore currents. Wave heights of <1.25m predominate with occurrences of 58.7% of the time. About 54.2% of the waves have a peak period within the range of 8.0 – 11.0 seconds. Within this range, wave periods of < 9.0 seconds represent 16.7%, 9.0 – 10.0 seconds equal 19.6 %, while >10.0 seconds account for 18.0 % of the wave occurrence at the site. In the EA concession area these run N-NW at 0.15-1.5 m/s (0.3-2.9 knots). The mean tidal range ranges from 1.1 to 2.5 m. The tide approaches the coast from the S-SW moving shore sediments out to sea.

Physico-chemical characteristics of coastal soils

The mangrove forest soils are made up of decomposing plant tissues mixed with silt/sandy mineral matter. The soils found in the mangrove ecosystem include the recently deposits of soft materials of >80% silt and clay and the more mature peaty clay popularly known as 'Chikoko'. They contain high amounts of iron sulphides or pyrites, which is responsible for the characteristics rotten-egg odour experienced in the mangrove ecosystem. The soils have pH of 6.5 to 7 and high organic matter contents ranging from 2.4% to 8.9%. Although the soft mud and Chikoko occupy most of the land in the mangrove area, there are small patches of saline deposits of up to 75% sands, with clay contents ranging from 4% to >20%, and lower organic matter content as compared to the Chikoko.

Land Use

Farming is seen along water ways, in rain forest and swamp clearings, and close to major communities. Common crops cultivated include sugar cane, plantain, cassava, yam and cocoyam. Subsistence fruit crops like mango, cashew, pawpaw, African bread fruit, and coconut were spotted around existing and abandoned settlements.

Microbiology of coastal Soil

The microbial population of the soils in the coastal area of the project showed that the total heterotrophic bacteria (THB) count ranged from 2.85×10^7 to 9.00×10^8 cfu/g while the hydrocarbon utilizing bacteria (HUB) was from 3.65×10^3 to 4.15×10^5 cfu/g. The percentage ratio of HUB to THB was <1% suggesting the absence of hydrocarbon pollution in the soils of the landfall area. The total fungi (THF) count ranged between 9.00×10^2 and 1.20×10^4 cfu/g. No hydrocarbon utilizing fungi (HUF) was detected. The predominant bacteria species isolated from the soil samples were *Klebsiella*, *Bacillus*, *Staphylococcus*, *Proteus*, *Pseudomonas* and *Micrococcus*, while the dominant fungal species were *Rhizopus*, *Mucor*, *Saccharomyces*, *Aspergillus*, *Candida* and *Penicillium*.

Coastal Vegetation

The vegetation of the coastal area of the project comprises basically two broad groups, i.e., the freshwater vegetation found on the Strand Coast/Barriers Islands and the mangrove vegetation growing in the brackish water swamp. The coastline vegetation is relatively less diverse and consist only a few species that could grow on the sandy strand coast. The predominant species include *Ipomoea pes caprae*, *I. stolinfera*, *Sesuvium portulacastrum*, *Dalbergia ecastophyllum*, and *Paspalum vaginatum*. Other species that grow on the strand coasts include *Cocos nucifera* (coconut), *Alchornea cordifolia*, *Ficus sp*, *Alstonia boonei*, *Costis afer* and oil palms.

The mangrove zone of the coastal area is characterised by dominant presence of *Rhizophora racemosa*, *R. harrisonii* and *R. mangle* (the red mangrove species). *Rhizophora racemosa* is known as the 'tall red mangrove' and they grow to heights of >20 m, while *R. harrisonii* and *R.*

mangle are much shorter and are called ‘short red mangrove’. In addition, *Avicennia africana*, also called white mangrove, are found in the mangrove ecosystem.

Coastal Wildlife

The wildlife of the EA study area was rich and diverse, comprising birds (kingfishers, cattle egrets, sparrows, vultures, kites, eagles, and owls) reptiles (crocodiles and snakes) and mammals (rats, antelopes (duikers), bush pigs and monkeys). Several species of sea bird breed on islands in the Gulf of Guinea or on the West African coastline. These include the White Tailed Tropic Bird, The Brown Booby, a range of tern species (Whiskered, Bridled, Sooty and Little), and Brown and Black Noddys. Migratory birds visiting the area include: Corys, Sooty Shearwaters, Wilson’s Storm Petrel, Skuas, Gulls (Blackheaded, Sabines) and Terns (Common, Arctic, Damara). Some of these bird nest on the shoreline and on the offshore islands of the Guinean Coast. Birds are particularly vulnerable to oil pollution.

Several species of turtle are listed as present in Nigeria including the critically endangered Green Turtle (*Chelonia mydas*) also nests in Akassa Coasts. This species is vulnerable to disturbances of its nesting areas. They come ashore at night to lay eggs and will be put off doing so by the occurrence of any abnormal noise or light. The Hawksbill Turtle (*Eretmochelys imbricate*), Loggerhead Turtle (*Caretta caretta*) and Leatherback Turtle (*Dermochelys coriacea*) is recorded as nesting in Nigeria. The Loggerhead Turtle (*Caretta caretta*) expected to nest in Nigeria. The West African Manatee (*Trichechus senegalensis*) is on the IUCN red list as a vulnerable species. It inhabits inshore and estuarine waters and is very vulnerable to injury from shipping. Its primary feeding grounds are sea grass areas which are vulnerable to pollution.

Social Profile

The proposed EA FOD project is contiguous to about twelve major neighbouring communities including Ezetu, Ekeni, Bisangbene, Amatu I, Amatu II, Letugbene, Orobiri, Azamabiri, Agge, Bilabiri I, Bilabiri II and Ogbeintu. Ezetu and Ekeni communities are located in the Southern Ijaw Local Government Area while the remaining 10 communities are located in Ekeremor Local Government Area (LGA) of Bayelsa State, situated in the South-South geo-political zone of Nigeria. Principally, these communities lie between the Ramos and Pennington Rivers. With respect to ethnicity, all the communities within the area are homogenously Ijaw (or Izon). The settlement pattern of the habitations in the area is scattered and linear along the coastal sand bars. Despite the diversities in cultural beliefs, the people freely move between their traditional religious/cultural practices and Christianity as situation demands. However, Christianity is increasingly becoming the dominant and covenanted religion. All communities in the study area have communal deities and shrines, sacred bushes, sacred streams and waters.

The population of the communities is increasing and shows a skewed distribution in favour of lower age-cohorts of persons below 18 years old, with high dependency ratio. The sex-ratio is

approximately 1.13 males to 1 female with a modal educational level of primary school attainment. The declined rate of divorced household heads in the area between 2008 (6.4%) and 2012 (1%) is an indication that the indigenes valued marriage. The 2012 field survey showed an average of 8 persons per dwelling unit with about 37% households having between 7 and 10 persons in a family as against 46.2% of households in 2008 having 7-10 persons.

The local economy is consistently dominated by fishing, farming and petty trading. However, there is reduction in the number of fisher folks and increased in number of crop farmers in the communities, and the income generated have also nominally increased between 2008 and 2012. The general quality of life measured in terms of housing types, productive and household asset ownership, and presence of functional social infrastructure in the communities was noted to be consistently low, suggesting poor standard of living and high level of poverty among the residents of the communities. Alcoholism is becoming a lifestyle in the coastal communities as well as smoking of cigarettes, Indian hemp especially among the youths. It is common to see youths smoking and drinking strong beverages in public places.

There exists a strong leadership structure at the community level in the study area. Governance system is typical of well-developed hierarchical structure that is gender and age sensitive, which have in-built mechanism to provide social cohesion, security and conflict management, prevention and resolution.

The general opinion of the inhabitants was that the communities have received more of negative impacts than positive impacts from the existing EA (Sea Eagle) facility located about 15km offshore.

Community Health Profile

The commonest ailments and diseases in the EA neighbouring communities are: malaria, skin rashes, conjunctivitis, cough, respiratory diseases, gastro-enteritis, hernias, leg ulcers and sexually transmissible infections. The integrated disease surveillance response data for Bayelsa State, (for both in-patients and out-patients) in 2005 revealed that the top three diseases recorded in the State were infectious diseases: malaria 49.88%, diarrhoea 23.65% and sexually transmissible infections 20.24%. Mortality (deaths) among the most vulnerable population groups, children under-five years and women of child-bearing age, have been reported to be high in Bayelsa State.

A major deficiency in the EA neighbouring is the lack of healthcare facilities. The main sources of healthcare delivery in the area are patent medicine stores, traditional healers and traditional birth attendants (TBA). To treat the severely sick, community members travel to Warri in Delta State and Yenagoa in Bayelsa State.

The nutritional pattern in the community follows the general trend in several parts of the country in which starchy food constitute a large part of the family diet. These starchy food include cassava, rice, yam, garri, dried cassava chaff (kpokpo garri) etc. Fish and other seafoods such as, shrimps, crayfish, and oysters are the sources of protein. The immunization coverage in the communities is low as Bayelsa State lags behind the regional and national average.

The awareness of the existence of STI in the communities was high. Despite the high awareness of the existence of HIV/AIDS, some respondents have knowledge of the mode of its transmission. The proportion of women and men with comprehensive knowledge of HIV/AIDS in Bayelsa State was found to be higher, than figures for South-South zone and Nigeria. Alcoholic beverages were freely available and at all times in the communities, while about 20% of the adult males in the communities smoke cigarette”.

Access to potable water is a major problem in the area. Water for drinking and sundry domestic needs is obtained from hand dug wells (often of high salinity), creeks and rainwater. The wastes generated in the area were from domestic, agricultural and fishing activities. These wastes are disposed by open dumping on land, water bodies and at times used as manure in the farms. There is no waste recycling. The houses are mainly small huts with inadequate ventilation and overcrowded.

Consultations

The identified stakeholders for EA FOD project were governments (Federal, Bayelsa State, Southern Ijaw and Ekeremor LGAs), regulators (FMEnv, Bayelsa State Ministry of Environment, DPR.), 11 communities, CBOs, NGOs, Media, consultants, etc. The scoping workshop held on Thursday September 05, 2013 at the conference hall of Matho-Crystal hotel, Yenogoa served as the first contact between SPDC and the various stakeholders and the neighbouring communities involved with the project. Stakeholders were made to express their perceptions and expectations, identify potential impacts (adverse and beneficial), propose measures to mitigate the negative impacts and enhance the positive impacts.

Interaction with the community was positive and there was widespread appreciation of the consultation process undertaken. The requests made by the various communities are summarized as follows: creation of job opportunities for the neighbouring communities during the project execution phase; provision of potable water, electricity, cottage hospitals and river transportation; involvement of the communities in the EIA study; and implementation of appropriate mitigation measures.

In response SPDC advised the communities to include areas of concerns relating to the provision of infrastructure in their Participatory Rural Appraisal Programmes for greater attention by SPDC. In addition, SPDC reiterated that all complaints/issues raised outside the context of the

project shall be sent to appropriate authorities. The workshop outcome is among the basis for the EIA study as consultation will be continuous and all mitigation measures shall be implemented.

ES 14.0: Existing, Associated, Potential and Cumulative Impacts

A combination of approaches was used for the assessment of the existing and potential impacts of EA/Eja field. The Rau and Wooten (1980) method was used for evaluating the existing impacts, while the ISO 14001 method was used for evaluating the potential impacts. Cumulative impacts were determined by combining the impacts from the existing facilities and potential impacts from the proposed EA Further Oil Development Project. Impacts were assessed at various stages of the project including pre-construction, mobilization, site preparation, drilling and pipeline construction, fabrication, installation and positioning of wellhead platform, commissioning operations and maintenance, demobilization, decommissioning and abandonment. The potential positive impacts of the project include opportunities for business and employment, increased oil production and revenue generation. Significant potential negative impacts of the project include:

- Risk of accident
- Risk of piracy & kidnapping
- Interference with fishing activities
- Increase in noise and vibration
- Impacts of wastes
- Impairment of air quality
- Injuries and death from blowouts
- Surface water and sediment pollution from chemicals, drill cuttings, and mud
- Exposure to radiation
- Potential for conflicts arising from labour issues.

About 36 water quality parameters were compared between 2001 and 2011. Of these, only 5 parameters increased significantly during this period, namely nitrate, phosphate, zinc, iron and copper. Nitrate and phosphate increased by 125% and 126% respectively over the 10 year period. Some heavy metals increased considerably from 2001 to 2011 particularly zinc (4420%), copper (2640%) and total iron (492%). Twenty four (24) sediment quality parameters were used to assess the impacts of existing EA/EJA field and Sea Eagle facilities. Of these, 6 parameters were found to be significant. From 2001 to 2011, nitrate and phosphate increased in the sediments by 3429% and 262% respectively. Some heavy metals increased between 2001 to 2011. They include cadmium (151%), zinc (172%), copper (290%) and lead (82%). The environmental impacts of these parameters have tendency to cumulate with the impacts of the proposed EA FOD project. However, the levels of these parameters were below intervention limits.

ES 15.0: Mitigation Measures

Mitigation measures were proposed for the predicted medium and high-ranking impacts. The risk of accident shall be mitigated via compliance with SPDC journey management policy for marine transport. The Risk of Piracy and kidnapping shall be mitigated via making adequate security arrangements at the project site and engagement of the youths from the neighbouring communities on worthwhile ventures e. g. skills acquisition. The impact of air quality and noise shall be mitigated by the use of equipment and machineries that are pre-mobbed and meet regulatory emission standards. Compliance with SPDC waste management guidelines (especially that for EA/Eja Field) shall mitigate the impact of wastes. Surface water and sediment pollution from chemicals, drill cuttings, and mud shall be mitigated by adequate drill cuttings and mud management.

ES 16.0: Environmental Management Plan

SPDC developed an Environmental Management Plan (EMP), to ensure that all identified significant negative impacts and the mitigation measures are implemented throughout project life cycle. The project team shall also rely on ISO 14001 audit and other national and international legal environmental management procedures to ensure compliance of the monitoring plan. The EMP team shall liaise with all contractors, engineers, quality assurance officers, supervisors and all relevant SPDC personnel as well as other stakeholders on all environmental matters. Monitoring requirements, duration and frequency of monitoring of key performance indicators as well as action party to manage the biophysical, health and social environments at various stages of the work have been proposed. The EMP is a dynamic working tool and should be updated from time to time throughout the project lifespan, to incorporate innovations, and changes in policy and in regulations.

ES 17.0: CONCLUSION

The EIA of EA FOD project was carried out in accordance with relevant local, national and international regulations based on FMENV approved terms of reference. The methodology applied for the study involved desktop studies, review of existing two season field data and community consultations. To achieve this objective, a multi-disciplinary approach was adopted in the assessment of the environmental status and sensitivities of the various biophysical, social and health components. The magnitude of the anticipated impacts of the project activities on the environmental components: air, water, soils, sediment, vegetation, fauna, fisheries, land use, waste management, social, economic and health issues were assessed, ranked and rated. The EIA of the project shows that it would have a significant beneficial impact on both local and national economy. The identified adverse impacts were generally short-term and can be prevented, reduced, ameliorated, or controlled if the recommended mitigation measures are implemented.

Mitigation measures were proffered to reduce the magnitude of identified adverse impacts, to a level as low as reasonably practicable (ALARP), while the positive impacts were enhanced.

These mitigation measures are incorporated in the Environmental Management Plan developed specifically for this project, and Environmental Monitoring Plan for the cumulative impacts, applicable to the entire lifespan of the project.

With the implementation of the EMP/Monitoring Plan, GMoU, respect for socio-cultural values, applicable legal and administrative frameworks and SPDC corporate policies and strict adherence to HSE provisions and other corporate best practices and design codes, this EA FOD project could be implemented sustainably. It is concluded that the execution of the EA FOD project will not cause serious damage to the environment if the EMP is implemented.

CHAPTER ONE INTRODUCTION

1.1: Background Information

The Shell Petroleum Development Company of Nigeria Limited (SPDC), on behalf of the Joint Venture partners (Nigerian National Petroleum Corporation [NNPC], Nigerian Agip Oil Company, and Total), conducted an Environmental Impact Assessment (EIA) study of the EA/EJA Further Oil Development (FOD) Project in OML 79. EA/EJA are Shallow Offshore fields located in OML 79, 90Km South East of Warri at a water depth of 15- 30m.

The combined STOIP is 875.7MMstb with an Ultimate Recovery of 373.8MMstb and a Developed Ultimate Recovery of 262.6MMstb. The fields came on stream in December 2002 and peaked in 2004 at a rate of 140Mbopd. The 1999 Field Development Plan was executed as EA Phase-1. The wells were drilled and completed between 2001 and 2003. A total of 61 wells have been drilled to date in EA/EJA out of which 28 are currently producing, 5 are closed-in and 28 have been abandoned (exploration /appraisal wells). EA/EJA produces from 3 platforms (DPA, DPB, and DPJ) to the Sea Eagle FPSO. The FPSO has a gross liquid handling capacity of 170Mbpd and 100MMscf/d AG. EA/EJA field's production is rapidly declining, coming down from 115Mbopd by mid-2010 to ca.70 million barrel of oil per day (Mbopd) as at end 2011. To reduce decline rate, unit operating cost and increase utility of the available ullage in the Sea Eagle FPSO, a three-fold integrated project known as EA FOD step1, step 2 and step 3 is proposed.

EA field has scope for further economic development of 125 Mbopd with 26 additional wells and 2 new platforms to maintain production plateau of 40 Mbopd until about 2020. This will extend the economic field life to 2032 (currently, the Sea Eagle NFA economics production limit is 2022, but production will decline to 20 kbopd by 2016). The plan is to merge the EA FOD steps 1 and 2 and then further mature the field's development as a merged project along with the EJA deep appraisal scope. Two (2) extra Platforms (subject to ongoing studies) and pipelines to the existing Sea Eagle would be required to accommodate the extra wells for both drilling & hook-up. There is enough ullage such that the existing processing facilities will be used. The expected hydrocarbon volume is some 363 million barrels. Peak oil production of some 128Mbopd in 2005 declined to 9Mbopd.

Consequent upon the availability of past EIA data, a desktop EIA study was approved by FMEnv, given that we have sufficient in-house environmental data based on the under listed environmental studies carried out by SPDC within EA (OML 079) field including recently acquired data from the field during the Environmental Evaluation Study and extension of the Fate and Effect of Produced Water Study-2012. Data sources consulted on the EA/EJA Field include:

- Report on the Environmental Evaluation Study and extension of the Fate and Effects Study of Produced Water Discharged from EA Sea Eagle FPSO (OML-079)-2012.
- Report of Produced Water Discharge Study for EA/Eja Fields (Fate and Effect Study)-2006
- A Study of Chronic Effects on the Marine Environment from Long –Term Discharge of Produced water in EA/Eja field -2004
- Environmental Impact Assessment (EIA) of EA Development Project- 2001
- Monthly Environmental Compliance Monitoring Reports (till date).
- Scientific reports on the Gulf of Guinea.

1.2: Scope of the EIA

This environmental impact assessment report presents the findings of an assessment of impacts expected from the EA development by SPDC, Nigeria. The offshore field development will be by means of six platforms (out of which 3 are already in place) and a floating production, storage and offloading (FPSO) unit in two phases. Oil and gas will be produced to the FPSO, where oil will be dehydrated and stabilized prior to storage in the cargo tanks to await offloading by trading tankers which will moor in tandem with the Floating Production Storage and Off-loading (FPSO). Associated gas will be treated and used for fuel gas, gas lift, while excess gas will be exported via the Offshore Gas-Gathering System (OGGS) to Bonny NLNG train 3.

1.3: Objectives of the EIA

The aim of the EIA is to comprehensively address the environmental issues associated with the EA development in line with corporate policies and expectations, in order to meet all requirements and secure necessary support and approval for the development as part of responsible environmental management. Furthermore, during the development of the EIA the consultation process has been used to develop a detailed understanding of local needs and public perceptions and expectations. The objectives of the EIA are to:

- Acquire baseline data of the environment as well as the socio-economic and health conditions of the neighbouring communities;
- Use the baseline data to describe and characterise the study area;
- Identify the environmental sensitivities of the project area;
- Determine and evaluate the potential impacts of the proposed project activities on the identified environmental sensitivities and the interactions between the sensitivities;
- Recommend appropriate mitigation measures; and
- Develop an Environmental Management Plan (EMP) and Monitoring Plan.

Benefits of the EIA include the following:

- Obtaining authorisation required by the regulatory authorities;
- Providing a forward planning tool to allow cost effective changes to be made to the design of the facilities;

- Providing a systematic approach to address the environmental aspects, risks and impacts of the development, together with identification of key issues;
- Involving key stakeholders in addressing issues and the formulation of impact mitigation measures; and
- Assisting in the formulation of long term management plans and the setting of targets and objectives, in order to minimize financial and environmental risks.

1.4: Project Location

EA & EJA fields are Shallow Offshore fields located in the south-eastern section of OML 79 about 90km southwest of Warri and 15km from the mouth of the Dodo River in Bayelsa State at a water depth range of 13 to 30m. First oil from the EA/EJA field was achieved on 14 December 2002 and an all high and peak production of 141.5 Kbpd was achieved in February 2004. EA Sea Eagle FPSO was evacuated following an incursion on 10 February 2006. Re-entry team mobilised and commenced work offshore on 03 September 2007 achieving full rehabilitation of the FPSO, and resuming production in July 2009.



Fig. 1.1: Map of the Project location showing the EA and Eja field

The Federal Republic of Nigeria lies in the tropics between latitudes 4 and 14 degrees north of the Equator and longitudes 3 and 14 degrees east of the Greenwich meridian. Nigeria borders the Gulf of Guinea between Benin (W) and Cameroon (E) and is bordered to the north by Niger. The country has a total area of 923,768 km² of which: 910,768 km² is land and 13,000 km² is water. The Niger- Benue Basin occupies about three fifths of Nigeria's land area and dominates the hydrology of the country. Part of the Lake Chad basin also lies within Nigeria. There is 8,575 km

of waterways. There are two principal rivers, the Niger and its major tributary the Benue. The Niger Delta covers an area of 70000km² and is the major onshore oil province in Nigeria. It is crossed by numerous smaller tributaries and creeks.

Land Use: 33% arable land, 3% permanent crops, 44% permanent pastures, 25% forest and woodland and 8% other (based on 1993 estimates).

Nigeria has mixed economy based largely on agriculture and petroleum production. The GDP is approximately \$110.5 billion (1999 estimate) of which agriculture accounts for 33%, industry 42% and services 25%. Industries include petroleum production, coal, tin, columbite mining, and agricultural production of palm oil, peanuts, cotton, rubber wood, hides and textiles. Cement and construction materials, chemicals and steel. Agriculture employs over 50% of the population. Staple crops include maize, sorghum, taro, yams, cassava and rice. Cocoa and Rubber are the only significant export crops. The capital intensive oil sector provides 20% of GDP, 95% of foreign earnings and about 65% of budgetary revenues. The agricultural sector has not kept pace with the rapid population growth and Nigeria is now a net importer of food.

Nigeria has a population of 140m people (June 2006) of which 54% are employed in agriculture, 6% in industry and 40% in services trade and transportation. Current environmental issues include: soil degradation, illegal deforestation (for fuel), desertification (inland) and locally severe hydrocarbon pollution from the Petroleum industry in the Niger Delta area.

1.5: The Applicant-Partners

The EA Development is being undertaken by SPDC (30%) on behalf of its joint venture partners Nigerian national Petroleum Corporation (NNPC-55% share), Elf petroleum Nigeria Ltd. (EPNL-10% share) and Nigerian Agip Oil Company (NAOC-5%). The development is funded by and "alternative funding arrangement for capex. The implementation budget is in the order of \$957 million.

Health Safety and Environmental (HSE) Management is recognised as a critical factor in the success of the EA project. In line with Shell corporate policies, comprehensive HSE management techniques will be employed throughout the project in order to ensure that risk levels to personnel and the environment can be managed so as to make them ALARP (As Low As Reasonably Practicable). Furthermore, the delivered asset will incorporate management systems, which are designed to facilitate continuous improvement. Shell Petroleum Development Company of Nigeria Ltd (SPDC) is the project developer and proponent for the EA/Eja Field.

1.6: The EIA Premises

The key premises which affect the Environmental Impact Assessment (EIA) process were established from the initial stages of the project to provide general guidance, framework, and a

commitment to standards acceptable nationally and internationally. The premises will be retained and variations allowed only in certain circumstances with supporting evidence to do so. The premises include that:

- The EA/Eja Field is sited within the Nigerian territorial zone (extends 24 nautical miles). Nigerian federal laws, including the environmental ones apply;
- the project recognizes the laws and regulations of the Federal Republic of Nigeria as represented by the Federal Ministry of Environment (FMEnv), the Department of Petroleum Resources (DPR) and the National Maritime Authority (NMA);
- the project will be designed and operated to comply with the regulations and standards of the above mentioned authorities, together with other applicable international protocols, agreements and conventions;
- the agreements and understandings made with government officials during the course of the EIA process will be respected;

1.7: Legal and Regulatory Framework

Operations and all forms of development activities in the Nigerian oil industry sector are regulated by specific laws, guidelines, and standards. These statutes together with applicable International Conventions and with SPDC health, safety, security and environment (HSSE) Policy provide a basis for an EIA of the EA further oil development project.

1.7.1: Relevant International Conventions, Guidelines and Standards

Nigeria is signatory to several laws, treaties and regulations that govern the environment.

Among these are:

- International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines 1996
- World Bank Guidelines on Environmental Assessment, 1991
- 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.
- Convention on International Trade in Endangered Species of Fauna and Flora (CITES) 1973
- United Nations Framework Convention on Climate Change (1992)

International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines 1996

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.

World Bank Guidelines on Environmental Assessment, 1991

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

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

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.

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.

Convention on International Trade in Endangered Species of Fauna and Flora (CITES) 1973

The fundamental principles of the Convention on International Trade in Endangered species of fauna and flora (CITES) is as follows: The Contracting States,

Recognizing that wild fauna and flora in their many beautiful and varied forms are an irreplaceable part of the natural systems of the earth which must be protected for this and the generations to come; *Conscious* of the ever-growing value of wild fauna and flora from aesthetic, scientific, cultural, recreational and economic points of view;

Recognizing that peoples and States are and should be the best protectors of their own wild fauna and flora; *Recognizing*, in addition, that international co-operation is essential for the protection of certain species of wild fauna and flora against over-exploitation through international trade.

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.

Guidelines of International Financing Institutions

When a plan or program such as the AN-OH consisting of a set of projects in a particular area is considered for finance by the International Finance Corporation, a Cumulative Environmental Impact Assessment is required. The IFC Procedure for Environmental and Social Review of Projects (IFC, December 1998) states that environmental assessment should include consideration of: “Cumulative impacts of existing projects, the proposed project and anticipated future projects.” To identify which other projects need to be considered alongside the project being assessed. The IFC Procedure states that:

“Assessment of cumulative impacts would take into account projects or potential developments that are realistically defined at the time the environmental assessment is undertaken, where such projects and developments could impact on the project area”. The Cumulative Environmental Impact Assessment also takes into consideration the provisions of the following IFC and World Bank guidelines relating to the environment:

- IFC Technical Guidelines on Hazardous Material Management, December 2001;

- IFC Technical Guidelines on Occupational Health and Safety, June 2003;
- IFC Policy on Forestry (OP 4.36), November 1998;
- IFC Policy on Natural Habitat (OP 4.04), November 1998;
- IFC Policy on Environmental Assessment (OP 4.01), October 1998;
- World Bank Policy on Forests (OP 4.36), November 1998;
- International Finance Corporation (IFC), Environmental and Social Standards (Equator Principle) Revised Edition, 2006
- IFC Guidelines for Noise
- IFC Guidance Note G: Assessment and Management of Cumulative Impacts, June 2001
- The IFC Procedure and Social Review of Projects (December 1998)

IFC Guidance Note G Assessment and Management of Cumulative Impacts, June 2001

The guidance note provides guidance on how to incorporate cumulative effects analysis into the components of an environmental assessment. A comprehensive CEIA comprises the cumulative effects of the projects in a plan or program. The current AN-OH CEIA falls more into this latter category.

IFC Guidelines for Noise

To assess the potential impact of a new noise source on the nearest noise sensitive receptors, the following approach shall be employed:

- Noise criteria specify absolute maximum accepted facility noise levels either at the site boundary or at the nearest noise sensitive receptors. These criteria are expressed in L_{Aeq} . Some of these criteria are also based on a Best Available Techniques (BAT) approach.
- Noise criteria also use a comparison of relative noise levels at the nearest noise sensitive receptors using existing ambient noise levels LA_{90} . Specific noise levels from the plant noise are assessed in terms of L_{Aeq} , with the difference between the two parameters giving the likelihood for complaints.

1.7.2: Federal Regulations/Guidelines

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:

- Environmental Impact Assessment Act CAP E12 LFN 2004.
- Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, 2002 Department of Petroleum Resources (DPR)
- Department of Petroleum Resources (DPR) Mineral Oils Safety Regulations 1997
- FEPA EIA Procedural Guidelines, 1995
- S.I.8 - National Environmental Protection (Effluent Limitation) Regulation 1991

- S.I.9 – National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes Regulation), 1991.
- S.I.15 – National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations of 1991
- The Petroleum Act No. 51 of 1969
- The Petroleum Drilling and Production Regulations – 1969
- The Oil Pipeline Act and Oil and Gas Pipeline Regulation of 1995
- 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
- Nigerian Ports Authority Act No 38 of 1999
- Urban and Regional Planning Law, Decree 88 of 1992

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.

The Mineral Oil (Safety) Regulations, 1963

Sections 37 and 40 of the mineral oil (safety) regulations, 1963, require provision of personal protective equipment (PPE) and the safety measures for workers in drilling and production operation in accordance with international standards.

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

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.

Endangered Species (Control of International Trade and Traffic) Act 11 of 1985

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.

Land Use Act of 1978

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 Inland Waterways Authority (NIWA) Act 13 of 1997

This Act established the National Inland Waterways Authority with a view to improving and developing inland waterways for navigation, providing an alternative mode of transportation for the evacuation of economic goods and persons, executing the objectives of the national transport policy as they concern inland waterways. The Act also prescribes regulations and sanctions on the use and exploitation of resources of inland waterways such as dredging, sand or gravel, mining and erection of permanent structures within the right-of-way or diversion of water from a declared waterway.

Oil Pipelines Ordinances (CAP) 145, 1956 and Oil Pipelines Act, 1965

The oil pipelines ordinance (CAP 145), 1956, as amended by the Oil Pipelines Act 1965, provides, under Section 4(2), for a permit to survey (PTS) a pipeline route to be issued to the applicant by the Minister of Petroleum Resources, for the purpose of transporting mineral oil, natural gas, or any product of oil or gas to any point of destination to which such a person requires such oil, gas or product, thereof, for any purpose connected with petroleum trade or operations.

Petroleum (Drilling and Production) Regulations (1969)

The Petroleum (Drilling and Production) Regulations (1969), empowers the holder of an OPL to do practically anything in the area covered by the license {Section 15 (1)}, but Section 15(2) holds such a holder responsible for all the actions of his agents and contractors.

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.

FMEnv Sectoral and Procedural Guidelines for Oil and Gas (1995)

In compliance with its mandate, FEPA issued the EIA Procedural Guidelines and Sectoral Guidelines for Oil and Gas Projects in 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.

FEPA (Now FMEnv) National Guidelines for Spilled Oil Fingerprinting (Act 14 of 1999)

This provides guidelines for spilled oil fingerprinting applicable throughout Nigeria, in order to improve the quality of the environment and to free it from pollutants and other environmental and health hazards.

FEPA (Now FMEnv) National Guidelines on Waste Disposal through Underground Injection (1999)

These Guidelines and Standards on waste disposal through underground injection provide the '*modus operandi*' for the most viable options for disposal of these wastes in a tropical environment as Nigeria.

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, 1994

The Forestry Act 1958 which was amended as the Forestry Law CAP 51, (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.

National Oil Spill Detection and Response Agency (NOSDRA), 2006

The National Oil Spill Detection and Response Agency (NOSDRA) was established in 2006 as the lead Agency in ensuring timely, effective and appropriate response to oil spills, through clean up and remediation of all impacted sites to all best practical extent.

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.

Associated Gas Re-Injection Act No. 99 of 1979 (CAP 26)

An Act to compel every company producing oil and gas in 1979 No. 99. Nigeria to submit preliminary programmes for gas reinjection and detailed plans for implementation of gas re-injection.

The Nigerian Oil and Gas Industry Content Development Act 2010

All regulatory authorities, operators, contractors, subcontractors, alliance partners and other entities involved in any project, operation, activity or transaction in the Nigerian oil and gas industry shall consider Nigerian content as an important element of their overall project development and management philosophy for project execution. There shall be exclusive consideration to Nigerian indigenous service companies which demonstrate ownership of equipment, Nigerian personnel and capacity to execute such work to bid on land and swamp operating areas of the Nigerian oil and gas industry for contracts and services contained in the Schedule to this Act.

Department of Petroleum Resources (DPR) Requirements for EIA

The Department of Petroleum Resources (in the Federal Ministry of Petroleum Resources) is empowered to ensure that petroleum industry operators do not degrade the environment in the course of their operations. Thus DPR is responsible for supervising operations in the oil industry and for enforcing remediation of impacted environments. Principal decrees and regulations that empower DPR to perform these functions include:

- Petroleum Act of 1969, Section 8(in)b (iii) which empowers the Minister of Petroleum Resources to make regulations for the conservation of petroleum resources, prevention of pollution of water courses and atmosphere;
- Petroleum (Drilling and Production) Regulations of 1969, Sections 25 and 36;
- Mineral Oil (Safety) Regulations of 1963, Part III, Section 7 and Part IV, Sections 44 and 45;
- Petroleum Regulation of 1967; the Oil in Navigable Waters Decree No. 34/Regulations 1968;
- Oil Pipeline Ordinance Cap 145 of 1956 as amended by the Oil Pipeline Act, cap 338, Laws of the Federation of Nigeria, 1990;
- Petroleum Refining Regulation of 1974, Section 43;
- Associated Gas Re-injection Decree No.99, Section 1 (a) section 2(1), and Section 3(1) of 1979;
- Associated Gas Re-injection (Continued Flaring of Gas) Regulations 1984; and
- Associated Gas Re-injection (Amendment) Decree No.7 of 1985, which amends section 3(2) of the Associated Gas Re-injection Act of 1979.

DPR requires EIA for use as an environmental management and enforcement tool. The DPR Environmental Guidelines and Standards of 1991 stipulates in Part VIII (A), Sections 3, 4, 5 and 6, the details of EIA process for the oil industry in Nigeria.

1.7.3: State Requirements

The Bayelsa State Environmental Protection Agencies (now ministries of environments) have the responsibility of environmental protection at the state level within their state. Although the project is not within state jurisdiction, the applicable State regulations have been taken into consideration as part of this project. Environmental Laws guiding Environmental management in Bayelsa state include but not limited to the following:

- Bayelsa State Environment and Development Planning Authority Edict 1998;
- Public Health Law-CAP103 of the Laws of Eastern Nigeria 1963
- Bayelsa State Land Use(Environmental Degradation/Protection) Charge Law 2005
- Bayelsa State Forestry Law 1998.

1.7.4: Shell Petroleum Development Company Policies

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.

HSE Policy

This policy states that, SPDC:

- has a systemic approach to HSE management designed to ensure compliance with the law and to achieve continuous performance improvement
- sets targets for improvement and measures, appraises and reports performance
- requires contractors to manage HSE in line with this policy
- To demonstrate commitment to HSE, SPDC is committed to
- Pursuing the goal of no harm to the people
- Protecting the environment
- Using materials and energy efficiently to provide our products and services
- Developing energy resources, products and services consistent with this aim
- Consulting our stakeholders and publicly report our performance
- Playing a leading role in promoting best practice in our industries
- Managing HSE matters as any other critical business activity
- Promoting a culture in which all SPDC employees share this commitment

In pursuance of this policy, SPDC shall:

- Carry out Environmental Impact Assessments and Evaluation in relation to all aspects of the natural and social environment that may affect or be affected by its activities;
- Identify any such interface for the complete life cycle of both new and existing facilities and operations;
- Enhance positive effects, prevent intolerable impacts from occurring;
- Limit the nature and extent of any residual negative impacts, however caused, such that they are as low as practicable;
- Consult relevant stakeholders;
- Leave the environment at the end of the useful life of any operation in a condition suitable for future use;
- Routinely monitor the environmental status of each operation and take corrective action as necessary.



Fig 1.2: Shell Commitment and Policy on Health, Security, Safety, Environment and Social Performance

Shell Biodiversity Policy

The Biodiversity Action Plan (BAP) is a set of actions that will lead to conservation or enhancement of biodiversity in a given area. In order to meet the challenges to the increased risk to biodiversity resulting from energy development activities typical of oil and gas projects, Shell in May, 2000 published a set of guiding principles on biodiversity for its companies – the Shell Group Biodiversity Standards. It states as follows:

“In the Group, we recognize the importance of biodiversity. We are committed to:

- Work with others to maintain ecosystems;
- Respect the basic concept of protected areas; and
- Seek partnerships to enable the Group to make a positive contribution towards the conservation of global biodiversity.

Shell companies will:

- Conduct environmental assessments, which include the potential impacts on biodiversity, prior to all new activities and significant modifications of existing ones, and
- Bring focused attention to the management of activities in internationally-recognized hot spots, including the identification of, and early consultation with key stakeholders”.

Realizing the need for further clarification of the commitment to ‘respect the basic concept of protected areas’, Shell in August 2003, amplified its definition of ‘protected areas’, and made additional commitments to biodiversity conservation as follows:

- We shall not explore for, or develop oil and gas resources within natural World Heritage Sites;
- We shall further upgrade our operating practices in IUCN Category I- IV protected areas;
- We shall become involved in spatial planning, assess our secondary impacts, implement Biodiversity Action Plans and conduct appropriate baseline and monitoring studies. This we shall also do in areas where impact assessments indicate high levels of biodiversity;
- We shall publicly report on our activities in IUCN Categories I-IV;
- We shall work with IUCN and others to develop and plot ways of strengthening the management effectiveness of protected areas through the provision of key skills, creation of sustainable livelihood and by exploring options for sustainable financing.

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 flares and otherwise;
- Manage and dispose of wastes in an environmentally responsible manner;
- Track and maintain records of waste streams and provide an auditable trail as to their management and disposal.

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.

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.

1.8: Structure of the Report

This report is presented in eight chapters.

Chapter One

This chapter contains a general introduction of the broad project outline and relevant background information about the proponent (SPDC); outline of the EIA Scope, Terms of Reference (ToR) and concept of integrating cumulative effects assessment. The key provisions for the Legal and Administrative Framework for the conduct of the EIA are presented.

Chapter Two

The second chapter discusses the project (facilities and pipelines) justification and presents the need/value and the envisaged sustainability of the project, alternatives/ development options considered (including the no project alternative) for pipelines and the basis of site selection.

Chapter Three

The third chapter describes the proposed project (facilities and pipelines), its location, overall layout, basis for design, type and specification of pipelines to be installed, specific project activities (for pipelines), waste management process for pipelines, project.

Chapter Four

Description of the biophysical, socio-economic and health environment, Study approach, literature review, baseline data acquisition method and QA/QC, geographical location, field data, climatic conditions, air quality, noise level, vegetation cover characteristics, land use and landscape pattern, ecologically sensitive areas and critical habitats, terrestrial fauna and wildlife,

soil studies, aquatic studies including hydrobiology and fisheries, ground water resources, social, economic and health studies, existing stresses on the various environmental resources and prediction of changes in the baseline condition without the development in place.

Consultation

This section describes the engagement sessions that were organized for various stakeholders. The consultation includes sessions with communities, institutions and Non Governmental Organisations.

Chapter Five

Presents a discussion of the various associated and potential environmental, social and health impacts of the different planned project activities, analysis of impacts on the identified valued ecosystem and social components of the project area of influence; identification and assessment of magnitude/significance of cumulative impacts.

Chapter Six

Mitigation Measures - The mitigation measures were proffered for past, existing and potential impacts.

Chapter Seven

Recommends a cost-effective environmental management plan that would be adopted throughout the project cycle to address the significant impacts. It also recommends the environmental monitoring programme and wastes management programme.

Chapter Eight

Provides major conclusions and recommendations arising from the assessment

References

Annexes

CHAPTER TWO PROJECT JUSTIFICATION

2.1: Project Background

The FOD opportunity was identified in the 1999 preproduction field development plan (FDP) as Phase Two. Phase one is already on stream (started December 2002). The FDP also identified EJA deep exploration as an upside for future development in a success case.

2.2: Project Location

EA is a shallow offshore field located in the south-eastern section of OML 79, about 90 km southwest of Warri and 15 km from the mouth of the Dodo River in Bayelsa State (Fig. 2.1 and 2.2).

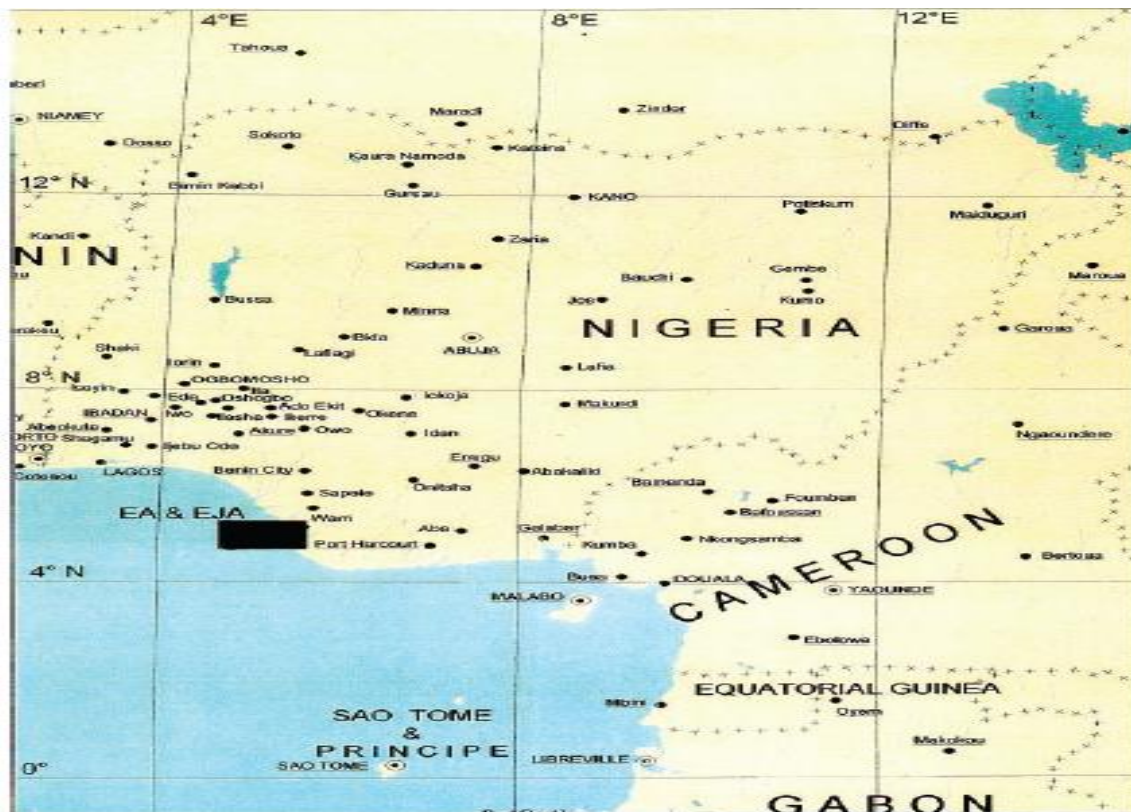


Fig. 2.1: Nigeria showing project location

The field is in water depth of 13 to 30m. The EA field was discovered in 1965 and has been in production since December 2002, achieving peak production of 140 kbpd in 2004. West of the EA field is the EJA field, which was discovered in 1968 and has been developed alongside the EA field.



Fig. 2.2: EA/EJA field location

There are currently 3 producing platforms in the EA/EJA field (DP-A, DP-B and DP-J) and wellhead fluids are processed in the “Sea Eagle” a Floating, Production, Storage and Offloading(FPSO) vessel (Fig. 2.2) which has a gross liquid handling capacity of 170 kbpd and 100 MMscfd associated gas (AG) capacity. A total of 61 wells have been drilled in the EA/Eja field of which 31 have produced/are currently producing.

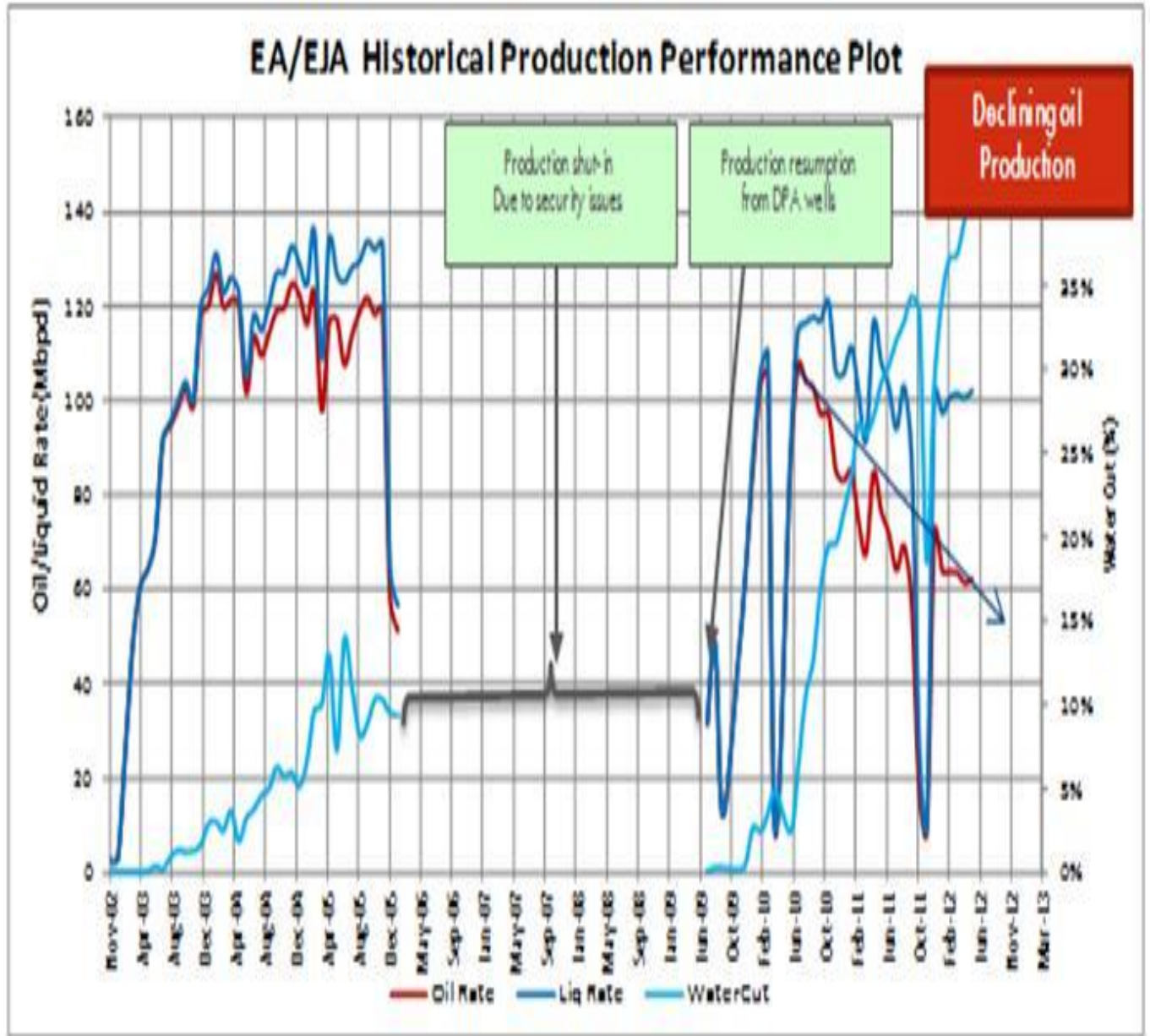


Fig. 2.3: EA/EJA Historical Production Performance Plot

EA/EJA production declined from 120 kbpd in 2005 to 80 kbpd in 2010. A further decrease of 12% from 83kbpd to 73 kbpd was experienced in 2011. With the declining oil production has come an increase in unit operating cost for the facility. In a bid to arrest declining production, extend field life and improve unit operating cost, the EA Further Oil Development (FOD) project was initiated. This project, as currently conceived, will mature ca. 70 MMstb of contingent oil resources from 10 developed and 11 undeveloped reservoirs.

Currently, the Sea Eagle no further action (NFA) economic production limit is 2022, but production is expected to decline to 20 kbpd by 2016. The combined production forecast for the

EA FOD project is as shown in Fig 2.3. The forecast is truncated in 2027 which is based on the FPSO design life of 25years. The exploration upside production volume, shown in Figure 2.3, relates to exploration/ appraisal activities in deep EJA field reservoirs.

2.3: Need for the Project

The EA Further oil development will achieve three main objectives:

- Develop the remaining oil and gas resources of the EA/Eja field and realise the financial benefits to the partners;
- Further contribute to the Nigerian Economy; and sustain the employment of staff and the development of infrastructure through a targeted community development programme as contained in the Social performance plan of the EA/Eja field; and
- Since it will extend the EA production, the EA Asset team will have the opportunity to keep on developing the skills and capabilities of local staff to international standards, as is already been done through short term deployment.

The EA FOD is an opportunity to develop 70MMboe of discovered hydrocarbon resources in EA/EJA fields (and an upside of 20 MMstb Expectation from EJA deep prospect) to increase the fields' economic production life beyond 2022 NFA economic life.

2.4: Value of the Project

The value of the project may be judged by its positive impact on economy, improved quality of life and quality of atmospheric environment, as follows:

- Economy: Full field development will enhance oil production and purposeful utilization of associated gas via existing OGGs pipeline to NLNG, and foreign exchange earnings from the sale of oil and gas, are positive signs of real development.
- Quality of life: Enhance the opportunities contained in the Social Performance Plan, as already being done by the EA Asset team, to improve quality of life of the neighbouring communities.
- The main driver for the EA FOD project is full field development implementation of the 1999 pre-production FDP. This will address the production decline in the EA/EJA fields, utilize the available ullage in the Sea Eagle FPSO and thus reduce the unit operating cost of the facility.

The project will further enhance the economic viability of the EA operation.

2.5: Envisaged Sustainability

Oil and gas are non-renewable natural resources, so, in this context, we are talking about sustainability within the limits of availability. Sustainability is anchored on sound economic, social and environmental health. It is based not only on compliance with regulatory and corporate standards and guidelines, but also largely on performance improvement. In recent

times, environmental managers have discovered that sustainable development means that they have to take into account labour conditions, employee's health and safety, community relations and other soft social and cultural factors, as well as uncertain environmental factors in relation to ecosystems. The thrust of the EA/Eja field sustainable development programme is derived from the SPDC's sustainable development management framework.

Economic Sustainability

The EA/Ejafield have proven reserves of oil and gas. Drilled reserves in the phase one have economically and commercially supported the operations of the Sea Eagle, with the export of oil through tankers and gas to NLNG via the OGGS Riser platform (RPA). SPDC policy on local content and employment of indigenous contractors will be applied in the project. Skilled and unskilled indigenous labour will be hired in the construction phase. The main contractors employed in this development shall be required to award minor contracts to local indigenous contractors for jobs in which they have the required expertise, when the need arises in line with the EA FOD Social Performance Plan. Such jobs will include but not limited to labour supply, catering, leasing, fabrication, etc. Efforts will be made also to upgrade the technical and managerial capacities of such indigenous contractors.

Technical Sustainability

The EA FOD Project is technically sustainable because of SPDC's track record of strict adherence to Nigerian National (and International) engineering codes and standards. Only proven technologies that are economically viable with minimal environmental, social and health impacts shall be utilised in the execution of the project.

Environmental Sustainability

The aim is to ensure that current use of the environment and its natural resources does not damage prospects for use by future generations. SPDC shall comply with all statutory regulations and its own corporate guidelines on Environmental Sustainability, whilst continuously striving towards performance improvement. Elimination of routine gas flaring is a positive step in the direction of sustainable development and will thus support transition to environmental sustainability. Adequate implementation of the environmental management plan will assure environmental sustainability.

Social Sustainability

The EA and EJA FOD projects will attract a lot of improvements in the social wellbeing of communities neighbouring the project area. Some category of jobs including some sub-contracting services shall be employed from the communities, resulting in financial upliftment and reduction in the number of unemployed youths that presently besiege the Niger Delta Region. This project will also attract contribution to the already existing Global Memorandum of Understanding (GMoU) between SPDC and the communities. Under the GMoU platform

funding is provided by SPDC with which communities agree, prioritise and execute and manage sustainable community projects in their area.

2.6: Project Alternatives

The development options proposed by EA FOD studies are centred on optimal well placements, slot availability in existing or proposed platforms, recompletion opportunities and timing of new wells. Scenarios focus on several alternatives, economic, technical and environmental sustainability, etcetera, with a view to optimizing well placements and the drilling sequence to maximize recovery in view of the key value drivers for the project. These scenarios are themed under five development options as follows:

Option 1: Chase the barrel: This option considers only validated wells that can be drilled from available slots in existing platforms without the need for construction of a new Platform. The scope of this option is to drill a total of 15 new wells from available slots in existing platforms and carry out 3 recompletions on existing wells.

Option 2: Minimum CAPEX: This option targets 3 recompletions plus wells with recoverable volumes of at least 2MMstb and drillable from existing platforms. Only 10 new wells met this criterion.

Option 3: Maximum Recovery: This option targets drilling of all validated 20 new wells and 3 recompletions. This option encapsulates the full implementation of Option 1 and in addition recommends construction of a new Platform in EA to drill the remaining 5 new wells which could not be drilled from the existing platforms.

Option 4: Minimum CAPEX + Optimized Development: This option desires to carry out 3 recompletions and drill all identified wells with recovery cut-off of 2MMstb per well. A total of 12 wells met this criterion and this option also requires construction of a new Platform in EA to host the two extra wells that could not be drilled from existing platforms.

Option 5: Maximum Production + Maximum CAPEX + EJA Deep: Option 5 scope consists of drilling a total of 23 new wells and 3 recompletions as follows: 15 new wells from existing platforms, 5 new wells from new platform in EA and 3 new wells from new platform in EJA. The new platform in EJA will be constructed in the event of the EJA deep exploration/appraisal success. This element is currently notional and considered an upside that would be matured after drilling the exploration/appraisal well.

The selected concept for EA FOD project is **Option 3** –Maximum Recovery. This option includes optimal lifecycle development of the field. The development proposes a total of 20 new wells and 3 recompletions. This concept includes some of the targets identified in Phase 2 FDP

and some new targets. Fifteen (15) of the new wells will be drilled from existing platforms, while 5 will be drilled from a proposed new platform located in EA. In terms of sustainability, it remains the preferred environmental, technical and economic viable option. It not only saved large of money but the environment and ease of operability.

The development strategy for the selected concept is planned to be executed as follows:

- Drill 15 wells and 3 recompletions from available slots in the 3 existing platforms in EA/EJA to develop 56.7 MMstb. This tranche comprises mainly drilling, completion and hook-up activities using existing platforms and is estimated to cost ca 565.7mln US Dollars (Level 2 cost estimate).
- Construct one new Platform in EA and drill 5 new wells from the proposed new Platform to develop 13.8 MMstb at a level 2 cost estimate of 460.4 mln US Dollars. This element of the project is still immature and will require further maturation and some other non technical risk assessments. Considering the high cost of constructing a new platform, this element of the project will undergo value engineering with the aim of further CAPEX reduction.
- The volumes quoted here are what will be produced by the proposed wells till 2027 when the FPSO will be dry-docked for scheduled maintenance.
- An exploration well shall be drilled to test the EJA Deep structure with an estimated upside of ca 20MMstb (2U) in the success case. This element of the project is still notional and maturation of a success case shall be the subject of future development.

2.7: Relationship to Other Projects

At the inception of EA phase 1 various options were considered and the FPSO option was finally selected. The FPSO incorporates separation, storage dehydration, water treatment and export facilities. The Trans Ramos Pipeline (TRP) was designed and built with EA production in view. The ongoing upgrade of Forcados terminal also anticipates production from EA. However, the capacity of the Trans Ramos Pipeline or loop-line is insufficient to take EA/Eja field Oil. The EA further oil development project leverages on existing facilities of the EA/Eja field. Gas will be exported through existing Sea Eagle connection to Offshore Gas Gathering System (OGGS) pipeline.

2.8: Surface Facilities Options

The option identified for the Ullage Fill Concept entails developing the EA/EJA fields and evacuating the produced reservoir fluids via new infrastructure to the Sea Eagle FPSO. For the Alternative HC Evacuation Concept, two options were identified, namely; FPSO Re-deployment and No FPSO option.

FPSO Re-deployment

The FPSO re-deployment option considered re-deployment of Sea Eagle FPSO to H-Block with purchase and deployment of smaller FPSO to EA/EJA field, lease and produce EA/EJA field to Bonga FPSO, some 82Km away from the EA/EJA field.

No FPSO option

The no FPSO option considered decommissioning the Sea Eagle FPSO and implementing multiphase pumping to Tunu Central Processing Facility (CPF). This option further considered either constructing a new multiphase pumping station/platform or converting an existing platform to a multiphase pumping station. Figure 2.4 depicts the surface development concepts and options framework.

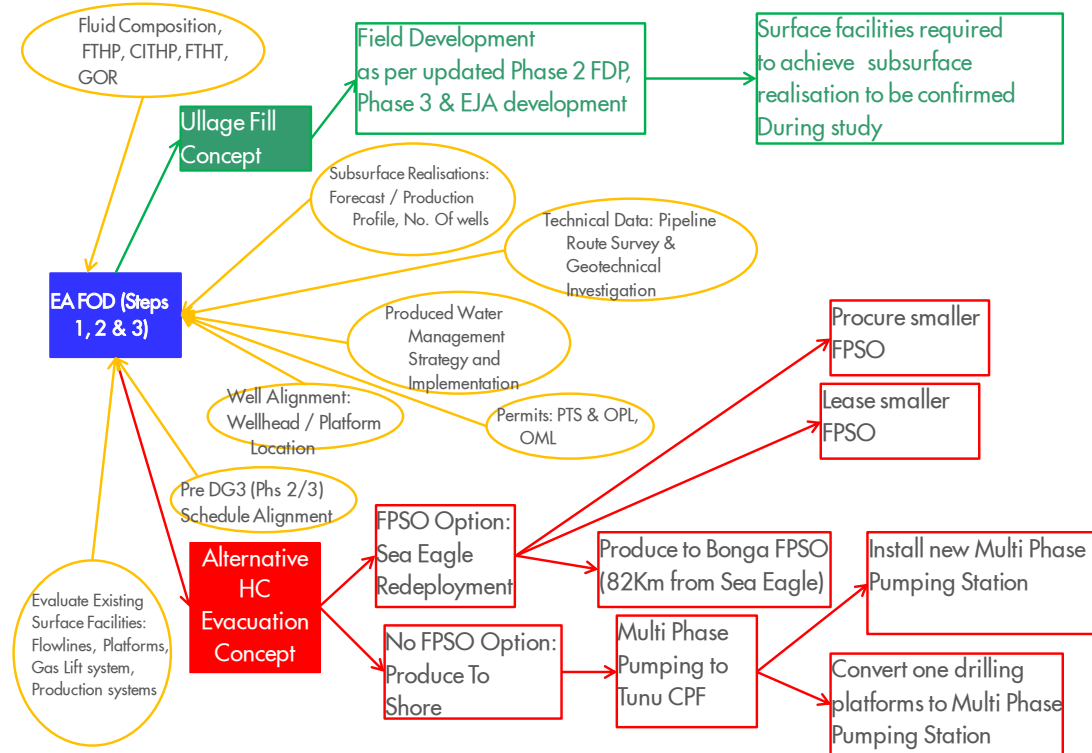


Fig.2.4: Surface Development Concepts and Options Framework.

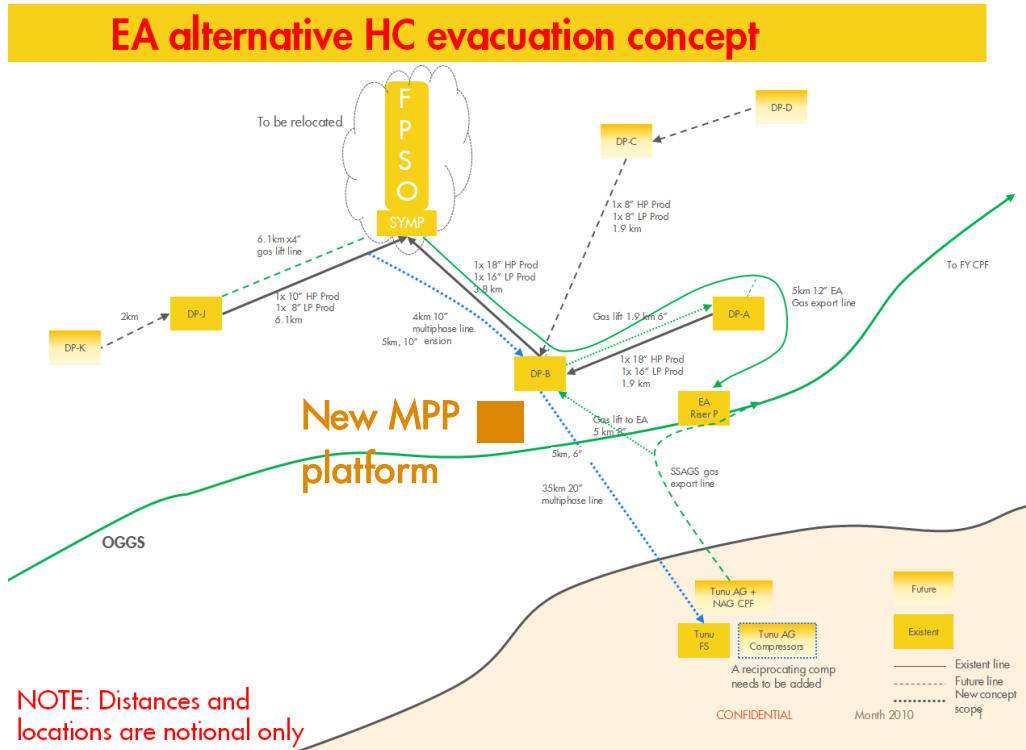


Fig.2.5: Alternative Hydrocarbon Evacuation Concept.

Pipeline Route Options: Route options for pipelines were based on the following considerations:

- Seabed obstructions and features
- Construction Limitations-Pipeline Crossings and cable/umbilical crossings
- Pipeline Length
- Cost
- DEM-1 Derogations Required (Process Safety Considerations)
- Ease of Construction

CHAPTER THREE

PROJECT/PROCESS DESCRIPTION

3.1: Project Overview

The EA/EJA Further Oil Development (FOD) project targets the development of oil contingent resource including appraisal opportunities in the EA and EJA fields. FOD opportunity was identified in the 1999 pre-production FDP (Field Development Plan) as Phase 2. Phase 1 has been on stream since December, 2002. The FDP also identified EJA deep exploration as an upside for future development in a success case. The EA FOD Project is to maximise the EA and EJA field's production. The project aims to develop 70.5 MMstb of discovered oil resources in EA/EJA fields (and an upside of 20 MMstb from EJA deep prospect) to increase the fields' economic production life from beyond 2022 no further activity (NFA) economic life. The work scope is modification of three unmanned Wellhead Platforms (WHPs) and drilling and completion of 15 wells from these WHPs, piping, hook-up and commissioning and drilling of 5 new wells from a new platform (DPC).

3.2: Project Objectives

Currently, the Sea Eagle NFA economic production limit is the year 2022, but production will decline to 20 Kbpod by 2016. The development project was initiated to optimise the full-life cycle further development of the asset and was conceptualised to mature the contingent resources in the fields. The EA FOD is an opportunity to develop 70MMboe of discovered hydrocarbon resources in EA/EJA fields (and an upside of 20 MMstb Expectation from EJA deep prospect) to increase the fields' economic production life beyond 2022 NFA economic life.

The EA FOD project aligns with SPDC's strategic goals and priorities by developing OML 79 and thus makes the case for renewal of its license which expired in 2008. The project will develop additional 68.11MMstb of oil and 14.99Bscf associated sales gas contingent resource (2C) from EA and EJA fields via drilling and completion of 20 new development wells and 3 work-over wells. The project will however be executed in two phases, 15 new wells and 3 work-overs first, [54.26MMstb of oil and 14.11Bcf of sales gas] and 5 wells requiring a new platform [13.85MMstb of oil and 0.73Bcf of sales gas] will come later subject to management approval post value engineering exercise by end Q4 2015.

The business objective of this project is to develop additional 68.11MMstb of oil and 14.99Bscf associated sales gas contingent resource in the EA/EJA fields within the expected production life of the FPSO (Sea Eagle). The main business drivers for the EA Further Oil Development project include:

- Achieving full field development (i.e. maximizing/ultimate recovery from the discovered wells);
- Improving cash flow from operating asset and contribute to SPDC growth aspiration;
- Utilizing the available ullage in the FPSO to maximize asset utilization;
- Reducing the unit operating cost by increasing the production in the field; and
- Testing the EJA Deep exploration scope with circa 20MMstb (2U) potential upside.

3.3: Project Schematics

The result of the preliminary evaluation and economic considerations favour the ullage fill concept, the following field development schematics (Fig. 3.1) has been proposed in line with previous Field Development Plans (FDP).

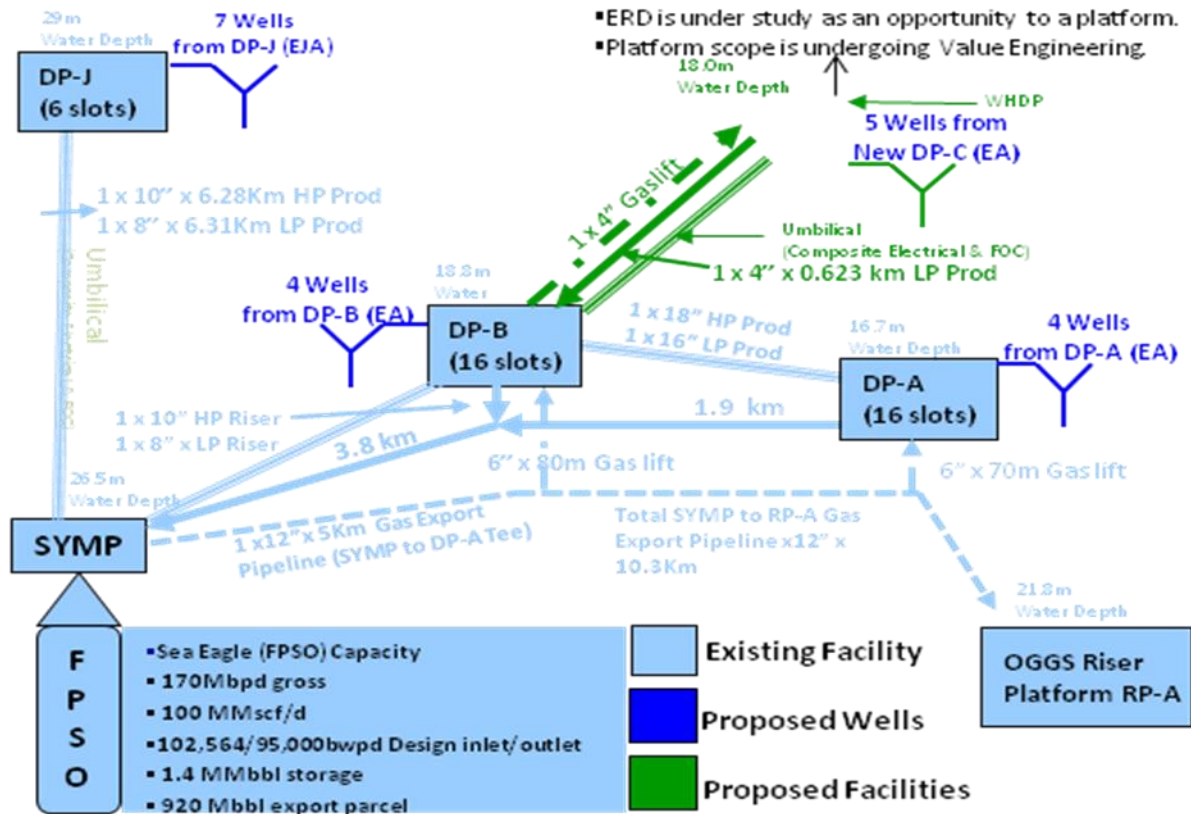


Fig. 3.1: Schematic for EA FOD Project Facilities

3.4: Proposed Project Scope

The EA FOD project scope is summarised as follows:

- A. 15 new wells will be drilled and work over (Appendix 3.1) will be carried out on 3 wells; all from existing platforms. This comprises
 - o 4 new wells and 3 work-over wells from DP-A,
 - o 4 wells will be drilled from DP-B and
 - o 7 wells will be drilled from DP-J.
 - o Installation of well hook-up piping system and ancillaries, well control systems, process automation, instrumentation, control and safeguarding and gas lift piping. Existing infrastructure; comprising evacuation pipelines and umbilical (composite electrical and fibre optic cables) from existing platforms to the Sea Eagle FPSO including processing facilities on the Sea Eagle FPSO are sufficient to support this development.

- B. 5 new wells will be drilled from a new drill centre DP-C.
- Drilling and hook up of 5 new wells from a new drill centre with 4 slots. The New platform should adopt, as much as possible, the structural design of Forcados Yokri Integrated Project (FYIP) new cluster 5A, in terms of structures.
 - Installation of hook-up arm (flow lines) between the new well heads and manifolds, including ancillaries, control & safeguarding system.
 - Installation of gas lifts piping for the new wells, including ancillaries, control & safeguarding system.
 - Installation of wellhead control system/panels.
- C. Drill EJA deep exploration well to prove up, upside volume of 20MMstb.

Rig tendering is in progress thus descriptions of rigs, well heads and key drilling equipments are not available. However, 10K/2000HP Shallow draft offshore Jack-up drilling and Workover rigs; Mud system working pressure – 5000psi, Test Pressure – 7500psi; H2S monitoring system, Combustible gas monitoring system shall likely be used.

3.4.1: Outline of Existing Facilities

EA / EJA field was developed using FPSO called Sea Eagle as the main facility processing fluids from the drilling platforms. Oil is evacuated by tanker and produced gas is exported through the offshore gas gathering system (OGGS) to Bonny NLNG plant. The area has 5000m exclusion zone. There are three existing drilling platforms in the EA/EJA fields; all designed as unmanned and the wells are produced into either a high or a low pressure (LP) flow lines depending on the LTHP. Every well is connected to the Test, High Pressure (HP) and Low Pressure (LP) manifolds. The produced hydrocarbons are piped through a subsea bulk line to the Sea Eagle FPSO for processing. Lift gas for use on DP-A and DP-B is tapped from the 12 inch export gas line to OGGS through 6 inch spurs. The Sea Eagle FPSO is moored to a soft yoke mooring platform (SYMP). The well fluids arrive on the topsides as HP and LP fluids and are routed to dedicated separators. The control system is such that, from the FPSO, a well can be directed to any of the three manifolds. The combined fluids are subsequently routed to a common final separator. The hydrocarbon fluid from the field is produced into and processed on the Sea Eagle FPSO, after which the processed oil is stored on the FPSO before being transferred to export tankers while the associated gas is dehydrated and exported to NLNG through OGGS.

The existing infrastructure comprising evacuation pipelines, and composite umbilical's from existing platforms to the Sea Eagle FPSO including processing facilities on the Sea Eagle FPSO are sufficient to support the 15 wells hook up and 3 work over wells scope. A new platform and a pipeline scope would be required for the 5 wells scope as shown in Table 3.1.

Table 3.1: The major facilities existing in the EA/EJA Fields

S/No	Description
1	2 x I6 Slot Drilling and Production Platform DP-A and DP-B comprising 4 legged jacket with topsides consisting of ESDV (Emergency Shutdown Valve) deck, Cellar deck, main deck and a top deck.
2	6 Slot Drilling and Production Platform DP-J comprising 4-legged jacket with topsides consisting of ESDV deck, Cellar deck, main deck and a top deck.
3	OGGS Riser Platform (RP-A)
4	Sea Eagle FPSO with a Soft Yoke Mooring Platform (SYMP): Oil processing facility to export specifications, associated gas (AG) processing facilities for exporting gas to NLNG via OGGS RP-A, Water treatment and disposal. Capacity: 170Mbpd Gross + 100MMScfd, 1.4MMbbl Storage, 920Mbbbl Export Parcel, Water Treatment Package Design inlet/outlet (102,564/95,000bwpd).
6	2 x 18" x 5.7km (1HP and 1 LP) production line running from DP-A to FPSO
7	2 x 10" (1HP and 1LP) production tie-back running from DP-B to DP-A – FPSO
8	1 x 10" x 6.28km HP and 1 x 8" x 6.1km LP production lines running from DP-J to FPSO
9	12" x 10.3 Km FPSO – OGGS RP-A gas export pipeline
10	Umbilicals provide power and Instrumentation & Control in the EA/Eja field connecting SYMP to DP-B, DP-B to DP-A, SYMP to DP-J, DP-A to OGGS Riser Platform RP-A.

Lift gas off-take for the wells producing to DP-A and DP-B drilling and production platforms is provided through 6 inch spur lines with subsea barred Tee-off along the 12" Sea Eagle – OGGS RP-A gas export pipeline. There is no lift gas pipeline for the wells producing to DP-J platform.

Three drilling platforms; DP-A, DP-B and DP-J were installed in water depths of 15 to 30 meters as part of the EA Phase 1 development. The purpose of these three installations is to produce and transfer well fluids to the Sea Eagle FPSO for processing. The field has a total of 33 producers; 19 wells producing on DP-A, 12 wells producing on DP-B and 2 wells producing on DP-J. The drilling platforms are connected to the FPSO by subsea pipelines and a composite umbilical carrying power and control signals. The design of DP-A and DP-B is based on modular topsides and a jacket with four main legs, anchored by piles through the jacket legs. The deck layout incorporates 16 well slots in a 4 by 4 configuration. DP-J is a smaller version of DP-A and DP-B, incorporating 6 well slots.

All the platforms support Mobile Offshore Drilling Unit (MODU) with a cantilevered drilling derrick module to drill from above the top deck of the platform. For each of the remote installations, the wells feed into one of two manifolds per platform. Production from individual wells can be diverted via the third manifold to a multiphase test-metering skid,

where oil gas and water production is measured. Corrosion Inhibitor is added before the well fluids are piped off the drilling platform to the Sea Eagle.

DP-A, DP-B and DP-J is normally unmanned with no provision for emergency accommodation or shelter. A minimum crew of three visit a platform and access for maintenance or other activities e.g. pig launching, is by boat landing area on the north side of each platform with the boat always remaining in attendance during the visit. No helideck facilities are provided on any of the drilling platforms.

Minimal control systems are provided on the drilling platforms, consistent with the process equipment on board. Emergency Shutdown including riser valve closure can be initiated from the Sea Eagle Central Control Room (CCR). A fusible loop fire detection system in the well bay area will initiate a platform ESD upon detection of a fire. Instrumentation, including Closed Circuit Television (CCTV) is monitored remotely from the Sea Eagle. All other processes onboard are manually operated with status indication relayed back to the Sea Eagle CCR.

A detailed process facilities description including set points is available in the Sea Eagle Process Operating Procedures Manual (POPM). DP-A, DP-B and DP-J; OD-OP04-024 version A3, OD-OP04-025 version A3 and OD-OP04-026- version A3 respectively. A central power generation system is provided on the Sea Eagle FPSO for the EA /Eja field. Electrical power generation on the Sea Eagle is provided by:

- Main Power Generation Packages A-87001/2/3/4/5.
- Emergency Generator GD-87152.
- Essential Services Generator GD-87151.

Each of the Main Power Generation Packages comprise a dual fuel gas turbine which is coupled through a reduction gearbox to an air cooled, brushless, synchronous 12.5 MVA, 11 kV, 3 phase, 50 Hz alternator set. The turbines normally operate on a fuel gas supply. A diesel fuel supply is available in the event that the fuel gas supply is not available.

The main generators supply the main 11 kVA switchboard. During normal operation, power from this Switchboard is distributed to the following:

- Sea Eagle Process and Utility Equipment
- Soft Yoke Mooring Platform (SYMP)
- Drilling Platforms
- Offshore Gas Gathering System (OGGS) Platform.

The total design load, for the above equipment, can be met by four generation units with one unit acting as a spare. Four units need to be on-line before the Gas Compression Drive Motors can be started. In the event of loss of main power, a backup supply is available for selected items of equipment. This back-up supply is provided by the diesel-driven emergency generator and/or the Essential Services Generator that are located in the Sea Eagle Machinery

Space. These generators supply emergency and essential switchboards that distribute power supplies to the selected users. In addition to the back-up provided by the diesel-driven generators, battery back-up supplies are provided for selected safety and control systems.

3.4.2: Wells Scope

The 5 well scope will incorporate a new drill center from a new platform. Below are the description of the Utility system, Topside configuration, Substructure, General and common facilities. Details of well design, casing, well depth mud scheme and treatment of drill cuttings are shown in Appendix 3.1, whilst well completions scheme indicating casing size and setting depths for EJA wells as references as well as tubing size and sand face completion types are shown in Table 3.3 and Fig 3.1.

Utility Systems:

Base case requirement is composite umbilical system with electrical power cable and fibre optic cable bundle. Two J-tubes (1 on DP-C and 1 on DP-B) are to be installed. The cables are to be sized during FEED and hence the umbilical and J-tubes sizes are to be determined. A confirmation of the capacity of existing switchboards, cables and generators to integrate the power distribution system with the entire EA FOD project is required.

Topsides

The selected platform concept has 2 decks with a total deck height of about 8m and 4m inter-deck height. The well slots shall be 4 in number (2 x 30" and 2 x 36") with inter-slot spacing of about 2.5m and guide slots on the topside of 40". The Topside shall be designed to safely support the worst expected load and load combinations (including environmental and accidental loads) from topside equipment as it relates to the deck specific functions and mode of operations (e.g. construction, drilling, and production operations). The platform layout concept shall ensure also that the possible/identified jack-up rigs to be used at the DP-C platform can reach the furthestmost well slot from the platform rig approach face while maintaining required rig spud can and transom distances from the platform.

Substructure

The selected concept is a 4 legged straight/un-battered jacket with piles driven through the 4 legs. Appurtenances on the jacket include, among others, a V-shaped boat catcher, boat landing, J-tube, mud-mat and two risers. The jacket shall be designed to safely support the worst expected load and load combinations (including environmental & accidental loads) from the topsides and appurtenances over different modes of operations on the platform (e.g. construction, drilling, and production operations). Risers supported on the jacket shall be positioned to minimise exposure to accidental damage.

General and Common Facilities

The Sea Eagle FPSO is the main facility for processing produced hydrocarbon fluids from the drilling platforms. The existing Control room on the FPSO will continue to serve as control and monitoring centre. All new hardware installed for the EA FOD will be integrated with the existing SIS/PAS/F&G systems.

Spare Parts and Special Tools

Given that the tie-in to DP-B facilities will be in a brown field environment, necessary measures must be taken to minimize the risk of fire and other hazards associated with concurrent operations and this may involve the use of special tools and machines during tie-in. Spares stocking on site will be required for the new facility, to ensure target availability which will be determined during FEED.

Movables

Hardcopy design documentation (folders, CDs) for operations personnel will be kept in existing EA document control centre. No major additional movable assets are envisaged on the FPSO.

Office Facilities for Company Personnel

Existing facilities in the FPSO will be utilized to accommodate any extra operations personnel due to this project.

Pipeline Scope for DPC

The pipeline scope is only for the new platform DPC. This project will:

- Construct and install a total of 3km tie-back pipeline (DP-C to DP-B).
 - 1x6-inch 1.5km LP bulkline.
 - 1x4-inch 1.5km gaslift line.
 - 1.5km Umbilical.

River Crossing

Project is located in a totally offshore environment and therefore, no river crossing.

3.5: Project Activities Description

The activities to be carried out for the project:

- Pre-Construction phase – Pipeline/Bulk lines offshore route survey (for the 5 wells scope);
- Mobilisation: Movement of personnel and equipment to site;
- Site preparation for the new wellhead platform;
- Fabrication of Well head Platform;
- Transportation/movement of Well Head Platform from fabrication base to site;
- Installation and positioning of Wellhead Platform;
- Well Drilling: 15 oil wells from existing DPA, DPB and DPJ Wellhead Platform & 5 oil wells from a new wellhead platform DPC;
- Piping/flow lines, well hook-up for the 15 wells from the existing platforms. A new 5 Well Head Platform – DPC with offshore Pipelines/Bulk lines;
- Civil works/related infrastructure for the new platform (DPC);
- Pipe welding, coating and testing;
- Hydro testing of pipelines/Bulk lines (DPC);
- Commissioning of pipelines; and

- Demobilisation of personnel and equipment.

3.6: Details of Main Project Activities

The main project activities are covered under the following headings:

3.6.1: 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. The Well design considerations of permeability, logging plan (Table 3.2), Slot arrangement for DPA, DPB and DPJ Platforms (fig. 3.2a to fig 3.2c), EA/Eja field Well Summary (Table 3.3) and the proposed Eja Wells Completion schematics (Fig. 3.3) are presented in this subsection. 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 in accordance with approved industry regulations (DPR and FMEEnv). 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.

Table 3.2: EA/Eja Field Well Logging Plan

Hole Size	Casing	Logs Required	Justification/Remarks
16/17 ½ inch	13 3/8"	MWD/GR/RES Mud logs	<ul style="list-style-type: none"> • Directional Surveys and correlation • Aid correlation and picking of the first casing point in shale
12 ¼ inch 9 5/8"		MWD/GR Mud Logs GR/RES/DEN/NEU	<ul style="list-style-type: none"> • Directional Surveys and correlation • Aid correlation of D & I that will be obtained from MWD. • Ditch cutting samples to monitor oil shows or gas counts • Aid reservoir correlation, fluid identification and stratigraphic/structural control Pilot Hole: to appraise present contacts
		CASED HOLE LOGS (PCL)	
		CBL/GR	For Cement bond/Zonal Isolation evaluation
8 ½ Inch		MWD/GR Mud Logs GR/RES/DEN/NEU	<ul style="list-style-type: none"> • Directional Surveys and correlation • Aid correlation of D & I that will be obtained from MWD. • Ditch cutting samples to monitor oil shows or gas counts • Aid reservoir correlation, fluid identification and

Hole Size	Casing	Logs Required	Justification/Remarks
			stratigraphic/structural control Pilot Hole: to appraise present contacts
6 inch		MWD/GR/Res Mud Logs	

SLOT ARRANGEMENT: DPJ

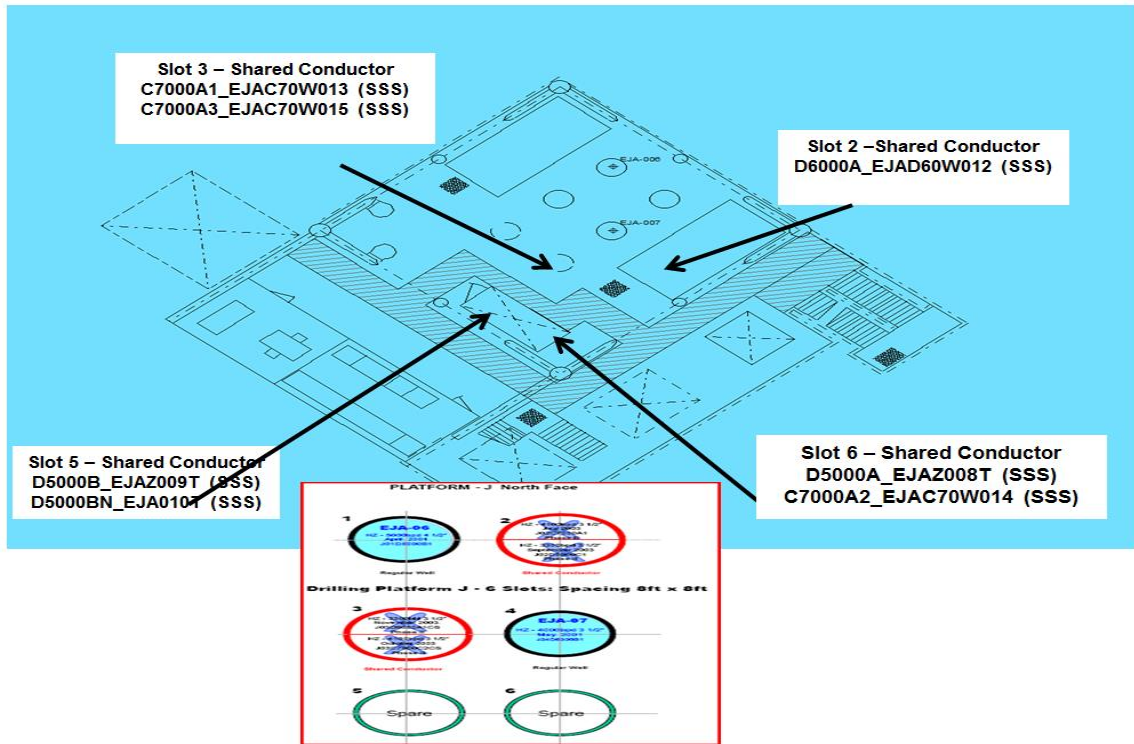


Fig 3.2a: Slot arrangement in DPJ Platform

SLOT ARRANGEMENT: DPA

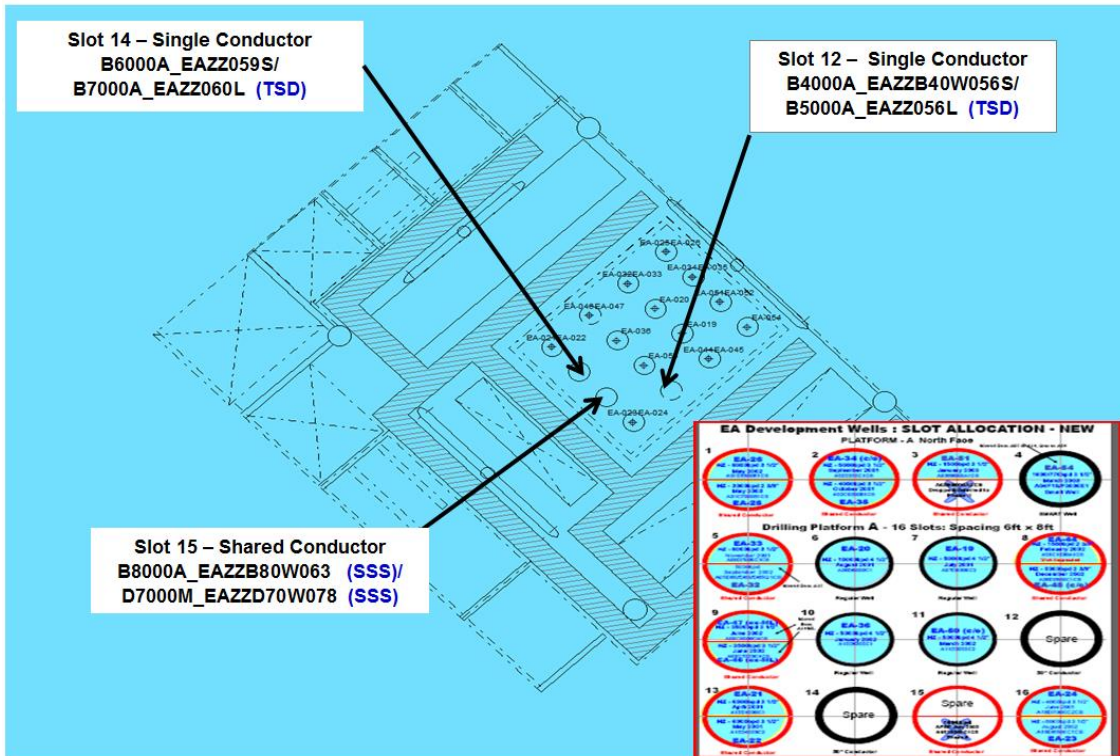


Fig 3.2b: Slot arrangement in DPA Platform

SLOT ARRANGEMENT DPB

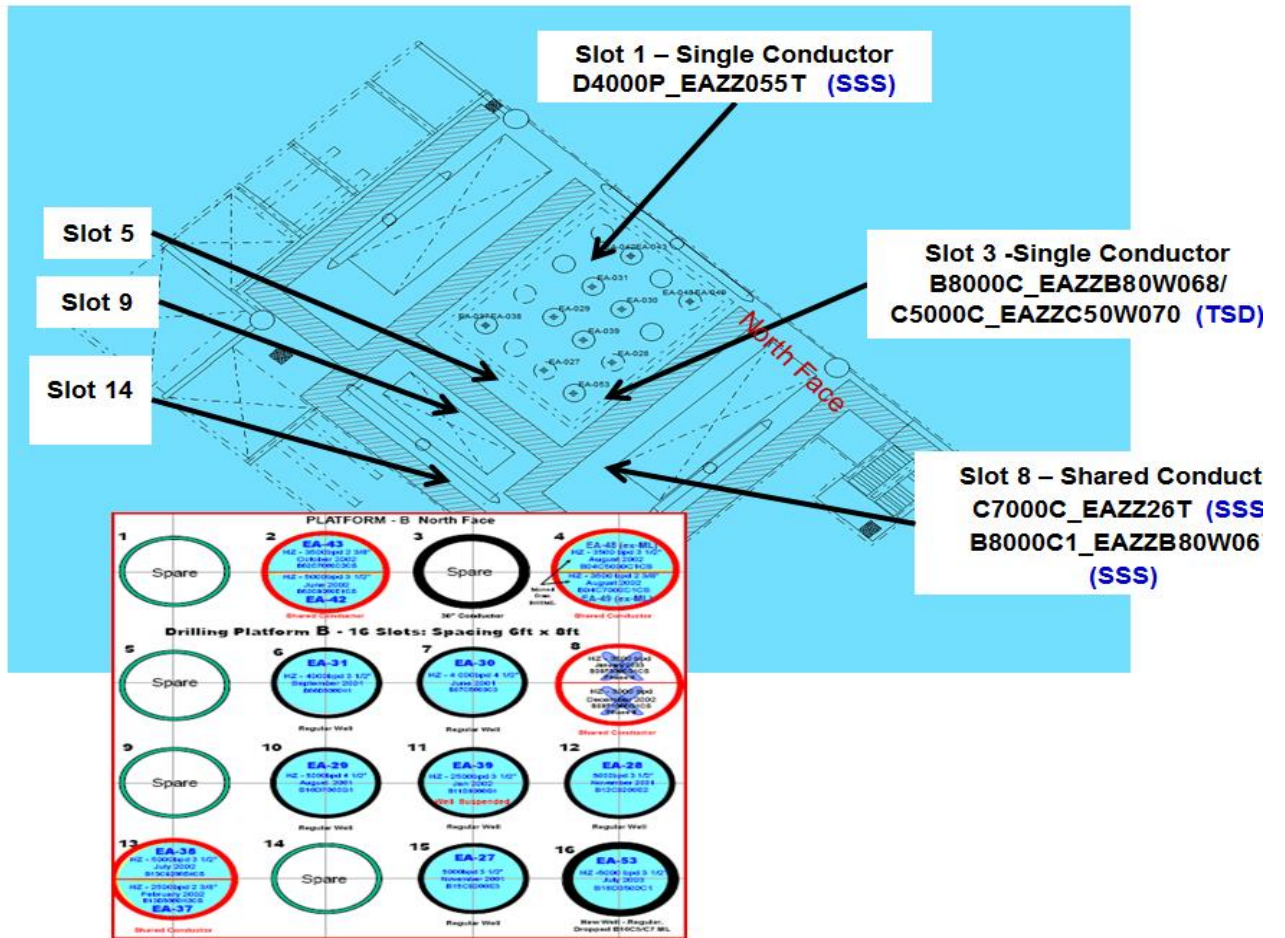


Fig 3.2c: Slot arrangement in DPB Platform

Table 3.3: EA/Eja field Well Summary

Well Name	Well Code	Deviation	HOLE SECTIONS/CASING SCHEMES (ftah/ftss)				
			16" 13-3/8" Csg	12-1/4" 9-5/8" Csg	8-1/2" 7" Liner	8-1/2" 6-5/8" Reslink	6" 4-1/2" Reslink
EJA D5000BN	EJAZ010T	Horizontal	3070	6277	9199		10767
EJA D5000B	EJAZ009T	Horizontal	3073	6935	9255		11364
EJA C7000A1	EJAZC70W013	Horizontal	3141	7105		8525	
EJA C7000A3	EJAZC70W015	Horizontal	3339	7291	9305		10629
EJA C7000A2	EJAZC70W014	Horizontal	3123	6293		7662	
EJA D5000A	EJAZ008T	Horizontal	3135	6490	8742		9823
EA B5000A	EAZZB40W056S /EAZZ056L	Horizontal	2220	5515		7615	
EA B7000A	EAZZ059T / EAZZ060T	Horizontal	2282	5816		7210	
EA D7000M	EAZZD70W078	Horizontal	2065	5634	10123		11123
EA D4000P	EAZZ055T	Horizontal	2153	4844	7300		8670
EA B8000C/C5000C	EAZZB80W068/ EAZZC50W070 (TSD)	Horizontal	2058	5402		6302	
EA C7000C	EAZZ026T	Horizontal	2135	6656		7399	
EA B8000C1	EAZZB80W067	Horizontal	2618	7623		8623	

Bulk/flow lines shall have approved anti-corrosion coating. Coating shall be done before transportation to the site. The handling, loading and stacking of coated pipes shall be carried out strictly in accordance with the SPDC standard specifications.

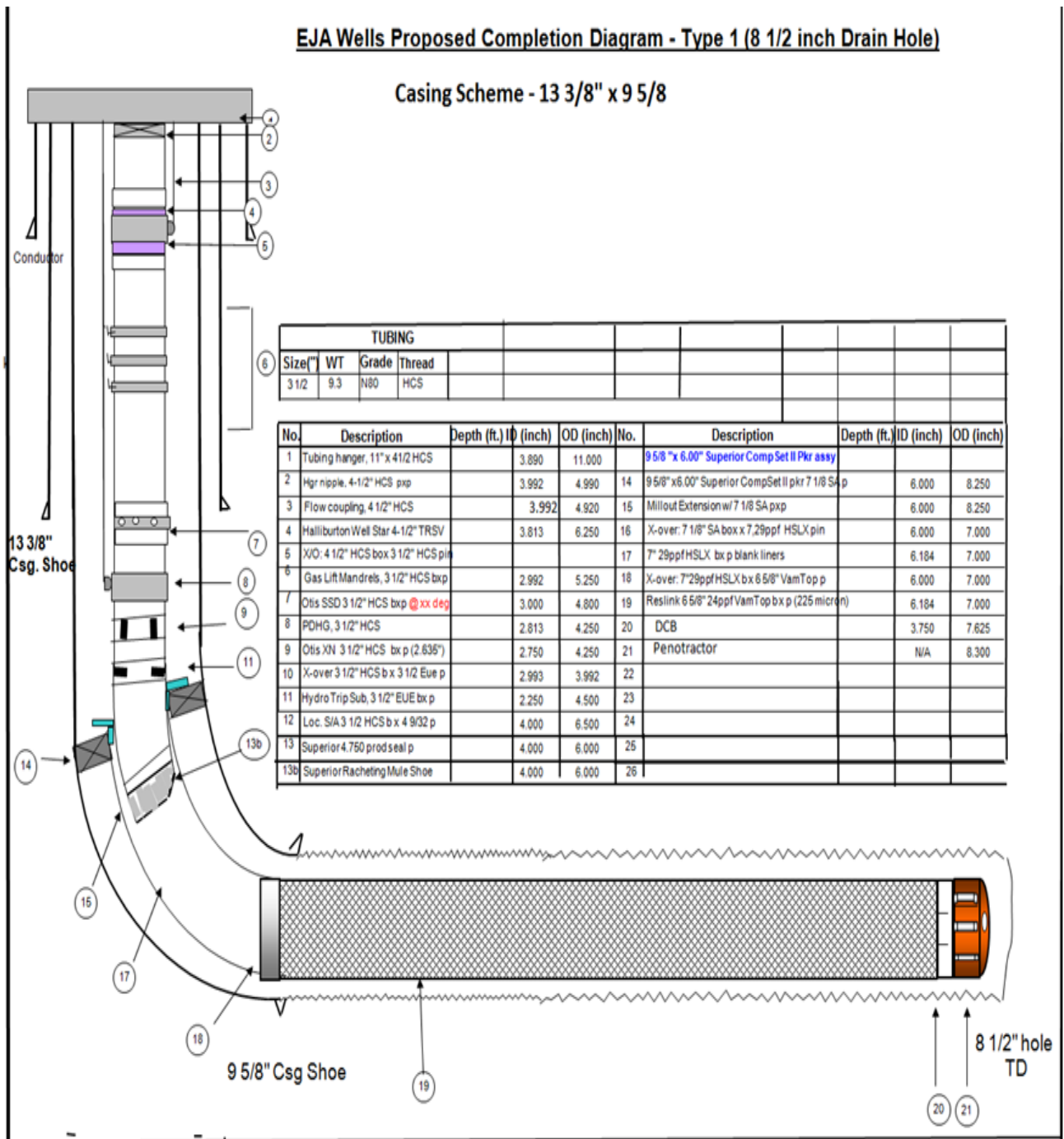


Fig. 3.3: Proposed Eja Wells Completion Diagram

3.6.2: Conceptual and Detailed Design

The conceptual design for the new facilities involves structural design of new platform, pipeline sizing, process simulation, slug catcher, material selection and requisition. The detailed design is part of the Engineering Procurement and Commission (EPC) contract, which covers mechanical hook up of flow lines on the platform, and the installation of a new platform, with all associated facilities. The 15 wells hook up detail engineering design shall be executed differently by a separate contractor. For the 5 wells scope the EPC will include the design and installation of 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.

3.7: General Basis for Design

Quality Assurance of Design

In a design of an offshore facility such as this, 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 realized. 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;
- Operability and maintainability;
- Life expectancy;
- Extendibility; and
- Compatibility with existing facilities

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.

Availability and Residual Flaring Target

No flaring is carried out presently at the EA/EJA field platforms. The new DPC platform is not designed with a flare boom.

Flaring at Sea Eagle

EA FOD will not increase the flaring capacity of the Sea Eagle. Presently sea eagle is producing below capacity. Capacity is 170,000bbls/day, but now producing about 45000bbls/d. EA FOD is bringing in 40,000bbls/day. This is still far below the design capacity.

Fire Protection

Minimal control systems are provided on the drilling platforms, consistent with the process equipment on-board. Emergency Shutdown including riser valve closure can be initiated from the Sea Eagle Central Control Room (CCR). A fusible loop fire detection system in the well bay area will initiate a platform ESD upon detection of a fire. Instrumentation, including Closed Circuit Television (CCTV) is monitored remotely from the Sea Eagle. All other processes on-board are manually operated with status indication relayed back to the Sea Eagle CCR. A detailed process facilities description including set points is available in the Sea

Eagle Process Operating Procedures Manual (POPM) DP-A, DP-B and DP-J; OD-OP04-024 Version A3, OD-OP04-025 Version A3 and OD-OP04-026- Version A3, respectively.

Process Design

Process configuration

This project is not bringing in any new process facility. The maximum volume of production from the FOD project is in the likelihood of 50,000bbls/day. The Sea Eagle FPSO oil processing facility has a capacity of 170Mbdp Gross + 100MMScfd, 1.4MMbbl Storage, 920Mbbbl Export Parcel and Water Treatment Package Design inlet/outlet (102,564/95,000bwpd). The EA FOD will deliver a peak incremental production of 40 kbopd through the new wells and platform. The capacities of key existing process facilities on the Sea Eagle FPSO have been checked and considered adequate to handle the forecast production.

- No separation is done on the drilling platforms; hence no separation is expected on DP-C. Separation is only done on the Sea Eagle FPSO.
- Though the EA FOD produces additional oil, in order to increase compressor operability and energy efficiency, a turn down study is recommended to look at the far future.

Mechanical Design

Pumps

Process pumps will be designed in accordance with API 610 specification and DEP 31.29.03.30-GEN. Pumps shall be installed to evacuate liquids from the closed drain vessel only on the new platform (DPC). Sizing and capacity of the pumps shall be determined during the FEED Control and it shall be integrated with the Control and Safeguarding System.

Compressor

Though the EA FOD produces additional oil, in order to increase compressor operability and energy efficiency, a turn down study is recommended to look at the far future.

3.8: Field Logistics Base

No field Logistics base. All logistics arrangement shall be in accordance with the approved offshore logistics plan for the EA/Eja field. The EPIC contractor shall maintain an offsite logistics base. Activities associated with the offsite logistics base shall support the fabrication and load out of the well head Platform Jacket and wellhead Platform Topsides. This will include but not limited to:

- Offsite Welding/Fabrications
- Storage of Project equipment and materials
- Movement of equipment and vehicles to support construction/fabrication activities, Personnel accommodation and office. All the listed activities will managed under the contractor`s Health, Safety and Environment Management System.

3.9: Pipelines

Design will be in accordance with the requirements of offshore Pipeline Engineering and other relevant DEP's. Design shall be carried out in the following steps:

- Pipeline system layout and routing.
- Pipeline preliminary sizing and flow assurance.
- Pipeline materials and wall thickness.
- Pipeline stability and preliminary strength assessment.
- Identification of special design and construction features

The pipeline route selection was carried out in accordance with DEP 31.40.00.10-Gen-Specification and DEP 31.40.00.10-Gen-Informative. The 4" Gas lift line and the 6" bulk line for the DPC-DPB routes follow as closely as possible the shortest distances between the start and end points indicated above, unless specific requirements dictate route deviations. Such requirements are:

- Obstructions (e.g. wrecks, wellheads).
- Pipeline or cable crossings.
- Existing pipeline or cable.
- Seabed conditions.
- Grouping of pipelines and/or cables in corridors.

The optimal route imposed minimal impact on the environment. Route selection was subjected to the statutory requirement for EIA. Considerations to improve access and re-routing to avoid areas where there may be difficulties with the pipeline construction were made during this study. The following points were also considered:

- Future route deviations shall be within the pipeline minimum bend radii.
- Deeper water areas considered where the choice exists.
- Pipeline and cable crossings minimized.
- Shipping channels, ship wrecks, fishing areas anchoring locations and unstable seabed.
- The risers were located away from boat landing areas to minimise the risk due to impact from boats.
- The angle of pipeline approach, where the minimum pipeline approach angle to a platform is greater than 30°
- The dropped object zone for dropped objects from material handling operations was avoided.
- Consideration shall be given to avoiding anchor patterns of vessels (supply boats and construction vessels) alongside installation and presence of adjoining pipelines.
- If the direct approach of a pipeline to the riser base intersects a jack-up rig approach corridor, analysis should be carried out to assess the risk of damage to the pipeline during the approach and positioning of the jack up rig.
- Pipeline approaches were selected with reduction in the number of bends, avoidance of pipeline crossings and positioning of spare pipeline risers. Other routing

requirements for offshore pipeline risers shall be in line with section 4.0 Riser Routing and Location of DEP 31.40.10.10-Gen, Riser Design.

- The distance between parallel pipelines should not be less than 10m.
- The crossing of existing pipelines and submarine cables should be at right angles (Ref. ISO 13623 sect. 6.9.5). If this imposes an excessive additional route length, lower crossing angles may be used, but not lower than 30 °.

All the sizing for the new proposed pipelines was done using the PIPESIM system analysis for the single branch. The optimum line size for the different cases was selected based on the criteria (includes DEP criteria) listed below:

- Liquid velocity (1 – 4 m/s).
- Gas velocity (5 – 10 m/s).
- Erosional velocity ratio (less than 1).
- Capacity utilisation and flow regime.

The carbon steel material grade selected for the bulk line and the gas lift line is API 5L X52 which is equivalent to ISO 3183 L360. The bulk line and gas lift line wall thicknesses are determined based on ASME B31.4, B31.8 and specific conditions in the Pipeline Engineering Specification DEP 31.40.00.10 – Gen. The governing criterion in the selection of pipe wall thickness and material grade for the pipelines is based on the conditions stated below:

- Minimum wall thickness for pressure containment.
- Diameter-to-wall thickness ratio shall not exceed 60.

The required wall thickness and steel grade of the pipeline for pressure containment is evaluated based on design pressure, design factor, nominal pipe diameter and the steel's specified minimum yield strength.

- a) Hydrostatic collapse.
- b) Local buckling.
- c) Propagation buckling.

Buckling and collapse analyses are performed in order to assess whether the pipeline is safe from failure by buckling or collapse due to external pressure. The check is of primary importance during pipeline installation when the pipeline is empty while being subjected to the external hydrostatic head of the surrounding water.

Three distinct cases relevant to buckling as a result of external pressure are considered:

Pigging and Inspection

Pigging facilities will be installed on each pipeline for removal of liquids. Pipelines shall be designed for intelligent pigging. The design of the Pig Trap systems for the new platform shall be guided by DEP 31.40.10.14-Gen., Design of Pig Trap Systems for Transmission Pipelines. A routine pipeline pigging and evaluation of the quantity and identity of removed

debris could be used to manage scale. Tie-in points are to be made available on the platform and mobile pig traps are to be provided for pigging, when the need arises.

Corrosion Protection

Pipelines shall be provided with suitable corrosion protection and monitoring systems, in line with offshore pipeline installation practise. In addition, corrosion inhibition chemical shall be injected at the platforms as currently practiced. Corrosion scale in bulk lines will be managed by pigging.

Design Pressure, Temperature and Material Selection

The determination of design pressures temperatures and the material selection of equipment the rules from the Shell DEP standards will be followed. The materials selection will be based on the process conditions as indicated in the heat and mass balance and on the process flow diagrams. In summary, existing well production flowlines are rated for the well CITHP and is class 600 rated. Similarly, new production flowlines will be class 600 rated with a maximum design temperature of 60 degree centigrade. Lines will be sized in accordance with the gross fluid volumes in the forecast production profile. The gas lift system up to and including the gas lift manifolds will be a class 900 rated system and hence will be compatible with the rating of the FPSO gas compression and pipeline export system. An overpressure protection system is to be considered in the design for these new gaslift lines to allow for the event where production is closed downstream of the tree without isolation of gas lift.

Based on sensitivity analysis done on the maximum and minimum flow rates and production forecasts for the EA FOD 5 wells scope, considering the operating parameters (mainly the flow velocity requirement), the recommended optimal bulkline size for evacuating the DP-C 5 Wells Scope production is the 6” bulkline. This recommended bulkline size and design parameters would be reviewed during detailed engineering phase using dynamic analysis. The gas lift pipeline hydraulics analysis shall also be revalidated. All bulklines will be designed to replicate the design parameters of existing bulklines in the EA/Eja field (95.6barg design pressure and 60°C design Temperature). Flowrate for the 5 wells scope is in the range of 5-15kbpd, but it is recommended that more rigorous checks be carried out in the define phase of this project using dynamic state analysis tools such as OLGA and COMPASS (softwares) to determine the level of slugging expected and the safe operating flowrates for the pipelines with respect to slugging.

3.10: Pre-Construction Activities

Pre-construction activities include (not necessarily in sequential order), but are not limited to:

- Permission to survey (PTS) and OPL applications;
- Conceptual and detailed design of the EA FOD facilities and
- Offshore survey of pipeline route/right-of-way (ROW) and facilities installation areas.

3.11: Construction Phase

Pre-Mobilization/Mobilization

Estimated population of workers for the project during mobilization and construction will be about 100, with a maximum of 150 at peak periods. Majority of these will be at the contractor's base, on land for fabrication and other management activities. Logistics and accommodation shall be provided for personnel using offshore accommodation facilities on vessels. Each vessel accommodating the personnel would have its own waste management process.

Site Preparation Activities

Site Surveys and Clearing

Offshore Environment Surveys will only be done.

Dredging/Location Preparation

No Dredging.

Piling

Piling shall be carried out to install the new platform (DPC), in line with offshore practice.

Pipeline Construction

Welding and Radiography

Pipeline installation shall be via an S-Lay vessel given the water depth. This activity shall involve welding of the bulk lines on the offshore lay-barge moving along the approved pipeline route. The line pipes shall be procured with capped bevel ends, a pipe storage barge shall be moored next to the lay-barge. The pipelines shall be coated with three-layer polyethylene coating to provide external corrosion protection. Field joints shall be coated with shrinkable sleeves.

Visual inspection and 100% radiography (non-destructive testing-NDT) of the welds shall be done as the welding progresses. Weld repairs shall be carried out where necessary, prior to pipeline pressure testing. Waste generated from welding and NDT activities shall be contained and safely disposed (for solid waste via the contractor's scrap/waste dump ashore). Successful welds shall be laid on the sea bed

Hydrostatic Testing

Hydrostatic testing which is the flooding of pipeline with treated water in order to strength test it shall also be conducted. The water used shall be filtered sea water. The hydrostatic pressure on the pipeline is set to 1.5 times minimum allowable operating pressure or 90% of hoop stress whichever is less and the test is held for 24 hours. When releasing the water back into the environment after the hydrotest, the test water will be cleaned of any harmful chemicals such as corrosion inhibitors, oxygen scavenger and biocides before disposal. Discharge would be made in such a manner that it does not stir up sediments.

During design, an assessment of the free spans will be conducted to determine limits on allowable span lengths for installation stage. Survey data would also yield seabed profile along the proposed route to identify the length and positions of pipeline spans. This will form the basis for determining if the spans are allowable (no support required) or further remedial works will be required (e.g rock dump).

3.12: Operation and Maintenance

Operation Philosophy

Tie-in to the existing EA/Eja field operations philosophy

Facility Availability and Criticality

Tie-in to the existing EA/Eja field operations

Facilities Safeguarding Philosophy

Tie-in to the existing EA/Eja field safeguarding philosophy

Maintenance Philosophy

(a) Upkeep of Structures

Maintenance and inspection activities, based on periodic inspection to determine the condition of structures and performance of their protection system include: refurbishment activity to restore the integrity of structures, replacement of and coating system applied to structures based on time maintenance schedule.

(b) Containment of Hydrocarbons

Periodic (monthly) inspections will be carried out to determine the condition of all elements of the process fluid containment envelope as well as any protective coatings applied thereon. Inspection programmes for certifiable pressure vessels, pressure/vacuum relieving devices will be inspected to meet the requirements of the Minerals Oils (Safety) Regulations of Nigeria. Refurbishment activity to restore the integrity to the envelope will be based on their condition. Where appropriate, economic systems to mitigate the effects of corrosion shall be put in place and their effectiveness routinely monitored.

(c) Control and Protection

Control and protection system, will be based on periodic inspections/calibration/testing both their input and output functions as detailed in the Maintenance Job Routines (MJR). Non-availability of hydrocarbon production caused by such inspection/calibrations/test will be accounted for in the Production Plan. Change of set points will be controlled by the plant change procedure.

(d) Hazard Detection System

Maintenance of hazard detection systems will be based on periodic inspection/calibrations/testing of both their input and output functions. Non-availability of hydrocarbon production caused by such inspections/calibrations /test will be accounted as already being practiced for the existing facilities in the EA/Eja field.

(e) Shutdown system

Maintenance of shut down system, both initiation and activation devices, will be based on periodic full function testing of both their input and output functions to ensure operation in accordance with SPDC guidelines, in line with the EA/Eja field practise.

Pre-commissioning

An SPDC pre-commissioning team, consisting of the project co-ordinator, production, maintenance and HSE personnel will be set up close to the completion of construction and installation works, and will be involved in the following pre-commissioning activities:

- Checking vendor data,
- Preparing commissioning procedures,
- Preparing test equipment/procedures,
- Checking project documentation,
- Assembling relevant project reference data,
- Checking individual system.

A commissioning plan is being developed and will be used during Pre-commissioning/commissioning.

3.13: Decommissioning/ Abandonment

General

The No Further Activity (NFA) of the EA/Eja field is currently 2022, and with this project shall extend to 2027. The Sea-Eagle shall be taken out of service then, and all other facilities shall be decommissioned in line with SPDC decommissioning plan and standard offshore practice.

Demolition and Site Clean-up

The demolition exercise is carried out with skill and diligence to avoid spill of hazardous liquids and damage to the environment. At the end of demolition, various solid wastes are sorted according to their types and then disposed of according to SPDC-EA/Eja Fields waste disposal guidelines(see appendix 5).

Rehabilitation of Site

Since it is offshore environment, after the completion of the project, all vessels shall be decommissioned. The facilities shall be handed over to the EA Asset team as approved by the Project to Asset (PtA) documentation.

3.14: Waste Management

It is anticipated that the following wastes shall be generated during the FOD project. The strategy for waste management will include:

- Waste segregation at source.
- Waste reduction.
- Waste recycling.

- Waste reuse.
- Treatment of toxic and hazardous wastes to make them innocuous before disposal.

The types of wastes generated during the construction activities shall be classified as: solid wastes, liquid wastes, and gaseous wastes. Possible sources of waste and control measures are listed in Table 3.4.

Table 3.4: Waste Sources and Control Measures

Operation	Source	Control measure
Drilling	Oil on Cuttings and cement returns.	Synthetic Oil-Based Mud (XP-07) will be used below 13 3/8" casing depth. Cuttings from the SBM will be discharged to the sea in 200 ft. of water after knocking down oil on cuttings to 5%.
	Cement residue from surge or day tank	Cuttings from water based mud systems will be discharged overboard. Discharge to the sea usually less than 250 sacks
Completion	Brine NaCl Discharge	Solids free lightweight non-toxic completion brine will be used.
BOP Actuation	Actuation fluid discharge	Water based fluid will be used.
General	Scrap metals	All will be collected on the rig and sent onshore to SPDC designated dumping sites
	Plastics	Shall be collected and recycled
	Waste oil	Onshore disposal
	Hazardous chemicals	Acids will be neutralized and dumped.
	Rubbish	Will be compacted and returned to shore for authorized disposal
Rig Bilge	Oily water Discharges	Controlled to less than 40ppm by the rig oil/water separation system or sent to the trading tanker via the FPSO.
Power generation	Combustion products, CO ₂	Release to atmosphere
Human waste	Domestic sewage	Will be treated and dumped overboard
Galley waste		Returned to shore for disposal
Xmas Tree actuation	Hydraulic oil	Full return line system
Domestic waste	Food waste and cleared vegetation	Macerated and disposed overboard
Co ₂	Emissions from use of	Anticipated volume is insignificant but Air

Operation	Source	Control measure
	generators, barges, diesel used for marine operations , etc	Quality Monitoring will be done

The solid wastes will be generated throughout the project. These include galley and domestic waste, deck waste, special hazardous waste, sand and scrap metal. All non-biodegradable wastes will be returned to shore and handled in accordance with SPDC environmental policies, environmental management system ISO 14001 and waste management procedures.

Liquid waste will include: sewage, spent chemicals (adhesives, lubricants, grease, detergent solutions). The gaseous waste will include dust particles and smoke from tug boats and barges. In accordance with legislative and SPDC requirements a waste management plan will be developed and maintained in order to quantify, account for and reduce waste at source wherever possible and ensure responsible disposal.

3.15: Project Schedule

The current activity schedule for EA FOD is as shown below: EIA as a component begins in 2014 and related permits should be obtained by first quarter 2015. All the details of the project schedule are presented in Fig. 3.4.

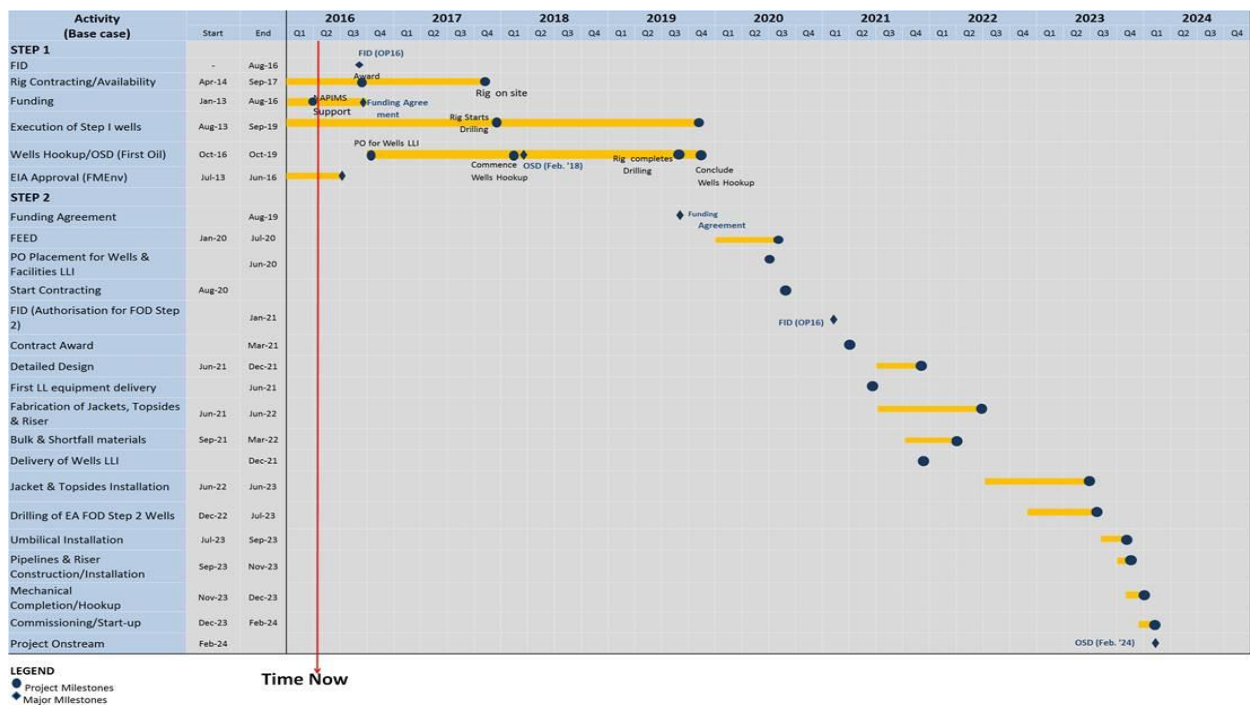


Fig 3.4: Project Activities and Schedule

CHAPTER FOUR

DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1: Introduction

The purpose of the baseline data acquisition is to establish, before the execution of the project, the status of the various environmental components that are likely to be affected by the proposed project. The EA FOD project is located offshore in the southeast corner of OML-79, 15 km south-west of the mouth of the Dodo River and about 90 km south-west of Warri, Delta State. The environmental components evaluated comprised biophysical, social and health. The status and sensitivities of the various ecological components of the project area were assessed from review of existing reports on baseline and EIA studies conducted in recent times by SPDC for other projects in the area, published literature, detailed questionnaires, interviews, maps, field sampling surveys, laboratory and data analyses. This was carried out after due consultation with Federal Ministry of Environment and approval was given to use these materials.

The baseline report was based on acquisition of data via field and laboratory analysis and a review of literature including previous environmental studies carried out in the area. The fieldwork for gathering this environmental data was carried out between January 17th to 20th 2011 for the dry season and July 29th to 1st August 2011 for the wet season. The environmental data gathering thus covered the dry and wet seasons. The methodologies for data collection and laboratory analysis are presented in Appendix 4.1.

4.2: Study Approach

This chapter documents the environmental (biophysical, health and socioeconomics) setting of the Project area, as it is presently constituted. For the purpose of this EIA, the impact indicators selected are the qualitative as well as quantitative or measurable characteristics of the various environmental components indicated below. Environmental sensitivities likely to be affected include:

- Air quality;
- Level of noise;
- Surface water quality;
- Sediment quality;
- Biodiversity (aquatic flora and fauna);
- Socioeconomics; and
- Human health.

Extensive review of available literature was undertaken to acquire background information and baseline data on the physical, chemical and biological characteristics of the project area. Materials reviewed included previous studies reports, textbooks, compliance monitoring reports, journal articles, survey maps and aerial photographs. The literature review focused on the following:

- Report on the Environmental Evaluation Study and Extension of the Fate and Effects Study of Produced Water Discharged from EA Sea Eagle FPSO (OML -079) 2012;

- Sea Eagle Quarterly Environmental Compliance Monitoring Reports;
- Report of Produced Water Discharge Study for EA /Eja Field (OML 79) 2006;
- A Study of Chronic Effects on the Marine Environment from long term discharge of produced water in EA/Eja fields 2004;
- Environmental Impact Assessment of EA/Eja Development Project, Final Report 2001;
- Relevant Federal and State regulations;
- Climatic conditions including rainfall pattern;
- H Block Cumulative EIA (2006); and

4.3: Baseline Environmental Conditions

4.3.1: Climate, Meteorology, Ambient Air Quality and Noise

The climatic information for the study area is based on the analysis of long term historical data collected by the Nigeria Meteorological Agency and Nigeria Liquefied Natural Gas complex. The results of statistical variations of climate, air quality and noise analysed for two seasons in the EA/Eja field are presented in Tables 4.3.1.1 and 4.3.1.2.

Climate and Meteorology

The project area is located within the equatorial belt that experiences rainfall for most of the year. The climate typifies that of the humid tropics with considerable marine influence. It is governed by the prevailing (seasonal) wind, latitude, apparent movement of the sun across the tropics and relative stability of the Inter Tropical Discontinuity (ITD) in the area (Ojo, 1977). The two dominating air masses are the drier Tropical Continental from across the Sahara in the North and the humid Tropical Maritime from across the Atlantic Ocean in the South. The Inter-Tropical Discontinuity (ITD) which separates them oscillates seasonally. The offshore section is located in the Bight of Bonny with a climate similar to that of the onshore. It is characterized with tropical wet and semi-hot equatorial climate with high solar radiation that is mostly diffused due to cloud cover. In addition to these are heavy precipitation, light winds, and low atmospheric pressure.

Ambient Air Temperature

Ambient air temperatures of the area were relatively moderate during the two seasons. A range of 25.1 - 28.5°C was recorded for the wet season with a mean value of 26.9 °C, while the dry season recorded values between 26.2 and 32.6 °C with a mean value of 29.8 °C. The corresponding values for the control stations were 25.1 - 28.7 °C with a mean of 29.5 °C for dry season, and 25.1 - 28.7°C with a mean of 26.7°C.

The relatively higher temperatures recorded during the dry season showed spatial variations at the monitoring points. However, these variations were not statistically significant at $p > 0.05$. Nonetheless, the mean temperature values obtained for dry and wet seasons were significantly different ($p < 0.05$). These ambient air temperature levels recorded for both seasons were typical of coastal tropical environments (Ayoade, 2004). Due to the depletion of incoming solar radiation by greater cloud cover, temperature values are slightly lower during

the wet season (Oguntoyibo, 1982). The spatial temperature variations recorded within the project area during the study may likely be accounted for by the transient cloud cover and time of day rather than as a result of effects of the plant operations.

Wind Speed and Direction

The long term wind distribution data retrieved and analysed for Bonny (2004 - 2010) shows that the wind blows generally from the south-westerly (SW/S/W) direction for both wet and dry seasons, calm periods are not frequently observed. This is as a result of the marine environment. Information on frequency distribution of wind speed and direction is important since it provides the basis for accurate estimation of the dispersion patterns of pollutants in the atmosphere.

Wind velocities recorded during the two seasons varied from 4.80-7.20m/s and 0.5-2.60m/s for wet and dry seasons, respectively. Relatively high mean wind speed value of 5.40 ± 1.04 m/s was obtained during the wet season while 0.92 ± 0.89 m/s were recorded in the dry season. These values compared favourably with the average values obtained at the controls. The values were significantly different, as strong south-westerly wind predominates during the wet season, especially at the near shore and offshore environment while relatively weaker north-easterly wind were observed at this region during the dry season. Wind directions were generally south-westerly and north-easterly during the wet and dry seasons, respectively (Figs. 4.3.1.1 and 4.3.1.2).

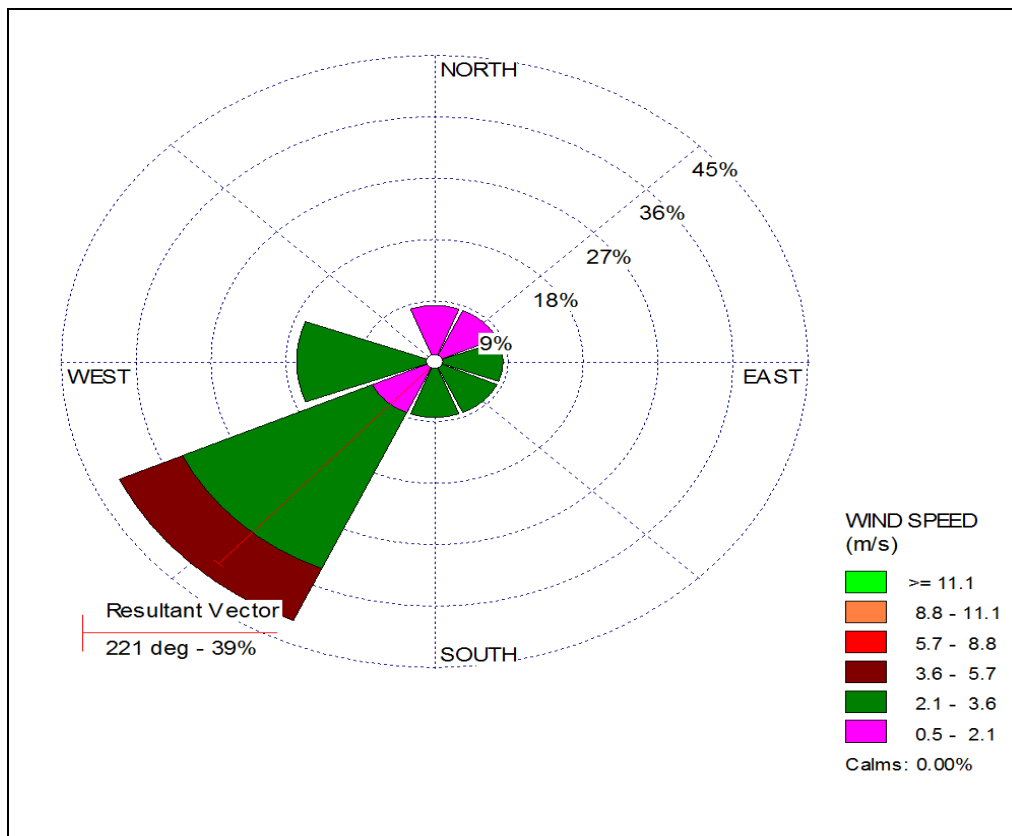


Fig. 4.3.1.1: Typical Wind Rose for the study area

Table 4.3.1.1: Meteorological Data, Measured Air Pollutants and Noise levels Recorded for the Dry Season

Parameter		Pt 1	Pt 2	Pt 3	Pt 4	Pt 5	Range	Mean ±SD	Control Values Range	Control Mean ±SD	DPR Limit	FMEnv limit
Meteorology	Ambient Air Temperature, °C	32.6	29.4	31.2	26.2	29.8	26.2-32.6	29.8±2.4	28.5-30.8	29.5 ± 1.1	N/A	
	Wind Speed, m/s	0.60	0.90	0.50	2.6	0.50	0.50-2.60	0.92±0.89	0.80	1.0±0.18	N/A	
	Wind Direction	NE	NE	NE	NE	NE	-	-	NE	-	NE	
Air Quality	SOx (as SO2) µg/m ³	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	100-150	26
	NOx (as NO), µg/m ³	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	150	75-113
	VOC , µg/m ³	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01		160
	SPM, µg/m ³	0.10	0.09	0.18	0.16	0.22	0.09-0.22	0.15±0.06	0.06-0.11	0.09	60-90	250
Noise	Noise Level, dB(A)	45.8	45.5	47.4	44.3	44.8	44.3-47.4	45.56±1.18	38.7-48.40	45.1	80 -100	90

Source: EA EER Field data gathering 2011

Table 4.3.1.2: Some Meteorological Data, Measured Air Pollutants and Noise levels Recorded for the Wet Season

Parameter		Sampling Stations							Control Stations		DPR Limit	FMEnv limit
		Pt 1	Pt 2	Pt 3	Pt 4	Pt 5	Range	Mean ±SD	Control Values (range)	Control Mean ±SD	DPR Limit	
Meteorology	Ambient Air Temp, °C	25.4	25.1	27.8	28.5	27.5	25.1-28.5	26.9± 1.51	25.1-28.7	26.7±1.60	N/A	
	Wind Speed, m/s	5.20	4.80	6.80	7.20	5.50	4.80-7.20	5.90±1.04	4.1-7.3	5.5±2.01		
	Wind Direction	SW	SW	SW	SW	SW	-	-	SW	SW		
Air Quality	SOx (as SO2) µg/m ³	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	100-150	26
	NOx (as NO), µg/m ³	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	-	<0.01	150	75-113
	VOC , µg/m ³	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	-	<0.01		160
	SPM, µg/m ³	0.71	0.25	0.16	0.71	0.40	0.25-0.71	0.56 ± 0.25	0.11-0.84	0.48	60-90	250
Noise	Noise Level, dB(A)	46.11	47.20	48.29	44.90	45.07	44.90-48.29	46.31±1.44	44.96-40.61	49.04±4.19	80 -100	90

Source: EA EER Field Data Gathering 2011

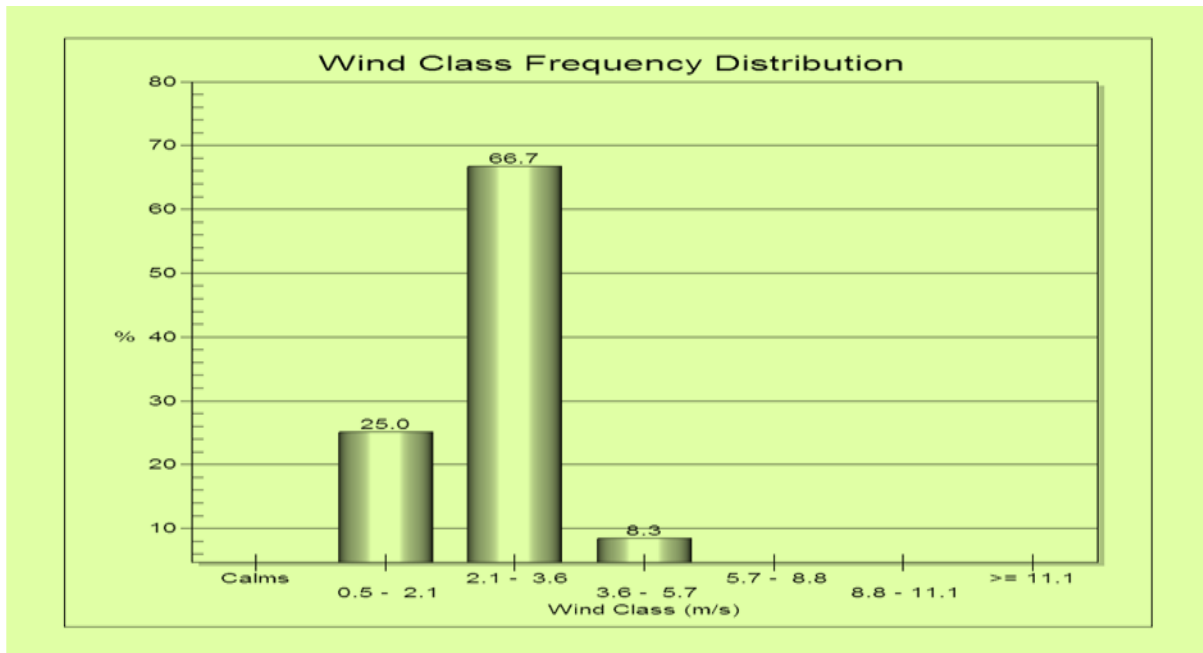


Fig. 4.3.1.2: Mean Wind Class Distribution Frequency for the study area

Relative Humidity

Annual relative humidity average for the project area is presented in Fig 4.3.1.3. The data show that relative humidity values are high all year round at an average of 78.5%, which is typical of equatorial climate. Humidity values naturally exceed 85% during the rainy season under the influence of the moisture laden Tropical Maritime air mass. The daily variation of relative humidity is intricate. Usually it is highest in the morning and drops to a low value just by noon. Diurnal relative humidity measured during fieldwork ranged from 72.9 to 97.50 % (SSAGS+, 2013).

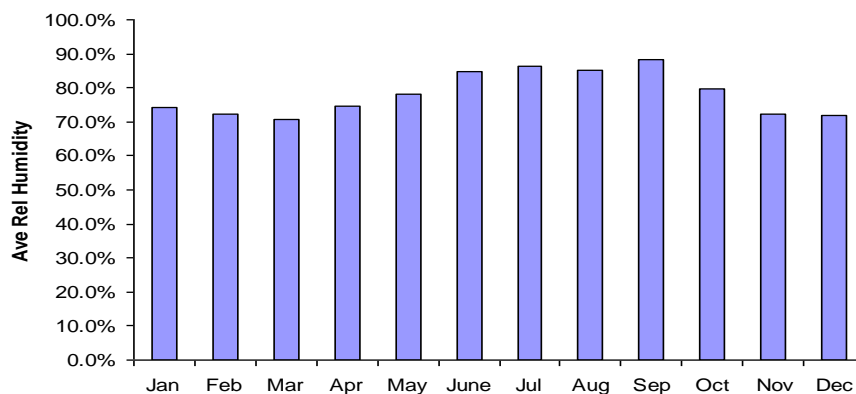


Fig. 4.3.1.3: Average Relative Humidity for Warri Synoptic Station (1991-2012)

Relative humidity and temperature move in opposite directions i.e., the higher the relative humidity, the lower the temperature and vice-versa. When relative humidity (the percentage value of water vapour in the air) rises above some critical point, suspended particles of soluble substances which were initially “dry” becomes “wet”, i.e. the particles go into solution. As the humidity increases, the particles takes up water and increases in size, too.

Rainfall Pattern

Data gathered from the area also shows that up to 300 mm rainfall has been recorded within 24hrs. The mean annual rainfall often exceeds 2500 mm. Available data from the Warri Meteorological Station, suggests a total annual rainfall in excess of 2,700 mm for the region. Rainfall is experienced from about eight to ten months with peaks in July and September and lower amounts of rainfall from November to February. The mean annual rainfall is above 2,700mm due to the area's location within the sphere of the Atlantic Ocean from which the southwest trade winds bring moisture laden air. The average monthly rainfall is presented in Fig. 4.3.1.4. The Figure shows that over 90% rainfall is recorded between the months of March and November. Rainfall in the area has a typical bimodal distribution which peaks in July, drops slightly in August, rises again in September and drops-off. It should be noted that rainfall is very important in air pollution studies because of its ability to cause wet deposition i.e., washing away pollutants from the atmosphere and depositing on land and water. Rains can create acid precursors in the air to form acid rain, which could be harmful to humans, plants, animals and the environment in general.

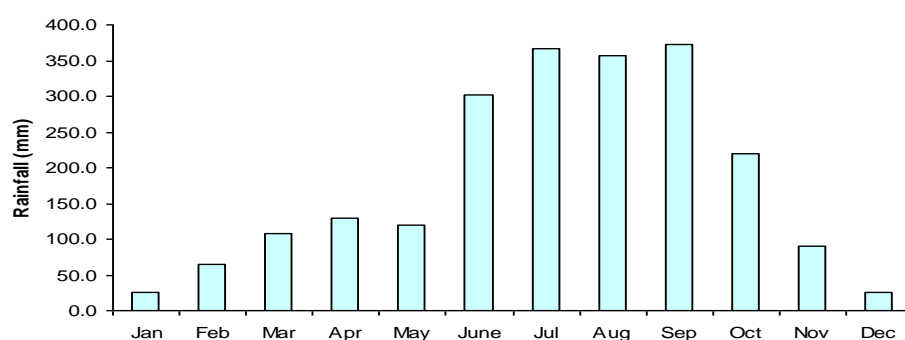


Fig. 4.3.1.4: Average Monthly Rainfall distribution for Warri Synoptic - Station (1991-2012)

Cloud Cover

Cloud cover maximums were found to occur in both day and night time, with the mean cloud cover in the area being 6.5 oktas. In Pasquill's method for atmospheric stability class, determination of the amount of cloud cover during the daytime is used. High amounts of cloud inhibit instability that enhances the dispersion of plumes and lower amounts promote atmospheric dispersion of plumes. However, there were no available data on cloud cover from the macro data used in this study.

Atmospheric Pressure

The complex interplay between pressure and other meteorological parameters does not easily yield to straightforward analysis. Recorded pressures are typical of the area which is often between 745 and 757 mmHg. There was no significant difference between indoor and outdoor atmospheric pressure as expected.

Air Quality

Air quality analyses for this study are predicated on the Report of the Environmental Evaluation Study and Extension of the Fate and Effects Study of Produced Water Discharged from EA Sea Eagle FPSO (OML 079) of 2012. Historical data for air quality is based on data from H-Block Baseline report of 2007. The Environmental Compliance Monitoring (Air Quality) Report for Sea Eagle FPSO Facility Quarter Four, 2013, though limited in scope (period) also had all the listed parameters within regulatory limits.

Sulphur Oxides, Nitrogen Oxides and Volatile Organic Compounds

Sulphur oxides, nitrogen oxides and VOC were generally below the detection limits of the respective measuring equipment for both seasons. There were no seasonal variations in the levels of these parameters. Also, zero concentrations of these air pollutants were recorded at each of the control points, thus, reflecting proper environmental management.

The dominant gaseous emission of sulphur is as sulphur (IV) oxide with small amount of sulphur trioxide. Fuels contain significant quantities of sulphur (IV) oxide with small amount of sulphur (< 1 percent) as in organic sulphides or organic sulphur and, on burning, SO_x and SO₃ are released. Nitrogen oxides (NO_x) are produced during the combustion of fossil. Significant health and environmental effects are caused by NO_x: NO₂ can cause respiratory problems. NO and NO₂ can cause smog, which can lead to pulmonary and bronchial disease.

According to the National Library of Medicine (2014) the health effects of volatile organic compounds can vary greatly according to the compound, which can range from being highly toxic or carcinogenic to dizziness or headache. The health effects of volatile organic compounds will depend on the nature of the volatile organic compound, the level of exposure, and length of exposure.

Table 4.3.1.3: Nigeria Ambient Air Quality Standard

<i>Pollutants</i>	<i>Time of Average</i>	<i>Limit</i>
Particulates	<ul style="list-style-type: none"> • Daily average of hourly values • Hourly value 	<ul style="list-style-type: none"> • 250µg/m³ • 600*µg/m³
SO _x as SO ₂	<ul style="list-style-type: none"> • Daily average of hourly values • Hourly value 	<ul style="list-style-type: none"> • 0.01ppm (26µg/m³) • 0.1ppm (260µg/m³)
NO _x as NO ₂	<ul style="list-style-type: none"> • Daily average of hourly values (range) 	<ul style="list-style-type: none"> • 0.04 – 0.06ppm (75-113µg/m³)
Carbon Monoxide	<ul style="list-style-type: none"> • Daily average of hourly values • 8 - hourly range 	<ul style="list-style-type: none"> • 10ppm (11.4mg/m³) • 20ppm (22.8mg/m³)
Petrochemical Oxidants	<ul style="list-style-type: none"> • Hourly value 	<ul style="list-style-type: none"> • 0.66ppm
Non-Methane Hydrocarbon	<ul style="list-style-type: none"> • Daily average of 3-hourly values 	<ul style="list-style-type: none"> • 160µg/m³

*Note: Concentration not to be exceeded for more than once a year.

Source: FMEnv 1991

Table 4.3.1.4: WHO Air Quality Guidelines

Pollutants	Time- Weighted Average ^a	Averaging time
SO ₂	500	10min
	300	1h
	100 - 150 ^b	24h
	40 - 60 ^b	1yr
CO	30	1h
	10	8h
NO ₂	400	1h
	150	24h
Total suspended particulates	150 - 230 ^b	24hr
	60 - 90 ^b	1yr

Source: SPDC 2001; ^aAll concentrations in μgm^{-3} except CO in mgm^{-3} ; ^bGuideline values for combined exposure to SO₂ and suspended particulate matter (they may not apply to situations where only one of the components is present).

Table 4.3.1.5: US National Ambient Air Quality Standards (NAAQS)

Pollutants	Average Time	Primary Standard ^a
SO ₂	3h	-
	24h	365 μgm^{-3} (0.14ppm)
	Annual average	80 μgm^{-3}
NO ₂	Annual average	100 μgm^{-3} (0.05ppm)
NO	1h	40 mgm^{-3} (35ppm)
	8h	10 mgm^{-3} (9ppm)
O ₃	1h	235 μgm^{-3} (0.12ppm)
Black smoke	100-150	24hr
	40-60 ^b	1yr
PM ₁₀ (d \leq 10 μm)	24h	150 μgm^{-3}
	Annual average	50 μgm^{-3}
Pb	3months	1.5 μgm^{-3}

Source: SPDC 2001 ^aTo protect health ^bTo protect public welfare

Table 4.3.1.6: DPR National Air Quality Guidelines for Maximum Exposure

POLLUTANT	1-Hour Mean (μgm^{-3})	8-Hour Mean (μgm^{-3})	Daily Average/ Mean (μgm^{-3})	Annual (μgm^{-3})
Total SPM	150-230		60-90	
Carbon Monoxide*	30		10	40-60
Sulphur Dioxide	350			
Nitrogen Dioxide*			100-150	0.5 – 1.0
Lead	400		150	

Source: EGASPIN, 2002; *Not to be exceeded

Suspended Particulate Matter (SPM)

Suspended Particulate Matter (SPM) levels within the study area varied from 0.16 - 0.71 $\mu\text{g}/\text{m}^3$ with a mean value of $0.56 \pm 0.25 \mu\text{g}/\text{m}^3$ for wet season while values ranging from 0.09-0.22 $\mu\text{g}/\text{m}^3$ (mean value of $0.15 \pm 0.05 \mu\text{g}/\text{m}^3$) were recorded in the dry season. The difference in the average values obtained in the study area and in the control points for each season were statistically not significant ($p > 0.05$). However, significant seasonal variation in SPM levels was observed with a relatively high average level in the wet season (Fig. 4.3.1.5), although all SPM levels at the sampling points were far below the DPR set maximum permissible limit of 250 $\mu\text{g}/\text{m}^3$. This relatively high SPM value in the wet season can be attributed to localized weather conditions at the time of sampling such as high wind intensity and vortex causing particulate entrapment in the aerodynamic air flow patterns around the sampling area.

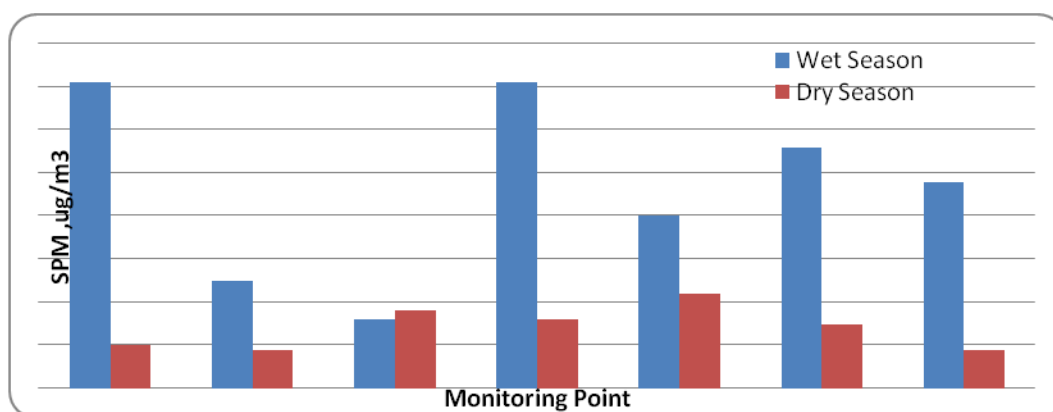


Fig. 4.3.1.5: Variations of SPM during Wet and Dry Seasons (2011)

Particulate matter has been shown to be part of the products of combustion of fossil fuel and other industrial and anthropogenic activities; it has been revealed by various studies to have adverse health effects. The effects include inflammatory reactions in the lungs, respiratory symptoms, adverse effects on the cardiovascular system and increase in medication use, hospital admission and mortality.

Noise

Sound is produced by any vibrating body and is transmitted in air only as longitudinal wave motion. Noise levels recorded at the study area in the dry season varied from 44.3 - 47.4 dB(A) with 45.1 dB(A) as average (Table 4.3.1.1), while the wet season recorded values ranging from 44.90-48.3 dB(A) with a mean value of 49.0 dB(A) (Table 4.2.1.2). The average values obtained for the two seasons were significantly lower than the allowable DPR/WHO set limit of 80 dB(A) as shown in Figure 4.2.1.6, with differences in the mean values of both seasons being statistically insignificant ($p > 0.05$). Similarly, the difference in the mean noise levels recorded at different sampling stations for both seasons were not statistically significant ($p > 0.05$). Summarily, noise levels recorded at this study area during the two seasons, were typical of rural coastal settings in this region, as reported in a similar study (SPDC, 2008) and they were far below the statutory 90dB (A) for 8 hours exposure recommended by FMENV (Table 4.3.1.7).

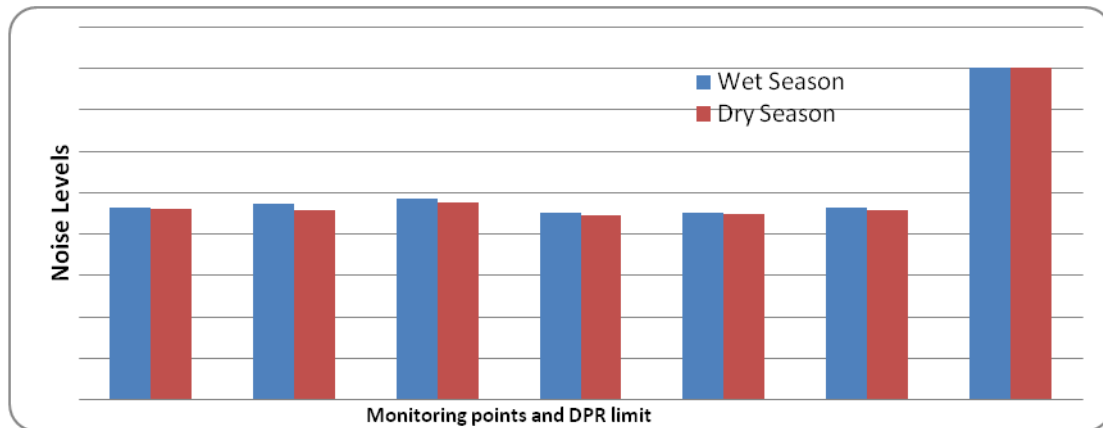


Fig. 4.3.1.6: Noise levels at monitoring points for both seasons compared to DPR limits

Table 4.3.1.7: Noise Exposure Limits for Nigeria

Duration Per day, hour	Permissible Exposure Limited dB(A)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Source: FEPA (1991)

4.3.2: Surface Water quality

The results of some physical and chemical parameters of surface waters of the study area and control for dry and wet seasons are summarized in Table 4.3.2.1. The detailed results for all sampling stations are presented in Appendix 4.2. Natural waters are extremely dilute chemical solutions with very small quantities of dissolved organic and inorganic compounds, and existing in equilibrium with the atmospheric gases, and the nature of the physicochemical qualities helps in delineating the water types.

The water of the study area had a dry season temperature range of 26.6 -30.0 °C for both the study area and control, while the range for the wet season was 26.3 – 32.7 °C for both study area and control. The water was colourless in both study area and control stations during the dry and wet seasons. The turbidity of the water had a range of 0.03 – 6.09 NTU (dry season) and 0.03 – 5.22 NTU (wet season) in the study area which are comparable to the values obtained in the control points. The Total Suspended Solids (TSS) were in the range of 1 – 8 mg/l (dry season) and 1.00 – 7.00 mg/l (wet season) in the study area which are higher than the range of values (1 – 2 mg/l in the dry season, and 1.0 – 1.0 mg/l in the wet season) obtained in the control points. Turbidity and suspended solids are usually very low in typical ocean waters because of the large volume, self-purification mechanisms and buffering

capacity. The total dissolved solids in the study area ranged from 15240 – 33780 mg/l in the dry season and 17870 – 32140 mg/l in the wet season. The water was slightly alkaline with a pH range of 7.05 – 8.08 (dry season) and a range of 7.51 – 7.92 (wet season) which compared very well with the control values in both seasons. These pH ranges are typical of normal sea water (7.5-8.5).

The Electrical Conductivity (EC) of the surface waters for the dry season had a range of values of 24, 600 – 62, 490 $\mu\text{S}/\text{cm}$ and the control area with range of 37, 660 – 54, 400 $\mu\text{S}/\text{cm}$ (Fig. 4.3.2.1). The wet season concentrations were 32, 490 – 58, 440 $\mu\text{S}/\text{cm}$ and 40, 290 – 50, 880 $\mu\text{S}/\text{cm}$ respectively for sampling and control points (Fig. 4.3.2.2). An annual mean of 43, 000 $\mu\text{S}/\text{cm}$ has been measured for the Atlantic Ocean (MPCA, 2000)

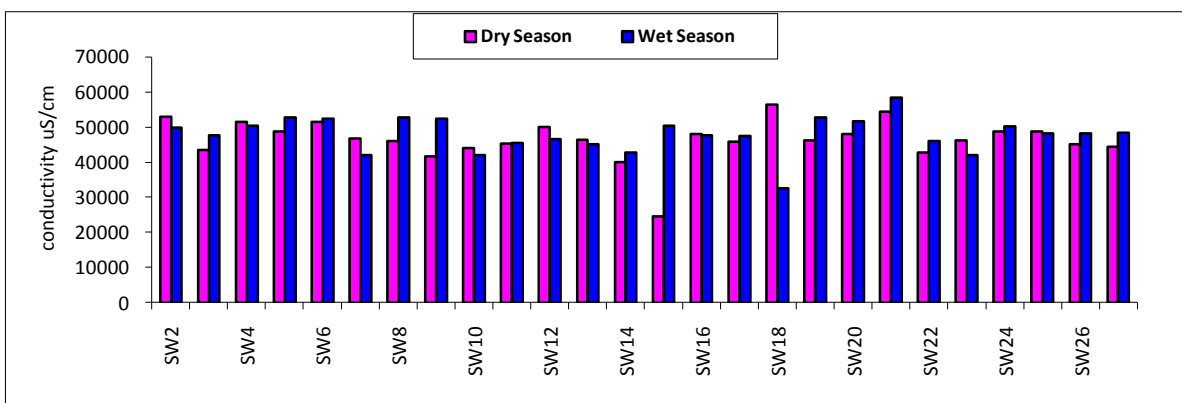


Fig. 4.3.2.1: Spatial variation in the conductivity of the study area in the dry and wet seasons

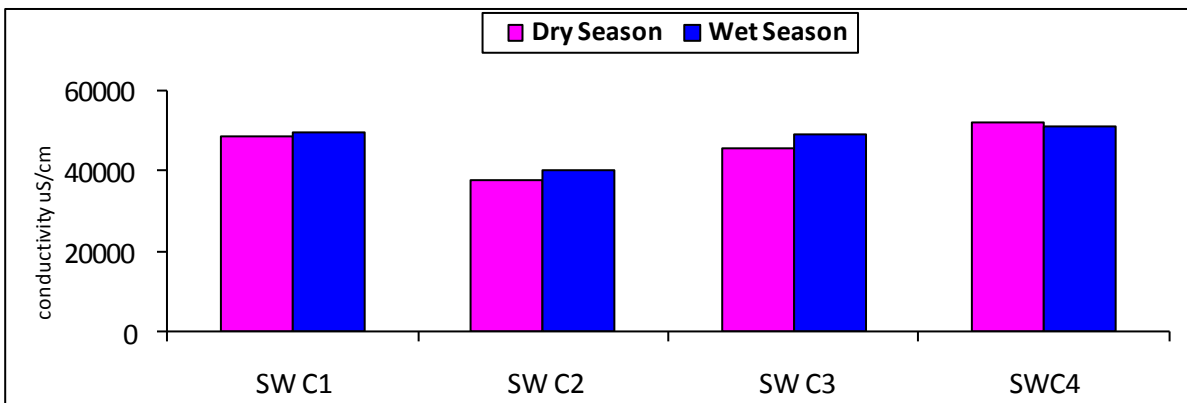


Fig. 4.3.2.2: Spatial variation in the conductivity of the control stations for both seasons

The amount of Dissolved Oxygen (DO) an aquatic organism needs depends on its species, its physical state, water temperature, and pollutants present. Consequently, it is impossible to accurately predict minimum DO levels for specific fish and aquatic animals. For example, at 5°C, trout uses about 50-60 milligrams (mg) of oxygen per hour; at 25°C, it may need five or six times that amount. Fish are cold-blooded animals and they use more oxygen at higher temperatures because their metabolic rates increase. Numerous scientific studies suggest that 4-5 ppm of DO is the minimum amount that will support a large, diverse fish population. The DO observed in the study area had a range of 3.93 – 4.78 mg/l while it was 4.23 – 4.97 mg/l

in the control areas during the dry season. The wet season had a concentration range of 7.33 – 8.85 mg/l while the control points had a range of 7.53 – 8.29 mg/l. There was no significant difference between the levels observed in the study areas and that of the control in both seasons, although the relatively higher levels in the wet season may be due to lower temperatures. It is imperative to note that the DO levels did not exceed the observed concentrations during the EIA studies conducted in 2001 which were in the range of 5.84-8.33 mg/l. The BOD and the COD observed during the dry season of the study area including the control (Table 4.3.2.1) showed that they were far below the DPR limits of 10 mg/l and 40 mg/l respectively. The same trend was observed in the wet season.

Alkalinity is the true measure of acid-neutralizing or buffering capacity which includes the bicarbonate (HCO_3^{-1}), carbonate (CO_3^{-2}) and hydroxide (OH^{-1}) ions. Alkalinity levels observed in this study for the dry season were 80 – 195.99 mg/l while for the wet season it was 56.4 – 199.9 mg/l. These levels were comparable to the values obtained for the controls during the dry and wet seasons.

Water hardness refers to the ability of water to precipitate soap. It is caused by the polyvalent metallic ions dissolved in water. In fresh water these are primarily calcium and magnesium although other metals such as iron, strontium and manganese contribute to the extent that appreciable concentrations are present. Water is considered to be “hard” if it is high in dissolved minerals, specifically calcium and magnesium. As the concentration of the dissolved minerals increases, the water becomes harder. The values observed for hardness in the study area were 2,160 – 9,688 mg/l (dry season) and 5,280 – 10,080 mg/l (wet season) which compared very well with those of the control points, 4385 – 6800 mg/l (dry season) and 5600 – 9992 mg/l (wet season). Any surface water whose hardness is above 300 mg/l is considered to be very hard (Sawyer, 1960). Hardness levels above 500 mg/l are generally considered to be aesthetically unacceptable, although this level is tolerated in some communities (Zoeteman, 1980). Aquatic organisms require a relatively constant concentration of the major dissolved ions in the water, much the same way as we require relatively constant concentrations of certain dissolved ions in our blood and other bodily fluids. Levels too high or too low may limit survival, growth and reproduction.

Salinity which expresses the salt content of water was high in the study area. It varied from 13.50 to 33.19 % for the dry season and 29.32 – 36.15 % for the wet season (Fig. 4.3.2.3). These ranges were not different from the records for the control locations for the dry and wet seasons (Fig. 4.3.2. 4). These salinity values are not different from the normal characteristics of any marine environment, usually with known average of 35 %.

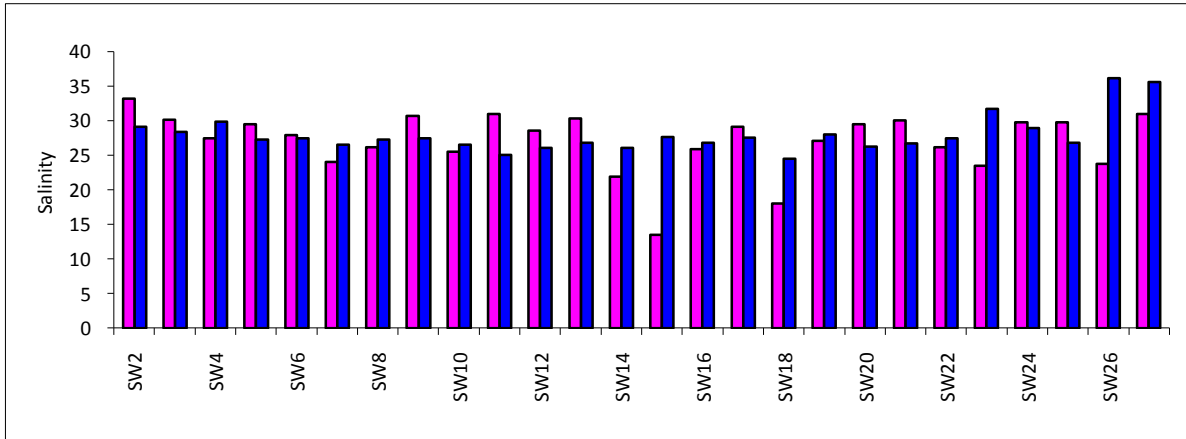


Fig. 4.3.2.3: Spatial variation in the Salinity (%) of the study area for both seasons

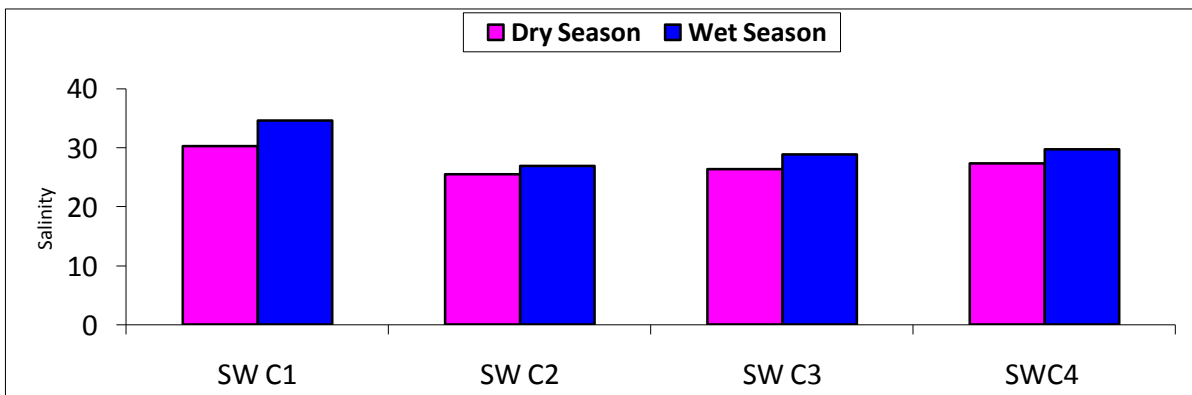


Fig. 4.3.2.4: Spatial variation in the Salinity (%) of the control stations for both seasons

The water was oligotrophic (low in nutrients like nitrates and phosphates). The low level of nitrate and phosphate indicates low level of anthropogenic biological pollution and organic decomposition and mineralization. Unpolluted waters generally contain low concentration of phosphate, usually less than 1.0 mg/L. From the results for cations, calcium has a range of 610 – 873 mg/l while magnesium has concentration of 65.51 – 305 mg/l in the dry season survey. These values compared favourably with those of the control points and the values observed in the wet season. Mg is normally higher than Ca in seawater. However, higher values of calcium showed that calcium hardness predominates over magnesium hardness which corroborates the findings of earlier study (NRC, 1977). The target threshold value for the calcium ion is in the range of 100–300 mg/l, depending on the associated anion, but higher concentrations are acceptable to consumers (Zoeteman, 1980).

Table 4.3.2.1: Summary of physicochemical characteristics of the surface water in dry and wet seasons, for both the study area and control, 2011

PRAMETERS	DRY SEASON						WET SEASON					
	STUDY AREA			CONTROL			STUDY AREA			CONTROL		
	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN
Physico-chemical												
Temperature, °C	26.6	30	27.862	27.2	28.5	27.78	26.3	32.7	27.006	26.1	28.2	26.975
Colour, Pt-Co							5	10	6.667			
Turbidity, NTU	0.03	6.09	1.173	0.07	0.99	0.57	0.03	5.22	0.958	0.04	0.2	0.09
Total Suspended Solids (TSS), mg/l	1	8	3.231	1	2	1.333	1	7	2.200	1	1	1
Total Dissolved Solids (TDS), mg/l	15240	33780	26840.000	22600	31220	27505	17870	32140	26959.310	22160	27960	26097.5
pH	7.05	8.08	7.726	7.8	8.1	7.9625	7.51	7.92	7.761	7.53	7.91	7.76
Electrical Conductivity (EC), µS/cm	24600	56400	46434.615	37660	52000	46015	32490	58440	48034.483	40290	50880	47495
Dissolved Oxygen (DO), mg/l	3.93	4.78	4.362	4.23	4.97	4.62	7.33	8.85	7.974	7.53	8.29	7.993
Biochemical Oxygen Demand (BOD), mg/l	4.02	4.98	4.600	4.22	4.56	4.38	2.9	3.98	3.330	3.22	3.56	3.43
Chemical Oxygen Demand (COD), mg/l	6.12	6.86	6.459	6.14	6.49	6.3775	4.82	6.8	5.606	5.6	6.76	6.04
Alkalinity, mg/l CaCO ₃	80	195.99	114.338	97.99	131.99	113.99	56.4	199.9	108.632	99.99	119.9	109.945
Hardness, mg/l CaCO ₃	2160	9688	5667.538	4385	6800	5493	5280	10080	7217.862	5600	9992	7628.000
Anions												
Salinity (as Chloride), mg/l	7498	18404	14996.077	14162	16828	15203.5	16261	20043	15037.009	14928	19213	16682.5
Salinity, %	13.50	33.19	27.04	25.53	30.34	27.41	29.32	36.15	27.11	26.92	34.65	30.08
Nitrate, mg/l	0.44	2.86	1.496	0.66	1.1	0.88	0.16	1.38	0.719	0.65	1.48	1.163
Phosphate, mg/l	0.003	0.05	0.018	0.01	0.11	0.06	0.002	0.9	0.158	0	0	
Cations												
Calcium, mg/l	610	873	693.692	678	744	696.25	80.19	874.8	747.406	726.4	865.3	790.25
Magnesium, mg/l	68.86	231	126.533	98.87	213	147.74	65.51	305	769.945	360	366.8	364.025
Ammonium, mg/l	0.4	11.61	5.153	0.17	2.08	1.373	0.8	4.58	1.984	0.12	1.65	0.933
Potassium, mg/l	860	1131	983.923	843	1124	957.25	9.33	988.76	825.895	913.31	956.65	928.048

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PRAMETERS	DRY SEASON						WET SEASON					
	STUDY AREA			CONTROL			STUDY AREA			CONTROL		
Physico-chemical	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN
Heavy metals												
Cadmium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, mg/l	0.256	0.755	0.483	0.409	0.648	0.52725	0.141	0.416	0.251	0.14	0.241	0.183
Total iron, mg/l	0.439	0.957	0.784	0.68	0.946	0.817	0.467	1.848	1.036	0.635	1.125	0.826
Copper, mg/l	0.098	0.357	0.232	0.266	0.331	0.308	0.092	0.212	0.137	0.121	0.171	0.137
Chromium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lead, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Organics												
Total Petroleum Hydrocarbons (TPH), mg/l	0.001	0.008	0.003	<0.001	<0.001	<0.001	0.001	0.004	0.002	<0.001	<0.001	<0.001
Polycyclic Aromatic Hydrocarbons (PAH), mg/l	0	0	0.000	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX, mg/l	0	0	0.000	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: EA EER Field data gathering 2011

Natural waters contain very small quantities of several essential metals including iron (Fe), cadmium (Cd), chromium (Cr), lead (Pb), copper (Cu), nickel (Ni), vanadium (V), zinc (Zn), manganese (Mn) and mercury (Hg). The heavy metal concentrations in the surface water of the study area were low in all the stations during the dry and wet seasons and do not pose any pollution threat (Table 4.3.2.1). Barium which is normally present in produce water was not detected in the surface water. Among the heavy metals analysed, only zinc, total iron and copper were detected at trace levels. These metals were however not detected during the EIA study but this difference is however statistically insignificant.

The Total Petroleum Hydrocarbons (TPH) in the surface water were very low (<0.0010 – 0.0080 mg/l) in the study area during the dry season. The wet season had a range of 0.000 – 0.0040 mg/l. Polycyclic Aromatic Hydrocarbons (PAHs) and BTEX were however not detected during the dry and wet season surveys.

Surface Water Trending Values for EIA 2001, H-Block 2007 and Present 2011 Study

The possible impact of the existing facilities was assessed by comparing mean and range values obtained during the Sea Eagle EIA (2001), H Block (2007), present EER study (2011) and Typical range for nearshore Nigeria (Table 4.3.2.2). From the comparative analysis, phosphate and nitrate values were significantly higher (P<0.05) in the present study than in the EIA 2001 study, but significantly lower than the values for H Block. Zinc and Cu were also significantly higher (P<0.05) in the present study than in the Sea Eagle EIA (2001). The increase in nutrients and some trace elements (Zn and Cu) may not be unconnected with oil exploration and production activities. The other parameters compare favourably with the earlier EIA (2001), H Block and Typical range for nearshore waters.

Table 4.3.2.2: Surface Water Trending Values

PARAMETERS	SEA EAGLE EIA 2001	STUDY AREA, DRY SEASON, 2011	STUDY AREA, WET SEASON, 2011	H BLOCK WET SEASON 2006+	Typical range for nearshore Nigeria*
Physico-chemical	RANGE	MEAN	MEAN	RANGE	
Temperature, °C		27.862	28.386	26.2-29.1	19-28.5
Colour, Pt-Co			6.667		
Turbidity, NTU		1.173	0.958	1-3	1-6
Total Suspended Solids (TSS), mg/l		3.231	2.200	250-750	240-850
Total Dissolved Solids (TDS), mg/l		26840.0	26959.310	31-40	19.1-34.8
pH		7.726	7.761	7.0 -8.8	4.7-8.18
Electrical Conductivity (EC), µS/cm		46434.6	48034.483	46-80	41.6-47.0
Dissolved Oxygen (DO), mg/l	5.84-8.33	4.362	7.974	4-10	3.5-6.7

PRAMETERS	SEA EAGLE EIA 2001	STUDY AREA, DRY SEASON, 2011	STUDY AREA, WET SEASON, 2011	H BLOCK WET SEASON 2006+	Typical range for nearshore Nigeria*
Biochemical Oxygen Demand (BOD), mg/l		4.600	3.330	0-4.5	0.53-20.5
Chemical Oxygen Demand (COD), mg/l		6.459	5.606	0-16	0.8-4.8
Alkalinity, mg/l		114.338	108.6		
Hardness, mg/l		5667.54	6898.182		
Anions					
Salinity (as Chloride), mg/l		14996.1	15037.009	30.1-40	
Salinity ‰		27.04	27.11		26.5-40
Nitrate, mg/l	0.32	1.496	0.719*	0.51-1.5*	0.02-73.3
Phosphate, mg/l	0.07	0.018	0.158*	0.51-1.0*	0.1-4.83
Cations					
Calcium, mg/l	2,300	693.692	747.406	239-845	284-426
Magnesium, mg/l	865	126.533	769.945		
Ammonium, mg/l		5.153	1.984		
Potassium, mg/l		983.923	825.895		
Heavy metals					
Cadmium, mg/l	<0.05	<0.005	<0.005		
Zinc, mg/l	<0.005	0.483	0.251*		
Total iron, mg/l	0.05-0.3	0.784	1.036	1.5-8.5	0.25-2.04
Copper, mg/l	<0.005	0.232	0.137*		
Chromium, mg/l	<0.01	<0.001	<0.001		
Nickel, mg/l	<0.01	<0.002	<0.002		
Lead, mg/l	<0.005	<0.002	<0.002		
Vanadium, mg/l		<0.001	<0.001		
Arsenic, mg/l		<0.001	<0.001		
Barium, mg/l		<0.001	<0.001		
Cobalt, mg/l		<0.001	<0.001		
Mercury, mg/l		<0.001	<0.001		
Organics					
Total Petroleum Hydrocarbons (TPH), mg/l		0.003	0.002	0-1.5	<1.0
Polycyclic Aromatic Hydrocarbons (PAH), mg/l		0.000	<0.001		
BTEX, mg/l		0.000	<0.001		

+ Source: FCNL Laboratory 2006; SPDC Offshore OMLs Reports, 2000. *P<0.05 (Chi square goodness of fit test)

Surface Water Microbiology

The summary of the offshore surface water microbiology is presented in Table 4.3.2.3, while the detailed two season baseline data collected from 27 stations and 4 controls is presented in Appendix 4.2. Total Heterotrophic Bacteria (THB) in the surface water ranged from 0.04 – 0.49 x 10³ cfu/ml

with a mean of 0.16×10^3 cfu/ml in the dry season and $0.5 - 0.97 \times 10^3$ cfu/ml with a mean of 0.83×10^3 cfu/ml in the wet season. The wet season THB was slightly higher due to the availability of more moisture. The THB population in the control sites was $0.14 - 0.32 \times 10^3$ cfu/ml (mean = 0.21×10^3 cfu/ml) in the dry season and $0.5 - 0.97 \times 10^3$ cfu/ml (mean = 0.98×10^3 cfu/ml) in the wet season.

Hydrocarbon Utilizing Bacteria (HUB) was in the range of $0.02 - 0.09 \times 10^2$ cfu/ml in the dry season and $0.16 - 0.56 \times 10^2$ cfu/ml (mean = 0.388×10^2 cfu/ml) in the wet season, whereas there was no growth in both controls; hence HUB accounted for 10% of the heterotrophic population, which indicates that the area had been previously exposed to hydrocarbons and that it had adequate microbial consortia to degrade oil in the event of a spill.

Results of seawater from historical record revealed that heterotrophic bacterial (HB) count ranged from 1.0×10^1 cfu/ml – 1.99×10^3 cfu/ml while hydrocarbon utilizing bacteria (HUB) ranged from nil to 1.44×10^2 cfu/ml (Table 4.2.2.2.2). The bacterial load comprised predominantly *Pseudomonas* sp, *Bacillus* sp, *Corynebacterium* sp, *Clostridium* sp, *Streptococcus* sp, *Proteus* sp, *Streptomyces* sp, *Flavobacterium* sp, *Serratia* spp. Total fungi (TF) in the water was in the same order with THB ranging from $0.04 - 0.23 \times 10^3$ cfu/ml (mean = 0.13×10^3 cfu/ml) in the dry season and $0.55 - 0.96 \times 10^3$ cfu/ml (mean = 0.739×10^3 cfu/ml) in the wet season. TH population was $0.11 - 0.32 \times 10^3$ cfu/ml (mean = 0.20×10^3 cfu/ml) in the dry season and $0.64 - 0.94 \times 10^3$ cfu/ml (mean = 0.82×10^3 cfu/ml) in the wet season.

Hydrocarbon utilizing fungi (HUF) ranged from $0.01 - 0.07 \times 10^2$ cfu/ml (mean = 0.033×10^2 cfu/ml) during the wet season $0.1 - 0.47 \times 10^2$ cfu/ml (mean = 30×10^2 cfu/ml) in the wet season, but no significant growth in the control sites for both seasons; hence, HUF accounted for 10% of the heterotrophic population, which indicates that the area had been previously exposed to hydrocarbons and it had adequate microbial consortia to degrade spilled oil. In 2001, the microbiology of the water samples showed that the microorganisms consisted of HUB, HUF and sulphur oxidising bacteria (SOB) (Sea Eagle EIA, 2001). The density of HUB and HUF was generally low and decreased gradually with depth. The highest density of HUB and HUF recorded were 2.68×10^3 and 2.80×10^3 cfu/ml respectively while the lowest was 1.00×10^3 cfu/ml. The total SOB counts were relatively low in all the areas. The highest density of SOB recorded was 2.5×10^3 cfu/ml and the lowest, 0.4×10^3 cfu/ml.

In 2006, heterotrophic fungi (HF) in the seawater ranged from $0.00 - 1.34 \times 10^2$ cfu/ml with mean of 4.0 cfu/ml while hydrocarbon utilizing fungi (HUF) ranged between nil and 3.8×10^1 cfu/ml. Heterotrophic and hydrocarbon utilizing fungi species were mainly *Rhizopus*, *Penicillium*, *Candida*, *Rhodoturola*, *Toruplois*, *Pichia*, *Mucor* and *Aspergillus* species. The percentage of hydrocarbon degraders in the surface water was generally less than 1%, suggesting an environment free of hydrocarbon pollution at the time of survey. Majority of the heterotrophic fungi and bacteria isolated from the area are hydrocarbon degraders, which are crucial for the degradation of hydrocarbons

following oil spills. Coliform bacteria were absent in the water samples, signifying that the sampled area was free from faecal coliform pollution at the time of survey.

Table 4.3.2. 3: Summary of microbiological characteristics of the surface water

PARAMETERS	DRY SEASON						WET SEASON					
	STUDY AREA (n = 27)			CONTROL (n=4)			STUDY AREA (n = 27)			CONTROL (n=4)		
	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN
Hydrocarbon Utilizing Bacteria, x10 ² Cf/ml	0.02	0.09	0.044	0	0	0	0.16	0.56	0.388	0	0	0
Hydrocarbon Utilizing Fungi, x10 ² Cf/ml	0.01	0.07	0.033	0	0	0	0.1	0.47	0.301	0	0	0
Total Heterotrophic Bacteria x10 ³ Cf/ml	0.04	0.49	0.160	0.14	0.32	0.215	0.5	0.97	0.832	0.6	0.98	0.76
Total Fungi, x10 ³ Cf/ml	0.04	0.23	0.127	0.11	0.32	0.2025	0.55	0.96	0.739	0.64	0.94	0.818

Source: EA EER Field data gathering 2011

Table 4.3.2.4: Summary of Seawater Microbiology Characteristics from Historical Data

Parameter	Species	Population Range (cfu/ml)
Total Heterotrophic bacteria (THB)	<i>Pseudomonas sp, Bacillus sp, Corynebacterium sp, Clostridium sp</i>	1.0 x 10 ¹ – 1.99 x 10 ³
Hydrocarbon utilizing bacteria (HUB)	<i>Streptococcus sp, Proteus sp, Streptomyces sp, Flavobacterium sp, Serratia spp</i>	0.00 – 1.44 x 10 ²
Heterotrophic fungi (HF)	<i>Rhizopus, Penicillium, Candida,</i>	0.00 – 1.34 x 10 ²
Hydrocarbon utilizing fungi (HUF)	<i>Mucor, Aspergillus sp, Rhodotorula sp, Torulopsis sp, Pichia sp</i>	0.00 – 3.8 x 10 ¹

4.3.3: Sediment quality

The physico-chemical characteristics of the sediment in the EA/Eja Field are presented in Appendix 4.3a (dry season) and 4.3b (wet season). The physico-chemical characteristics are summarized in Table 4.3. 3.1. In the dry season, temperature of sediment varied between 25.1°C and 28.20°C and in the wet season, it varied between 26.2°C and 27.8°C as shown in Table 4.3.3.1 and Appendix 4.3. These data did not show any significant difference in temperature between the control points and the other sample points. Much as there were no significant seasonal differences in temperature, it is worthy to note that variations in temperature were more pronounced in the dry season than in the wet season.

Spatial and seasonal variation in the pH of sediment in the study area in both dry and wet seasons is presented in Fig. 4.3.3.1. In the dry season, pH of sediments fluctuated from 6.12 (slightly acidic) in sample point SD 26 to pH 7.81 (slightly alkaline) in sample point SD 10 of the Fate and Effect Study (2011). In the wet season, the sediment was slightly alkaline and pH values fluctuated between 7.24 and 7.73. These values did not show any spatial and seasonal differences in pH of the EA/Eja field. The pH values for sediment samples were within the normal range for marine sediments (6.50 – 8.50). In H Block, a value pH value of 7.65-8.63 was reported (SPDC, 2007) and this observation did not deviate from the results recorded for pH in EA/Eja field.

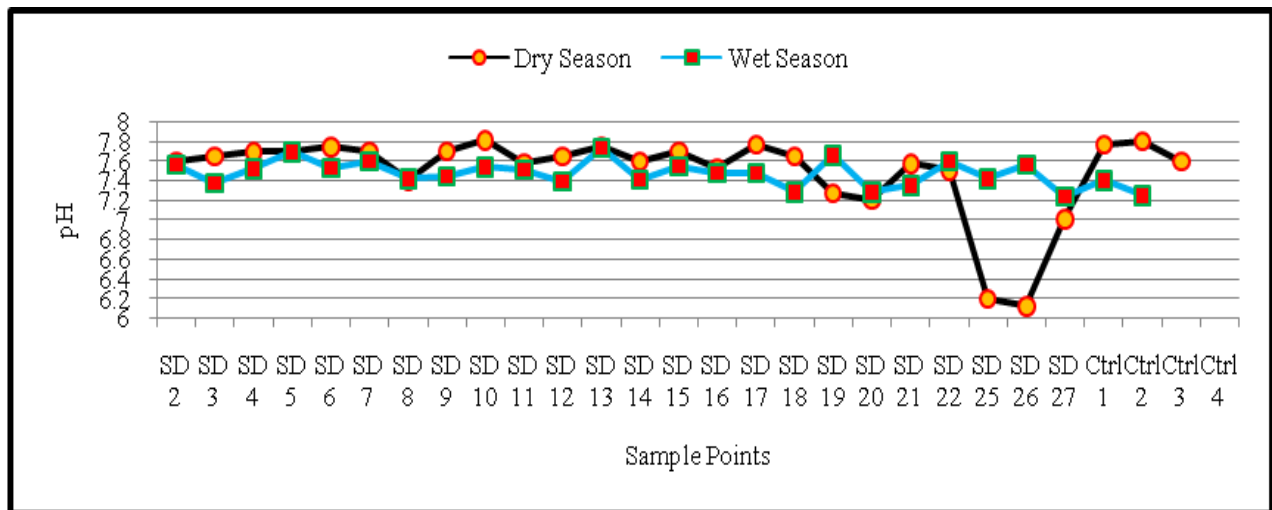


Fig. 4.3.3.1: Variation in pH of Sediment in EA/Eja Field

The electrical conductivity of sediment in EA/Eja field in the dry and wet seasons of the study area is graphically presented in Fig. 4.3.3.2. In the dry season, significant spatial variation in electrical conductivity was observed in SD 3 (95067 μ S/cm) and SD 6 (89010 μ S/cm) where the increment was 10 fold when compared to other stations. Similar inflexions in electrical conductivity values were also observed for the sediment in the wet season at Control Station 2 (96910 μ S/cm) and Sample stations 26 (94400 μ S/cm) and 25 (85200 μ S/cm). This may be attributed to hydrological variations associated with button sediments.

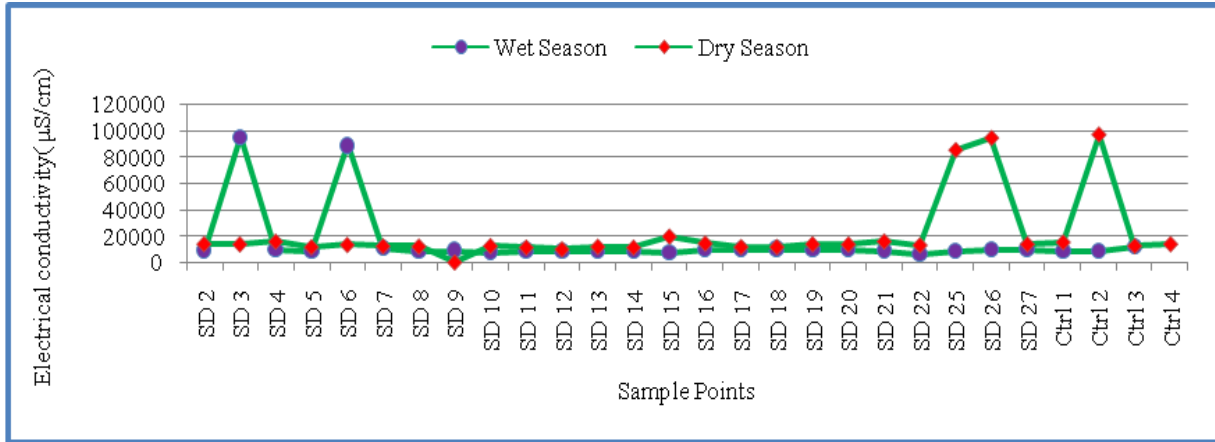


Fig. 4.3.3.2: Variations in pH in EA/Eja Field (Source: field survey 2011)

Anions in Sediment

Chloride and nitrate levels in the sediment of the area in the dry and wet seasons are summarized in Table 4.3.3.1. Chloride levels varied from 1799-4998mg/kg ($\bar{X} = 3080.04$ mg/kg) in the dry season and 1063-4608mg/kg ($\bar{X} = 2652.08$ mg/kg) in the wet season. Spatial and seasonal variations in chloride concentrations in sediment of the study area were not significant. Nitrate concentrations varied between 6.29-191.33 mg/kg ($\bar{X} = 80.32$ mg/kg) in the dry season and 3.47 - 539.92 mg/kg ($\bar{X} = 141.17$ mg/kg) in the wet season and showed that wet season levels of nitrates were generally higher than dry season levels (Fig. 4.3.3.3). In the control area, nitrate levels varied 36.04-488.57mg/kg ($\bar{X} = 169.98$ mg/Kg) in the dry season and 27.85-131mg/kg ($\bar{X} = 65.51$ mg/kg) in the wet season. There was no difference in the nitrate concentrations in sediment of both the sample areas and the control. Nitrate concentrations in sediment of EA/Eja field were relatively higher than previous values of 2.5-3.5mg/kg recorded in H block EIA (2007).

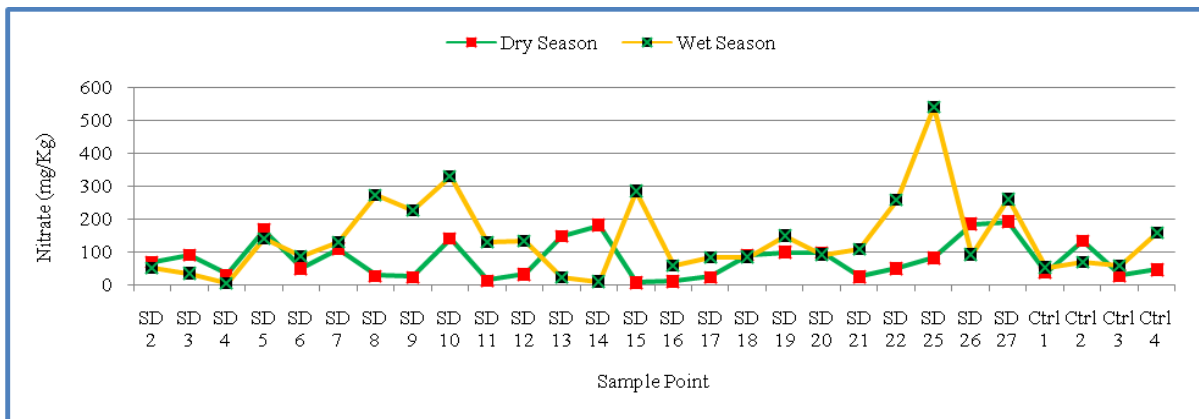


Fig. 4.3.3.3: Variations in Nitrate in EA/Eja Field (Source: field Survey 2011)

The levels of phosphate in the sediment of the area are presented graphically in Fig. 4.3.3.4. Phosphate levels ranged from 68.4 to 184.61 mg/Kg in the dry season and 104.94 to 361.6 mg/Kg in the wet season. Wet season values of phosphate concentration in the sediment are relatively higher than dry season values but were comparable to those in the control stations. Similarly, the values recorded in EA/Eja field were higher than in previous data in the area.

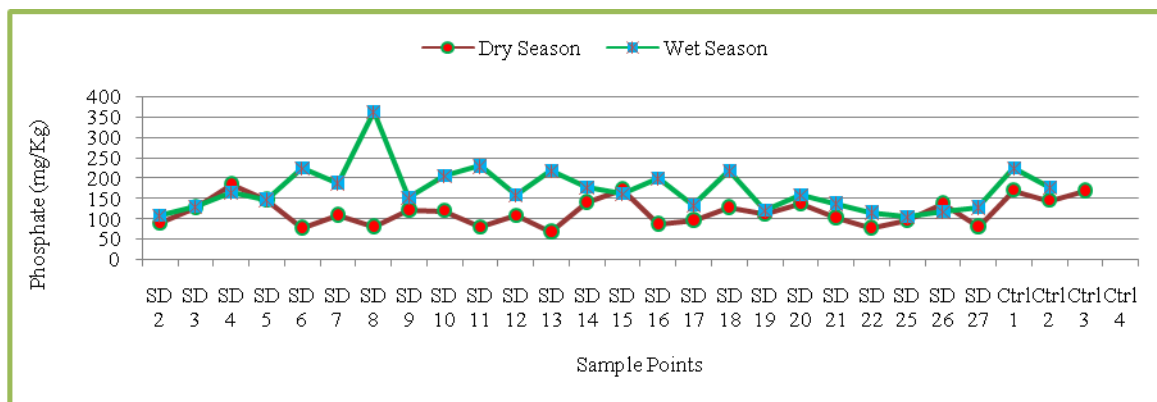


Fig. 4.3.3.4: Variations in Phosphate in EA/Eja Field (Source: field Survey 2011)

Cations in Sediment

The concentrations of cations (potassium, calcium and magnesium) in the sediment at various sample points within the EA/Eja field in the dry and wet seasons are summarized in Table 4.3.3.1. Levels of potassium in the sediment varied from 422 to 1992 mg/kg in the dry season and from 1104 to 2126 mg/kg in the wet season without observable difference in both time and space. Phosphate levels in the study area were similar to those in control area.

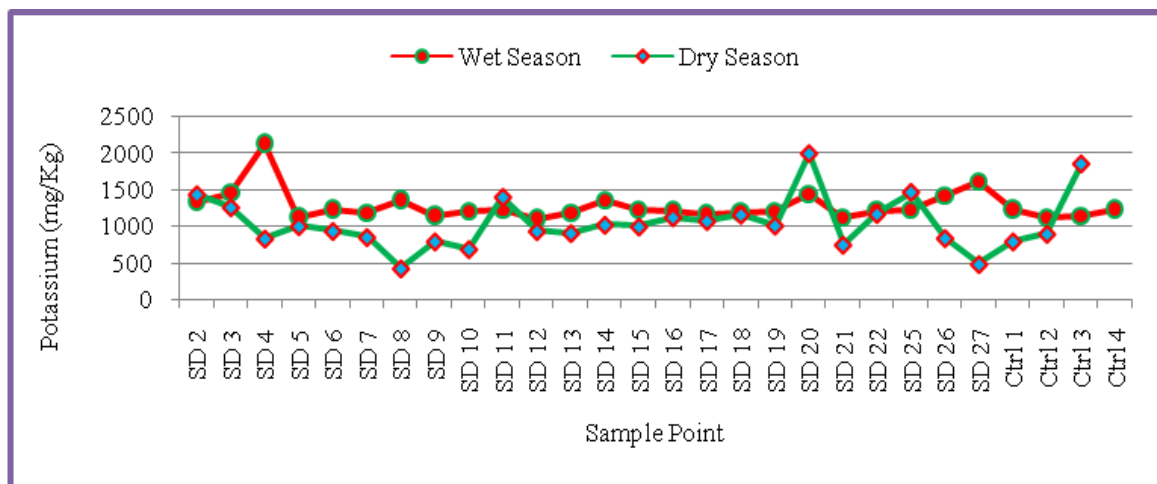


Fig. 4.3.3.5: Variation in Potassium in EA/Eja Field (Source: field survey 2011)

The concentration of calcium in EA/Eja field is summarised in Table 4.3.3.1. In the dry season, the concentration of calcium ranged from 1053 to 2463 mg/kg and in the wet season, this variable ranged from 116.20 to 892.6 mg/Kg. (Fig. 4.3.3.6). These values point to a seasonal variation in the concentration of calcium in the sediment of EA/Eja field.

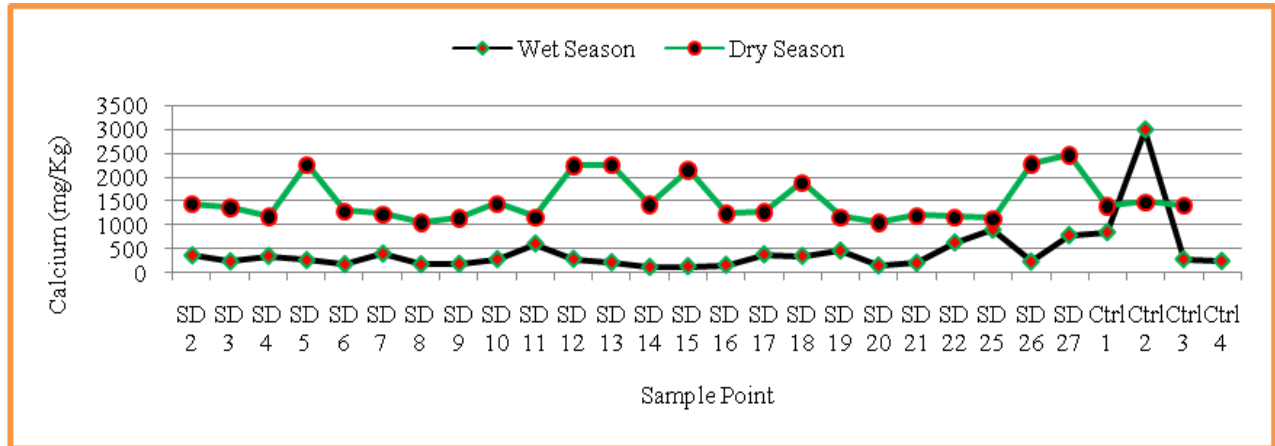


Fig. 4.3.3.6: Variations in Calcium in EA/Eja Field
(Source: field Survey 2011)

The concentration of magnesium in the sediment of EA/Eja field in both the dry and wet seasons is presented in Fig. 4.3.3.7. Magnesium concentration in sediment ranged from 18.75 to 182.00 mg/kg and 447 to 1782 mg/kg in the dry and wet seasons, respectively. These values show that the concentration of magnesium in the area during the dry season was higher than those in the wet season. The concentration of magnesium in sediment recorded in this study in both seasons were generally lower than was recorded in the EIA of H Block (SPDC, 2007) as shown in Table 4.3.3.1.

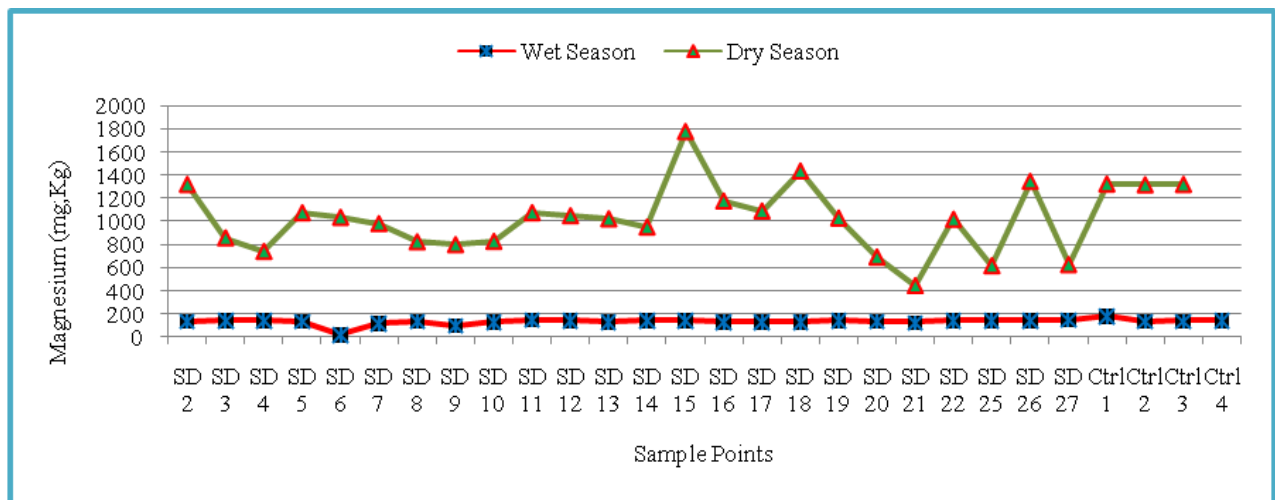


Fig. 4.3.3.7: Variations in Magnesium in EA/Eja Field
(Source: field Survey 2011)

Organics in Sediment

Results for the concentration of organics in the sediment of EA/Eja field in the dry and wet seasons are presented in Appendices 4.3a and b and summarised in Table 4.3.3.1. Polycyclic aromatic hydrocarbon and BTEX were not recorded in the sediment of EA/Eja field in both seasons. However, TPH levels in sediment of EA area were generally low and ranged from 0.17-5.14mg/kg (mean=1.74mg/kg) in the dry. Concentrations of TPH in the wet season ranged from 0.008 to 3.11 mg/kg. The total hydrocarbon content (THC) was generally below 5 mg/kg and this indicates that the sediment was not polluted with petroleum hydrocarbon.

Table 4.3.3.1: Summary and Trend Analysis of Physico-chemical Characteristics of Sediment in EA/Eja Field

PARAMETERS Physico-chemical	DRY SEASON STUDY AREA			WET SEASON STUDY AREA			Range	Typical Values for Near shore Nigeria	Global average/range for marine sediments (Reference)
	Min	Max	Average	Min	Max	Average			
pH	6.12	7.81	7.46	7.24	7.73	7.47	7.61-8.2	7.65-8.63	7.3-8.6
Temperature, °C	25.1	28.2	26.55	26.2	27.8	27.10			
Colour	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish			
Electrical conductivity, µS/cm	6490	95067	15950.29	117.8	94400	18662.99			
Anions									
Salinity (as Chloride), mg/kg	1799	4998	3080.04	1063	4608	2652.08			
Nitrate, mg/kg	6.29	191.33	80.32	3.47	539.92	141.17	2.5-5.5	3.32-5.12	
Phosphate, mg/kg	68.54	184.61	112.14	104.94	361.6	170.93	24.5-70.0	27.4-87.1	
Cations									
Potassium, mg/kg	422	1992	1019.16	1104	2126	1286.69	181-2501	165-1826	
Calcium, mg/kg	1053	2463	1523.13	116.2	2984	453.42	629-21500	444-83,880	629-21500
Magnesium, mg/kg	18.75	149.56	132.46	447	1782	995.38	2180-13813	3,002-34,270	
Organics									
Total Petroleum Hydrocarbon, mg/kg	0.17	5.14	1.74	0.008	3.11	1.15	0.4-16.4	<0.01-10	<0.01
Polycyclic Aromatic Hydrocarbon (PAH), mg/kg	0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
BTEX, mg/kg	0.001	<0.001	<0.001	<0.001	<0.001	<0.001			

Heavy Metal Concentrations in Sediment

The heavy metal concentrations of sediment within the EA/Eja field are presented in Appendices 4.3.a and b and summarised in Table 4.3.3.2. The data showed that vanadium, arsenic, barium and mercury were not detected in the sediment in both seasons of the season. Cobalt was similarly below detectable limits of <0.001mg/l in the dry season and in the wet season concentration of cobalt in sediment ranged from 0.11-1.26mg/l.

The results of the concentration of Pb, Ni, and Cr are presented in Fig. 4.3.3.8, 4.3.3.9 and 4.3.3.10, respectively. The concentration of Pb varied from 25.15 to 53.34 mg/kg and 14.27 to 33.72 mg/kg for dry and wet seasons respectively. The concentration of Pb and Ni in the wet season was lower than that of the dry season. From results of previous reports in H block it appears there is an appreciation in the level of lead in the sediment within EA/Eja field.

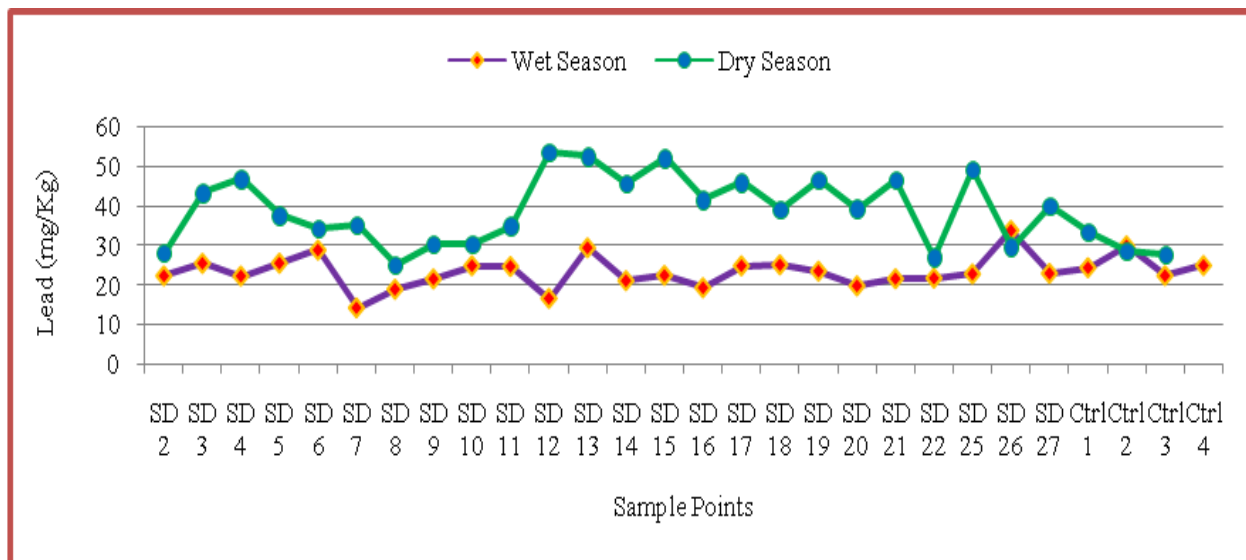


Fig. 4.3.3.8: Variation in Lead in EA/Eja Field (Source: field Survey 2011)

In the dry season, maximum Ni levels in sediment was highly varied between a minimum value of 56.26 mg/kg while in the wet season values for this element varied between 2.59 and 24.43 mg/kg (Fig 4.3.3.9). The concentration of nickel in sediment of OML 79 in the present was comparably lower than in previous reports (Table 4.3.3.2). The concentration of Cr in sediment of the study area in the dry season ranged from a minimum of 10.54 in SD 3 to a maximum of 43.2 mg/kg in SD 27. Minimum Cr level in the sediment in the wet season was 5.04 mg/kg (SD 6) while maximum value was 21.11 mg/kg (Fig 4.3.3.9). Table 4.3.3.2 also shows that there are temporal variations in Cr in favour of dry season levels. Similarly, mean concentration of Cr in the dry season (\bar{x} =9.33mg/kg) was comparable to wet season (\bar{x} =12.49mg/kg). These results were generally lower than in previous studies and may indicate a depreciation of this element in sediments within OML 79.

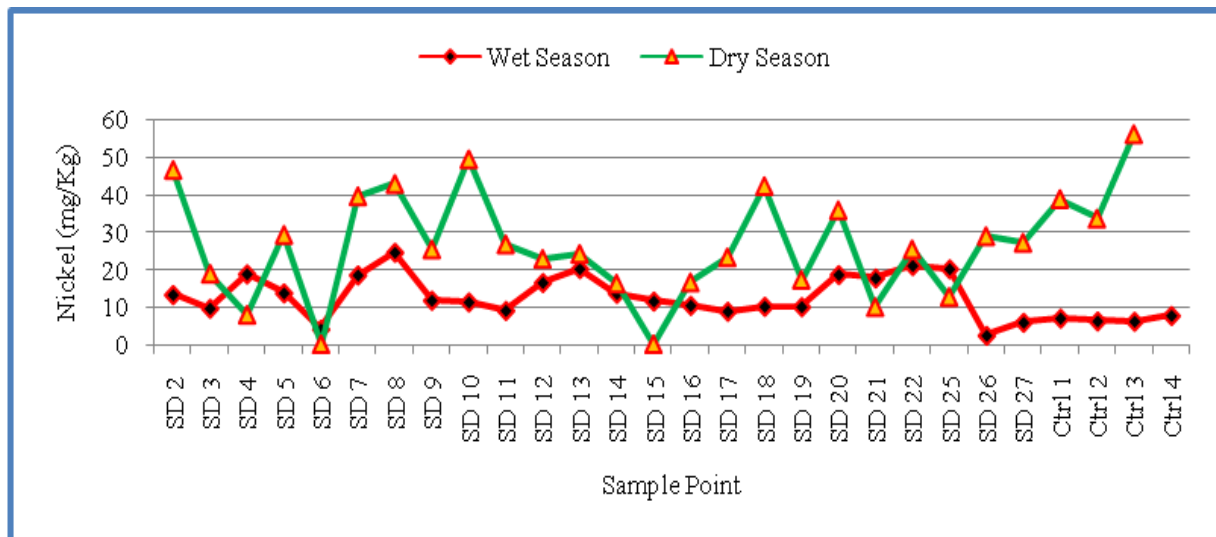


Fig 4.3.3.9: Variation in Nickel in EA/Eja Field
(Source: field Survey 2011)

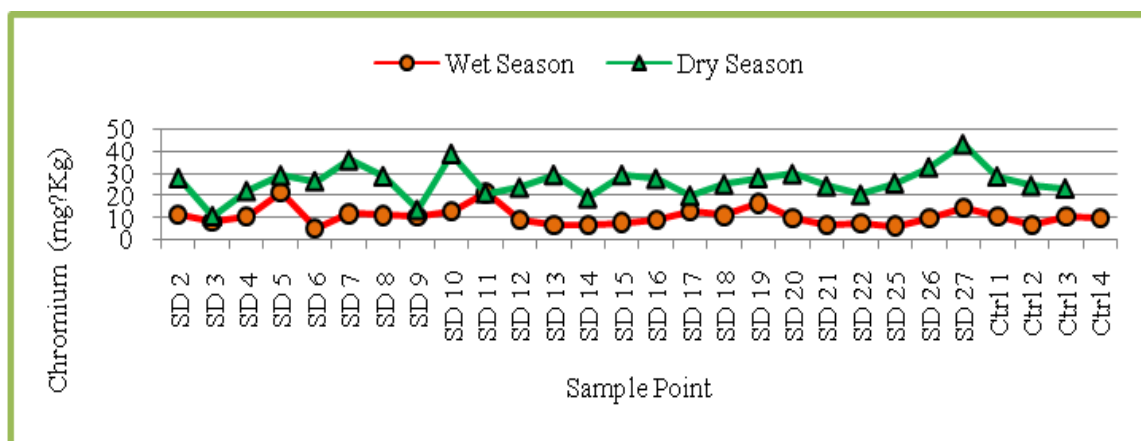


Fig 4.3.3.10: Variation in Chromium in EA/Eja Field
(Source: field Survey 2011)

The levels of copper (Cu) and Zn in sediment of EA/Eja field in the dry season of the study area are presented in Table 4.3.3.2. The concentration of Cu ranged from 4.79 mg/kg to 18.69 (\bar{x} =9.33mg/kg) in the dry season and 2.49-20.49 mg/kg (\bar{x} =12.49 mg/kg) in the wet season. Zinc (Zn) levels in sediment varied from 10.88 to 87.12- mg/kg in the dry season and 24.09-86.58 mg/kg in the wet season. These values for the level of Zn in the sediment did not indicate differences in the two seasons. Results presented in Table 4.2.2.3.2 show that there is a gradual accumulation of Zn in the sediment within EA/Eja field.

A representation of the concentration of total Fe in sediment of the EA/Eja field in the dry season is shown in Fig 4.3.3.11. The concentration of Fe in sediments of OML 79 fluctuated between

930.4 and 1987 mg/kg in the dry season and 377.97 and 895.08 mg/kg in the wet season. Wet season iron levels in the sediment were generally lower than those for the dry season.

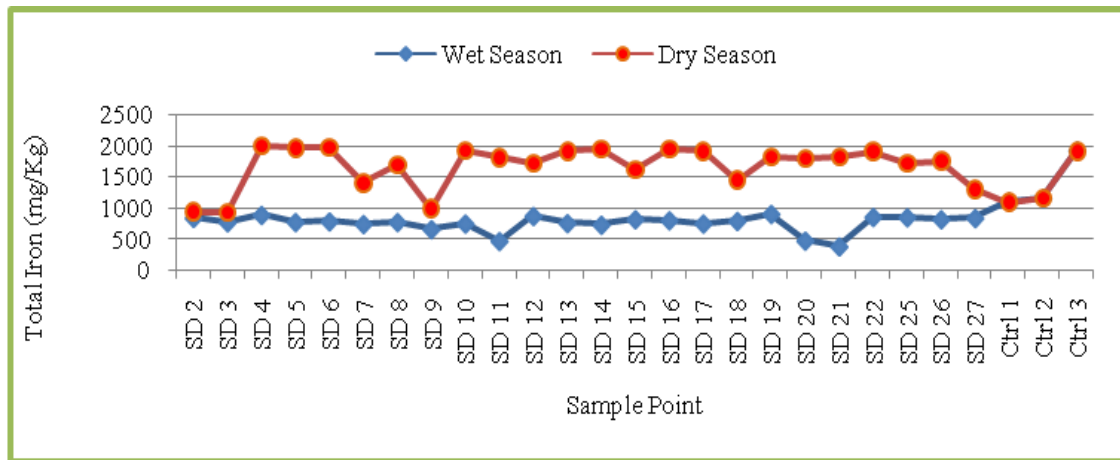


Fig 4.3.3.11: Variations in Total Iron in EA/Eja Field
(Source: field Survey, 2011)

Cadmium (Cd) was also recorded in variable concentrations in the sediment in both the dry and wet seasons of the study (Fig. 4.3.3.12). Results ranged from 0.81 to 8.32 mg/kg in the dry season and <0.005-4.16 mg/kg in the wet season. The concentration of cadmium in the wet season is generally lower than in the dry season.

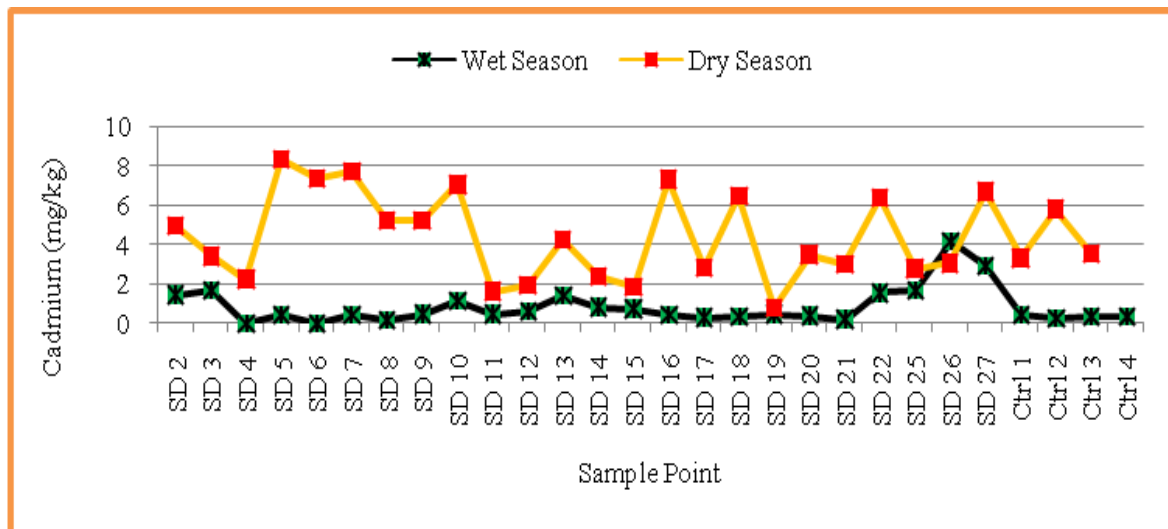


Fig. 4.3.3.12: Variations in Concentration of Cadmium in EA/Eja Field
(Source: field Survey, 2011)

In the dry season, cobalt (Co) was recorded in the sediment in all the stations in concentrations ranging from 0.11 to 1.26 mg/kg (Table 4.3.3.2). In the rainy season, this element was not detected (<0.001 mg/kg) in the sediment indicating seasonal variation.

The mean levels of heavy metals in the sediments of EA/Eja field showed that concentration of the metals were generally low and within the acceptable limits set by FEPA (1999) and the World Health Organization (WHO).

Table 4.3.3.2: Mean heavy metal concentration in sediment of EA/Eja Field

Heavy Metals (mg/kg)							EIA 2001		EIA 2007	
	WET SEASON			DRY SEASON			Range	Mean	Range	Mean
	Min	Max	Mean	Min	Max	Mean				
Cd	0.146	4.16	0.98	0.81	8.32	4.44	<0.33–0.5	0.39	<0.02	<0.02
Zn	24.09	86.58	54.74	10.88	87.12	39.66	<0.1 – 29.5	20.1	1.09 – 98.8	36.7
Total Fe	377.97	895.08	753.61	93.04	19.87	1670.78	15,894 - 95,304	41,900	12,740 - 106,100	38,881
Cu	2.49	20.49	12.49	4.79	18.69	9.33	0.12 – 7.5	3.2	<0.05 – 20.8	5.05
Cr	5.04	21.11	10.63	10.54	43.2	26.26	2.1 – 238.5	21.5	0.24 – 822	33.4
Ni	2.59	24.43	13.11	7.88	49.53	26.81	1.6 – 80.32	37.9	2.14 – 98.4	26.9
Pb	14.27	33.78	23.28	25.15	53.34	39.69	<0.2 – 45.1	12.8	<0.20 – 33.1	15.98
Vn	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.1 – 2.5	1.6	<0.03	<0.03
As	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	-
Ba	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.1 – 1,427	65.8	<0.03 – 2,937	108
Co	<0.001	<0.001	<0.001	0.11	1.26	0.67	<0.01 – 16.3	5.7	<0.01 – 25.7	9.8
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002

Sediment Microbiology

Details of the offshore sediment microbiology data are presented in Appendices 4.3a and b, while a summary is presented in Table 4.3.3.3. The THB values ranged from 0.96 - 2.99x10⁴ cfu/g in the wet season and 1.02 - 1.83 x10⁴ cfu/g (1.34 x10⁴ cfu/g) in the dry season. The THB population was similar to that of the controls in both seasons. THB was 1.59 - 2.01 x10⁴ cfu/g for the wet season control and 2.33 - 3.06 x10⁴ cfu/g for the dry season control. The HUB values ranged from 0.02 - 7.66 x10² cfu/g in the wet season and 0.45 - 6.82 x10² cfu/g in the dry season. There was no significant growth in the control samples for both seasons. HUB accounted for 1% of the heterotrophic bacteria population.

Total Fungi (TF) population was in the same range as THB. It ranged from 0.86 - 2.8 x10⁴ cfu/g in the wet season and 1.00 – 1.75 x10⁴ cfu/g in the dry season. Hydrocarbon utilizing fungi (HUF) ranged from 0.01 - 5.34 x10² cfu/g in the wet season and 0.11 - 2.1 x10² cfu/g in the dry season. Hydrocarbon utilizing fungi was 1% of the total fungi population.

Table 4.3.3.3: Sediment microbiological characteristics of the study area

PARAMETERS	WET SEASON						DRY SEASON					
	STUDY AREA (n = 27)			CONTROL (n=4)			STUDY AREA (n = 27)			CONTROL (n=4)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Hydrocarbon utilizing bacteria, x10 ² cfu/g	0.02	7.66	1.61	Nil	Nil	Nil	0.45	6.82	1.44	Nil	Nil	Nil
Hydrocarbon utilizing fungi, x10 ² cfu/g	0.01	5.34	1.48	Nil	Nil	Nil	0.11	2.1	0.745	Nil	Nil	Nil
Total Heterotrophic Bacteria, x10 ⁴ cfu/g	0.96	2.99	1.92	1.59	2.01	1.83	1.02	1.83	1.34	2.33	3.06	2.72
Total Heterotrophic Fungi, x10 ⁴ cfu/g	0.86	2.8	1.79	1.54	2	1.77	1	1.75	1.27			

In 2006, heterotrophic bacteria ranged from 1.0 x 10³ - 7.75 x 10⁵cfu/g. Lower counts were recorded for the hydrocarbon utilising bacteria (HUB) in the sampled sediments. HUB ranged from 0 - 9.7 x 10²cfu/g. *Pseudomonas sp* was predominant. Other bacteria isolated in the area include *Bacillus sp.*, *Proteus sp.*, *Serratia sp.*, *Streptococcus sp.*, *Clostridium sp.*, *Staphylococcus sp.*, *Corynebacterium sp.*, *Flavobacterium sp.* and *Erwinia sp.* The percentage of hydrocarbon degraders in the sediment samples were generally less than 1%, suggesting an environment free of hydrocarbon pollution as at the time of the survey. Recent data obtained from the study area showed similar trend. Total fungi ranged from nil - 3.7 x 10² cfu/g. Hydrocarbon utilizing fungi were scanty. Fungi species include *Candida sp.*, *Rhizopus sp.*, *Aspergillus sp.*, *Penicillium sp.*, *Fusarium sp.*, *Rhodotorula sp.*, *Sporobolomyces spp.* and *Mucor sp.*

4.3.4: Hydrobiology

Phytoplankton

A checklist of the phytoplankton within EA/Eja field in both the dry and wet seasons is presented in Appendices 4.4a and b, respectively. In both seasons, the recorded major families of phytoplankton were five (5); namely Baccillariophyceae, Chlorophyceae, Euglenophyceae

Cyanophyceae and Dinophyceae. Chowdhury (2007), Nwankwo *et al.* (2008), Onyemma (2007) and Chindah and Braide (2004) had similarly observed these families of phytoplankton in the Gulf of Guinea. In the dry season, the contribution of each of the major families of phytoplankton in the marine environment is graphically presented in Fig. 4.3.4.1. Baccillariophyceae were the dominant family and constituted 57% of the total number of phytoplankton (Fig. 4.3.4.2).

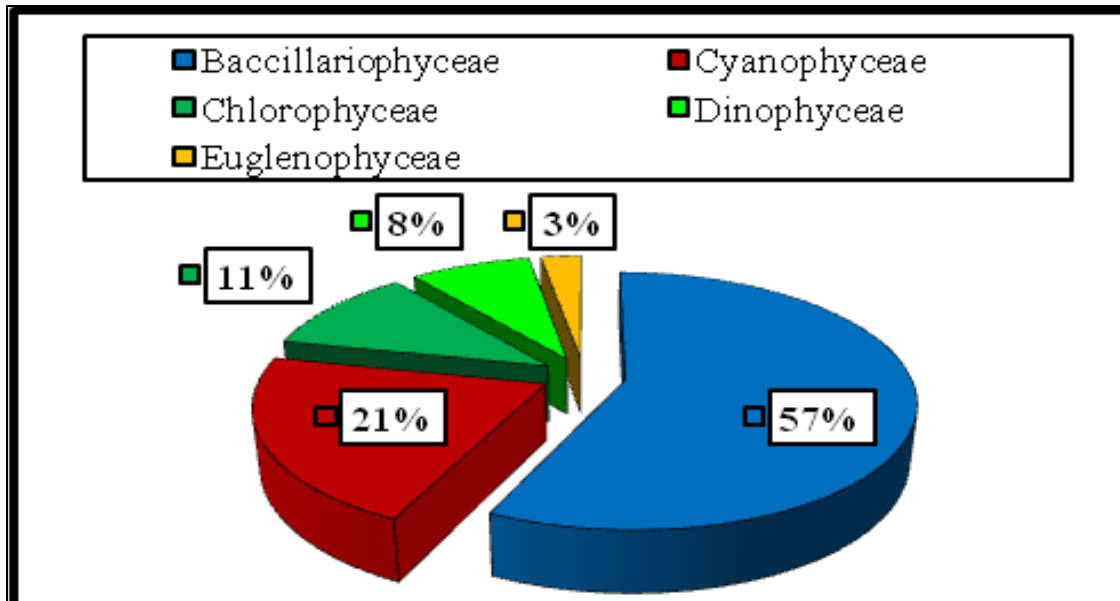


Fig. 4.3.4.1: Contributions of Phytoplankton divisions in the dry season

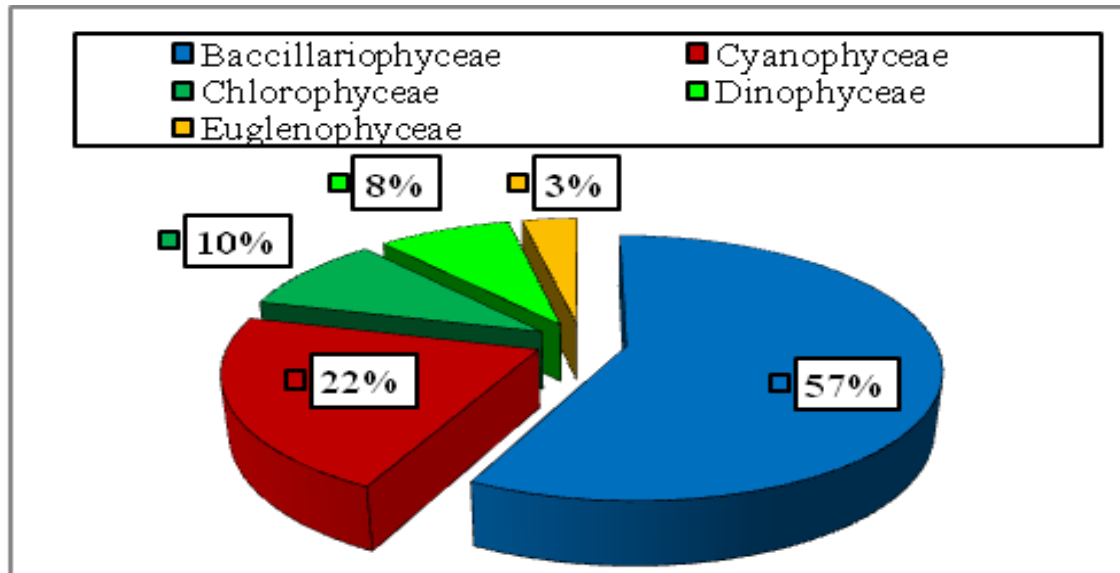


Fig. 4.3.4.2: Contributions of Phytoplankton divisions in the wet season

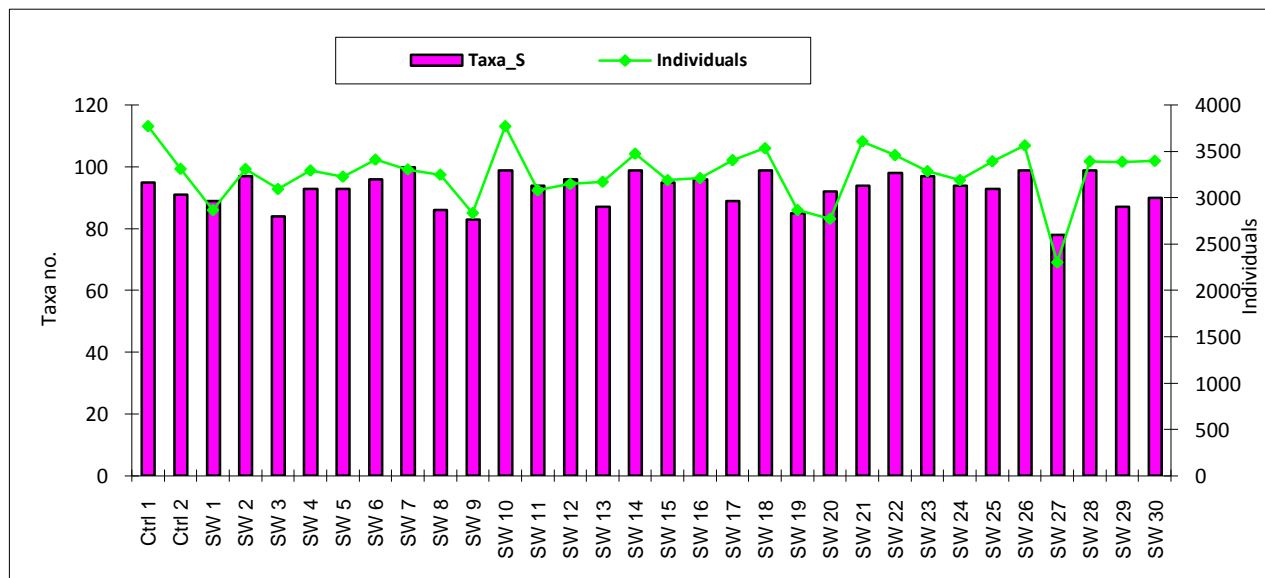


Fig. 4.3.4.3: Spatial variation in the Taxa number and individuals of phytoplankton of the study area in the dry season

The Bacillariophyceae were represented by 67 species with numerical contribution ranging from 0.57% (*Bacillaria paradoxa*) to 1.29% (*Amphora ovalis*) (Appendices 4.4a and b). The second dominant group of phytoplankton was Cyanophyceae, which contributed 21% of the total number of phytoplankton count (Fig.4.3.4.3). They were represented by 25 species. The dominant Cyanophyceae species were *Isocystis planktonica* (1.21%), *Phormidium brevis* (1.07%) and *Oscillatoria formosa* (1.02%). Other members of this family include *Lyngbya lutea* (0.96%), *Oscillatoria limosa* (0.95%) and *Anabaena flos-aquae* (0.89%). The third dominant group of phytoplankton was Chlorophyceae and they contributed 11% of the total number of phytoplankton. Twelve (12) species were represented in this family and these include *Halosphaera viridis* (1.22%), *Scenedesmus acuminatus* (1.14%) and *S. quadricauda* (1.03%). In all, the dominance pattern of the various families of phytoplankton in the marine waters of EA/Eja Field in the dry season was Bacillariophyceae > Cyanophyceae > Chlorophyceae > Dinophyceae > Euglenophyceae.

In the wet season, the dominant phytoplankton family, the Bacillariophyceae similarly contributed 57% of the phytoplankton and the dominance pattern was, Bacillariophyceae > Cyanophyceae > Chlorophyceae > Dinophyceae > Euglenophyceae and was similar to that in the dry season. In the dry season, the total number of phytoplankton in the various stations ranged between 2302×10^3 cells per litre in sample point 27 and 3768×10^3 cells per litre (Control 1) while in the wet season, it ranged between 2179×10^3 cells per litre in sample point 8 and 3351×10^3 cells per litre in sample point 24.

A total of 117 species of phytoplankton were recorded in the environment in the dry season and a spatial variation varied between 79 species in sampling points 27, 107 and 7 (Fig. 4.3.4.4). In the wet season, 101 species were recorded and varied between 65 and 84 in sample points 17 and 18. It is significant to note that in the EA/Eja field, there was no seasonal change in the density of phytoplankton but there was a slight decrease in the number of species in the wet season. This can be associated with changes in light regime and higher photosynthetic activities in the dry season.

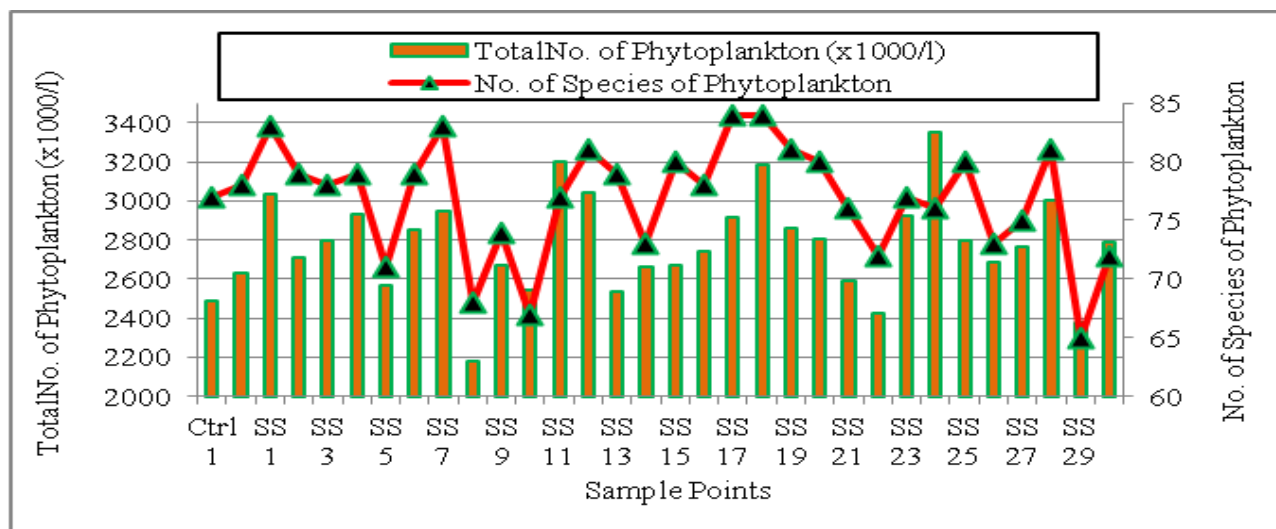


Fig. 4.3.4.4: Spatial variation in the Taxa number and individuals of phytoplankton of the study area in the wet season (SS=SW)

Diversity measures for Phytoplankton

Diversity indices measure the stability and resilience capacity of ecosystems against any form of perturbations. The results of diversity analysis for phytoplankton (Table 4.3.4.1) revealed that the community was highly diverse and ecologically stable.

Table 4.3.4.1: Diversity measures for phytoplankton

Stations	Taxa_S	Individuals	Dominance_D	Shannon_H	Simpson_1-D	Margalef	Equitability_J
Ctrl 1	95	3768	0.01486	4.363	0.9851	11.42	0.958
Ctrl 2	91	3309	0.01611	4.291	0.9839	11.11	0.9512
SW 1	89	2865	0.01619	4.278	0.9838	11.05	0.9531
SW 2	97	3307	0.01495	4.354	0.9851	11.85	0.9517
SW 3	84	3092	0.01645	4.242	0.9835	10.33	0.9573
SW 4	93	3291	0.01688	4.265	0.9831	11.36	0.9411
SW 5	93	3225	0.01613	4.287	0.9839	11.39	0.9458
SW 6	96	3408	0.01477	4.363	0.9852	11.68	0.9559
SW 7	100	3303	0.01445	4.395	0.9855	12.22	0.9543
SW 8	86	3246	0.01736	4.222	0.9826	10.51	0.9477

Stations	Taxa_S	Individuals	Dominance_D	Shannon_H	Simpson_1-D	Margalef	Equitability_J
SW 9	83	2834	0.01989	4.118	0.9801	10.32	0.9318
SW 10	99	3768	0.01477	4.364	0.9852	11.9	0.9497
SW 11	94	3077	0.01602	4.313	0.984	11.58	0.9493
SW 12	96	3147	0.0153	4.339	0.9847	11.8	0.9507
SW 13	87	3170	0.0185	4.194	0.9815	10.67	0.9391
SW 14	99	3472	0.01442	4.383	0.9856	12.02	0.9539
SW 15	95	3187	0.01565	4.332	0.9843	11.65	0.9513
SW 16	96	3209	0.01667	4.29	0.9833	11.77	0.9399
SW 17	89	3403	0.01736	4.223	0.9826	10.82	0.9407
SW 18	99	3531	0.01451	4.376	0.9855	12	0.9524
SW 19	85	2865	0.01872	4.163	0.9813	10.55	0.937
SW 20	92	2771	0.01567	4.31	0.9843	11.48	0.9531
SW 21	94	3605	0.01535	4.333	0.9847	11.36	0.9537
SW 22	98	3457	0.01416	4.391	0.9858	11.9	0.9577
SW 23	97	3284	0.01519	4.363	0.9848	11.86	0.9537
SW 24	94	3188	0.01515	4.332	0.9848	11.53	0.9536
SW 25	93	3391	0.01587	4.302	0.9841	11.32	0.9492
SW 26	99	3561	0.01474	4.379	0.9853	11.98	0.953
SW 27	78	2302	0.02143	4.041	0.9786	9.946	0.9276
SW 28	99	3391	0.01543	4.348	0.9846	12.06	0.9462
SW 29	87	3385	0.01602	4.283	0.984	10.58	0.959
SW 30	90	3395	0.01551	4.312	0.9845	10.95	0.9582

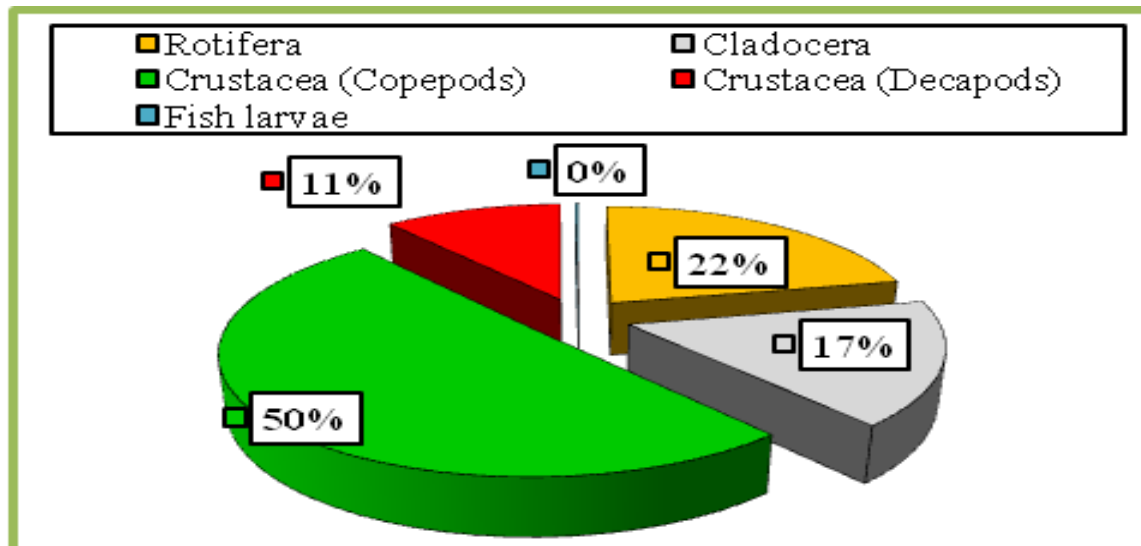
Trend analysis for Phytoplankton

A comparison of phytoplankton for the EIA 2001 and the present study showed that the total number of species was significantly higher in the present study (117) than in the EIA 2001 report (19). The overall abundance of phytoplankton was also higher in the present study. This difference may be related to obvious difference in the size of areas sampled.

Zooplankton

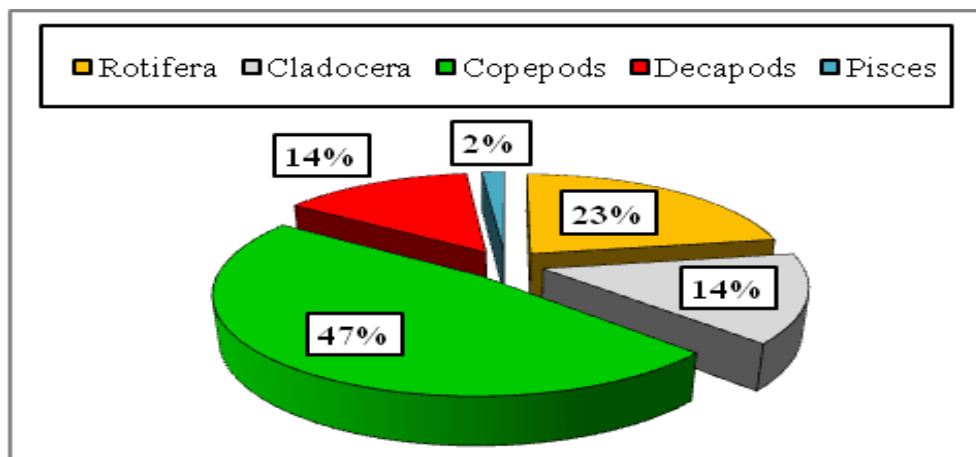
The checklists of the zooplankton species recorded in EA/Eja Field in the dry and wet seasons are presented in Appendices 4.5a and b, respectively. The identified zooplankton fauna were categorized into crustaceans (copepods and decapods, Cladocera, Euphausiacea), rotifers, the larvae of molluscs and Pisces. The percentage composition of each of these major zooplankton groups in each of the seasons (dry and wet) is presented in Figs. 4.3.4.5 and 4.3.4.6. In the dry season, copepod crustaceans were the dominant zooplankton and contributed 50% of the zooplankton. Among copepods, *Gaetanus armiger* (4.99%), *Calanus helgolandicus* (4.05%) and *Rhincalanus* (4.01%) were predominant. The rotifers were the second dominant zooplankton with respect to density and constituted 22% of the total zooplankton count in the dry season. This

category of zooplankton was represented by eight (8) species. The relative abundance of Cladocera and decapod crustaceans in the dry season was 11% and 17%, respectively.



Figs. 4.3.4.5: The relative contribution of major zooplankton groups in the dry season

In the wet season, the dominant zooplankton was copepods which constituted 47% of the zooplankton (Figs. 4.3.4.6). Major copepod species include *Calanus helgolandicus* (3.92%), *Centropages typicus* (3.63%) and *Paracalanus parvus* (3.52%). Rotifers were the second dominant group constituting 23% of the total zooplankton and members of this group included *Brachionus calyciflorus* (5.08%), *Lecane bulla* (5.04%) and *Filinia longiseta* (3.37%).



Figs. 4.3.4.6: The relative contribution of major zooplankton groups in the wet season

Spatial variation in abundance and diversity of zooplankton in EA/Eja Field is presented in Fig. 4.3.4.7 (Dry Season) and Fig. 4.3.4.8 (wet Season). In the dry season the highest zooplankton numbers of 492×10^2 organisms/m³ was recorded in sampling point 29 while the lowest count of

234 x 10² organisms/m³ was recorded in sampling point 7. More species (37) of zooplankton were recorded in station 3 while the least (17) in terms species diversity of zooplankton was recorded in sample point 10.

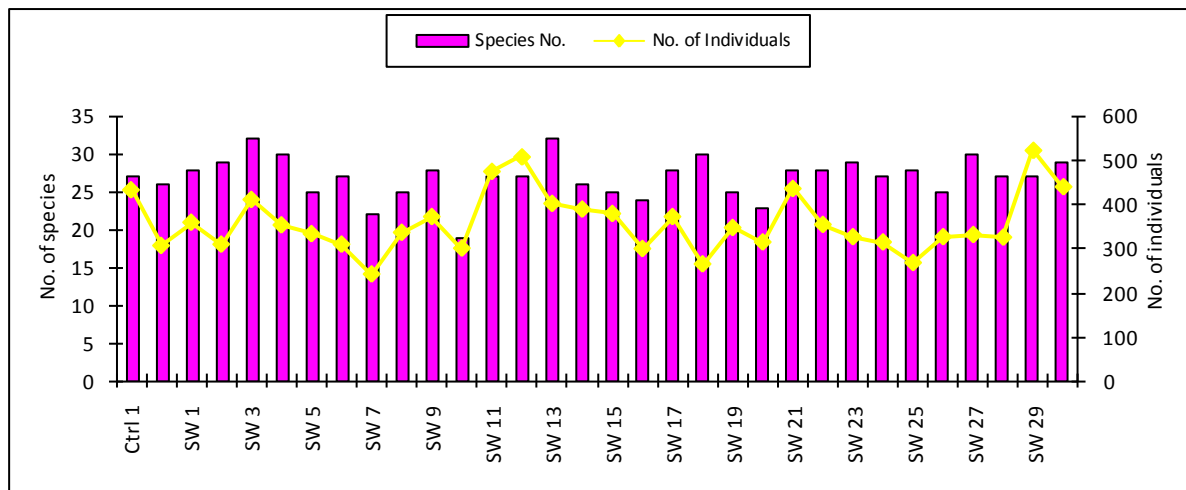


Fig. 4.3.4.7: Spatial variation in the Taxa number and individuals of Zooplankton of the study area in the dry season

Wet season records showed that zooplankton density of 538 x 10² organisms/l was at the peak in sample point 5 and least at point 29 where the density was 142 x 10² organisms/l. plankton density did not indicate any seasonal or spatial trend in the study area.

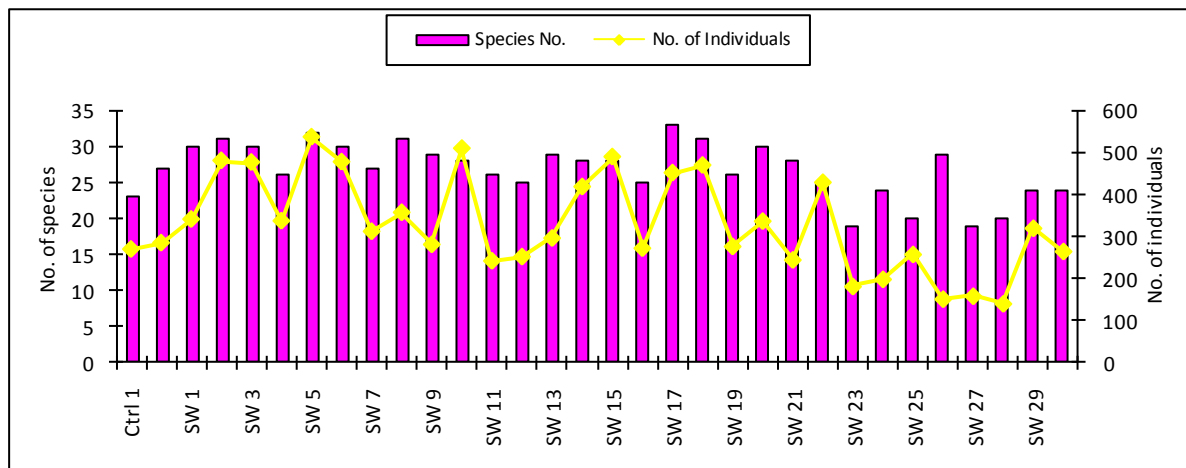


Fig. 4.3.4.8: Spatial variation in the Taxa number and individuals of Zooplankton of the study area in the wet season

These observations are in accordance with literature values (Chowdhury, 2007, Davies *et al.*, 2009). Density and diversity of zooplankton are governed by a number of factors which include dissolved oxygen and biochemical oxygen demand levels (Davies *et al.*, 2009).

Diversity measures for Zooplankton

Diversity indices measure the stability and resilience capacity of ecosystems against any form of perturbations. The results of dry season diversity analysis for zooplankton (Table 4.3.4.2) revealed that the community was highly diverse and ecologically stable. The species richness, equitability (evenness) and Shannon diversity were high, with low dominance, reflecting the equitable distribution of individuals among the species. In the wet season (Table 4.3.4.3) the community was also highly diverse and ecologically stable. The species richness, equitability (evenness) and Shannon diversity were high, with low dominance, reflecting the equitable distribution of individuals among the species. The diversity measures were higher in the dry season due to enhancement from increased food items (phytoplankton) and photosynthetic activities.

Table 4.3.4.2: Diversity measures for dry season zooplankton

	Taxa_S	Individuals	Dominance_D	Shannon_H	Margalef	Equitability_J
Ctrl 1	27	433	0.05672	3.052	4.283	0.9261
Ctrl 2	26	306	0.0651	2.968	4.368	0.9109
SW 1	28	359	0.05884	3.03	4.589	0.9093
SW 2	29	309	0.05952	3.04	4.884	0.9028
SW 3	32	411	0.06447	3.047	5.151	0.8793
SW 4	30	353	0.05199	3.134	4.943	0.9213
SW 5	25	333	0.07984	2.836	4.132	0.8812
SW 6	27	309	0.0683	2.936	4.535	0.8909
SW 7	22	241	0.06989	2.836	3.829	0.9175
SW 8	25	336	0.08376	2.794	4.126	0.8679
SW 9	28	372	0.06271	2.96	4.562	0.8883
SW 10	19	300	0.09742	2.598	3.156	0.8823
SW 11	27	475	0.08557	2.802	4.219	0.8503
SW 12	27	508	0.09587	2.704	4.173	0.8205
SW 13	32	402	0.04903	3.178	5.17	0.917
SW 14	26	389	0.06588	2.946	4.192	0.9041
SW 15	25	379	0.09651	2.753	4.042	0.8553
SW 16	24	299	0.05733	2.995	4.035	0.9423
SW 17	28	372	0.06642	2.971	4.562	0.8915
SW 18	30	264	0.05412	3.088	5.201	0.9079
SW 19	25	347	0.06465	2.921	4.103	0.9074

EIA of EA/Eja Field Further Oil Development Project

	Taxa_S	Individuals	Dominance_D	Shannon_H	Margalef	Equitability_J
SW 20	23	314	0.07006	2.823	3.826	0.9004
SW 21	28	436	0.06386	2.967	4.443	0.8905
SW 22	28	354	0.06314	3	4.6	0.9003
SW 23	29	326	0.06553	2.959	4.839	0.8788
SW 24	27	314	0.06988	2.952	4.522	0.8957
SW 25	28	267	0.06418	2.931	4.832	0.8797
SW 26	25	326	0.07575	2.846	4.147	0.884
SW 27	30	331	0.06662	2.996	4.998	0.8808
SW 28	27	325	0.06992	2.935	4.495	0.8904
SW 29	27	523	0.079	2.868	4.154	0.8701
SW 30	29	440	0.05557	3.079	4.6	0.9144

Table 4.3.4.3: Diversity measures for wet season zooplankton

	Taxa_S	Individuals	Dominance_D	Shannon_H	Margalef	Equitability_J
Ctrl 1	23	272	0.06461	2.887	3.925	0.9208
Ctrl 2	27	287	0.09437	2.738	4.594	0.8308
SW 1	30	343	0.06519	3.002	4.968	0.8827
SW 2	31	482	0.06541	3.031	4.856	0.8827
SW 3	30	478	0.05241	3.136	4.7	0.922
SW 4	26	339	0.06819	2.958	4.291	0.9079
SW 5	32	538	0.0658	3.047	4.93	0.8792
SW 6	30	479	0.0574	3.089	4.699	0.9081
SW 7	27	314	0.07205	2.927	4.522	0.8882
SW 8	31	359	0.04852	3.196	5.099	0.9308
SW 9	29	283	0.05373	3.085	4.96	0.9161
SW 10	28	511	0.05628	3.076	4.329	0.9231
SW 11	26	244	0.07679	2.852	4.548	0.8753
SW 12	25	254	0.1122	2.6	4.334	0.8077
SW 13	29	298	0.05565	3.082	4.915	0.9153
SW 14	28	420	0.07675	2.897	4.47	0.8693
SW 15	28	491	0.05576	3.061	4.357	0.9185
SW 16	25	274	0.05807	3.002	4.276	0.9327
SW 17	33	453	0.04962	3.214	5.232	0.9191
SW 18	31	471	0.05781	3.102	4.874	0.9032

	Taxa_S	Individuals	Dominance_D	Shannon_H	Margalef	Equitability_J
SW 19	26	278	0.07546	2.894	4.442	0.8882
SW 20	30	338	0.04828	3.195	4.98	0.9394
SW 21	28	246	0.05946	2.996	4.904	0.8991
SW 22	25	430	0.07055	2.876	3.958	0.8936
SW 23	19	183	0.105	2.558	3.455	0.8688
SW 24	24	200	0.08035	2.788	4.341	0.8771
SW 25	20	259	0.1038	2.558	3.419	0.854
SW 26	29	153	0.05447	3.11	5.566	0.9236
SW 27	19	160	0.09258	2.619	3.547	0.8893
SW 28	20	142	0.1019	2.58	3.834	0.8614
SW 29	24	321	0.08172	2.758	3.985	0.8678
SW 30	24	266	0.07154	2.88	4.119	0.9063

Trend analysis for zooplankton

A comparison of zooplankton for the EIA 2001 and the present study showed that Copepoda dominated the zooplankton community during both studies, reflecting the typical community structure in the oceans. The overall abundance of zooplankton was also higher in the present study. This difference may be related to obvious difference in the sampled area.

Macrobenthic fauna

Benthos Population and Abundance

The checklist of the benthic fauna within the EA/Eja Field in the dry and wet seasons of the study is presented in Appendices 4.6a and b, while Fig. 4.3.4.9 shows the relative abundance of each of the major taxonomic groups that were recorded. During the dry season, 2771 organisms were encountered. Benthic fauna encountered in the dry season belong to nine (9) major taxonomic groupings namely Sponges, Holothuroidea, Polychaetes, Echinoderms, molluscs (gastropods and bivalves), Arthropods, Coelenterates, and Crustaceans. During this season, gastropod molluscs were the dominant benthos and they constituted 25% of the macro-benthic organisms while crustaceans and polychaetes each constituted 18% of the number of benthos. The gastropods, coelenterates and polychaetes constituted 61% of the total benthos during the dry season with the gastropods contributing 25%, coelenterates 18% and the polychaetes 18%.

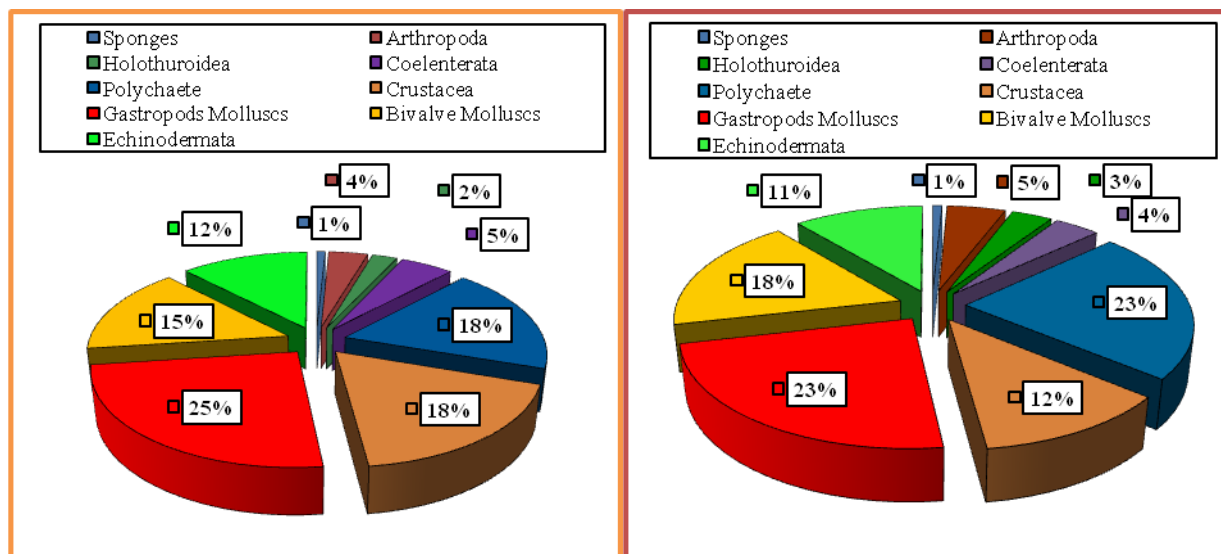


Fig. 4.3.4.9: Relative abundance of major families of benthos in EA/Eja Field (wet and dry seasons)

In the wet season, nine (9) major taxonomic groupings namely sponges, holothuroidea, polychaetes, echinoderms, molluscs (gastropods and bivalves), arthropods, coelenterates, and crustaceans were encountered. Again as in the dry season, the gastropod molluscs and polychaetes dominated the benthic population and contributed 23% each. Bivalve molluscs contributed 18% of the benthos. The composition of benthos in the EA/Eja field did not vary with season but the contribution of polychaetes and bivalve molluscs was more pronounced in the wet season.

In both seasons of the study, gastropod molluscs were represented by 9 species (Fig. 4.3.4.10). In the dry season, *Nassarius reticulatus*, constituted 17% of the gastropod population while *Tellina nymphalis*, *Thais forbesi* and *Nautica machrochiensis*, each contributed 16% of the molluscs. In the wet season, *Turritella annulata* with a population of 22% were the dominant gastropods species. Other major species of gastropods recorded in the wet season were, *Thais forbesi* (14%), *Terebra maculata* (13%) and *Nassarius reticulates* (10%).

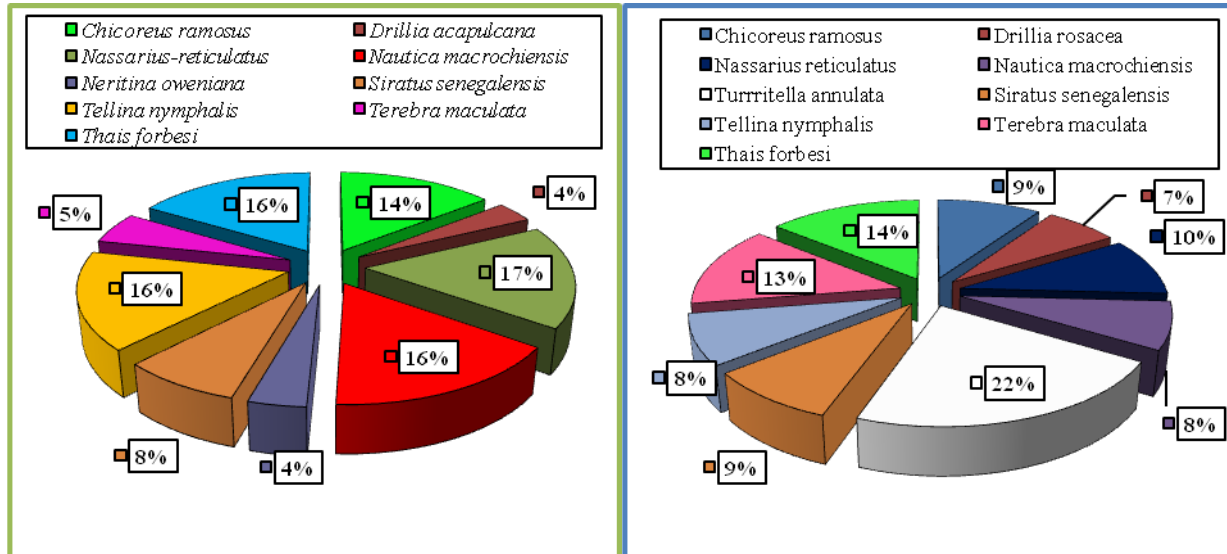


Fig. 4.3.4.10: Relative abundance of gastropod molluscs in EA/Eja Field (wet and dry seasons)

The spatial variation in the total number of benthos in the study area in both dry and wet seasons is graphically presented in Fig. 4.3.4.11. In the dry season, the number of benthos fluctuated between 50 organisms per m² (sample point 6) and 194 organisms per m² (sample point 27). In the wet season, population density of the benthic fauna ranged between 46 organisms per m² (sample point 13) and 154 organisms per m² (Control 2). The number of benthos was generally higher in the control stations. The number of benthos in each station was relatively high (Victor and Ogbeibu, 1985; Olomukoro and Ezemonye, 2007; Emere and Nasiru, 2008). This may be due primarily to the muddy nature of the sediment. Another possible reason for the high density of benthos during the study is attributable to low level of pollution.

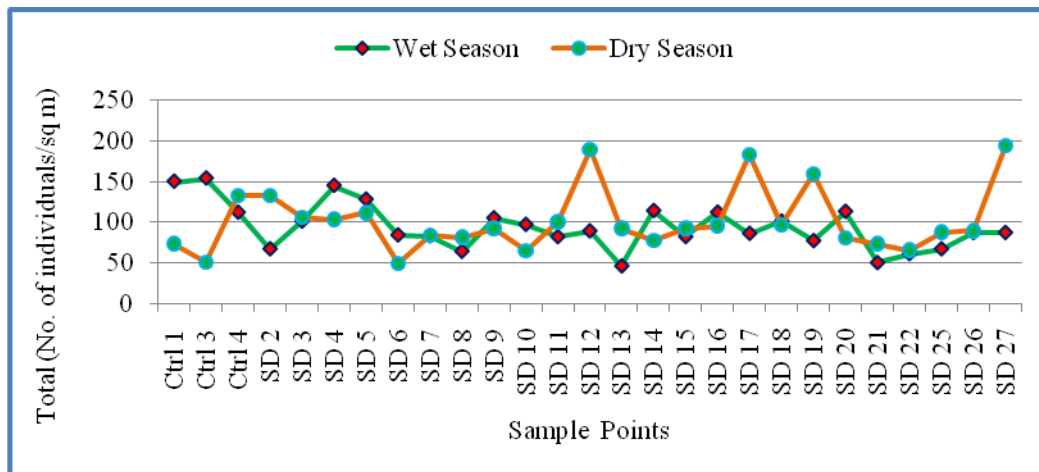


Fig. 4.3.4.11: Spatial variation in total benthos count in EA/Eja Field (wet and dry seasons)

The spatial variation in the number of species of benthos in the study area in both dry and wet season is graphically presented in Fig. 4.3.4.12. The number of species of benthos in the control

station was 16 (Control Point 3) while those from the sampling stations 12 and 27 were 31 in the wet season. In the dry season, species count varied between 16 and 34.

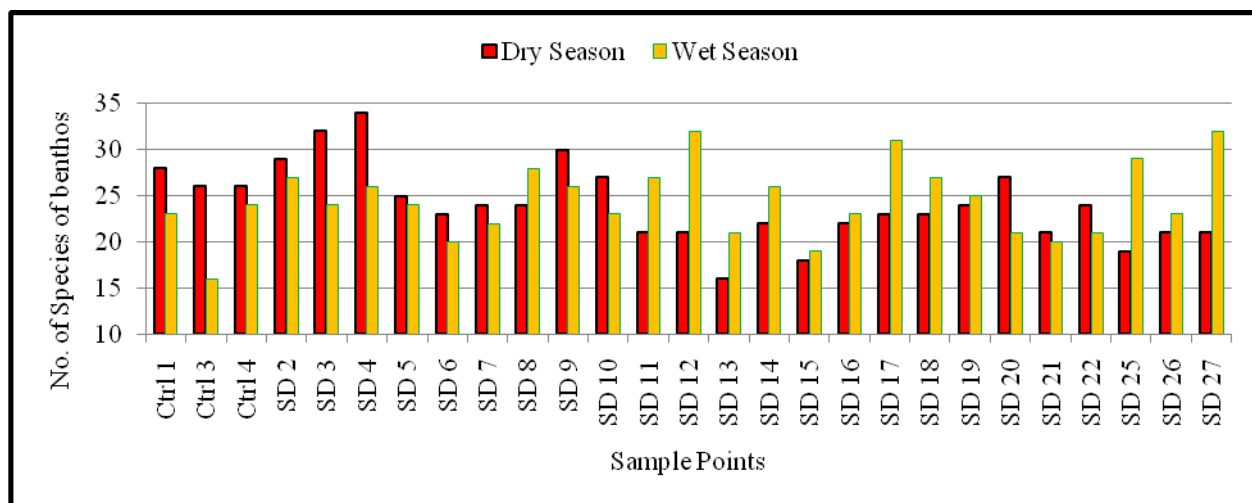


Fig. 4.3.4.12: Spatial variation in total number of species of benthos in EA/Eja Field (wet and dry seasons)

Comparison Benthos Community in EIA 2001 and EES 2011 in EA/Eja field

A summary of the comparison of benthos community in aquatic systems within EA/Eja Field in this EIA report of 2001 on the one hand and those in EER report of 2011 is presented in Table 4.3.4.4. The Table shows that a maximum of 23 species of benthic organisms were recorded in the previous report as compared to 16-32 species in the present study. Similarly, there was an increment in the number of major families of benthos from 6 in the EIA report of 2001 to 9 in the EER. The table also shows that Mollusca was dominant in EA a field in the 2001 and 2011 reports.

Table 4.3.4.4: Comparing benthos in EA/Eja field (2001) and EA/Eja field (2011)

Parameter	EIA report 2003	EER Report 2011			
		Wet Season		Dry Season	
		Study Area	Control	Study Area	Control
No. of species	23	16-32	16-24	21-34	26-28
Total count	1,973	2544		2771	-
Total Count per m ² per	-	46-145	112-154	50-194	51-133
No. of Major Families	6	9	9	9	9

Parameter	EIA report 2003	EER Report 2011			
		Wet Season		Dry Season	
Major Families	Porifera, Coelenterata, Annelida, Molluscs and Pisces.	Sponges, holothuroidea, polychaetes, echinoderms, molluscs (gastropods and bivalves), arthropods, coelenterates, and crustaceans	Sponges, holothuroidea, polychaetes, echinoderms, molluscs (gastropods and bivalves), arthropods, coelenterates, and	Sponges, Holothuroidea, Polychaetes, Echinoderms, molluscs (gastropods and bivalves), Arthropods, Coelenterates, and	Sponges, Holothuroidea, Polychaetes, Echinoderms, molluscs (gastropods and bivalves), Arthropods, Coelenterates, and
Dominant Division	Molluscs	Molluscs	Molluscs	Molluscs	Molluscs

Fisheries

Fisheries Studies: Fin-fish Sample Collection

Fish specimens were obtained from fishers using gill nets, long lines, traps and stakes. Catches were isolated and conveyed in thermos cool boxes to the laboratory. Fish families were identified using monographs, descriptions checklist and keys (Reed et al 1967, Jiri, 1976 and Holden and Reed 1972). The total length (TL) of the fish was measured from the tip of the anterior or part of the base of the pectoral fin to the caudal fin using metre rule calibrated in centimetre. Fish were measured to the nearest centimetre. Fish weight was measured after blot drying with a piece of clean hand towel. Weight was done with a table top weighing balance, to the nearest gram. The length measurements were converted into length frequencies with constant class intervals of 2cm. The mean lengths and weights of the classes were used for data analysis, the format accepted by FISAT. The relationship between the length (h) and weight (w) of fish was expressed by the equation (Appendix 4.5).

Information outlined below on fisheries was obtained from literature (Troadec and Garcia, 1980; Chindah and Osuamkpe, 2008; Ekeke *et. al.*, 2008, Abowei and Hart 2008). Artisan fishers or small scale fishers dominate the fishery along the coastline adjacent to the EA field. Artisanal fishers operate largely in rivers creeks and creeklets that empty directly or indirectly into the Atlantic Ocean EA field. The following rivers: Pennington, Ramos Dodo, Middleton, Sangana and Nun all empty into the Atlantic Ocean around EA block and are breeding grounds for fishes that migrate into and out of EA field. Fishers operate in motorized dug-out wooden canoes. Fishing gears are largely made of long setlines, circling nets and seine nets of different mesh sizes varying between ½”, 1”, 1½”, 2”, 2½ and 3” (1.0mm to 5.0mm). Table 4.3.4.5 shows fish catch size and income magnitudes from fishing around the area.

Table 4.3.4.5: Gear specifics and fish landing estimates around the area

Gear	Total			Average				Annual catch (wet wt kg)				
	Canoe Unit	No of Gear	Fish ers	Value N	Catch Dry Wt Kg	Catch wet wt kg	Annual earning (N)	Per Canoe Nit	Per Gear	Per Fisher	Per Canoe unit	Per Gear
Cast net	254	831	381	324621.00	2164.14	5410.35	8520.24	12780.35	3906.39	14.20	21.30	6.51
Drift gill net	267	645	255	3098028.00	2065.31	5163.38	12149.13	11603.10	4803.14	2024	19.33	8.01
Set gill net	219	772	323	3044430.00	2029.62	5074.05	9425.48	13901.51	3943.56	15.00	23.71	6.07
Hook and Line	381	9092	1111	3503808.00	2335.87	5839.68	3153.74	9196.35	385.37	55.26	15.32	0.64
Assorted traps	347	8780	933	3062806.00	2041.87	5104.68	3282.75	8826.53	348.84	5.47	14.71	0.58
Local Fish ponds	37	24,003	1372	3726138.00	2040.53	5101.33	8923.61	21862.84	1016.88	4.53	167.84	1.65
Stakes/fences	140	3010	343	3060789.00	2040.53	5101.33	8923.61	21862.84	1016.88	14.87	36.44	1.65
Total	1645	47213	4718	22742160.00	15,161.43	37903.6	4820.30	13825.02	481.69	8.03	23.04	0.80

Source: Abowei and Hart (2008)

A checklist of finfish and shellfish identified in the experimental catch and catches from artisanal fishers is presented in **Table 4.3.4.6** and **Table 4.3.4.7**. The list includes 44 species of fish belonging to 23 families. **Table 4.3.4.7** included the Length-weight relationship and condition factor of some fishes, 3 species of crabs, 5 species of shrimps and 3 species of mollusks. The fishes were in good state of health. The result varied slightly from other studies from similar water bodies (Abowei, 2010, Hart and Abowei 2007). This could be attributed to the limited time frame associated with this study.

Table 4.3.4.6: Inventory of Fish species in the Project Area

FAMILY	SPECIES	COMMON NAME	ABUNDANCE RATING
Family Belonidae	<i>Strongylura senegalensis</i>		2
Family Tetradintidae	<i>Ephippion guttifer</i>		2
	<i>Lagocephalus laevigatus</i>		1
Family Megalopidae	<i>Tarpon atlantica</i>	Tarpon	3
Family Pristidae	<i>Pristis pristis</i>	Saw fish	2
Family Ephippidae	<i>Chaetodipterus goreensis</i>		3
Family Clupeidae	<i>Ethmalosa fimbriata</i>	Bonga	2
	<i>Sardinella maderensis</i>	Sardine	1
	<i>Sardinella aurita</i>	Sardine	3
Family Mugilidae (Mulletts)	<i>Liza falcipinnis</i>	Mullet	3
	<i>Liza grandisquamis</i>	,	1
	<i>Mugil bananensis</i>	,	1
	<i>Mugil curema</i>	,	2

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FAMILY	SPECIES	COMMON NAME	ABUNDANCE RATING
Family Sphyraenidae	<i>Sphyraena guachancho</i>	Barracudas	3
Family Polynemidae	<i>Galeoides decadatylus</i>	Threadfins	3
	<i>Pentanemus quinquarius</i>	Shiny nose	2
	<i>Polydactylus quadrafilis</i>		2
Family Eleotridae	<i>Butis koilomatodon</i>	Sleepers	1
Family Elopidae	<i>Dormitator pleurops</i>	Lady Fish	2
Family Trichuridae	<i>Trichuris lepturis</i>		1
Family Drepanidae	<i>Drepane africanus</i>	Spade Fish	1
Family Scianidae	<i>Pseudotolithus senegalensis</i>	Short croaker	2
	<i>P. elongates</i>	Long croaker	4
	<i>P. brachignathus</i>	Croaker	1
	<i>P. typus</i>	Croaker	2
Family Scombridae	<i>Scomberomorus tritor</i>		3
	<i>Thunnus obesus</i>	Big eye tuna	2
	<i>T. albacares</i>	Yellow fin tuna	2
	<i>Euthynnus alletratus</i>	Frigate tuna	1
Family Lutjanidae	<i>Lutjanus goreensis</i>	Snapper	2
	<i>L. dentatus</i>		2
	<i>L. agennes</i>		1
Family Haemulidae (Grunts)	<i>Plectorhinchus macrolepsis</i>	Grunt	1
	<i>Pomodopsis jubelini</i>		1
	<i>P. peroteti</i>		1
Family Lobotidae	<i>Lobotes surinamensis</i>		1
Family Gerreidae	<i>Eucinostomus melanopterus</i>		1
Family Serranidae	<i>Epinephellus aeneus</i>	Groupers	2
Family Syngnathidae	<i>Enneacampus kaupi</i>		1
Family Ariidae	<i>Arius heudeloti</i>	Sea catfish	1
	<i>A. latisculatus</i>	Sea catfish	1
	<i>A. gambiensis</i>	Sea catfish	1
	<i>A. mercatoris</i>	Sea catfish	2
Family Denticipitidae	<i>Denticeps clupeoides</i>	Denticle herring	2

Source: field work 2011, Key to Abundance Rating: 1 = Rare; 2 = Low abundance; 3 = Abundant; and 4 = Very Abundant

Table 4.3.4.7: Some Biological Characteristics of finfish and shell fish within Study area

Fin Fish Species	Length (cm)	Weight (g)	Condition Factor (K)	shellfishes Scientific Name	Common Name
<i>Syhyraenia sphyraenia</i>	19.8– 30.7	20.0 – 115.7	1.9-2.3	<i>Callinectes anonicola</i>	Swimming crab
<i>Trichiurus lepturus</i>	15.6 – 24.3	48.7 – 138.6	1.5 – 2.0	<i>Callinectes marginatus</i>	
<i>Pseudolithus elongatus</i>	9.0 – 31.6	11.2 – 365.	1.5-2.0	<i>Ocypoda Africana</i>	Ghost crab
<i>P. senegalensis</i>	10.1 – 28.4	11.7 – 340.	1.9-2.0	<i>Nematopalaemon hostatus</i>	White shrimp
<i>Dasyatus magarita</i>	11.3 – 25.8	45.2 – 309.2	1.4-1.9	<i>Paenaeus notialis</i>	
<i>Trichuris lepturus</i>	18.3 – 25.6	11.6 – 192.3	1.2-2.0	<i>Paenaceus duorarum</i>	
<i>Sardinella aurita</i>	8.2 – 26.3	15.7 – 138.	1.6-2.3	<i>Paenaeus. kerrathurus</i>	
<i>Pomadasy jubelini</i>	15.3 – 28.9	101.2 – 242.7	1.2-2.1	<i>Parapaenopsis longirostris</i>	
				<i>Pachymelania aurita</i>	
				<i>Tympanotonus fuscatus</i>	Periwinkle
				<i>Tellina nymphalis</i>	

Bonga dominates the pelagic fishery. But there are modest catches of shad (*Ilisha*), sardine (*Sardinella*), various jacks (*Caranx* spp.) and Atlantic bumper (*Chloroscombrus chrysurus*).

Migration Patterns of Exploited Species

Some of the exploited fish species, include bonga, croakers, sardinella, snappers, threadfins, pink shrimp and barracuda, make seasonal migrations from the sea into the creeks and back to sea. The mechanism of migrations and their significance to the coastal inshore fisheries has still to be evaluated. The extent of lateral migrations along the coast should also be studied, since such migrations are likely to affect the movement of fishing units along the coast. Besides, the inshore/offshore and lateral migrations mean that a number of stocks are harvested by both artisanal and industrial fleets.

Fish Tissue Analysis

A total of 5 fish species were collected around the study area and their tissues analysed for heavy metals and hydrocarbon contents.

Heavy metals in fish samples

The concentration of copper in the fish samples varied from 7.81 – 16.01 µg/g and this is below the limit in fish flesh (FAO, 1983). The concentration of lead in all the fish samples were

generally below detectable limits in most fish species analysed. Levels of lead ranged from 0.00 to 0.15 µg/g. Lead in all analysed fish species was also below the WHO and FAO limits. Concentrations of iron (Fe) in the fish tissue were high with a range of 54.75 µg/g to 248.52 µg/g. This high value could be due to high iron value in the sediment. Vanadium, arsenic and nickel were not detected in any fish sample. The concentration of lead and chromium were in excess of the regulatory limits prescribed by WHO (1989) and FAO (1983). These results are presented in **Table 4.3.4.8**.

Table 4.3.4.8: Heavy Metals in Fish Samples

Fish Species	Zn ppm	Cd ppm	Cu ppm	Pb ppm	Ni ppm	Fe ppm	Co ppm	Cr ppm	V ppm	As ppm	Phenol ppm	TPH ppm	CN ppm	THC ppm
<i>Pseudotolithus (F.)elongatus</i>	5.16	0.01	14.41	0.05	ND	248.55	2.15	1.16	ND	ND	ND	ND	ND	5.98
<i>Lutjanus agennes</i>	8.12	ND	07.81	0.26	ND	222.2	2.01	1.18	ND	ND	ND	ND	ND	4.01
<i>Raja miraletus</i>	6.19	ND	16.01	0.02	ND	132.1	1.76	1.01	ND	ND	ND	ND	ND	5.21
<i>Boops boops</i>	10.10	ND	11.21	0.16	ND	109.1	1.01	0.05	ND	ND	ND	ND	ND	4.63
<i>Arius heudeloti</i>	2.10	ND	9.01	ND	ND	54.75	1.33	ND	ND	ND	ND	ND	ND	5.89
WHO (1989) standards	10	2	1	2	0.5	-	-	0.5	-	-	--	-		
FAO (1983) standards	-	0.5	30	0.5	-	-	-	-	-	-	-	-		

Source: SPDC 2006, ND= Not Detected

Hydrocarbon content in Fish samples

The total hydrocarbon content in the fish samples was generally less than 6.0 mg/kg. The THC recorded was below the EGASPIN standard of 25.0mg/kg allowed in food fish for human consumption. There were no traces of BTEX and poly-aromatic hydrocarbons in all the Fish samples, as shown in **Table 4.3.4.9** and **Table 4.3.4.10**.

Table 4.3.4.9: BTEX in Fish Samples/ppb

Fish Species (Fish Fillets)	Benzene	Toluene	Ethyl Benzene	P-Xylene	M-Xylene	O-Xylene
<i>Pseudotolithus elongatus</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
<i>Lutjanus agennes</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
<i>Raja miraletus</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
<i>Boops boops</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
<i>Arius heudeloti</i>	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Source: SPDC 2006

Table 4.3.4.10: Polynuclear aromatic hydrocarbon in fish samples/ppm

Fish Species (Fish Fillets)	Acenaphthalene	Benzo(k)fluoranthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(gh)perylene	Benzo(a)pyrene	Chrysene	Dibenzo(ah)anthracene	Fluoranthene	Fluorine	Indeno(1,2,3,cd)pyrene	Phenanthrene	Pyrene	Perylene
<i>Pseudotolithus elongatus</i>	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<i>Lutjanus agennes</i>	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<i>Raja miraletus</i>	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<i>Boops boops</i>	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<i>Arius heudeloti</i>	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Source: SPDC 2006, ND= Not Detected

4.2.5: Geology, Hydrogeology and Hydrography

The geology of the EA/Eja Field area consists of sedimentary deposits of the Cenozoic age (about 160 million years) namely Benin, Agbada, and Akata formations. The sediments were eroded from Basement Complex rocks in the hinterland of the West African sub-region. The area is characterized by fairly uniform geomorphology and lacks geological features like mountains, and rock outcrops. The EA/Eja Field is part of a highly faulted NW-SE trending major rollover feature in the SE corner of OML 79 overlying the youngest of the well-developed belts of the Niger delta. It is separated from the adjacent coastal swamp by a major growth fault.

Geophysics

Vertical Electrical Sounding (VES) obtained from SSAG+ Project (2013) located about 45 km north of EA was used to the geophysics of the coastal area. A total of 13 vertical electric sounding (VES) stations were engaged in that study. The VES curves can be grouped into three classes as A, B and C.

Type A: VES – 5, 8 and 13 curves comprise simple bell-shaped. They gave a computer interpretation of best fit model for a five-layer case. All VES points show low resistivity values. Except at VES 8, all curves are characterized by a right – most descending curve. At VES 8 there is a small rise probably due to a longer spread length. The top soil and the geoelectric substratum gave resistivity values corresponding to possible saturated sandy formations. However the second derived layer has high resistivity values corresponding to wet silty sands. The trough of very low resistivity of 10 Ω m is indicative of salt water intrusion as no clay medium was

encountered in the drill hole at that depth. The peak of the rise shows a moist silty sand column preceding the near surface aquifer whose thickness is in the range of 0.5 meters. The only exception is VES 1. The field curve is generally a rising bell that seems truncated because of limited spread length. The resistivity values denotes thick sandy column.

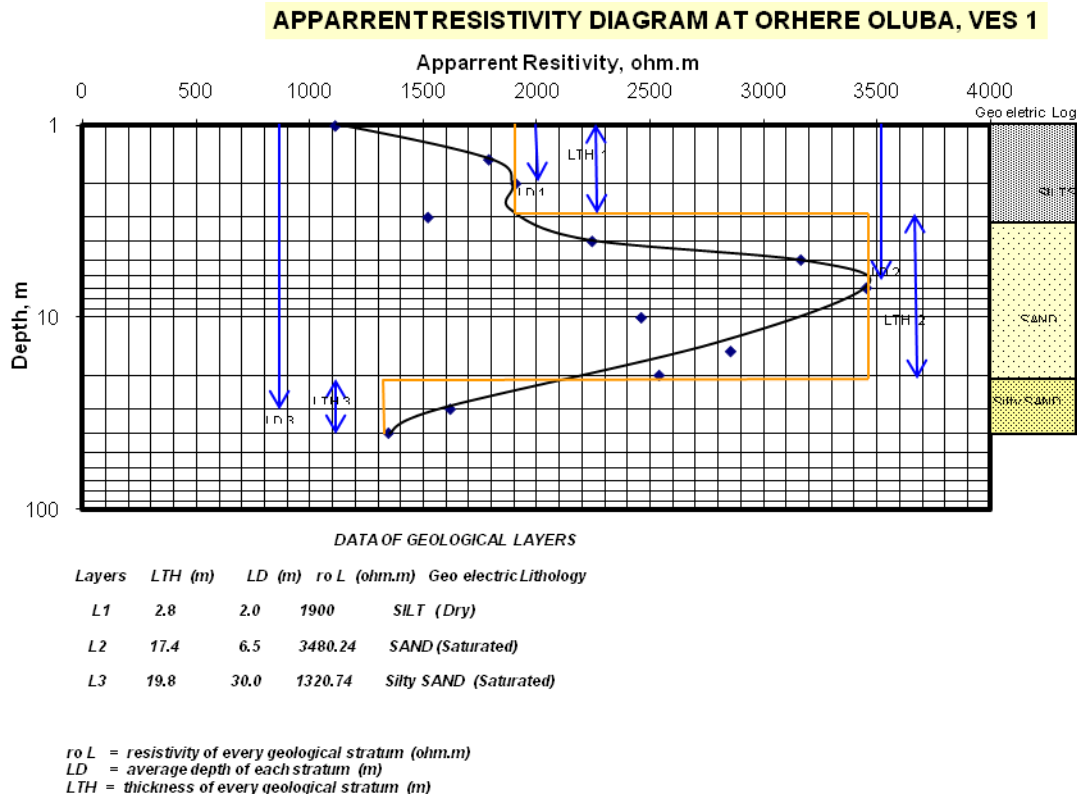


Fig 4.2.5.1: Apparent Resistivity at Orhere Oluba (VES 1)

Type B: are bowl type curves represented by VES 9, 16, 24 and C4. It is characterized by a left – most decent and a right – most rise. All flanks showed relatively high resistivity values in the range of 100 to 150 Ω m in the top geoelectric layer and the substratum signifying an all sandy soil that is also moist.

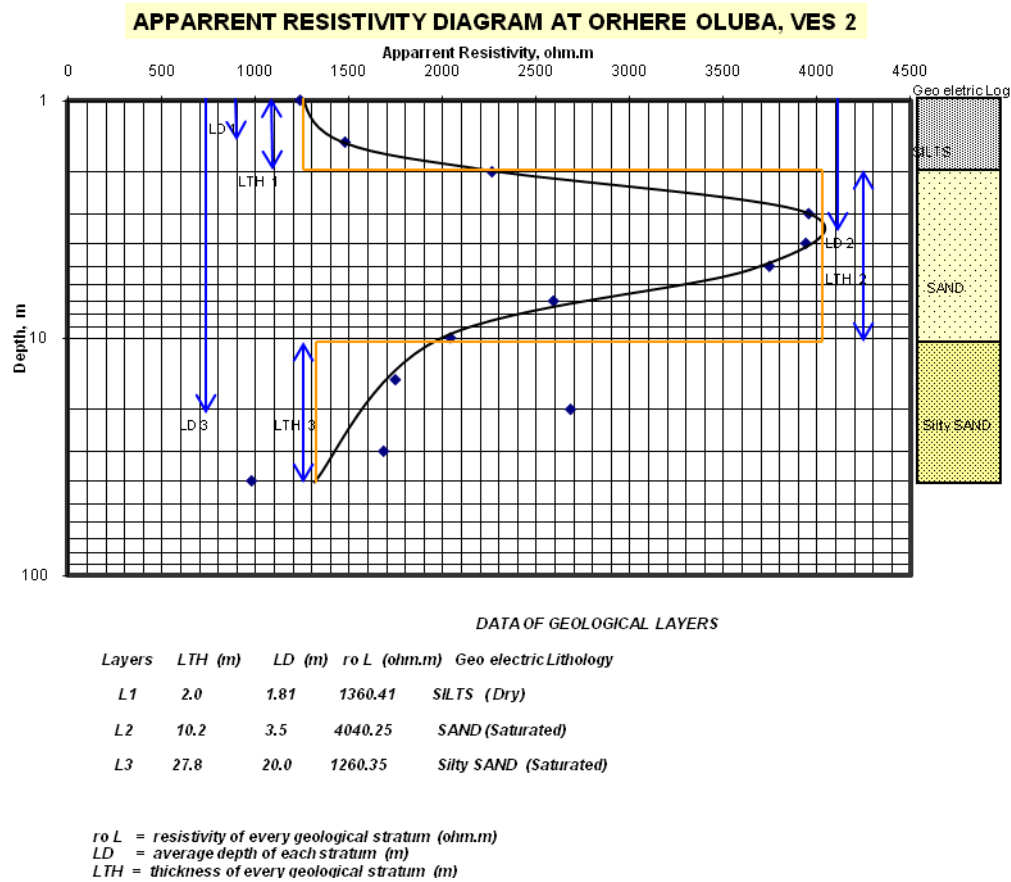


Fig 4.2.5.2: Apparent Resistivity at Orhere Oluba (VES 2)

Type C: is the dominant curve type. These are a combination of bowl – and bell-shaped curves probably as a result of longer spread length better survey conditions; and electrical signals improved considerably. These are made up of relatively low resistivity values representing saturated sandy soil with clay intercalations.

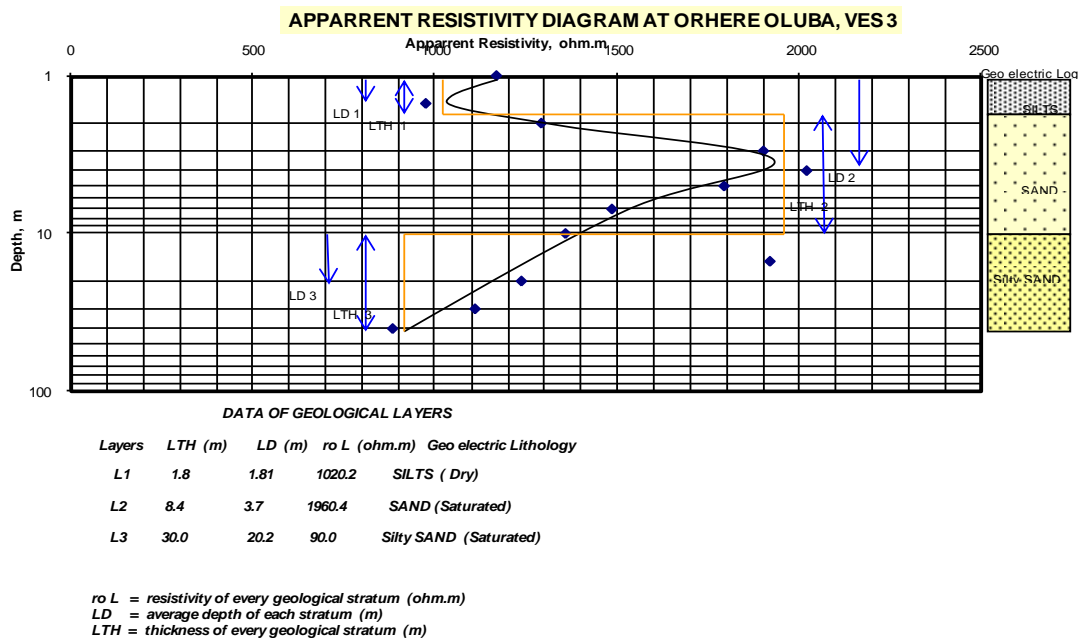


Fig 4.2.5.3: Apparent Resistivity at Orhere Oluba (VES 3)

Geomorphology

Details of the geomorphology of the area are narrated in the EIA of EA Development Project 2001. Based on map analysis, the EA concession is located 15 to 16 off the Ramos River to Pennington River stretch of coastline. The area is characterised by fairly uniform geomorphology. Plains and lowlands are the dominant features of the landscape. Generally the coastline is sandy while tropical rainforest and salt water swamps covered with mangrove are situated behind the sand beaches. In the extreme south, the area is covered by silt and mud. There is a sandbar formation in the western part extending from Araomi to Zion Pepe, Agba to Etigbo/Pare, to Mahin/Ugbo-Nla In the eastern part, about 75% of the area is covered by water with small islands separating the water bodies. Some of the geomorphological features date from the Tertiary, the rest is more recent products of fluvial and meteorological interaction.

East of the EA area, there is a complex area of beaches, levees, islands and estuaries. The beaches in the EA area have gentle concave to almost flat profiles. Shells and remains of various sea organisms are deposited continuously on the beach by wave action. Deposited materials consist of logs and shell of sea organisms mixed with sand and silt. These structures serve as embankments and protect the floodplains behind from being flooded by the sea. Two Coves and

creeks- between the Ramos and Pennington Rivers serve as intermittent tidal inlets. At very low tides the water supply to these coves is cut off. At very high tides these coves/creeks become channels through which the coastal settlements and back swamps are flooded by the sea. These features break up the continuous spread of the beach and are the only constraint on vehicular movement along the coast at low tide.

Hydrogeology

The EA/Eja Field is entirely within marine environment, therefore previous studies of adjacent coastline areas was used to interpolate for this study. The reports used are those of HBlock (2007) and the SSAG+ Project (2013).

Stratigraphy

The stratigraphy is uniform in all the boreholes. This comprises of a muddy clayey sand top soil, a saturated silt and sand mélange that grade into silty sand substratum. This makes the aquifer phreatic. Also, the texture and structure implication is that the aquifer has a moderate to high permeability rate. Its nearness to major river systems in the area means a hydraulic connectivity that permits easy intrusion of chemical components to and from the aquifer. The major handicap in the region is salt water intrusion. The stratigraphy of some of the boreholes in the different sites is shown in Figures. 4.2.5.4 and 4.2.5.5.

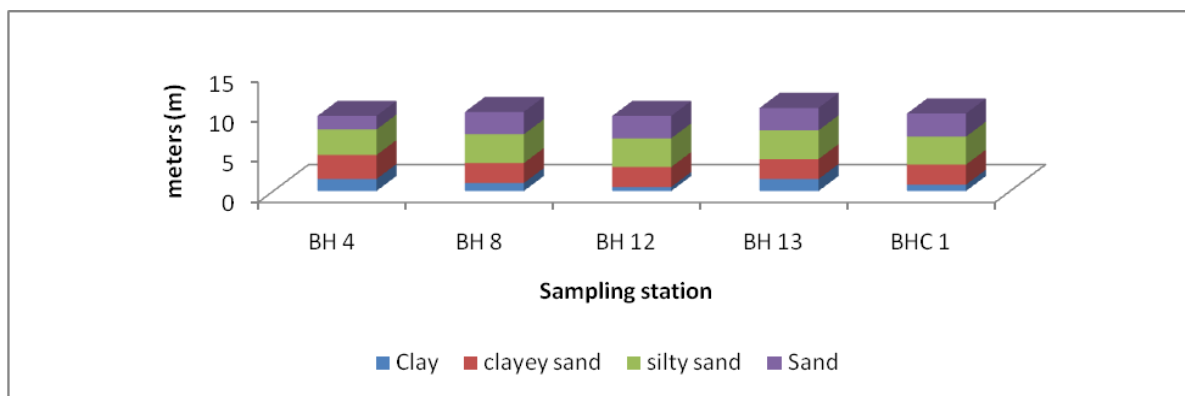


Fig 4.2.5.4: The stratigraphy as seen from the BH points at Benisede

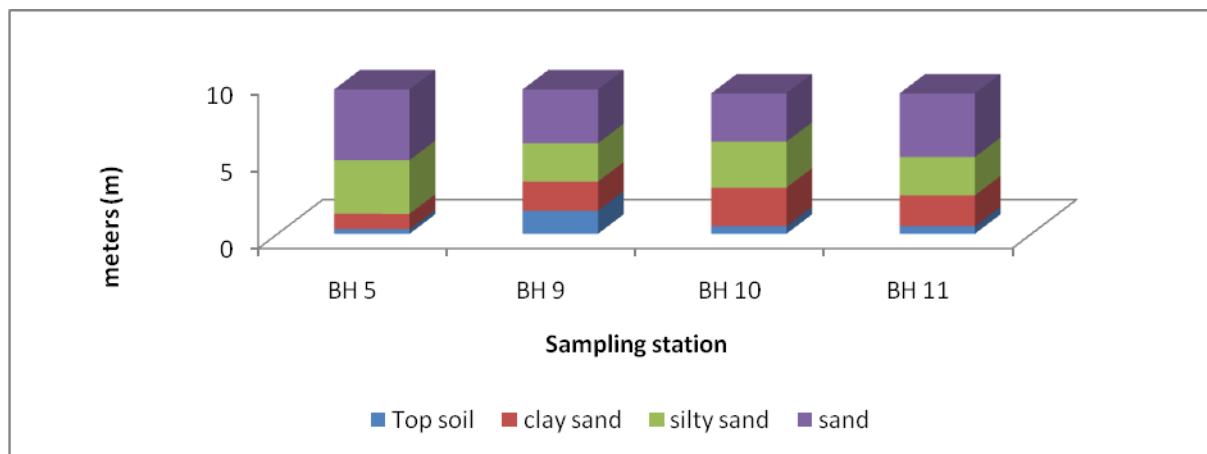


Fig 4.2.5.5: The Stratigraphy as seen from the BH points at Ogbotobo

Groundwater Flow Direction

All static water levels derived were mostly at the surface (in the range of 0 to 0.5 m). Thus the direction of flow is consistent with the surface water flow which is in the south of southwest direction in most locations occupied. Since the environment is subject to tidal flow, the groundwater flow direction will be reversed when the tide is up resulting into a north of north east directional flow. This type of flow during high tide results in deposition of materials in the swampy terrain that gives rise to muddy top soil. With time, growth faults begin to develop due to the unstable nature of the underlying unconsolidated sand medium.

Groundwater Quality

The results of physico-chemical and biological properties of ground water are presented in Table 4.2.5.1. Groundwater in all the locations and the control point were slightly acidic with range of 5.13 to 6.59. The pH values of all the locations and that of the control were slightly below neutral point (pH = 7). Electrical conductivity (EC) is a direct indication of total dissolved solids and salinity in the water. Higher EC implies higher total dissolved solids (TDS) and salinity. Salinity is slightly high in all the boreholes except in BH2 which had similar concentration with the control in BH9. However, the control in BH3 was similar to that of the other locations. All the locations are within water quality (regulatory standards) standards for domestic use. With the exception of iron which is above 1.0 mg/l in all the boreholes and the control (BH4). However BH2 boreholes were below the critical level. Alkali earth metals exist in trace quantity and pose no hazard to the ground water; however chromium content was slightly above the tolerable limit in all the boreholes and the control. Turbidity was within tolerable limits. Sulphate and phosphate contents were favourable; the two radical's concentrations therefore have no serious impact on the ground water status in all the locations and stations.

Total heterotrophic bacteria counts ranged from 2.59 to 4.13×10^4 cfu/ml. Total fungal counts ranged from 1.15 to 2.08×10^2 cfu/ml. The percentage hydrocarbon utilizing bacteria and fungi was below 1.0 % that is critical for ground waters. This is suggestive of little or no hydrocarbon presence in the groundwater.

Table 4.2.5.1: Mean Groundwater Quality from different locations within the Southern Swamp Associated Gas Solution Plus Project

PARAMETERS	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	BH9	DPR LIMITS
pH	6.28	6.59	5.70	3.99	5.51	5.53	7.59	6.50	6.61	6.5-9.2
Temperature, °C	26.2	26.03	27.38	27	27.20	31.08	31.45	31.46	31.07	
Electrical Conductivity, µS/cm	105.8	22.75	270.23	236.9	259.87	495.50	615.00	1892.10	1402.87	
Colour, pt-Co	6.25	11.25	5.00	5	5.00	98.25	356.75	219.40	318.00	20
Dissolved Oxygen (DO), mg/l	2.35	2.33	6.40	6.3	0.00					
Chemical Oxygen Demand (COD), mg/l	8.06	8.13	7.36	7.05	7.18	8.40	24.10	26.80	19.73	40
Total Dissolved Solids (TDS), mg/l	64.23	14.35	148.37	120.12	137.62	246.75	315.50	945.00	994.50	200-500
Total Suspended Solids (TSS), mg/l	11	7.48	5.00	5	5.00	12.25	80.75	127.80	184.17	
Biochemical Oxygen Demand (BOD), mg/l	5.99	6.71	5.70	5.51	5.62					40
Turbidity, NTU	7.85	5.48	7.50	7.5	7.50	16.00	197.00	123.80	150.50	25
Alkalinity, mg/l	4.49	1.99	18.57	<0.01	18.99					
Hardness, mg/l	11.5	11.00	51.00	51	50.67					
Salinity, mg/l	24.71	4.77	27.81	22.45	27.12					
Nitrate, mg/l	1.32	1.19	3.66	1.23	3.51	0.11	0.11	0.075	0.08	10
Sulphate, mg/l	10.55	2.69	7.29	0.72	6.28	7.35	9.83	9.22	8.28	400
Carbonate, mg/l	0	0.00	0.00	<0.01	0.00	70.75	204.58	661.40	502.17	
Phosphate, mg/l	0.91	0.18	0.36	0.11	0.15	0.10	1.35	0.71	0.66	<5.0
Calcium, mg/l	5.15	6.98	10.28	8.05	11.21	14.03	25.00	16.41	38.75	
Magnesium, mg/l	2.24	3.74	6.47	7.75	6.41	8.75	15.35	50.01	121.60	50
Hydrogen Sulphide, mg/l	0	0.00	0.00	<0.001	0.00					
Phenol, mg/l	0	0.00	0.00	<0.001	0.00					
Nitrite, (NO ₂ ⁻), mg/l	0	0.00	0.00	<0.001	0.00					
Cyanide, mg/l	0	0.31	0.00	<0.001	0.00					
Ammonia, mg/l	0.20	0.29	4.14	4.02	4.06	0.02	0.03	0.045	0.05	
Heavy metals										
Cadmium, mg/l	0	0.00	0.00	<0.001	0.00	0.00	0.01	0.002	0.01	0.01
Zinc, mg/l	0.15	0.23	0.22	0.213	0.23	0.16	0.16	0.045	0.16	15
Iron, mg/l	1.40	0.50	3.32	3.233	3.32	10.36	38.72	5.96	7.26	1.0

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PARAMETERS	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	BH9	DPR LIMITS
Manganese, mg/l	0.21	0.07	0.12	0.223	0.09					0.5
Silver, mg/l	0	0.00	0.00	<0.001	0.00					
Copper, mg/l	0.11	0.14	0.12	0.132	0.12	0.004	0.01	0.28	0.004	
Chromium, mg/l	0.11	0.12	0.06	0.041	0.06	0.01	0.001	0.231	0.004	
Nickel, mg/l	0	0.00	0.00	<0.002	0.00	0.02	0.01	0.004	0.02	
Lead, mg/l	0.01	0.01	0.00	<0.002	0.00	0.10	0.09	0.01	0.40	
Vanadium, mg/l	0	0.00	0.00	<0.001	0.00	0.02	0.01	0.005	0.01	
Arsenic, mg/l	0	0.00	0.00	<0.001	0.00					
Mercury, mg/l	0	0.00	0.00	<0.001	0.00	0.002	0.002	0.003	0.002	

Hydrography

The hydrography of the region is greatly influenced by the tides of the Atlantic Ocean (which move in and out through the estuaries) and the flood regime of the major rivers (Dodo, Ramos, and Pennington). The area is affected by the Guinean current which flows at a speed in the range of 1.0 – 1.3 knots (0.51 – 0.66m/s) from the west to east direction and is typically a warm current. The sea heights in offshore location show significant direct correlation with wind speed but this relationship is affected by water depth. In general, the magnitude of sea swells tends to increase towards the shore in the EA area.

As the Guinean current flow eastwards in the Bight of Biafra, they are joined by the Equatorial counter currents which carry cold Atlantic central water to the warm waters of the Gulf of Guinea. The equatorial counter current in the area result from the convergence of the different currents in the Gulf of Guinea, and is characterized by turbulence and eddy flows. Its speed can be as much as 1.0 – 1.7 knots (0.51 – 0.87m/s) in the wet season, but subsides to 0.7 – 1.1 knots (0.36 – 0.56 m/s) in the dry season.

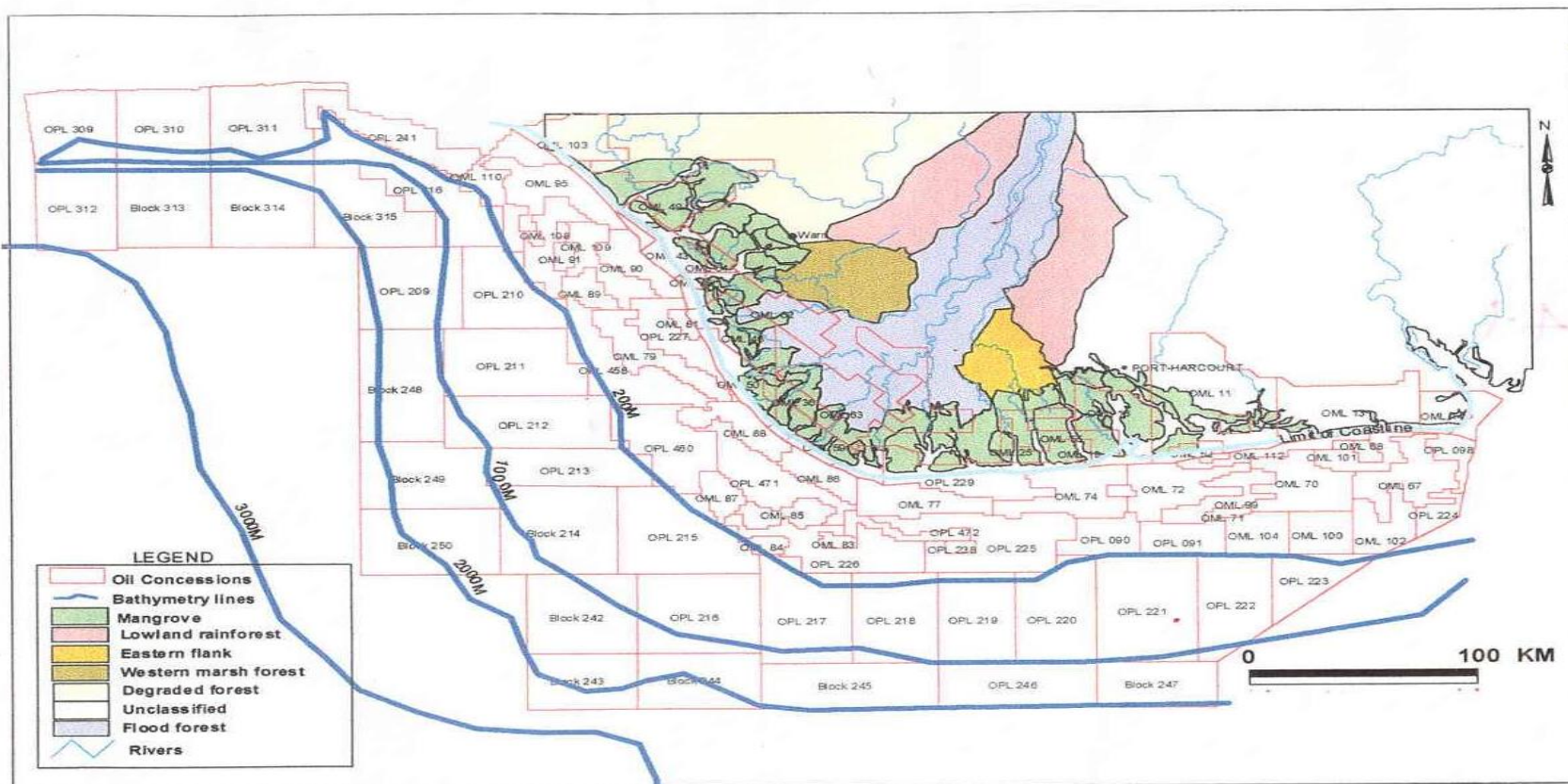


Fig.4.2.5.6: Bathymetric Configuration of Nigeria’s Coastline
 Source: OPL 238 Mecocean Reference Document, 2012

MetOcean Conditions

The average annual wave heights and their occurrence at the site (OML 79) are within an average value of 0.75m for 98% of the time. Wave heights of <1.25m predominate with occurrences of 58.7% of the time. About 54.2% of the waves have a peak period within the range of 8.0 – 11.0 seconds. Within this range, wave periods of < 9.0 seconds represent 16.7%, 9.0 – 10.0 seconds equal 19.6%, while >10.0 seconds account for 18.0% of the wave occurrence at the site. The waves that have their peaks within the above mentioned ranges are $\geq 2.25\text{m}$. The waves are northward 88% of the time and north-northeast for another 9.9% of the time.

The Nigerian coast has high intensity wave action. The waves have a long fetch and are generated by the prevailing S-SW winds. These winds originate in storm centres far out in the Atlantic. Typical wave energies are 4-80 kJ per metre of crest. The S-SW waves strike the shore obliquely and generate strong longshore currents. In the EA concession area these run N-NW at 0.15-1.5 m/s (0.3-2.9 knots). The mean tidal range ranges from 1.1 to 2.5 m. The tide approaches the coast from the S-SW moving shore sediments out to sea. The tides also generate strong currents in tidal inlets (0.4-1.8 m/s) transporting sand and gravel out to sea. Where river mouths are near perpendicular to the coastline large, highly destructive waves predominate, causing backwash of beach material out to sea. The resultant coastal erosion has been a major threat to coastal communities. Around Agge Community in Ekeremor LGA of Bayelsa State, many metres of land and buildings have been destroyed and submerged in this process.

4.2.6: Coastal Soils / Land-Use

Soils of the Barrier Islands/ Strand Coasts

The soils found along the coasts and most of the beach ridges are generally sandy with low organic matter contents of <2% (Ayolagha, 2004; 2005). The barrier island soils were formed from the action waves and currents on sediments that were river deposited at the mouths and estuaries. Due to their genesis the beach ridge sands are of low inherently fertility, and because of their sandy nature, they are prone to erosion. Loamy soils can be found in the back swamps on the beach ridges, but the agricultural value of the soils is low. However, the strands coasts serve as critical ecological functions such as serving as feeding, nesting/breeding sites for wildlife. Therefore they are critical to the sustenance of biodiversity. Also, some sections of the strand coasts have beaches that could be developed as recreational sites; therefore they have potentials for tourism.

Physico-chemical characteristics of coastal soils

The mangrove forest soils are made up of decomposing plant tissues mixed with silt/sandy mineral matter. The soils found in the mangrove ecosystem include the recently deposits of soft materials of >80% silt and clay and the more mature peaty clay popularly known as 'Chikoko'. They contain high amounts of iron sulphides or pyrites, which is responsible for the

characteristics rotten-egg odour experienced in the mangrove ecosystem. The soils have pH of 6.5 to 7 and high organic matter contents ranging from 2.4% to 8.9%. Although the soft mud and Chikoko occupy most of the land in the mangrove area, there are small patches of saline deposits of up to 75% sands, with clay contents ranging from 4% to >20%, and lower organic matter content as compared to the Chikoko. The sandy saline deposits support the *Rhizophora* species of mangrove. The physicochemical parameters of the mangrove soils are shown in Table 4.2.6.1.

Table 4.2.6.1: Summary of physico-chemical parameters of soils in the coastal region of OML 79

Parameter	Mean \pm SD	Range
pH	6.80 \pm 0.08	6.64 - 6.92
Moisture Content (%)	5.00 \pm 0.60	3.12 - 5.65
Organic matter (%)	6.13 \pm 1.79	2.40 - 8.90
Salinity (mg/kg)	1306 \pm 1829	67 - 6900
Phosphate (%)	3.64 \pm 3.12	1.18 - 11.44
Sulphate (mg/kg)	91.03 \pm 71.9	18.85 - 264.30
Nitrate (mg/kg)	5.16 \pm 2.95	0.12 - 11.09
Ammonium (mg/kg)	8.31 \pm 1.09	6.09 - 10.34
Cation Exchange Capacity (meq/100g)	3.98 \pm 0.87	2.69 - 5.58
Calcium (meq/100g)	1.56 \pm 0.30	1.11 - 1.99
Magnesium (meq/100g)	1.50 \pm 0.34	0.91 - 2.00
Sodium (meq/100g)	0.42 \pm 0.38	0.08 - 1.29
Potassium (meq/100g)	0.51 \pm 0.18	0.20 - 0.88
Vanadium (mg/kg)	<0.001	<0.001 - <0.001
Nickel (mg/kg)	10.80 \pm 4.65	2.81 - 20.25
Lead (mg/kg)	<0.01	<0.01 - <0.01
Chromium (mg/kg)	10.19 \pm 4.50	2.40 - 22.78
Zinc (mg/kg)	32.84 \pm 9.69	12.11 - 48.17
Cadmium (mg/kg)	0.03 \pm 0.15	<0.01 - 0.48
Iron (mg/kg)	19929 \pm 6941	7459 - 34991
Manganese (mg/kg)	213 \pm 122	31.73 - 493.30

Source: Environmental baseline studies for Boubouwei-Bou/Elepa oil field (SPDC, 2007)

Soil Microbiology

The microbial population of the soils in the coastal area of the project showed that the THB counts ranged from 2.85×10^7 to 9.00×10^8 cfu/g while the HUB were from 3.65×10^3 to 4.15×10^5 cfu/g. The percentage ratio of HUB to THB was <1%, suggesting the absence of hydrocarbon pollution in the soils of the landfall area. The THF count ranged between 9.00×10^2 and 1.20×10^4 cfu/g. No hydrocarbon utilizing fungi (HUF) was detected. The predominant bacteria species isolated from the soil samples were *Klebsiella*, *Bacillus*, *Staphylococcus*, *Proteus*, *Pseudomonas* and *Micrococcus*, while the dominant fungal species were *Rhizopus*, *Mucor*, *Saccharomyces*, *Aspergillus*, *Candida* and *Penicillium* (Table 4.2.6.2).

Table 4.2.6.2: Microbiology of the coastal soil

Total Heterotrophic Bacteria (THB)	THB Count (cfu/g)	Hydrocarbon Utilizing Bacteria (HUB)	HUB Count (cfu/g)	% of HUB in THB	Total Fungi (TF)	TF Count (cfu/g)	Hydrocarbon Utilizing Fungi (HUF)	HF Count (cfu/g)
<i>Proteus</i> <i>Micrococcus</i>	8.30 x 10 ⁷	<i>Bacillus</i>	1.60 x 10 ⁵	0.19	<i>Rhizopus</i> <i>Aspergillus</i> <i>Mucor</i> <i>Penicillium</i>	1.75 x 10 ³	Nil	0.00
<i>Staphylococcus</i> <i>Klebsiella</i> <i>Pseudomonas</i>	9.00 x 10 ⁷	<i>Pseudomonas</i> <i>Bacillus</i>	1.95 x 10 ⁵	0.22	<i>Mucor</i> <i>Rhizopus</i> <i>Penicillium</i>	2.70 x 10 ³	Nil	0.00
<i>Pseudomonas</i> <i>Bacillus</i> <i>Staphylococcus</i>	3.50 x 10 ⁷	<i>Pseudomonas</i>	3.65 x 10 ³	1.04	<i>Mucor</i> <i>Penicillium</i>	6.30 x 10 ³	Nil	0.00
<i>Proteus</i> <i>Micrococcus</i> <i>Bacillus</i> <i>Staphylococcus</i>	9.00 x 10 ⁸	<i>Bacillus</i>	1.75 x 10 ⁵	0.02	<i>Penicillium</i> <i>Candida</i> <i>Mucor</i> <i>Saccharomyces</i>	9.55 x 10 ³	Nil	0.00
<i>Bacillus</i>	2.14 x 10 ⁸	<i>Bacillus</i>	4.15 x 10 ⁵	0.19	<i>Mucor</i> <i>Saccharomyces</i>	1.20 x 10 ⁴	Nil	0.00
<i>Bacillus</i>	2.85 x 10 ⁷	<i>Pseudomonas</i>	3.00 x 10 ⁵	1.05	<i>Rhizopus</i> <i>Mucor</i> <i>Penicillium</i>	1.00 x 10 ³	Nil	0.00
<i>Proteus</i> <i>Bacillus</i> <i>Klebsiella</i> <i>Micrococcus</i> <i>Pseudomonas</i>	3.50 x 10 ⁷	<i>Pseudomonas</i>	3.90 x 10 ⁵	1.11	<i>Mucor</i> <i>Saccharomyces</i>	9.00 x 10 ²	Nil	0.00

Source: SPDC, 2007

4.2.7: Coastal Vegetation

The vegetation of the coastal area of the project comprises basically two broad groups, i.e., the freshwater vegetation found on the Strand Coast/Barriers Islands and the mangrove vegetation growing in the brackish water swamp. The characteristics of the two vegetation groups are discussed below.

Strand Coasts/ Beach Ridges/ Barrier Islands Ecosystem Zone

Species Composition: The coastline vegetation is relatively less diverse and consists of a few species that could grow on the sandy strand coast. The predominant species include *Ipomoea pes caprae*, *I. stolinfera*, *Sesuvium portulacastrum*, *Dalbergia ecastophyllum*, and *Paspalum vaginatum*. Other species that grow on the strand coasts include *Cocos nucifera* (coconut), *Alchornea cordifolia*, *Ficus* sp., *Alstonia boonei*, *Costis afer* and oil palms.



Plate 4.2.7.1: Coastal vegetation in the study area

Table 4.2.7.1: Composition, frequency and type of plants found on the Strandline Coast

Scientific Name	Common Name	Frequency	Type
<i>Calapogonium mucunoides</i>	Calapo	3	Creeper
<i>Cyperus spp</i>	-	5	Herb
<i>Dalbergia ecastophyllum</i>	-	68	Creeper
<i>Ipomoea pes caprae</i>	Seaside morning glory	45	Creeper
<i>Kylingia peruviana</i>	-	2	Herb
<i>Paspalum vaginatum</i>	Couchgrass	14	Herb
<i>Cassytha filiformis</i>	-	14	Climber
<i>Canavalia rosea</i>	Seaside bean	23	Creeper
<i>Diodia maritime</i>	-	6	Herb
<i>Ipomoea stolonifera</i>	Fiddle-leaf morning glory	13	Creeper
<i>Sesuvium portulacastrum</i>	-	7	Herb
<i>Kylingia peruviana</i>	-	5	Herb
<i>Brachiaria falcifera</i>	-	6	Creeper
<i>Stigmatophyllum ovatum</i>	-	9	Creeper
<i>Tetracera alnifolia</i>	-	5	Climber
<i>Phragmites communis</i>	Reed	2	Herb
<i>Casuarina equisetifolia</i>	Whistling pine	6	Tree
<i>Flaucortia flavescence</i>	-	5	Shrub
<i>Vigna marina</i>	-	12	Creeper
<i>Telanthera sp</i>	-	2	Herb
<i>Chrysobalanus icaco</i>	-	10	Shrub
<i>Terminalia cattapa</i>	Indian almond	8	Tree
<i>Dissotis rotundifolia</i>	-	3	Creeper

The coastal barrier islands have freshwater forest vegetation that is stratified into two layers. The tall trees occupy the topmost, while shorter trees and shrubs constitute the lower layer. Species that can be found in the topmost layer include stands of mature trees species such as *Uapaca heudelottii*, *Chrysobalanus orbiculare*, *Syzygium guineense var. litorale*, *Anthocleista sp.*, and *Piptadeniastrum africanum*. In the lower layer, the species found include *Smilax kraussiana*, *Fleurya ovalifolia*, *Tetracera alnifolia*, *Mussaeda sp.*, *Alchornea cordifolia* and *Spondias mombin*, as well as younger stands of the tall species. The floor of the barrier island forest is occupied mostly by seedlings of tree/shrub species, climbers and herbs. Details of composition of vegetation found on the coastal barrier islands are shown in Fig. 4.2.7.1.

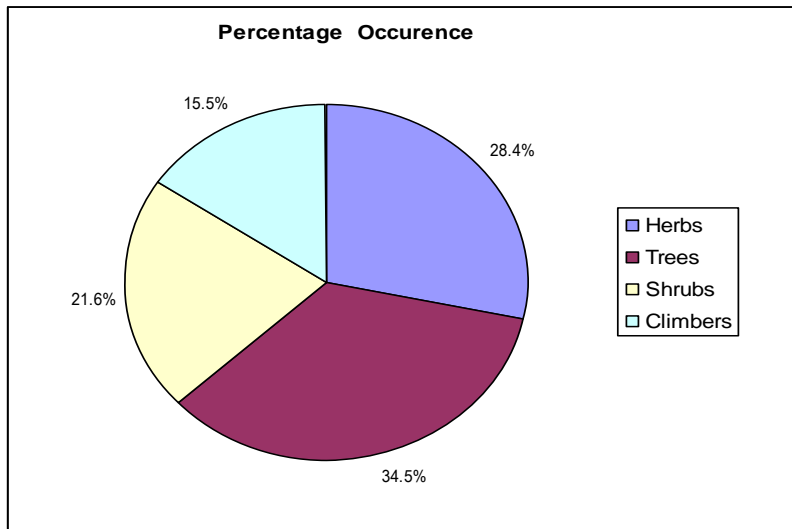
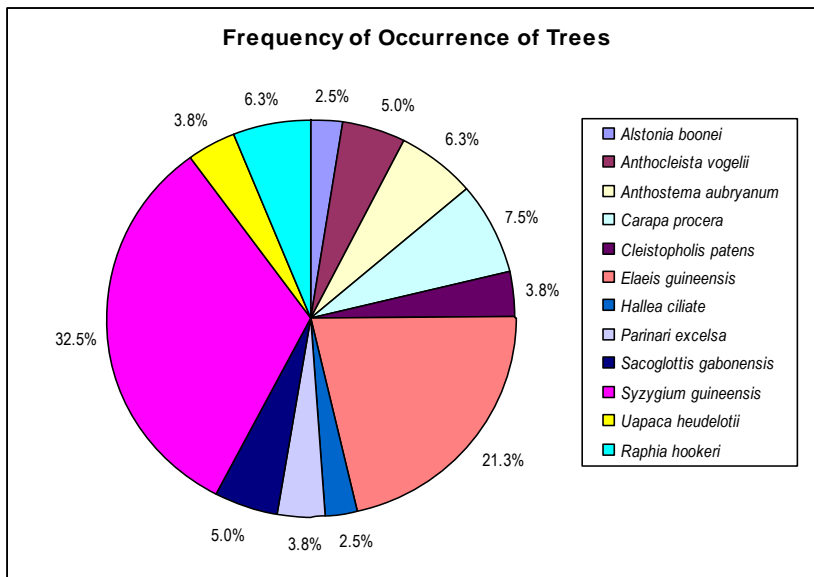


Fig. 4.2.7.1: Percentage composition of the major vegetation group on Barrier Island



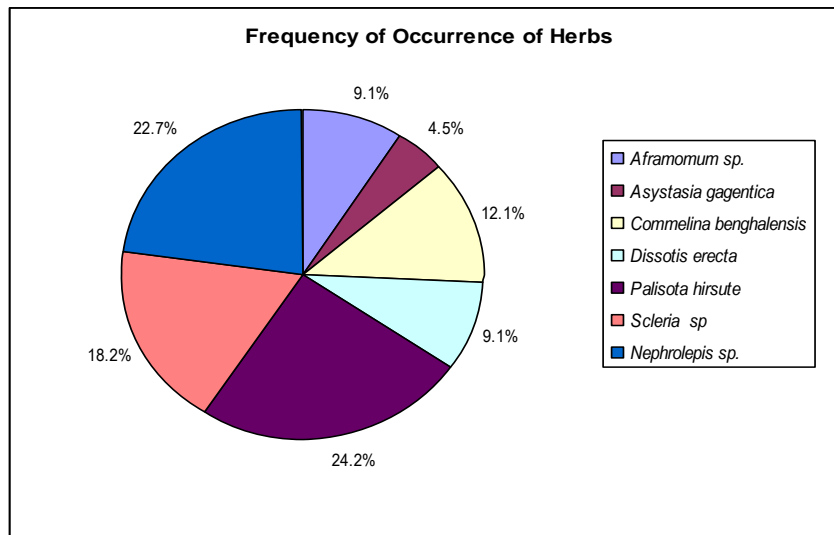
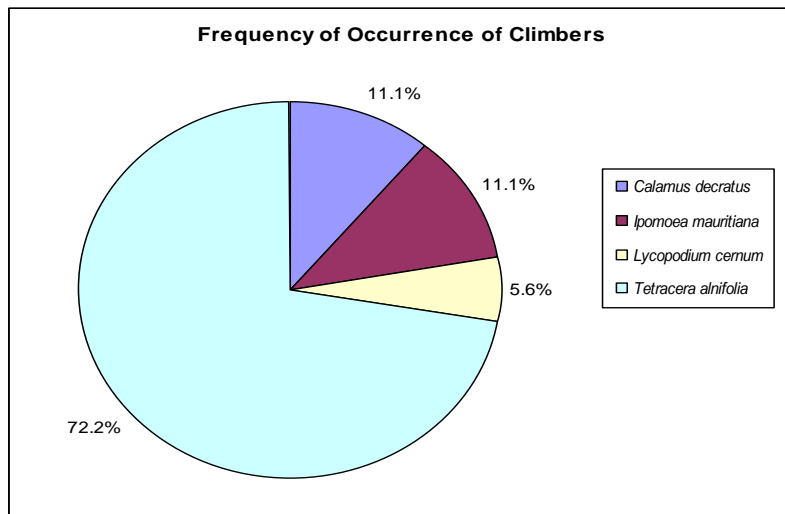
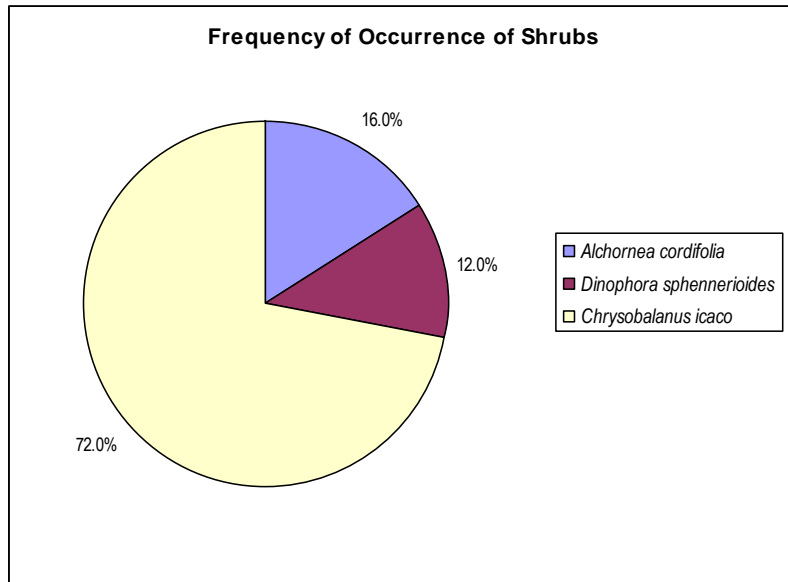


Fig. 4.2.7.2: Percentage composition of the vegetation of Barrier Island



Plate 4.2.7.2: Coastal vegetation including mangrove in the study area

Other plant species that thrive on the barrier islands include *Symphona globulifera*, *Syzygium guineensis*, *Pandanus togoensis*, *Hallea sp*, *Musanga cecropioides*, *Alchornea cordifolia*, *Nephrolepis biserrata*, *Alstonia boonei*, *Costus afer*, *Palisota sp*, *Elaeis guineensis*, *Aframomum spp.* and *Anthocleista vogelii* and the riparian species like *Raphia hookeri* can be found in swampy locations. Also, on the back swamps where there is tidal water intrusion, mangrove species (*Rhizophora sp*) predominate.

However, the general trend is that this type of vegetation is declining at a fast rate. A time-lapse analysis of this type of forest cover shows that the rate of decline is about 2.93% per annum (Fig. 4.2.7.3).

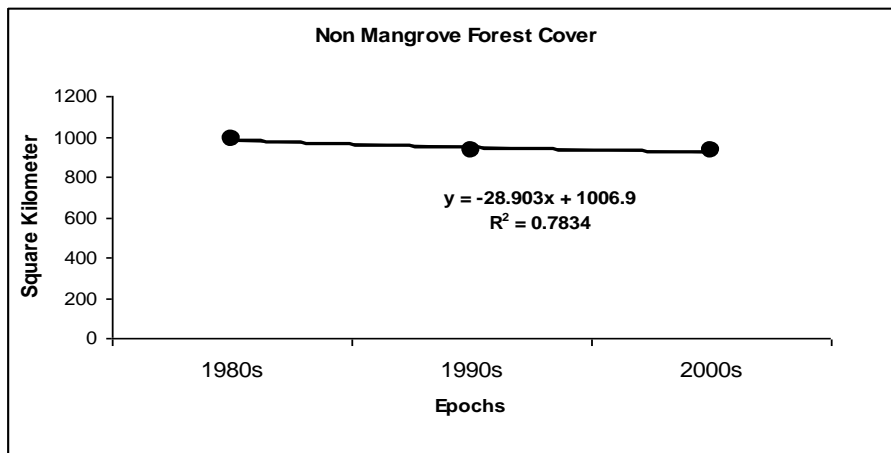


Fig. 4.2.7.3: Rate of decline of coastal vegetation

Mangrove Ecosystem Zone

Vegetation Species Occurrence / Spatial Distribution: The mangrove zone of the coastal area is characterised by dominant presence of *Rhizophora racemosa*, *R. harrisonii* and *R. mangle* (the red mangrove species). *R. racemosa* is known as the ‘tall red mangrove’ and it grows to heights

of >20 m, while *R. harrisonii* and *R. mangle* are much shorter and are called ‘short red mangrove’. In addition, *Avicennia africana*, also called white mangrove, is found in the mangrove ecosystem. The mangrove vegetation constitutes about 90% of mangrove zone (Fig. 4.2.7.4). The freshwater type of vegetation (found on the ridges and in back swamps) is about 10% of the density of species found within the mangrove section of the study area.



A Typical mangrove vegetation

A typical patch of freshwater vegetation

Plate 4.2.7.3: Mangrove and freshwater vegetation

A graphic display of the species composition found within the mangrove zone is shown in Fig. 4.2.5.4.

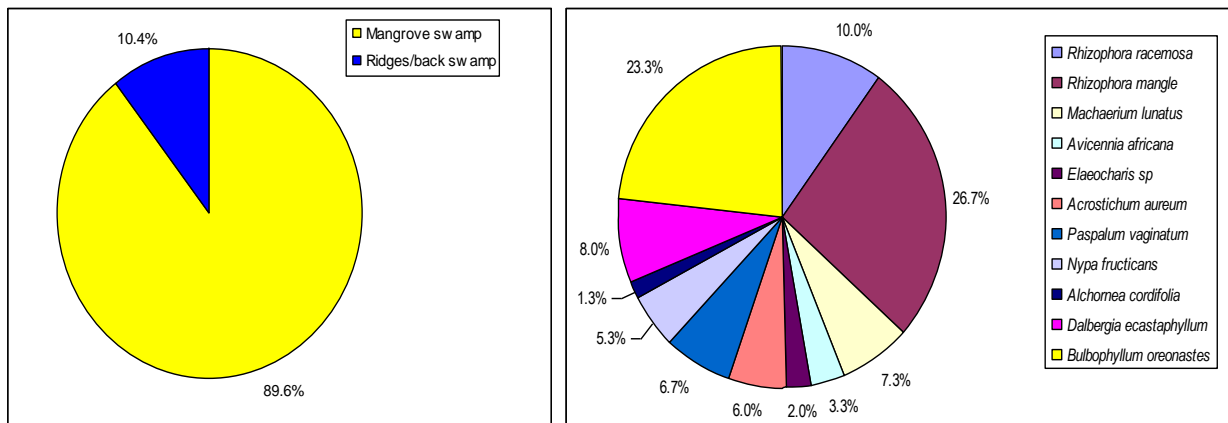


Fig. 4.2.7.4: Percentage composition of mangrove vegetation

Apart from the dominant mangrove species, mangrove ecosystem include *Machaerium lunatus* and *Dalbergia ecastaphyllum*, also called the ‘mangrove associates’; and epiphytes such as *Bulbophyllum oreonastes* and mangrove moss (*Ocoblepharum sp*). Other species found in the mangrove zone include and non-mangrove species such as *Acrostichum aureum* (mangrove fern) *Nypa fruticans* (Nipa palms) and grasses such as *Paspalum vaginatum* (Fig. 4.2.7.5).

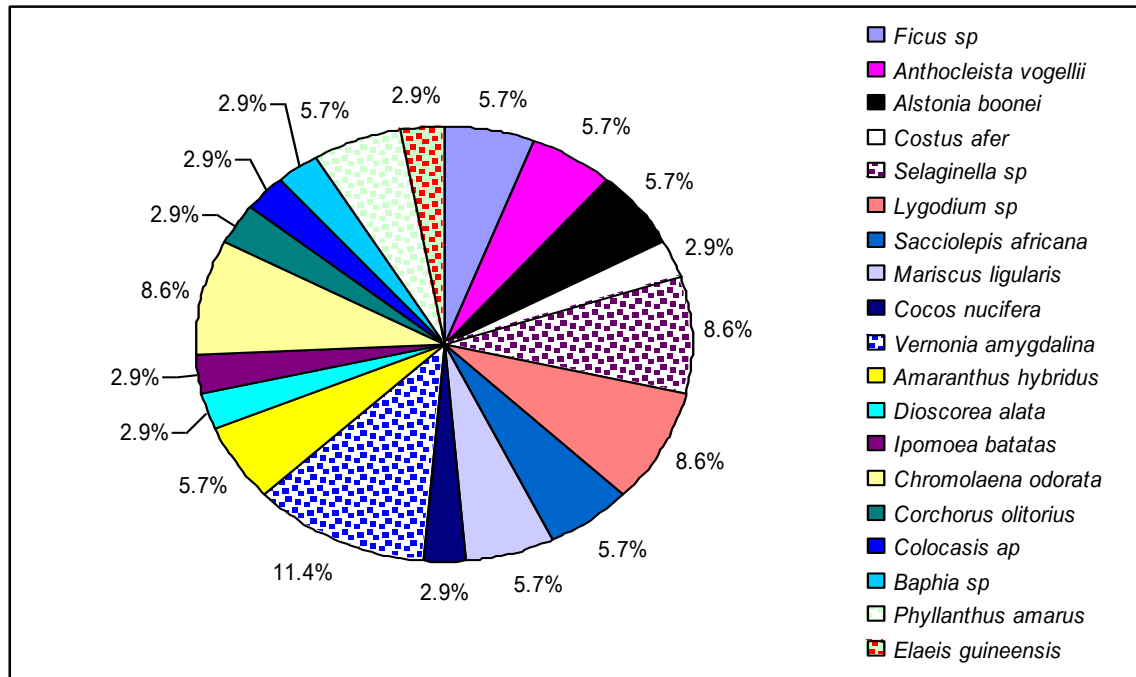


Fig. 4.2.7.5: Percentage composition of the non-mangrove species

The spatial distribution of the mangrove species is related to the nature of the soils and extent of salt water intrusion (especially due to tidal inundation). The tall red mangroves *R.racemosa* species thrive on recently deposited soft mud (usually adjacent the bank of estuaries), while *R. harrisonii*, and *R. mangle* grow on fibrous peaty clays (Chikoko) found in the tidal flats/marshes. While the tall red mangrove grows significantly much taller than the short red mangroves, the short mangroves are more tolerant to high salinity (Onofeghara, 1986). The white mangrove *Avicennia africana* occurs as scattered stands amongst the red mangroves species in patches of elevations where the soils are less waterlogged. The Nipa palm, which is an exotic species, is found in degraded areas as they are more resistant to changes in the ecosystem, hence they out-compete the native mangrove species.

Within the mangrove zone, patches of freshwater forest vegetation thrive on the high grounds, especially around the back-swamps and they include *Achornea cordifolia*, *Ficus sp*, *Anthocleista vogellii*, *Alstonia boonei*, *Costis afer* and *Selaginella sp*. The areas that support freshwater vegetation are usually found in the back-swamps near homesteads, hence they are often converted into small-scale farms where crops such as coconut, oil palm, bitter leaves, amaranthus, and others are grown.

Plant population density: A synthesis of results from various studies carried out in the mangrove ecosystem is shown in Fig. 4.2.7.6. The tall and dwarf red mangroves are the most dominant species and together, they occur at an average density of > 500 stands ha⁻¹. They were also the most spatially distributed species in the mangrove forest. Apart from the mangrove species,

Alstonia boonei can be found at an average density of 38 stands ha⁻¹, while *Elaeis guineensis* and *Cocos nucifera* had densities of 5 stands ha⁻¹ and 3 stands ha⁻¹ respectively. The non-mangrove species are found in patches of high grounds mostly near homesteads.

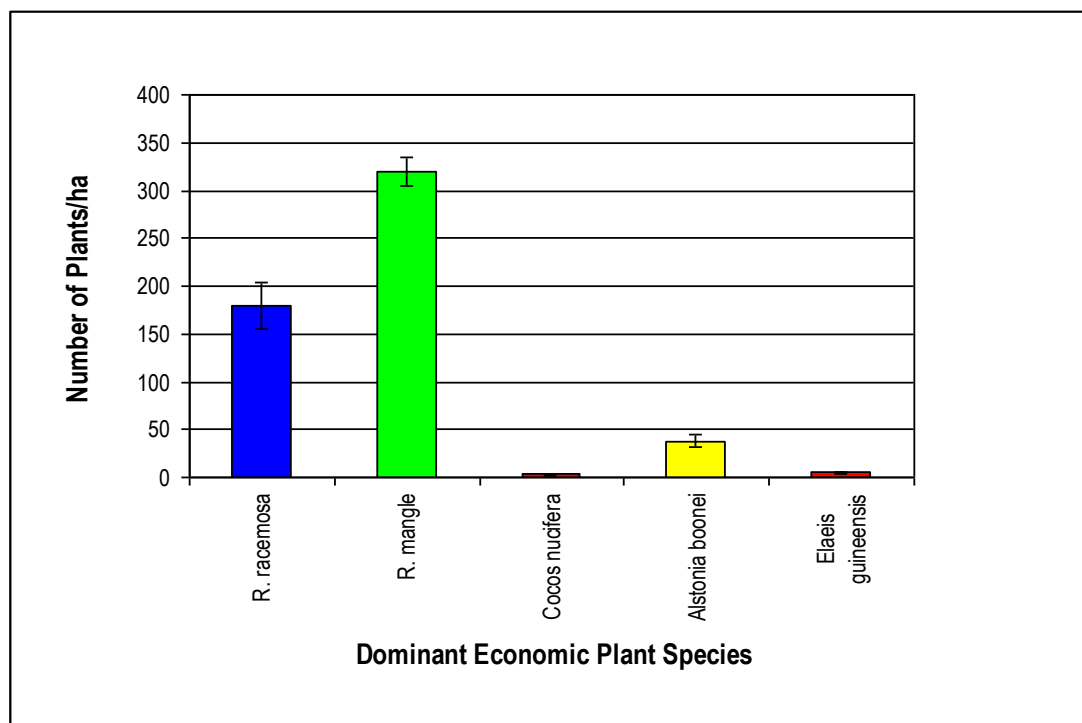


Fig. 4.2.7.6: Density of economic plant species in the mangrove zone
(Adapted from SDPC, 2007)

Table 4.2.7.2: Checklist of plant species with known economic importance

Scientific Name	Common Name	Economic Importance
<i>Rhizophora racemosa</i>	Tall red mangrove	Timber/fuel wood
<i>Rhizophora mangle</i>	Dwarf red mangrove	Fuel wood
<i>Machaerium lunatus</i>	Machaerium	Medicinal
<i>Elaeocharis</i> sp	Swamp reed	Mat weaving
<i>Acrostichum aureum</i>	Mangrove fern	For trapping crayfish
<i>Alchornea cordifolia</i>	Christmas bush	Medicinal
<i>Alstonia boonei</i>	Stool wood	Timber/Medicinal
<i>Cocos nucifera</i>	Coconut	Food (fruit)
<i>Vernonia amygdalina</i>	Bitter leaf	Leafy vegetable
<i>Amaranthus hybridus</i>	Amaranthus	Leafy vegetable
<i>Dioscorea alata</i>	Water yam	Food (Tuber)
<i>Ipomoea batatas</i>	Sweet potato	Food (Tuber)
<i>Chromolaena odorata</i>	Siam weed	Medicinal

Scientific Name	Common Name	Economic Importance
<i>Corchorus olitorius</i>	Corchorus	Leafy/fruit vegetable
<i>Colocasis ap</i>	Cocoyam	Food (corn)
<i>Baphia sp</i>	Baphia	Chewing stick
<i>Phyllanthus amarus</i>	Phyllanthus	Medicinal
<i>Elaeis guineensis</i>	Oil palm	Food/wine

Source: Environmental baseline studies for Boubouwei-Bou/Elepa oil field (SPDC, 2007)

Land Use

Generally, within the study area, it was observed that agriculture is one of the major occupations (Fig 4.2.7.7). Farming is seen along water ways, in rain forest and swamp clearings, and close to major communities. Common crops cultivated include sugar cane, plantain, cassava, yam and cocoyam. Subsistence fruit crops like mango, cashew, pawpaw, African bread fruit, and coconut were spotted around existing and abandoned settlements.

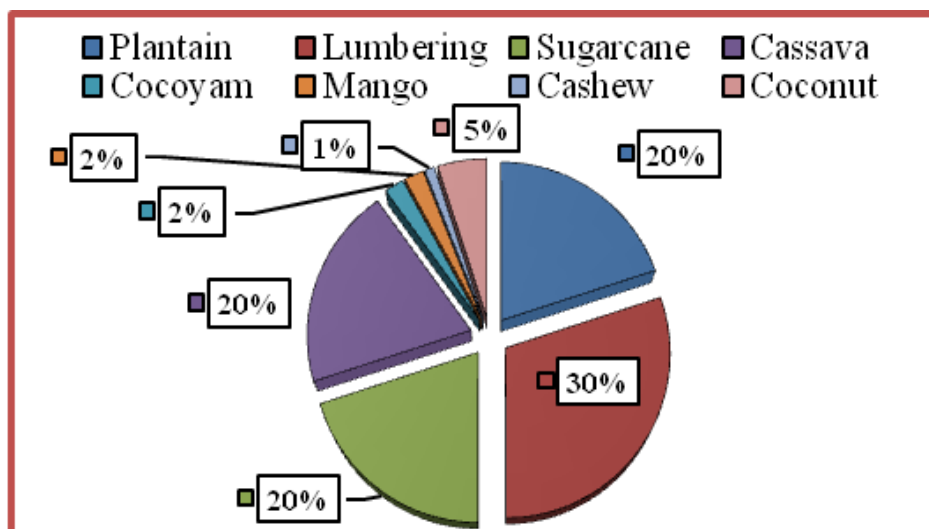


Fig. 4.2.7.7: Agriculture and Land use in coastal zones EA/Eja of EA/Eja Field (Source: EIA SSAG,2010)

4.2.8: Coastal Wildlife

The wildlife of the coastal region of the EA study area was rich and diverse, comprising birds (kingfishers, cattle egrets, sparrows, vultures, kites, eagles, and owls), reptiles (crocodiles, turtle and snakes) and mammals (rats, antelopes (duikers), bush pigs and monkeys). Table 4.2.8.1 presents the checklist of key vertebrate species and their protection status.

Table 4.2.8.1: Checklist of key vertebrate species and their protection status

Common name	Scientific name	Status (if known)
Aves (Birds)		
Pied Kingfisher	<i>Ceryle rudis</i>	Not listed
Pelican	<i>Pelecanus rufescens</i>	Not listed
West African river eagle	<i>Haliaeetus vocifer</i>	Cites App. II
Spur – winged goose	<i>Plectropterus gambensis</i>	Cites app. III
Pintail duck	<i>Anas acuta</i>	Cites App III
White – faced tree duck	<i>Dendrocygna viduata</i>	Cites App. III
Kite	<i>Milvus migrans</i>	Cites App. II
Swallow	<i>Hirundo nigrita</i>	Not listed
Pied Crow	<i>Corvus albus</i>	Not listed
White Egret	<i>Ardeola sp.</i>	Cites App III
Grey Parrot	<i>Psittacus arithacus</i>	Cites App. II
Fishing owl	<i>Scotopelia peli</i>	No listing
Palm nut Vulture	<i>Gypohierax angolensis</i>	Cites App. II
Reptilia (Reptiles)		
Leatherback Turtle	<i>Dermochelys coriacea</i>	Cites App. II endangered
Green Turtle	<i>Chelonia mydas</i>	Cites App. I Critically endangered
Hawksbill Turtle	<i>Eretmochelys imbricata imbricata</i>	Cites App. I Critically endangered
Olive Ridley turtle	<i>Lepidochelys olivacea</i>	EN (endangered)
Water snake	<i>Netrix enoscopus</i>	No listing
Monitor lizards	<i>Varanus spp.</i>	Cites App. II
Genets		No listing
Agama Lizard	<i>Agama agama</i>	No listing
Crocodiles	Family Crocodylidae	No listing
Land Mammals		
Speckle Throated Otter	<i>Lutra maculicollis</i>	Cites App. II
African Swamp Rat	<i>Otomys occidentalis</i>	IUCN 1996 red list endangered
African Soft Furred Rat	<i>Praomys hartwigi</i>	IUCN 1996 red list endangered
Marsh Mongoose	<i>Atilaxpaludinosus</i>	No listing
Giant Rat	<i>Cricetomys gambianus</i>	No listing
Wild Boar	<i>Sus scrofa</i>	No listing
Fruit Bat	<i>Myonycteris torquata</i>	No listing
Brush-tailed Porcupine	<i>Atherurus africanus</i>	No listing
Mona Monkey	<i>Cercopithecus mona</i>	Cites App. II
Collared or Sooty Mangabey	<i>Cercocebus torquatus</i>	Cites App. II
Black Squirrel	<i>Heliosciurus punctatus</i>	No listing

Common name	Scientific name	Status (if known)
African pygmy squirrel	<i>Myosciurus pumilio</i>	IUCN red list- Vulnerable
Crested Genet	<i>Genetta cristata</i>	IUCN red list endangered
Cane rat	<i>Thryonomys swinderianus</i>	No listing
Wart Hog	<i>Phacochoerus aethiopicus</i>	No listing
Bush Buck	<i>Tragelaphus scriptus</i>	No listing
Marine mammals		
Humpback whale	<i>Megaptera novaeangliae</i>	Cites App. I vulnerable
West African Manatee	<i>Trichecus senegalensis</i>	Cites App. II IUCN red list 1996 - vulnerable
Atlantic humpback dolphin	<i>Sousa teuszii</i>	Cites app. I
Harbour porpoise	<i>Phocoena phocoena</i>	Cites App. II vulnerable
Common dolphin	<i>Delphinus delphis</i>	Cites App. II
Blue whale	<i>Balaenoptera musculus</i>	Cites App. I
Atlantic spotted dolphin	<i>Stenella frontalis</i>	Cites App II

Several species of sea bird breed on islands in the Gulf of Guinea or on the West African coastline. These include the White Tailed Tropic Bird, The Brown Booby, a range of tern species (Whiskered, Bridled, Sooty and Little), and Brown and Black Noddys. Migratory birds visiting the West coast of Africa include: Corys, Sooty Shearwaters, Wilson’s Storm Petrel, Skuas, Gulls (Blackheaded, Sabines) and Terns (Common, Arctic, Damara). Some of these bird nest on the shoreline and on the offshore islands of the Gulf of Guinea Coast. The vulnerability of birds to oil pollution have been addressed by IMO 1988-manual on oil pollution Section IV Combating Oil Spills.

Several species of turtle are listed as present in Nigeria including the critically endangered Green Turtle (*Chelonia mydas*) (Plate 4.2.6.1) nests in the Gulf of Guinea from November to February. This species is vulnerable to disturbances of its nesting areas. They come ashore at night to lay eggs and will be put off doing so by the occurrence of any abnormal noise or light. The Hawksbill Turtle (*Eretmochelys imbricata*) is recorded as nesting in Nigeria (CITES list). The Loggerhead Turtle (*Caretta caretta*) is also expected to nest in Nigeria but there are no reported sightings. The endangered, Leatherback Turtle (*Dermochelys coriacea*) is also reported as documented in Chronic effects of long time discharge of produce water on Marine Environment in EA/Eja field (2004).



Plate 4.2.8.1: Green Turtle (*Chelonia mydas*)
Source: SPDC 2004



Plate 4.2.8.2: Olive Ridley turtle (*Lepidochelys olivacea*)
Source: SPDC 2004

The West African Manatee (*Trichechus senegalensis*) is on the IUCN red list as a vulnerable species. It inhabits inshore and estuarine waters and is very vulnerable to injury from shipping. Its primary feeding grounds are sea grass areas which are vulnerable to pollution.



Plate 4.2.8.3: The West African Manatee (*Trichechus senegalensis*)
Source: SPDC 2004

4.2.9: Social Profile

Project Area and Historical Perspective

The coast off the EA-FOD proposed project is contiguous to about twelve major coastal settlements and immediate hinterlands that are likely to be exposed to the potential influence of the project. These include Ezetu, Ekeni, Bisangbene, Amatu I, Amatu II, Letugbene, Orobiri, Azamabiri, Agge, Bilabiri I, Bilabiri II and Ogbeintu. Ezetu and Ekeni communities are located in the Southern Ijaw Local Government Area while the remaining 10 communities are located in Ekeremor Local Government Area (LGA) of Bayelsa State. These communities are located geographically to the north in a distance of no less than 15km away from the project site. Each of the “parent” communities has numerous fishing/farming settlements along the coastal strip and along the main waterways sources. Principally, these communities lie between the Ramos and Pennington Rivers.

Historical and sociological studies have shown that these communities, as other Niger Delta communities have strong tribal and cultural affinities that override community boundaries, except in the area of political and local governance arrangements. Thus, these communities are traditionally grouped under different clans; the dominant clans in the area being the Khou Clan and the Iduwini Clan.

The indigenes have a common migration story and this is tied to their common language, festivals and taboos. All the communities within the area are homogenously Ijaw (Izon), a major ethnic group in the Niger Delta region of Southern Nigeria. The Ijaws, whose settlements are mainly around the coastal belt, claim to have descended from a common ancestor who migrated from ‘Benin-Aboh’ in the hinterland. The indigenes have close historical and kinship ties with the Oporoma, Eastern Olodiamaaand Ogbe tribes. Historically, the indigenes settled in the area several thousand years before the arrival of the Portuguese on the coast of the Niger Delta in the 15th century (Alagoa, 2005).

All the communities in both local government areas are oil producing. This is manifested in the oil exploration related activities that are seen daily all over the locality. The area is believed to have the highest number of oil wells in the Niger Delta. This includes both onshore and offshore locations. Major oil companies that operate here includes; Shell Petroleum Development Company, Chevron Nigeria Limited, and Nigeria Agip Oil Company Limited.

Religion, Cultural/Archaeological Properties, Customs, Belief Systems and Values

The general belief/value system of the indigenes in EAFOD neighbouring communities does not differ significantly from that of the neighbouring tribes. Christianity predominates as evidenced in the presence of different denominations of churches in the communities. This suggests reducing African Traditional Religion (ATR) adherence in the communities over the years. The

reality on ground is that traditional worship is rooted in the communities' culture and even acclaimed Christians participate in the festivals at different levels of commitment.

The people are both patrilineal and matrilineal, depending on the degree of marriage. Inheritance rights are biased towards biological offsprings especially male household members. It is rich in cultural diversity. Some of the best cultural troupes and traditional festivals can be found in the area. One of the renowned cultural troupes popularly known as the "egbelegbele" dance troupe is a common phenomenon within this locality. The area is also known for its prowess in wrestling. The likes of Jackson Bidei and other great wrestlers that have represented Nigeria in international competitions are from this area. The coastal area is rich in natural splendour and a very good tourist destination for people that want to see the exotic aquatic beauty and other numerous tourist attractions.

Generally, to promote pro-environmental behaviour, order and social cohesion among the residents there are standard social norms that are common in the communities. Some of these include respect to the elders by the youth/children, wives and husbands and relational social capital. There are other belief systems, which revolve around common taboos. Typical prohibitions include killing of tortoise, python and the pure white coloured bird. Because of the cultural significance attached to these animals, the indigenes have been ensuring that their habitats are protected. Apart from these, the people really do not have so many forbidden food or cultural/traditional taboos. Non-indigenes therefore, find it easy to mix freely with the indigenes leading to considerable population of other ethnic groups residing in the area, including Urhobo, Isoko, Igbo, Yoruba, Ibibios and Efiks. These mixed groups are particularly concentrated in the satellite settlements and outposts, stretch between Agee and Obiri Creek. Emotional and religious attachments forbid open discussions about some deities, their activities and abodes. Their systems of traditional administration are similar, so are the folklore, dances, arts, crafts and mode of dressing. As in any evolving and developing community where there is influx of people, there are noticeable signs of alteration in the socio-cultural system of the communities.

The high humidity of the climate does not allow for preservation of archaeological artefacts in the area. Moreover, termites and other insects would not permit preservation of wooden artefacts. Stone objects are rare in the area because rocky formations are not part of the geological heritage. Sacred sites are routinely out of bound to strangers and some indigenous elements alike.

Demographic Studies

Population Description

Ekeremor and Southern Ijaw Local Government Areas occupy land size of 1,810km² and 2,682km² respectively. The Nigeria 2006 Census estimates the population of the Ekeremor LGA at 270,257 with males constituting 51% (137,831) and females 49% (132,425), but with a population growth rate of 2.5% the population figure is estimated to be 502,758 comprising

(256,406) males and (246,351) females as at 2013. For Southern Ijaw LGA, the 2006 figure stood at 319,413 comprising 256,406 males and 246,351 females, which increased to about 594,202 with males comprising 303,043 persons and females 291,159 persons in 2013 (Fig. 4.2.9.1). This suggests an increase in population of the study area with implications on increased demand on social amenities.

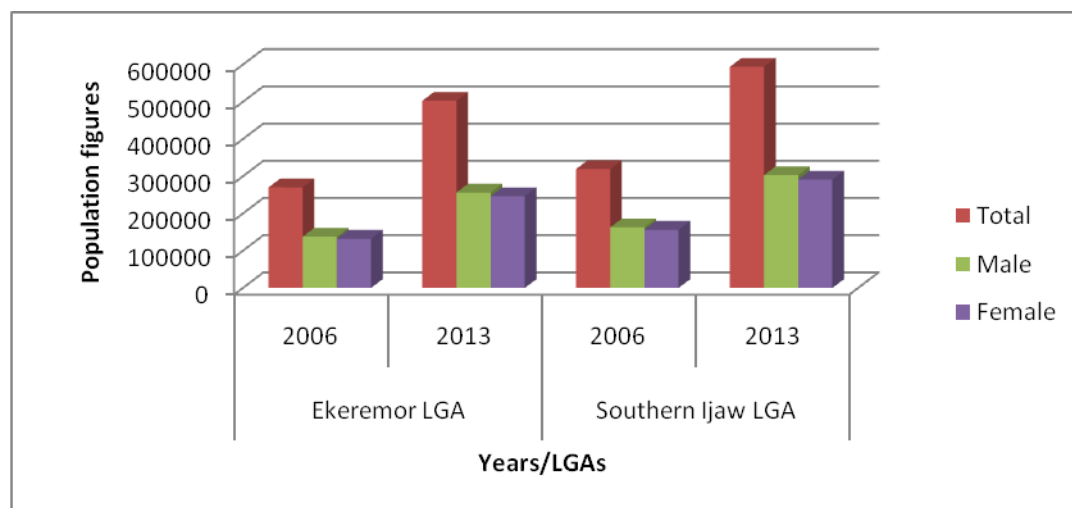


Fig. 4.2.9.1: Population of Ekeremor and Southern Ijaw LGAs of Bayelsa State

In the Niger Delta region it is noted that there are slightly more males than females. The coastal area from the Pennington River to the Ramos River is home to numerous communities. A realistic appraisal of the population of the communities will in all cases include the population of the primary community with the satellite settlements. As in the case of macro population of the entire LGAs, the population in the communities has been on the increased. Table 4.2.9.1 shows the estimated population of some of the communities as at 2003 and the 2013.

Table 4.2.9.1: Estimated population in some of the coastal communities

s/no	Community	Population (2003)	Population (2013)* based on growth rate of 3%
1	Letugbene	5000	6720
2	Ekenie	4040	5429
3	Agge	4000	5376
4	Bisagbene	3000	4032
5	Ezeati	3000	4032
6	Bilabri (1&2)	2500	3360
7	Azamabiri	2000	2688
8	Orobiri	2000	2688

As shown in Table 4.2.9.1, the population of the area has increased following the natural factors that influence population dynamics, which are birth rate, death rate and migration. In most Niger Delta communities, the high birth rate is kept in check by a high mortality rate especially among infants and the elderly who are vulnerable to premature death due to lack of basic health care facilities.

Sex ratio structure

Information on secondary sex ratio in Niger Delta region of Nigeria is limited. Certain factors like cultural practices, seasonal variation, small-family size policy and sex selective technology have been known to influence sex ratio structure (Eneni *et al.*, 2013). Sex ratio is the ratio of males to females in a given population, usually expressed as the number of males for every 100 females (Haupt and Kane, 2004). As usual in the Niger Delta region it is noted that there are slightly more males than females in the states, LGAs and the communities, based on the NPC census of 2006. Surveys carried out in the course of the Niger Delta Master Plan development process show that there are actually more males (54%) than females (46%) in the Region.

Sex distribution of the population in the study environment reveals a slightly male dominant structure in the ratio of approximately 1.13:1. In a recent work carried out by Eneni *et al.* (2013), it is revealed that between April 2007 and March 2012 the annual average male to female sex ratios were 1.24, 1.89, 1.3 and 1.34 for 2008, 2009, 2010, and 2011 respectively in Bayelsa State (Fig. 4.2.9.2). When pooled together, the average ratio was 120:100. This shows some bias for male births and the difference shown to be statistically insignificant ($P > 0.05$). Data also indicates less male birth in the peak period of rainy season and the highest male to female ratio in harmattan season, suggesting a seasonal variation of sex ratio. These findings further confirmed that male –female sex ratio is higher in South-south when compared to those of southwest Nigeria or other regions in Nigeria as well as other populations of African origin.

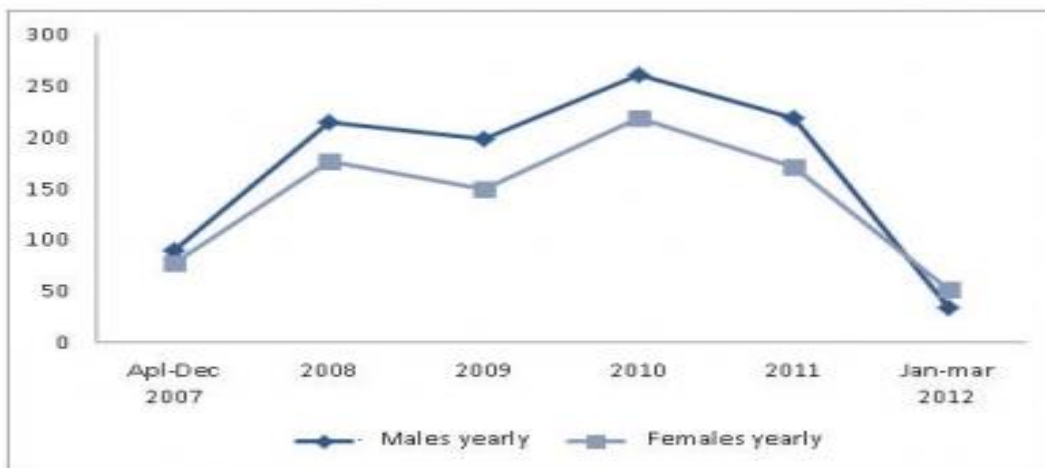


Fig. 4.2.9.2: Sex ratio structure in Bayelsa State (2007-2013)

Marital status, household size and Household Composition

Fig. 4.2.9.3 reveals increase in the number of married persons in the neighbouring communities between 2008 and 2012. About 65.2% of the communities' members were married in 2008 which increased to about 81% in 2012. For the married, polygamy is preponderant in the area accounting for 71.4% and 65.8% in 2008 and 2012 respectively with one man having 2-4 wives. The declined rate of divorced household heads in the area between 2008 (6.4%) and 2012 (1%) is an indication that the indigenes valued marriage.

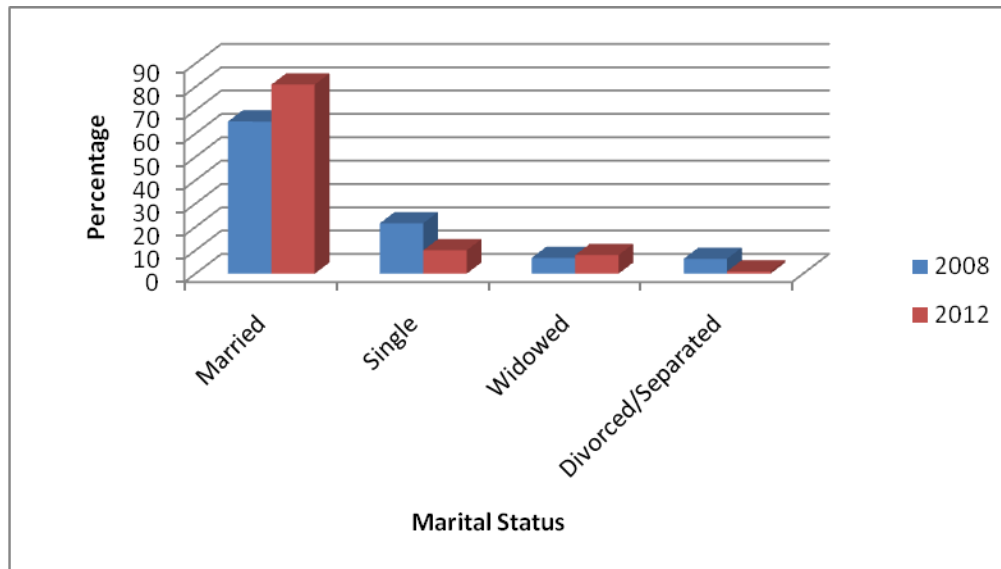


Fig. 4.2.9.3: Marital status of the Households in the project neighbouring communities

Household size Structure

The size of families differs from community to community, influenced in large measure by the cultural attitude of the people, economy of the settlement and educational status/awareness of the resident population amongst other factors. The 2012 field survey showed an average of 6-8 persons per dwelling unit with about 37% households having between 7 and 10 persons in a family as against 46.2% of households in 2008 having 7-10 persons (Fig. 4.2.9.4). The results suggest that the communities are largely dominated by youths and agree with findings of EIA of SSAGGP (2003).

A total of 3,919,364 households were enumerated during the preparation of the Niger Delta Regional Master Plan Development with an average household size of 7.4, but with more than 70% of them having an average of 8 occupants. Large households were found more prevalent in the rural areas (NDDC, 2006).

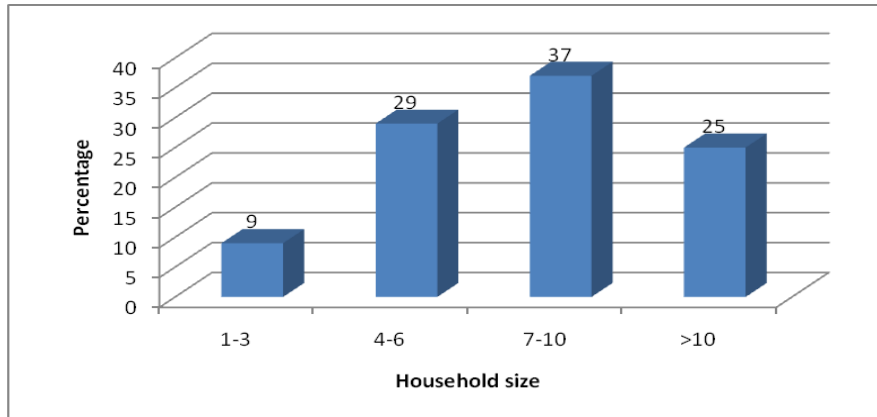


Fig. 4.2.9.4: Family size in typical coastal communities

Age Distribution structure

The household age structure and distribution in Bayelsa State conforms to the overall Nigeria’s pyramidal structure. The Niger Delta population is rather overwhelmingly loaded from the lower age-cohorts. The socioeconomic sample survey of the most coastal communities and settlements showed that persons below the 26 years age bracket constitute an overwhelming percentage of approximately 63 percent (Fig. 4.2.9.5). In all, children are proportionately more while the aged (>60 years) are fewest in the population. A comparatively high proportion of people below the working age also tend to reduce labour input per capita and income per capita (UNDP, 2006). The active age involved in economic activities contributing to family income is 35%. The rest are either children of school age or very old people. The overall implications of the age profile is that the population is young and growing and places a heavy burden on the adult population, a high dependency ratio, as well as huge unemployed human number. More importantly, the provision of educational facilities and health care services are paramount in the study affected area to accommodate this young population.

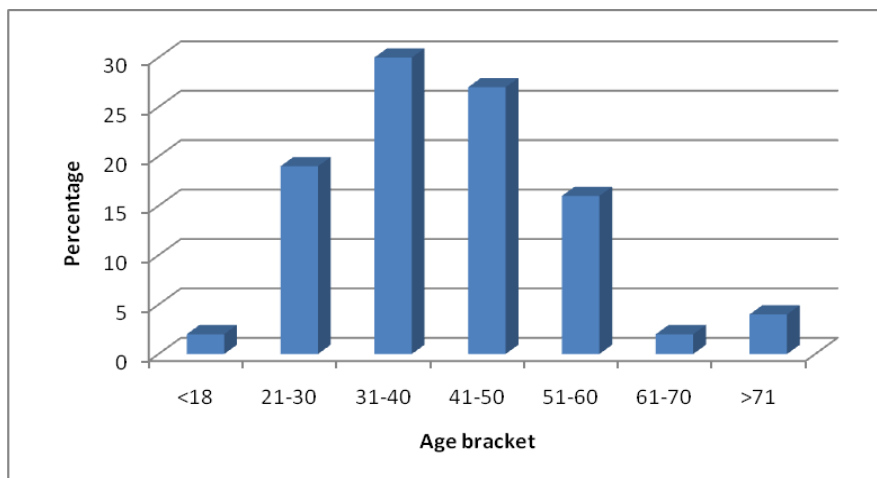


Fig. 4.2.9.5: Age Structure of sampled respondents at project neighbouring Communities

Educational structure

An overview of the current state of education in Bayelsa State reveals, there are 537 primary schools in Bayelsa, with Ekeremor and Southern-Ijaw LGAs having 86 and 131 schools respectively. Over the years, these schools are characterized by low completion rate, and high dropout rate arising from inadequate teaching staff both in quality and quantity, dearth of educational inputs and the peculiar riverine terrain which makes the deployment of teachers in rural schools very difficult. Besides, whereas the schools for migrant fishermen only exist in the statute books, they are non-functional. The same ugly fate has befallen the vocational and adult schools in the State.

These challenges have reduced the morale of teachers, attenuated educational standards and consequently increased the illiteracy rate. The teacher's population in the State totals 3031 qualified in the primary schools level, with Ekeremor and Southern Ijaw LGAs having had 261 and 519 teachers respectively as at 2009. From the above data, there is significant manpower gap; this lacuna requires training and retraining the teachers.

Bayelsa State has the lowest educational attainment and literacy level, especially among the female gender in the south south States. Africa Health, Human and Social Development Services report recently released, placed the State among the educationally disadvantaged states in the federation and having high incidence of both under age marriage and under age child bearing. Irrespective of the dismay literacy level in the state an appreciable proportion of the population in the coastal communities has received some formal educational training. The modal educational attainment amongst the population in the communities is primary educational level. Result from the 2005 field survey showed that about 58% of the total respondents claimed to possess primary education, 35% secondary education and 5% tertiary education. Only about 2% of the sampled population claimed to have no form of formal education (Fig. 4.2.9.6). However, the low level of those with tertiary/post-secondary education may be because of limited job opportunities in the past, coupled with limited access to the creeks due to water transportation problem and predominantly fishing occupation of the indigenes. This is commendable considering that educational facilities are relatively absent and not within easy reach of those desirous of this necessary service.

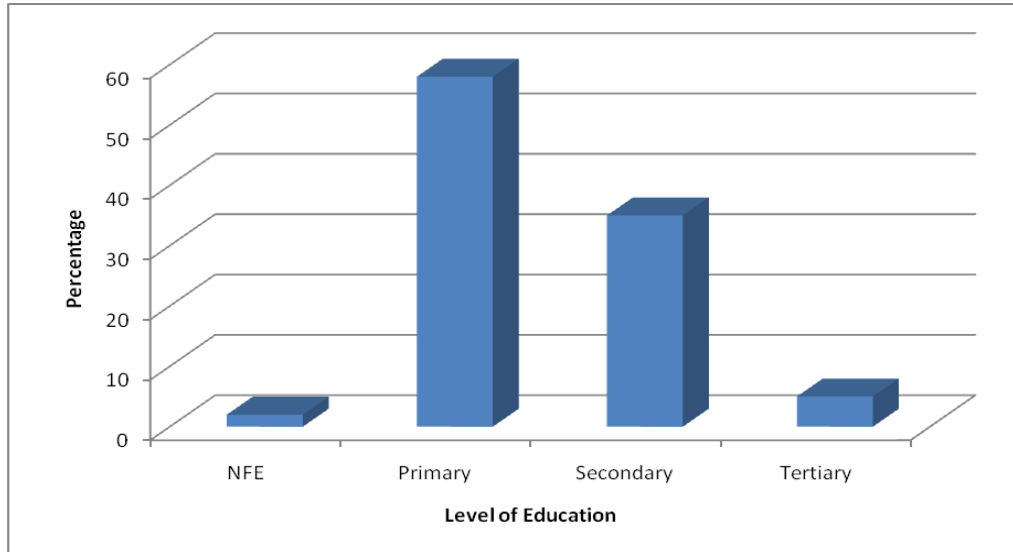


Fig. 4.2.9.6: Educational attainment in the project neighbouring communities of Bayelsa state

In 2012, the government declared free primary and secondary education in Bayelsa State. This is the first time an all-inclusive pronouncement of free education was proclaimed in Bayelsa State since its creation 15 years ago. The pronouncement was predicated on the fact that Bayelsa State has remained acutely disadvantaged since creation. It is expected that the fortune of educational level and literacy level would have changed with attendant positive impacts.

Economic characteristics and livelihood

Occupation and Employment Status

Agriculture is the main source of livelihood in the area. The people are predominantly fishermen and farmers although others engage in trading and civil service employment (Plate. 4.2.9.1). Some are into Oil and Gas services as contractors to SPDC, Chevron and other operators in the area in providing services such as surveillance, Right of Way maintenance, civil and mechanical works. The competition for Oil and Gas contracts is very fierce because there are limited livelihood opportunities.

The occupational distribution (Fig. 4.2.9.7) suggests different occupations or income generating activities exist in the communities. Based on the 2012 field survey majority (43.8%) were fisher folks, 17.7% and 15% were into both crop farming and trading as major occupations as against 58%, 10% and 10% in fishing, trading and farming respectively as at 2003. Though there is reduction in the number of fisher folks between 2008 and 2012, fishing is still the dominant primary source of income for the residents of the coastal communities. There is virtually no single person in the communities who is not knowledgeable in the art of fishing; even the children of primary school ages have considerable experiences in fisheries activities. Fishing is conducted along the surrounding creeks, rivers, slots/canals and deep into the Atlantic Ocean. Fishing techniques employed remains largely unchanged from the baseline condition and

includes hooks, lines, cast nets, drag nets, sweep nets, fish traps and conical baskets. Trading is largely undertaken by women and trading items include fish in fresh and roasted forms, foodstuffs, confectionaries, etc. In the recent times, there has been increased demand for exotic ice fish in the communities with concomitant increase in the supply/sale. The traders sourced these iced fishes from Warri and Yenogea towns and market them in the local markets.

Mixed cropping is a dominant feature of the farming system of the area. Common crops grown include maize, cassava, yam, plantain, banana, and vegetables such as okra and fluted pumpkin. Simple farm tools, such as cutlasses and hoes characterize the crop farming system in the area.

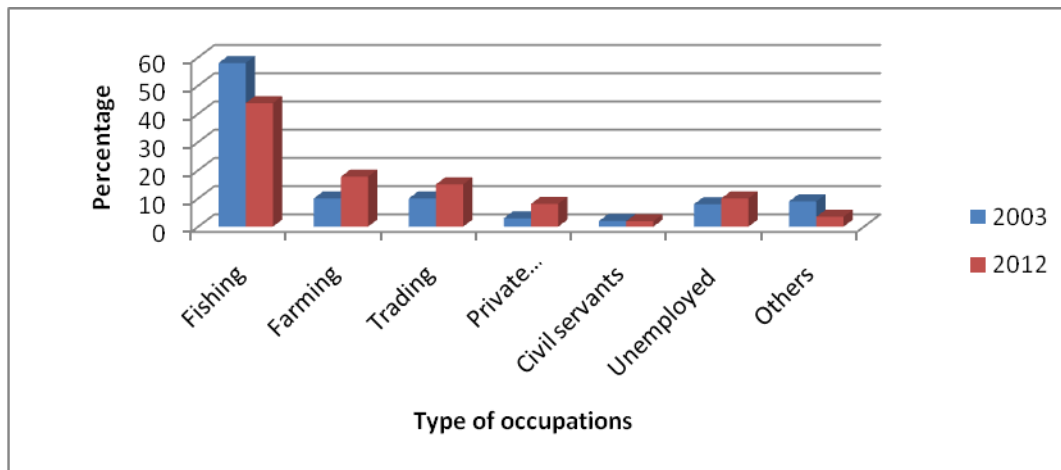


Fig. 4.2.9.7: Major occupation structure

The observed level (10% of the studied sample) of unemployment rate may account for a high level of youth restiveness and continued illegal bunkering activities observed in the area. Some factors contributing to youth unemployment include:

- Lack of local industries to create employment;
- Lack of marketable skills due to non-availability of vocational skill development programmes;
- Inadequate mobilization, support and incentives for self-employment through Small and Medium Enterprises (SMEs);
- Lack of poverty-reduction programmes such as micro-credit schemes in the region;
- Abandonment of traditional occupations, which are low yielding, fraught with hardship and no longer command respect;
- Attraction for better paying and more dignifying jobs in the oil sector;
- Limited job opportunities provided by oil and gas sector; and
- The boom and bust patterns of oil company temporary contract jobs, resulting in long periods of prospecting in between short spells of work.

Respondents appeared to be quite experienced in their occupation as shown in Table 4.2.9.2. About 51% had more than one decade experience in their jobs while about 11% had between 1 and 5 years of working experience. An interesting implication of this is that the individuals would be quite familiar with the challenges associated with their current economic activities.

Table 4.2.9.2: Working experience of respondents

s/n	Experience (Years)	Percentage
1	Unemployed	10
2	1-5	11.0
3	6-10	28.0
4	11-20	31.0
5	21-30	18.7
6	>30	1.3
Total		100



Plate 4.2.9.1: Livelihood earning activities in the project neighbouring communities

The community does not enjoy the abundance of skilled labour as obtainable in the local government headquarters and other large settlements. Skilled labour does not abound and most of the tertiary graduates seek employment in other communities and towns. The artisans who exist are mostly in the areas of carpentry, welding, hand crafts, tailoring, commercial boat driving, and hair dressing. Unskilled labours abound and are mostly engaged by NGOs and companies as helpers. There was a general concern for the lack of skill development centres.

Quality of Life

Income and Expenditure Levels

Personal income levels of self-employed rural households is always difficult to assess because many local people do not keep records and are therefore uncertain of the gross or net amount actually earned from self-endeavours. Some who may have information about their earnings are also not willing to divulge such sensitive data, fearing the effects of taxation. The consequence is that incomes of rural householders are very unreliable. The non-existence of income and expenditure receipts among households made some respondents to over- exaggerate their income while others under-estimated theirs depending on how they perceived the implications of the questions. Those who believed that the figures might be used as a basis for the payment of compensation in the future normally over-exaggerated their income while others thought it was better to paint a pathetic condition of abject poverty.

In most riverine communities of Niger Delta, incomes range for a weekly mean catch of “small fishing” is between ₦4,000.00 and ₦10,000.00, using hand-pulled canoes, with a monthly average income of about ₦80, 000.00 (SPDC, 2001; SPDC, 2011). However, in the project neighbouring communities, an examination of the income level (Fig. 4.2.9.8) reveals that majority 13.5% earned ₦5000 and below weekly, about 30.8% earned ₦5000-10,000 while 16.9% earned ₦11, 000 -15,000, but the average weekly income is estimated to be about ₦15,450.00. Respondents however noted that the income range is not consistent throughout the years as it changes with the seasons and festivities.

Household expenditure followed the distribution of income level as shown in Fig. 4.2.9.8 in the study area. About 24.2% households spend between ₦5,000.00 and ₦10,000.00 weekly while about 12.3% spend less than ₦5,000.00 weekly. Only 1.6% of the households spend over ₦30,000.00 in a week and the average expenses per household amounts to about ₦13,971.00. The observed expenditure profile in Table 4.2.9.3 clearly shows that over 50% of household income is spent on food for the family, 20% spent on transportation/communication and less than 20% for human development. This distribution pattern is common for households that are considered to be living below acceptable poverty threshold. The EIA SSAGG of 2003 noted that most community residents were subsistence in their livelihood pursuits i.e. producing largely for themselves and selling only the little surplus they had from their fishing and farming activities.

Table 4.2.9.3: Expenditure Profile of households in the area

S/N	Expenditure Profile	Percentage
1	Feeding	51.0
2	Clothings	5.4
3	Medicare	4.3
4	Education	11.1
5	Social/transfer	8.1
6	Communication/Transport	20.1
Total		100

The pattern of both income and expenditure distribution provides insight into the standard of living/quality of life of the project neighbouring communities’ residents. Given that the average household size in the area is about 8 persons per family, it therefore implies that in a week per capita income and expenditure is about N1, 927.50 and N1, 746.37 respectively. Therefore, on the bases of one dollar or N160.00 per day poverty line thresholds, it can be inferred that majority of the residents are relatively poor. When asked to self-evaluate their poverty status most ranked themselves as very poor (71.9%) while 28.1% saw themselves as being averagely poor. Interestingly none perceived themselves as being non-poor. This self-evaluation by the respondents and the proportion of income spent daily, gives an insight into the high rate of poverty prevalent in the communities studied.

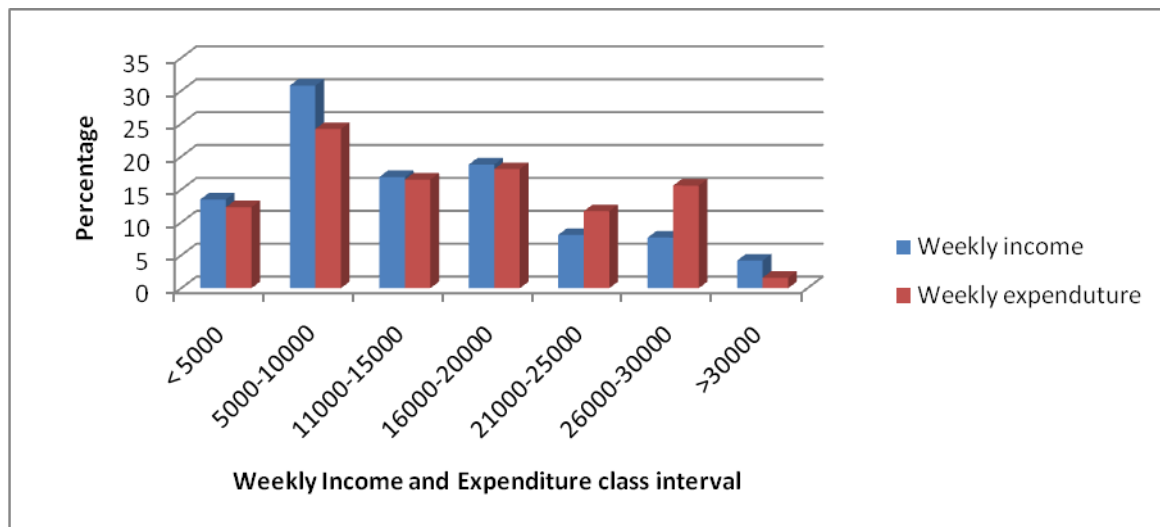


Fig. 4.2.9.8: Weekly Income and Expenditure distributions

Source: EER Sea Eagle, 2012

Household Asset Ownership

A typical household in the communities lacks modern home assets probably because of low household purchasing power and temporary nature of settlement. Besides dug-out canoe, which

is virtually owned by all the households, about over 69 % of the households possess sets of Radio. Also, according to Table 4.2.9.4 few members of the community possess valuable household items such as television (4.6%), Engine boats (3.1%) and generating sets (2.7%). Only about 5.2% of the respondents claimed to have purchased and have titled ownership to farmland.

Table 4.2.9.4: Household Assets ownership structure

s/no	Household Assets	Percentage of ownership
1	Beddings (mattress, pillow, etc)	43.6
2	Radio/ Dc Players	69.2
3	Television	34.6
4	Freezer/Fridge	3.8
5	Cushion Chairs	1.3
6	Generating set	2.7
8	Dug-out canoe	96.9
9	Engine boat	3.1
10	Land	5.2

Energy for Cooking

Energy for cooking is mainly from firewood cut from the mangrove forest. The modal fuel or primary energy source in the communities is firewood (a mean of 73%), followed by kerosene (24.8%) and gas (1.2%). This has led to the gradual depletion and destruction of the mangrove with its environmental and economic costs. Therefore, the general sources of household fuel are firewood, charcoal, kerosene, gas, electricity, crop residues, animal waste and others.

Housing Types, Pattern and Quality

Qualitatively, rural and urban housing in Niger Delta falls below minimum standards in all aspects, especially in the swamps and creeks where dwellings are made up largely of mud walls, and stilt or strip foundations (UNDP, 2006). There are several factors, which may be used in assessing the quality of housing, including liveability, level of comfort afforded, safety, and ease of maintenance. These factors include wall and roofing materials, as well as household facilities.

Traditionally, most Nigerians (about 80%) live in their own houses, which are constructed of locally available materials (NEST, 1991). These include mud walls and bamboo and thatch roofs particularly in the rural areas and cement blocks and corrugated iron sheets/zinc roofs in the urban areas. The settlements exhibited similar housing patterns and local architecture. There are very few houses depicting modern architectural design and these houses are known to be owned by one single person. Settlement pattern observed in the communities is predominantly linear.

The housing quality is generally poor. Most of the houses are built of ephemeral materials such as reeds and thatch (Plate 4.2.9.2). Along the shoreline, the houses are built on stilts, which although fairly durable, are physically very fragile and aesthetically unattractive. Eighty six percent of the community members live in their own houses, while 13.4% live in rented accommodation. Most of the houses are built with blocks with either zinc or asbestos roofing. However, there are several communities where the majority of the houses are made of mud, bamboo and thatched roofs.



Plate 4.2.9.2: Typical Residential housing in the coastal communities

With regards to sanitary condition of the communities, drawing from data from the National Bureau of Statistics (2009), the most widespread methods of waste or refuse disposal are disposal within household compounds and disposal in unauthorized heaps. Domestic wastes are disposed of indiscriminately in and around the communities in bushes, water bodies (rivers streams and creeks). Human sewage disposal is mostly by pit latrines and in the open, in nearby bushes or directly into the water bodies for most communities living along watercourses. Thus, the commonest toilet disposal system is the pier system (Plate 4.2.9.3).



Plate 4.2.9.3: A typical overhung toilet in Ezetu community

Social and Infrastructural facilities

The level of infrastructure and amenities available and functional in any area or community has direct implications on the quality of life in that area, and therefore the willingness of people to live and remain there. The availability, accessibility and functionality of social infrastructure explain the extent of socio-economic development of the people. It is a well-known fact that the available social infrastructures and services in the Niger Delta communities are inadequate and of poor quality.

School and Educational Facilities

Most project communities have primary and secondary schools, many of which were government owned while few are private owned. There are 12 primary schools distributed evenly in the communities and 2 secondary schools located in Letugbene and Ezetu (Plate 4.2.9.4).

Regardless of the school ownership, these schools suffer from inadequate staff and facilities such as tables and chairs. Across the communities, the inventory of educational facilities is far from adequate and nearly all school facilities are in different states disrepair, requiring major rehabilitation. None of the schools had a functional staff quarters for teachers.



Plate 4.2.9.4: Community Comprehensive Secondary School in Ezetu

Potable Water Sources and Facilities

Most communities lacked potable water. Thus, most communities have to depend on river water as their major water source, which has implication for health as it is not uncommon to see the same river being used for waste disposal. Some communities noted that a reason for their lack of borehole water was because past attempts to drill bore-hole water in the community only produced salty water which is unfit for human consumption. They believed if the bore-hole is drilled to the proper depth they would get fresh water.

Data from the Federal Office of Statistics, (now the National Bureau of Statistics), reveals that water in the majority of Niger Delta States comes from unsafe supply facilities, including rivers, lakes or ponds, unprotected wells and boreholes. The Bureau classifies available sources of potable water for household consumption as: pipe borne, untreated pipe, borehole, protected well, unprotected well, river/lake/pond, vendor trucks and other categories. A safe and reliable water supply is currently available to only a small fraction of the population in the Niger Delta Region. In the supply systems surveyed and reported in the NDRDMP Report (NDDC, 2006), approximately 8% of the population actually enjoys water supply in urban and rural centres, while only 3% of the population in rural villages were actually served by the supply.

Electricity and Power Sources

Few communities like Bilabiri (1 and 2) with electricity claim supply is irregular. Available electricity infrastructures in some communities remain in poor condition either due to vandalism or breakdown. It is pertinent to note that none of the communities with electricity is serviced by regular public power provider or PHCN. Rather electricity is supplied by oil companies operating in the areas through the giant generating sets donated to the communities, especially Chevron. However, the twin problems of frequent break down of the generating sets and lack of diesel make it difficult to have regular power supply from these facilities. According to the NBS (2009), on average, only 34% of people living in Niger Delta communities use electrical lighting; 61% use kerosene or a lantern. Less popular sources of lighting are gas (1.2% on average), a generator (1.5%), batteries (0.2%), candles (0.6%), firewood (1.8%) and others (1.2%). However, due to the increasing influence of urbanization, the usage rate of generator is increasing.

Transportation and Communication

Located by the water side and surrounded by water, these communities are accessible only through water using hand-dug canoes and the popular fibre or outboard engine boats usually fitted with various grade of HP engines. Marine transport to the coastal and riverine settlements can be cumbersome, risky, and costly. For instance, a 20 litre fuel that cost about N2000 in other states in the south cost about N4000-45000 in the project area. The rough water is a cause for concern; while low tide constrains attempts to access some of the settlements via the creeks since these are influenced by the tidal regimen of the ocean. There are no concrete landing jetties in the villages. Cargo boats used by the women for trading navigate the rivers and creeks during high tide.

Communication via telephoning is grossly difficult even though different GSM providers' masts are located in the area. Telephone networks are weak and inerratic, and signals are mostly received when GSM users either climb trees or stay at specific locations.

Waste Management

In many coastal communities, there are no organized and sanitary waste management systems. Most houses in the study area lack modern convenience or waste disposal facilities. The usual waste disposal method is in the bushes behind homes and/or directly into the river. This applies to both human and other domestic waste. No doubt this constitute a serious health hazard considering the fact that the river remains largely the source of water for drinking and other domestic purposes such as bathing, washing etc. SPDC had assisted to some extent in this regard by providing public toilet facilities in communities like Bilabiri.

Other infrastructures

The presence of financial institutions, markets, agro-allied processing facilities, cooperative organization, police post/stations in these communities is rather inadequate and poorly established. Based on the field visits reports for 2012, none of the settlements was found to be serviced by a bank, police posts/stations, agricultural extension facilities and research institutes. Local markets are common in the area where buyers and sellers meet periodically to engage in commercial activities, but the shops are in deplorable stages (Plate 4.2.9.5). The most common processing facilities are family owned fish processing facilities. To strengthen social capital, fisher folks and farmers have formed co-operative societies, mostly along family ties.



Plate 4.2.9.5: Ezetu Central Market

Local Governance and Social Structure

Leadership structure

There are two levels of political organizations, the first being formal governmental and the local/traditional administration. The second level of political organization consists of three tiers of authority- the traditional ruler and his Chiefs, Community Development Committee (CDC)

executives headed by a chairman, and the youths. The pattern of traditional institutions and local governance observed in the area are ideologically uniform in all the communities. The power structure of each community has at the apex a (traditional) paramount ruler, who is assisted by Council of Chiefs, Elders, Community Development Committee CDC and Youth Executives in ensuring effective local governance and decision making process. Women groups have since being integrated into the power structure of these communities and is known to have remarkable socio-cultural influences on the society.

There exists a strong leadership structure at the community level in the study area. The political administration is well structured. The CDC, youth and women leaders report to the traditional leader/chief council. It should be borne in mind that the CDC and/youth chairman wields great authority at the community level. Every project activity must of necessity get the approval of this leadership arms if it is to be successfully implemented. These positions are considered financially lucrative and have a constituted a source of clash at the community level especially in deciding the next leadership. Fortunately, some communities have evolved a tenural arrangement especially for the position of Youth Chairman by pegging the leadership duration at one year without option of recontesting. This, no doubt, has greatly contributed to the existence of peaceful transition from one leadership to the next. These tiers of leadership structure align with other studies (EIA of SSAGG of 2003 and EIA of Benisede Catchment Area Phase I 2004) in the area suggesting no change in community leadership structure over the years. This implies a sense of leadership stability at the community level.

The paramount ruler is called or addressed as the Amananawei or king appointed by the Royal House. He is assisted by the council of chiefs Council of elders, Community Development Committees (CDC), the youth council and women council. The power flow of the study area is presented in Fig. 4.2.9.9. The Council of Chiefs consists of traditional chiefs among whom a chairman is elected. Their responsibility is to ensure peace, progress and stability. The elder's council are made up/drawn for the oldest members of individual families; old men of proven integrity and impeachable characters.

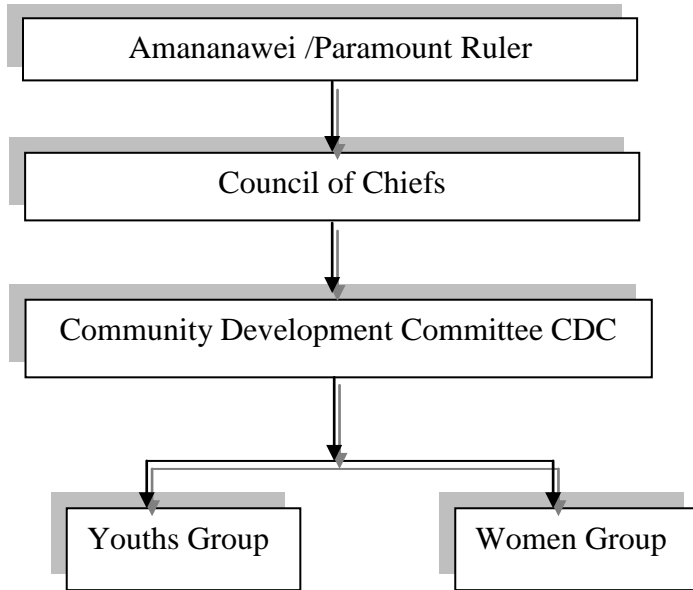


Fig. 4.2.9.9: Power Flow in the Study Area

The role of Youth and Women Group/Association

The youths of the area are quite active and their most significant role is in the mobilization of the youths for development and in the sensitization of the community about political issues and government projects. They are more vigilant and appear to be in control over information input and dissemination. They are responsible for swift coordination of activities and alertness in the event of day to day running of the community affairs especially when confrontational actions are involved. Like the CDC, the youths are formidable pressure group. They maintain law, order and security in their communities.

In the study area, there exist a number of women groups. Their associations are usually welfare oriented; they render financial and moral assistance to members that are in need. They pursue peace in the land and also carry out sanitation exercises to keep the environments clean. Women also play major role during ceremonial functions such as festivals, marriage ceremonies and burials.

Joint meetings between the various bodies are held from time to time to discuss various issues affecting the communities. It can therefore be stated that the political administration and local level of governance in the coastal communities is basically traditional, title holding, executive committees and group association, local power authority and the direction of flow of power is clearly exhibited, in general the traditional authority is valued with utmost significance. The basis of social stratification is the age of the individual, education and social attainment.

Conflict Management and Resolution Mechanism

As in any social environment and in oil producing communities, there are various cases of both internal and external conflicts that have exerted influence on the social structure and relationship among individuals as well as between the community and oil producing companies, especially SPDC. Internal conflicts are mostly related to domestic issues, land disputes, election of youth executives, compensation matters, and occasional chieftaincy disputes. However, the major party of external conflict that the community has is with SPDC. The major causes of conflict between the communities and SPDC includes the following:

- Non-recognition of communities,
- Oil spills,
- Border/land disputes,
- Agitation for employment,
- Non-payment of compensation.

Others include non-compliance with court rulings and orders, failure to honour MOUs, perceived intimidation of the communities, perceived “divide and rule tactics” and ineffective communication channels (SPDC, 2008). The remoteness of the swamp location and inadequate transport infrastructure means that opportunities for other rewarding enterprises are rare. There is high level of youth unemployment and reasonably high tendencies for restiveness in the area. The perceived injustice in the allocation of national revenue, long-standing marginalization of the Niger Delta and the resource control agitation provide the ingredients for youth restiveness and insecurity. Strategies used in resolving these conflicts in the communities include community meetings, elders-in-council, dialogue, oath taking, appeals and summons, youth council, women councils, the police and courts. There are procedural guidelines for conflict resolution and management in these communities. These include:

- Adjudication by the traditional customary process
- Dialogue
- Reaching of consensus
- Proclamation of sanctions
- Administration of fines such as payment of fines with such things like wines/drink, goat and of cash depending on the adjudged magnitude of the offence
- Administration of oath of sincerity and allegiance to the interest of the community
- Use of law enforcement agents e.g. Police, local police or vigilante.
- Use of court
- Banishment of the culprit for a specified period of time

In the event that a matter is not resolved on the spot when the community member runs afoul of the law, the matter is handed over to the lower organ (youth and women) i.e. action group and the deviant are punished according to the gravity of the offence. Serious cases therefore involve meting out serious punishments including ostracism or handing over the criminal to the police. In

most cases or more often than not, cases/disputes were amicably settled without resort to the police or court proceedings.

Social Grouping

The need to have institution, relationships, and norms that shape the quality and quantity of the communities' social interactions have been the propelling factor for formation of social groupings. There are social groups/clubs in the communities e.g. cooperative societies, women club, fishing club and credit groups. These clubs/groups are organized on the basis of common interest and affiliations and also mostly on gender basis. The women with common social identity like marriage or visions such as fostering, friendship and solidarity within their community can form their own social clubs.

Typical women social clubs have lot of cultural trappings which are usually indicated in their names and strict adherence to traditional dresses at public functions. Entertainment through dances at social functions is another area of culture which is commonly practiced by the social clubs. The social clubs provide mutual support for their members in times of child birth, marriage, bereavement and other festive occasions. They also provide common fronts for support of community development programmes, donations of equipment, physical infrastructures and other items for public use. Women are also known to intercede for peace during inter/intra community crises.

As is the case in other Niger Delta communities, there are also age groups in the study communities and each age group embraces children born within a period of three years. The contributions of age groups are generally recognized but their direct roles/responsibilities and involvements in developments differ from community to community. In some communities, they have contributed to the development of physical infrastructures. Generally, they are effective vehicles for social mobilizations and they also offer mutual support for their members during times of bereavement and festivities.

Local Security Arrangement/Management

The youths of oil producing communities are vibrant and militant and are in-charge of labour, security and protection of their environment, swift co-ordination of activities and alertness in the events of the day to day running of the villages/communities especially when confrontational and security issues are involved. They were solely in-charge of security and defence of their communities prior to the militancy period but with the upsurge and escalation of militancy in the region, the region has been militarized with the Joint Task Force (JTF) taking over the security and defence of the Niger Delta to protect life and property especially multi-national oil workers and installations in the rich oil and gas region of the Niger Delta.

Historically, the study area was generally very peaceful until the problems of militancy in the 1990`s and 2000s. In the recent years normalcy has returned to the communities, though occasional fears are still being entertained because of the sporadic nature of attack in the Niger Delta. The reported social vice in the area include: piracy, pipeline vandalisation, petty stealing and prostitution are fast becoming routine activities.

Natural Resource Acquisition, Ownership and Management

Land Ownership/Access and Tenure System

By providence, in and around the communities and settlements, land resource availability is very limited because of the overwhelming influence of hydrology; myriads of rivers, creeks and creeklets criss-cross the terrain, leaving very limited land space either for habitation or cultivation. Consequently, the little land available is held in very high value, especially since lands on which oil wells and facilities are located confer additional advantages on the land-owning individual, family or community. Two forms of land-ownership are common in the study area under study, namely, *family* and *communal land ownership*. In most communities land is not available for sale, as it is communally owned. Inter community strife over land rights is uncommon in the area. The only significant dispute over land was between the people of Letugbene and Agelabiri over ownership of the land where the SPDC Tunu flowstation is sited but this was since resolved. Responses from 2012 survey carried out in coastal communities in the area affirmed that the structure of landownership as observed in 2012 has not changed significantly from what was tenable in 2008. Result confirmed nature of landownership to be mainly through family inheritance; approximately 96% claimed to have personal land as opposed to 4% that claimed communal landownership.

Forest and wildlife exploitation

The primary source of energy for cooking in the community is fuel wood which is sourced from the mangrove swamps. The red mangrove is very good for making fire and is especially important to fish smoking and for canoe carving. More than 90% of community members use firewood as energy source, only about 10% use kerosene for cooking. Some members of the communities are engaged in hunting as a source of livelihood, a few others as past time. The wildlife provides the much needed proteins, vitamins and mineral salts and also income for the people.

Local conservation practices

As already noted, members of some communities do not kill or eat python, tortoise and white birds, rather their habitats are protected. Equally, sharks are neither killed nor eaten but worshipped as a god. Even though the community members are not doing this as conservation practice per say, it constitutes or serves as a means of conservation of the natural resource base.

Lifestyle and Social Vices

Alcohol and Drug Use

Based on the opinion of key informants, the level of use and abuse of alcohol and drugs have increased in Niger Delta communities over the years, as more young persons are involved in alcoholism and drug use. About 87% of the community members drink alcohol especially local dry gin and about 55% of the young male smoke cigarettes. Alcoholism is becoming a lifestyle in the coastal communities as well as smoking of cigarettes, Indian hemp especially among the youths. It is common to see youths smoking and drinking strong beverages opening in the public places.

Discrimination against Women

There appears to be some level of discrimination against women. For example they have no inheritance rights to land/buildings. However, they are allowed to contest or hold some political positions. The observation at the community level was that women leadership role is expressed within women groups. Only few respondents agreed (25.4%) that women are indeed given the freedom to contest political positions. Some community members interviewed noted that women do not wield real power at the community level.

Child Labour

Child work as an aspect of child entrepreneurship instead of child labour was a common feature in the communities as children are known to assist parents in their economic activities. Children were seen to help their parents in fish catching, processing and in cutting firewood required for fish processing and this did not affect the school enrolment, retention and completion of the children. This was not perceived as an abuse; though parents succinctly accepted the responsible of caring for their wards, but current realities suggest that assistance of all household members is required to sustain the home economically.

Crime Rate

The level of crime is moderate. The commonest crime in the area is crude oil theft. Across the coastal communities, the lack of employment opportunities for the teeming youth members is a constant complaint. Statistically, approximately 90% of respondents interviewed in many previous field surveys confirmed this as the most challenging social problems in the area. The number of youths observed to hanging around the oil facilities attested to the prevalence of the problem. Lack of gainful employment can effectively account for youth delinquency and other anti-social activities such as the rampant stealing and illegal bunkering activities in the area. It was therefore, not surprising that some youth members are always very aggressive and are always suspicious toward visitors.

Physically Challenged People

The study examined the status of the physically challenged in the communities. Although physically challenged persons are fully assimilated into the communities, no designed programs are in place to assist them. These people are often left to fend for themselves and can only expect support from family but all are completely absorbed/ assimilated into the system in the communities, nevertheless there are no programmes specifically designed to assist them. Obviously the physically challenged, which are acknowledged to exist in the communities, are left to fend for themselves and can only expect supported from families within the community. According to the elders, the foundation of the communities is built on justice, equity and fair play.

Perceptions, concerns and social needs/expectations of the population

People’s Support for SPDC Project

The general populace in the Niger Delta communities have a mixed outlook on the presence of the SPDC facilities. Responses from the community members (elders, women and youth respectively) affirmed varying perceptions with respect to positive and negative impacts the SPDC project have on the communities, resulting in respective degrees of support. Field survey revealed a generally wide support for the project (Fig. 4.2.9.10) dut to its envisaged benefits. About 70% gave their full support while 18.5% said their support was with reservations. Similarly 11.5% had little support for the SPDC project. Their lack of full support was borne out of fear that the project usually end up benefiting few individuals in the community. Equally of concern was that the proposed benefits of SPDC project are mostly hijacked or diverted away by the community leadership who may take the funds and fail to apply such to development projects.

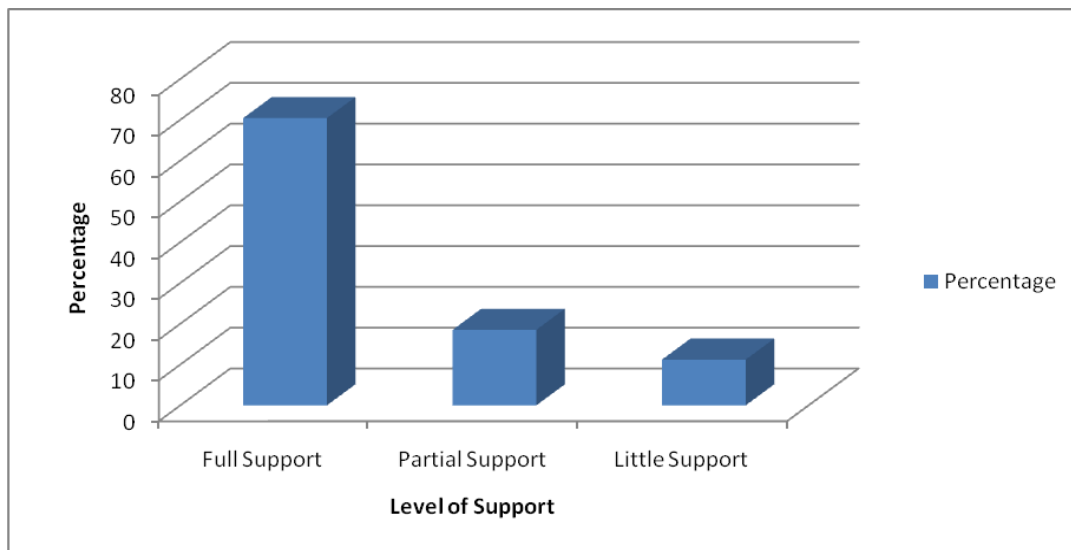


Fig.4.2.9.10: Support for SPDC projects

Source: SPDC EER, 2012

Perceptions of impacts of existing EA facility on human environment

Interaction with the population in the EA FOD project environment revealed a mix of perceptions on how the operations of SPDC have impacted the human and physical environments. Specifically, the general opinion of the youth, adult male and female was that the communities have received more of diseconomies (negative impacts) than economies (positive impacts) as showed in Table 4.2.9.5. The people perceived that the negative impacts have occurred since oil and gas development activities intensified in the area.

Table 4.2.9.5: Perceived impacts on the communities from the existing SPDC facilities

Physical environment/Health related issues	Socio-economic issues
Oil spills	Decrease in fish catch
Water pollution due to oil spillage	Harassment by JTF personals
Noise from operations	Acid rain phenomenon
Noise from chopper	Reduction in farm harvest
Destruction of the environmental beauty of the area	Lack of basic amenities
Contamination of local water supplies	Low number of employment of indigenes.
	Increased incidence of oil theft
	Disruption of fishing another business of community members

It was the opinion of the people that environmental pollution and hazards particularly from oil spills has effects on fisheries and farm harvests. Also, the emissions and gas flared have caused deterioration in rain water quality (acid rain phenomenon) and thus makes rain water undrinkable. Harassment of inhabitants by the military was mostly reported. Noise pollution resulting from operations and constant chopper flights were reported during the FGD sessions. The people, especially the youth believed that the number of employment opportunities for indigenes were very low and unacceptable.

Perceptions of impacts of proposed EA FOD Project activities

The general population in the EAFOD neighbouring communities has a mixed outlook on the proposed project. While many perceived the potential impacts of the project in the negative light, a few were hopeful that increased employment opportunities and social infrastructural development could accrue from the increased development activities if properly executed and these will more than compensate for the negative impacts.

Majority of the population (85%) in the project area fear that the proposed project activities shall impact on the livelihood system in more ways than one. These shall include further disruption of fishing activities (31%), pollution of fishing grounds (28%) and blockage of transportation routes

(26%). About one-tenth (14%) also fear that crime and other social vices shall increase during project implementation and further impact on their social lives (Table 4.2.9.6).

Table 4.2.9.6: Perceived Fears of the people

People's perceived fears	Percentage of response
Further disruption of fishing activities	31.0
Pollution of fishing grounds	28.0
Blockage of transportation routes	26.0
Increased crime and other social vices	14.0
Damage to cultural properties	1.0
Total	100

Community Expectations and needs

Community members in the EA area have high expectations regarding the proposed project activities with particular reference to the associated benefits and/or positive effects; overall social issues, including increased and more permanent employment opportunities to indigenes at the skilled, semi-skilled and unskilled levels as company's operations enlarges and as opportunities emerge, economic empowerment of youth and women group through skills training/acquisition and micro-credit programs; vendor services/minor supplies (contractor), compensation for resource losses, scholarships and provision of infrastructures, e.g., educational, health, electricity, water, among others are expectations of the communities. Statistically, all of the positive expectations have equal weight by respondents at the coastal communities (Fig. 4.2.9.11).

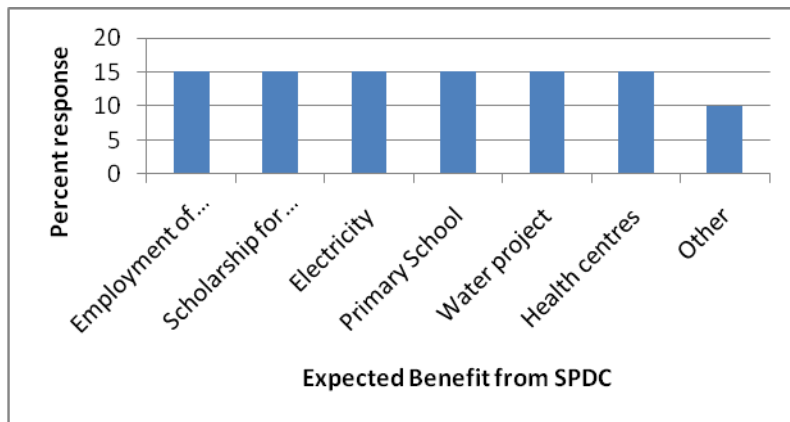


Fig. 4.2.9.11: Benefits expected from EAFOD Project

4.2.10: Community Health Profile

Healthcare is the sum total of all resources that individuals require to maintain, retain and promote good health, as well as meet challenges of ill health and diseases. The determinants of human health include; environmental (physico-chemical or biological), socio-economic and

genetic factors. The health status of communities in the EA study area has been considered taking into account these determinants.

Disease Pattern in the Communities

The EA neighbouring communities are in similar ecological environment as those in the Atala, Southern Swamp and Eremor fields. The commonest ailments and diseases in the EA communities are: malaria, leg ulcers, skin rashes, conjunctivitis, cough, respiratory distress, gastro-enteritis, hernias, sexually transmissible infections (SPDC, 2001; Excel E & P, 2005; SPDC, 2013). The proportional morbidity of diseases encountered in the Atala Field communities are malaria 27.5%, gastroenteritis 18%, cough/ catarrh 13.25%, abdominal pains 12.25%, measles 11.5% (Bayelsa Oil Company, 2008). These show that the infectious or communicable diseases are the commonest diseases in the project communities.

The integrated disease surveillance response data for Bayelsa State, (for both in-patients and out-patients) in 2005 revealed that the top three diseases recorded in the State were infectious diseases: malaria 49.88%, diarrhoea 23.65% and sexually transmissible infections 20.24%. These three account for 93.8% of all diseases recorded for the period. Malaria accounted for half of the proportional morbidity of all the diseases. A community woman with fungal skin infection under the breast is shown in Plate 4.2.10.1.



Plate 4.2.10.1: Fungal Breast Skin Infection affecting a Community Member

The 2008 National Disease and Health Survey (NDHS) indicated that fever (mainly due to malaria) remains an important cause of illness among children under five. As shown in Table 4.2.10.1, 18.1% and 20.6% of under-five children recorded a febrile illness in the two weeks preceding the survey in Bayelsa State and in South-South zone – both being higher than the national median of 15.9%. The Nigeria Malaria Indicator Survey of 2010 reported a malaria slide positive rate of 32.2% among children 6-59 months old in Bayelsa, showing the relative importance of malaria as a cause of febrile illness in the area.

Table 4.2.10.1: Morbidity Pattern among Children in Project State/ Region

	Proportion of children under age five who had a fever in the two weeks preceding the survey	Proportion of children under age five who had diarrhoea in the two weeks preceding the survey	Proportion of children under age five who had ARI in the two weeks preceding the survey
Bayelsa State	18.1%	3.2%	n.a.
South-South Zone	20.6%	3.8%	3.5%
National	15.9%	10.1%	2.8%

Source: NPC and ICF Macro, 2009

Non-communicable diseases have also been documented as important causes of ill health in Bayelsa State where the project is located. Oni *et al.* (2009) reported that stroke patients constituted 2.3% of the total hospital admissions and 9.3% of medical admissions at the Niger Delta University Teaching Hospital, Okolobiri. Hypertension was found in 89% of these individuals that had stroke.

Mortality (deaths) among the most vulnerable population groups, children under-five and women of child-bearing age, have been reported to be high in Bayelsa State. The Multiple Indicator Cluster Survey of 2011 reported that infants (under-1 year old) died at a rate of 107/1000 live births, which was higher than the average rates in the South-South zone and Nigeria as a whole (Table 4.2.10.2). Similarly, the death rate in children under-5 was also relatively higher in Bayelsa State.

Table 4.2.10.2: Mortality Rates in the Project State

	Infant Mortality Rate* (per 1000 live births)	Under-Five Mortality Rate* (per 1000 live births)
Bayelsa State	107	178
South South Zone	75	118
National	97	158

*Using North Model

Source: Nigeria Multiple Cluster Indicator Survey 2011 (NBS, UNICEF and UNFPA, 2013)

Healthcare Facilities and Services

A major deficiency in the EA area is the lack of healthcare facilities. None of the communities have a doctor, nurse or any other trained medical staff. There are no hospitals, clinics, maternity facilities, or any formal drug-dispensing outlet. There are non-functional healthcare centres at Agge and Ezetu (Plate 4.2.10.2). The main sources of healthcare delivery in the area include:

- The patent medicine stores in these communities. They stocked drugs ranging from painkillers to anti-malarial and antibiotics (Plate 4.2.10.3)

- Traditional healers play a prominent role in providing health care in these communities including fracture bone treatment (Plate 4.2.10.4).
- The Traditional Birth Attendants (TBA) receives a high level of patronage from the pregnant women.

To treat the severely sick from Agge, Letugbeneetc, people have to travel to Burutu in Delta State. Communities in Ekenie and Ezota have to travel to Yenagoa, Bayelsa State Capital, which takes about four hours by speedboat for such treatments.



Plate 4.2.10.2: Non-functional Community healthcare center at Ezetu



Plate 4.2.10.3: A Typical Drug Store in the Community.



Plate 4.2.10.4: Traditional Bone Healer and his Patient in Ezetu Community

Nutritional Status and Immunization

The nutritional pattern in the community follows the general trend in several parts of the country in which starchy food constitute a large part of the family diet. These starchy foods include cassava, rice, yam, garri and dried cassava chaff (kpokpo garri). Other less starchy foods consumed include plantain and beans.

Fish is the chief source of proteins. Seafoods such as, shrimps, crayfish, oysters are the other sources. Vegetables and fruits were consumed but not in large quantities. Basic staples (rice, flour) items are very costly because most of them have to be brought in from Warri, Yenagoa and other inland communities of the Niger Delta. The people however appear strong and healthy and do not show visible signs of malnutrition.

The 2011 Multiple Indicator Cluster Survey reported a prevalence of chronic and acute malnutrition as 15.9% and 7.3%, respectively in Bayelsa State where the project is located. However, these figures represent a decrease in the rates from the 2008 NDHS findings, and are lower than the South-South and national averages (Table 4.2.10.3). Nonetheless, qualitative information gathered during the fieldwork indicate that the local populace reported health concerns regarding a declining state of household food security, which they attributed to the lull in economic activities. Regarding the immunization status of children under-five in the communities, Bayelsa State figures for percentage of DPT3 coverage have remained below the averages for South-South zone and Nigeria. This is in spite of the increase observed between 2008 and 2011 as shown in Table 4.2.10.3.

Table 4.2.10.3: Nutritional status and immunization status of under-five children in the Projects Region

	Bayelsa State		South-South Zone		National	
	2008*	2011‡	2008*	2011‡	2008*	2011‡
Proportion of children under age five with Height-for-Age below -2 SD of reference value (Stunting)	28.7%	15.9 %	31.1%	19.5%	40.6%	35.8%
Proportion of children under age five having Weight-for-Height below -2 SD of reference value (Wasting)	7.4%	7.3%	7.5%	6.5%	13.9%	10.2%
Proportion of children under age five with Weight-for-Age below -2 SD of reference value (Under-nutrition)	8.0%	12.9%	12.8%	12.1%	23.1%	24.2%
Proportion of children aged 12-23 months who had received DPT3 vaccination	27.6%	38.3%	54.2%	60.2%	35.4%	70.5%

*National Demographic and Health Survey 2008 (NPC and ICF Macro, 2009)

‡Nigeria Multiple Cluster Indicator Survey 2011 (NBS, UNICEF and UNFPA, 2013)

Knowledge, Attitude, Practices and Behaviour on Sexually Transmissible Infections (STI)

The knowledge, attitude, practices and behaviours of the people on sexually transmissible infections were evaluated because of its public health importance. The awareness of the existence of STI in the communities was high, 73.7% of respondents. The males at 41.4% had more awareness than females, 32.3%. About 26.3% of respondents are unaware of the existence of STI. The level of awareness of HIV/AIDS at 81.2% is higher than that of STI even though HIV/AIDS is an STI. This could be due to the high publicity that HIV/AIDS enjoy over the other STIs both locally and internationally. Despite the high awareness of the existence of HIV/AIDS, only 28.7% of the respondents have knowledge of the mode of its transmission in 2005.

According to the 2008 NDHS Report, the proportion of women and men with comprehensive knowledge of HIV/AIDS in Bayelsa State was found to be higher, at 41.7% and 76.2%, respectively, than figures for South-South zone and Nigeria (Table 4.2.10.4). However, it appeared that this level of knowledge did not translate into lower risk behaviours in Bayelsa State as higher rates of multiple sex partners were also found among women and men (2.7% and 22.1%) than the average rates for South-South zone and Nigeria (Table 4.2.10.4).

Qualitative information obtained from key informants in the communities in 2012 indicated that many of them had heard of HIV/AIDS; that polygamy was common; and there were allusions to

preponderance of male infidelity. Due to the importance of tuberculosis (TB) in public health and as an opportunistic infection, the prevalence in the community was assessed. About 19% are aware of current or former cases of infection in the community based on relations diagnosed in hospitals as having the disease and receiving treatment. Use of alcohol and tobacco was also reported in the SSAGG+ EIA Report of 2013, from qualitative assessments. It was noted that, “alcoholic beverages were freely available and at all times in the communities, while about 20% of the adult males in the communities smoke cigarette”.

Table 4.2.10.4: Sexual Behaviour and HIV/AIDS Knowledge in Project Area

	Proportion of women aged 15-49 with comprehensive knowledge of HIV/AIDS	Proportion of men aged 15-49 with comprehensive knowledge of HIV/AIDS	Proportion of women aged 15-49 who had 2+ sex partners in past 12 months	Proportion of men aged 15-49 who had 2+ sex partners in past 12 months
Bayelsa State	41.7%	76.2%	2.7%	22.1%
South South Zone	26.0%	37.0%	2.2%	18.4%
National	23.4%	44.9%	1.0%	9.9%

Source: NPC and ICF Macro, 2009

Environmental Health

Access to Safe Drinking Water

Access to potable water is a major problem in the EA neighbouring communities. Water for drinking and sundry domestic needs is obtained from hand dug wells (often of high salinity) creeks (Plate 4.2.10.4) and rainwater. Boreholes in Agge, Letugbene and a ringwell in Ekenie are unserviceable. In most cases the water is unfit for human consumption and not even for general domestic use. The reliance on creek and local well water makes these communities very vulnerable to the effects of pollution from oil or chemical spills.



Plate 4.2.10.4: Fetching Water from Creek for Domestic Use in Ezetu Community

Likely sources of potable water include, pipe borne well or borehole, and protected well. Data from the 2011 Multiple Indicator Cluster Survey showed that less than one-third (27.5%) of households in Bayelsa State have access to improved drinking water sources (Table 4.2.10.5). Though this represents a slight increase from the 26.6% reported in the 2008 NDHS, the figure is lower than the zonal and national averages.

Table 4.2.10.5: Access to Improved Drinking Water Sources and Sanitation Facilities

Proportion (%) of Households having:	Bayelsa	South-South	National
Improved drinking water			
Piped into dwelling, plot or yard	1.3	4.1	4.7
Other improved	26.2	66.4	53.9
Unimproved drinking water	72.5	29.5	41.5
Total	100.0	100.0	100.0
Improved Sanitation	8.4	30.4	31.0
Unimproved Sanitation			
Shared improved facilities	8.7	25.3	20.3
Unimproved facilities	50.8	21.7	20.2
Open defecation	32.1	22.6	28.5
Total	100.0	100.0	100.0
Improved drinking water sources and improved sanitation	4.3	25.4	21.6

Adapted from National Bureau Of Statistics (NBS) [Nigeria], UNICEF and UNFPA. Nigeria Multiple Indicator Cluster Survey 2011: Main Report. Abuja, Nigeria: National Bureau Of Statistics. April 2013.

Household Wastes and Access to Sanitation Facility

The wastes generated in the area were from domestic, agricultural and fishing activities. The domestic wastes include ashes, cassava peels, food remains, kitchen wastewater, vegetable, and fish parts including human/animal faeces. These wastes are disposed by open dumping on land (Plate 4.2.10.5), into the water bodies and at times used as manure in the farms. The human wastes are disposed via direct defecation into the water bodies, on land and pit latrine. There is no waste recycling.



Plate 4.2.10.5: Open Dumping of Refuse on Land

Sanitation facility is defined as a private excreta disposal facility that is either a toilet or a latrine, but not an overhung toilet, or a flush toilet without septic tanks that channels its effluents directly into the river (NBS, UNICEF and UNFPA, 2013). A household is classified as having an improved toilet if the toilet is used only by members of one household (i.e. it is not shared with other households) and if the facility used by the household separates the waste from human contact (WHO/UNICEF, 2004).

Data from the 2011 Multiple Indicator Cluster Survey showed that only 8.4% of households in Bayelsa State have access to improved sanitation facilities (Table 4.2.10.5). This represents a slight increase from the 6.1% reported in the 2008 NDHS. This figure is far lower than the zonal and national averages of 30.4% and 31.0% respectively. Among those that use unimproved sanitation facilities, over-hung toilets and open defecation were pronounced. Open defecations was reported as high as 32.1% of households in Bayelsa State (Table 4.2.10.5). Qualitative assessments conducted in 2012 among members of the project communities corroborated the widespread use of over-hung (jetty-type) toilet (Plate 4.2.10.6). The use of overhung toilet not only contaminates the receiving water body with fresh faeces, but also has been linked to several excreta-related diseases, including diarrhoea and typhoid.



Plate 4.2.10.6: An Over-hung toilet in a Riverine Community in Bayelsa State

Housing Conditions

The quality of housing contributes to health problems in the area. Overcrowding and poor ventilation are major problems. The houses are mainly small huts (Plate 4.2.10.7) with inadequate ventilation. There are on the average 6 to 7 persons per hut and a consequence of this is the high rate of spread of skin and airborne diseases. In most houses there is one communal living/cooking room. Fish and other seafood are smoked in the huts exposing inhabitants to high levels of air pollution, respiratory conditions are caused and exacerbated by the smoky atmosphere.

The 2008 NDHS Report showed that not many households in Bayelsa State own insecticide-treated mosquito nets (ITNs) or reported that household members sleep under them (Table 4.2.10.6). This figure increased from 2.4% to 19.0% following the mass distribution of 576,192 Long-Lasting Insecticide-treated Nets by the national and Bayelsa State Malaria Control Programmes in 2011. However, the nets utilization rate reduced from 8.1% to 6.7% and this was lower than rates reported for the South-South zone and the national average.



Plate 4.2.10.7: A thatch house at a fishing port in the Community

Table 4.2.10.6: Ownership and Use of Mosquito Nets in Project Region

	Bayelsa State		South-South Zone		National	
	2008*	2011‡	2008*	2011‡	2008*	2011‡
Proportion of households with at least 1 Insecticide-Treated Net (ITN)	2.4%	19.0%	10.3%	39.6%	8.0%	38.6%
Proportion of under-five children who slept under an ITN	8.1%	6.7%	9.4%	21.5%	5.5%	16.4%

Consultations

Consultation/ Stakeholder Engagement

In the EIA process, consultation is accorded high priority so as to capture and address issues and concerns of the stakeholders. Consultation with the identified stakeholders for the EAFOD Project is designed to be a continuous process throughout the development and operation of the facilities. The principal objective is to acquire and disseminate information, identify and address legislative, community, and environmental concerns, proffer appropriate mitigation options for all the negative impacts, and enhance the positive impacts.

The scoping workshop held on Thursday September 05, 2013 at the conference hall of Matho-Crystal hotel, Yenagoa served as the first contact between SPDC and the various stakeholders and the neighbouring communities involved with the project. Relevant stakeholders were identified and engaged during the scoping exercise. Consultation is a continuous process that spans through the life cycle of the project. Stake holders invited include:

- Regulators – DPR, FMEnv, NIWA, Bayelsa State Ministry of Environment.

- Southern Ijaw Local Government Area and Ekeremor Local Government Area Chairman (Bayelsa State)
- SPDC team (including community Relation Team (CLOs), Impact Assessment team and EA Project team).
- Non-Governmental Organizations (NGOs) – Niger Delta Peace Coalition (NDPC).
- EIA Consultants.
- Representatives of twelve (12) Stakeholders communities within the proposed project area.

Scoping Workshop Aims and Objectives

The EIA Act requires an EIA reports on all proposed projects and significant modifications to existing facilities or projects. In line with the new SPDC EIA Process Manual, consultations are part of all EIA reports and hence the present consultation initiative which is intended to carry along all the stakeholders in this project. The consultation process for the EIA is undertaken at an early stage to help develop a scope of issues to be addressed and to identify the significant issues relating to the project activities. Stakeholders were made to express their perceptions and expectations, identify potential impacts (adverse and beneficial), propose measures to mitigate the negative impacts and enhance the positive impacts. The Terms of Reference (ToR) was developed after the Scoping Workshop. It was developed in an integrated manner to include the Scope of Work for Biophysical, Social and Health Impact Assessments.

Issues and Concerns

Interaction with the community was positive and there was widespread appreciation of the consultation process undertaken. The summary of concerns expressed by the major stakeholders, especially the 12 neighbouring communities during the scoping workshop include the under listed:

- The dredging activity proposed as part of the project may close up the Dodo River mouth. (Dredging has however, been expunged from the project activities).
- Fishing which is the main occupation of the people may be a thing of the past due to the project impacts.
- There should be full implementation of community content.
- Loss of fishing may lead to low income and unemployment.
- Dredging may cause more erosion problems due to heavy duty equipment and tidal waves. (Dredging has however, been expunged from the project activities).
- Emission of gaseous substances will cause heavy corrosion which is already experienced in the communities due to continuous gas flaring.
- Provide health facilities and make existing facilities functional.
- In course of this project, comply strictly with employment acts and regulations.
- Increase funding level of the GMOU to enable the execution of more projects in the communities.

- There may be increase in piracy, so increase number of surveillance in the communities.
- There will be noisy operations and other construction impacts. Gaseous emission, spill, etc due to construction activities.
- Water pollution will lead to the scaring away of fishes in the area.
- Sudden pollution due to oil spill may lead to destruction of economic trees.
- There will likely be change in the quality of sea water as a result of the projects activities.
- The project activities will negatively affect aquatic life.
- Oil spillage most likely due to oil field operations will affect livelihood.
- Social and economic lives will drastically be affected.
- There may be landslide, shore cuts, depression and collapse of lands and coastline communities.
- The project will definitely bring waste deposits on coastline communities and oil emission that will impact water-lily and aquatic animals.
- Flooding and overflow of tide due to oil field operations.
- Project will bring more development and infrastructure to the communities that will help curb youth restiveness.
- Project community content will boast socio-economic activities in the communities.
- Chemical pollution- e.g. radioactive materials may bio-accumulate in marine organisms. Materials like drilling mud, effluents, sewage, radioactive isotopes used in agitating oil wells might affect the environmental negatively.
- Flares- from oil wells (i.e gas wells) might trigger acid rain.
- Construction of underwater pipelines and associated structures will lead to the formation of an entirely new ecosystem. Invasive species might prey on the native species leading to extinction and loss of livelihood on the part of fishermen.
- Though the economy of the impacted communities will improve, the health effects might be challenging due incidence of diseases like HIV/AIDS.
- There may be serious agitation due to limited job slots.
- Groundwater in the neighbouring communities should be studied to ascertain possible interactions and seepages.
- There will be littering of domestic wastes from drilling operations, health risks like sight problems. Desecrating of native culture and tradition by job seekers flooding the area in search of jobs.

In response SPDC advised the communities to include areas of concerns relating to the provision of infrastructure in their Participatory Rural Appraisal Programmes for greater attention by SPDC. In addition, SPDC reiterated that:

- All complaints/issues raised outside the context of the project shall be sent to appropriate authorities

- Terms of reference (TOR)/scope of work from the workshop will form the basis of the EIA study
- Consultation will be continuous and all mitigation measures shall be implemented.

The requests made by the various communities are summarized as follows:

- Creation of job opportunities for the host communities during the project execution phase.
- Provision of potable water, electricity, cottage hospitals and river transportation.
- Involvement of the communities in the EIA study
- Implementation of appropriate mitigation measures

Future consultations

SPDC, contractors and subcontractors would continue to consult with all relevant parties (host communities, Ekeremor and Southern Ijaw LGAs, Bayelsa state government, the Federal Ministry of Environment, DPR) and all parties concerned with or are likely to be affected by the project, at all stages of the project development.



Plate 4.2.10.8: Cross section of the EA FOD communities at the scoping workshop

CHAPTER FIVE

EXISTING, POTENTIAL AND ASSOCIATED ENVIRONMENTAL IMPACTS

5.1: Introduction

There are several approaches and techniques developed for evaluating existing, associated, potential and cumulative impacts of any project on the environment. The Overlays techniques (McHarg, 1968); Leopold matrix (Leopold *et al.*, 1971); Battelle Environmental Evaluation System (Dee *et al.*, 1973), Peterson Matrix (Peterson *et al.*, 1974), Rau and Wooten (1980) and ISO 14001 are among the most widely used methods. However, in this EIA, the Rau and Wooten (1980) method was used for evaluating the existing impacts, while the ISO 14001 method was used for evaluating the potential impacts. Cumulative impacts were determined by combining the impacts from the existing facilities and potential impacts from the proposed EA Further Oil Development Project.

5.2: Assessment of Potential Impacts using ISO 14001 and RAM Method

The ISO 14001 method is simple to apply and provides a high level of detail and also relies on limited data. This method was therefore selected for the evaluation of potential impacts for the proposed project. In line with general guidelines for an Environmental Impact Assessment (EIA) process, the following were the basic steps adopted for identification and evaluation of impacts (Fig. 5.1):

- Impact identification
- Impact description
- Impact qualification
- Impact Risk and Severity rating

Impact Identification

The aim of impact identification is to account for the entire potential and associated bio-physical, social and health impacts making sure that both significant and insignificant impacts are accounted for. The anticipated impacts were determined based on the interaction between project activities and environmental sensitivities. The identified existing, associated, potential and cumulative impacts of the project are listed in Table 5.1.

Impact Description and Qualification

The identified impacts of the project were described based on the following criteria:

- Positive or negative
- Direct or indirect

Negative impacts are those that adversely affect the biophysical environments while positive impacts are those which enhance the quality of the environment. Direct impacts refer to those impacts that are caused by the project activity and occur at the same time and place. Indirect

impacts are impacts caused by a project activity, but would occur in the future or outside the project area and are reasonably foreseeable. Impacts are qualified either as:

- Short term < 3 months (S) or Long term > 3 months (L), or
- Reversible (R) or Irreversible (I).

For this study, short term means a period of time less than three months while any period greater than three months is considered long term. Reversible means the environment can revert to its previous conditions while irreversible means the impacts remain permanent even after the activity causing the impact is terminated.

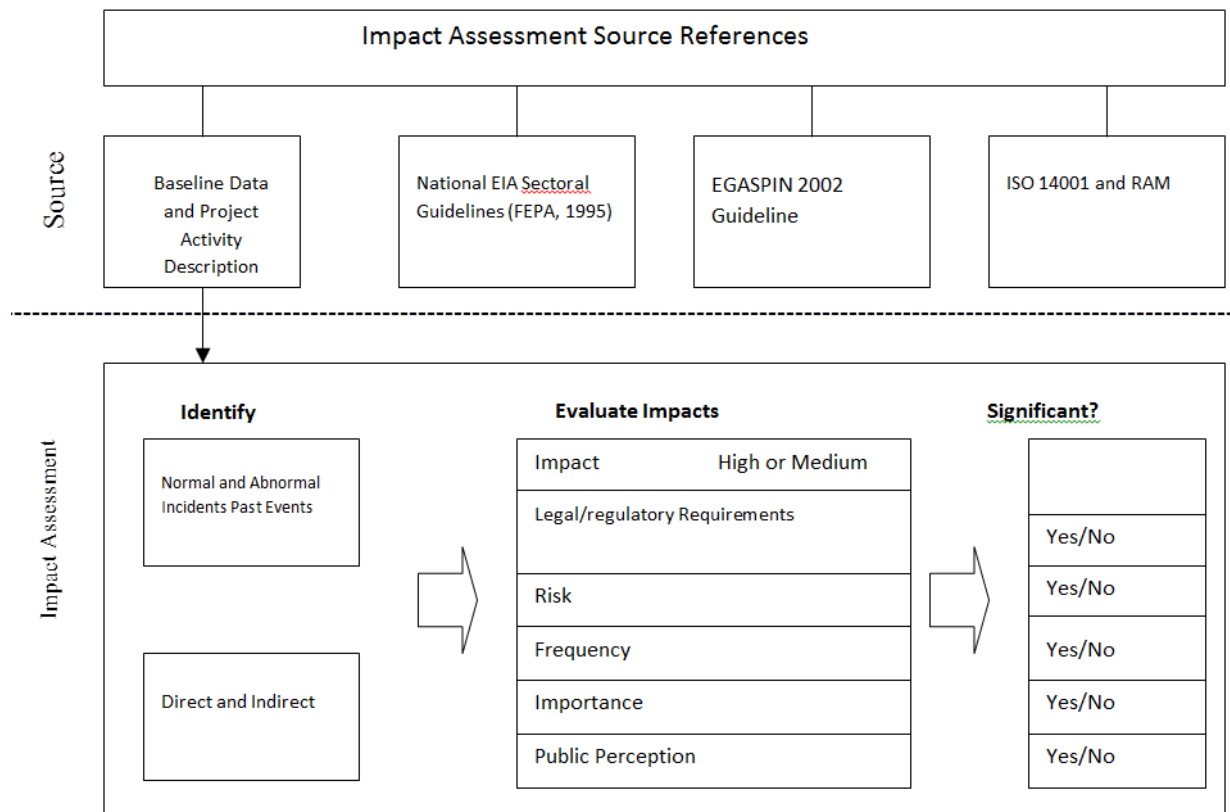


Fig. 5.1: Impact Assessment Methodology

Table 5.1: Associated and Potential Impacts of Proposed EA Further Oil Development Project

Project Phase	Project Activity	Project Activities/ Environmental Aspects	Potential and Associated Impacts
PRE-CONSTRUCTION	Survey	<ul style="list-style-type: none"> • Measurements (sounding, geotechnical/ geomechanical, pipeline route) • Transportation 	<ul style="list-style-type: none"> • Risk of accident • Risk of Piracy & kidnapping attacks.
MOBILIZATION AND RIG MOVE	Mobilization of Equipment and Personnel to Site	<ul style="list-style-type: none"> • Transportation of personnel, materials, equipment and Rig to site by road and water; • Employment of local labor and award of contracts; 	<ul style="list-style-type: none"> • Impairment of air quality from emissions of air pollutants including greenhouse gases • Increase in noise and vibration/levels • Kidnappings • Third party agitations • Increase in income to local hired labor hands • Impairment of water quality due to disposal of sanitary waste. • Constant lighting which can affect nocturnal life in the vicinity. • Alteration of population structure. • Visual interference due to presence of rig.
DRILLING OPERATIONS	Drilling (Rig positioning, Casing, Logging, Cementation, Production (well Testing), Production (operations))	<ul style="list-style-type: none"> • Boring into the earth crust to get to the Oil & Gas Reservoir • Employment of local labour and award of contracts to members of the communities • Accidents and injuries • Surface water contamination and impairment of air quality • Waste generation and disposal • Increase in noise and vibration levels • Increase in periods of brightness • Contamination of the environment by 	<ul style="list-style-type: none"> • Impairment of air quality by emissions of air pollutants including greenhouse gases • Noise and vibration nuisance • Contamination of seawater • Injuries and death from blowouts • Continuous glare from rig operation • Opportunities for business and employment • Water pollution from chemicals, drill cuttings and mud • Third party agitation

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Project Phase	Project Activity	Project Activities/ Environmental Aspects	Potential and Associated Impacts
		<ul style="list-style-type: none"> chemicals/drilling wastes • Contamination of the environment by domestic wastes • Threats to health of workers or aquatic wildlife injuries, etc 	<ul style="list-style-type: none"> • Accidents and injuries • Contamination of the surface water and sediment by wastes
DEMOBILIZATION	Mobilization of Equipment and Construction workers out of the project site	<ul style="list-style-type: none"> • Transportation of personnel, materials, equipment and Rig from site by water and air • Downscaling of local labour and community contracts • Emigration of workers and followers (dependants, bounty seekers) from the host Communities • Increase potential for water traffic volume and accidents from movement of heavy equipment from worksites • Clearing and Disposal of wastes 	<ul style="list-style-type: none"> • Impairment of air quality by emissions of air pollutants including greenhouse gases • Water traffic incidents • Improper disposal of materials removed from site • Increase in noise and vibration level • Loss of employment/ income
OPERATIONS AND MAINTENANCE	Operation of well clusters	<ul style="list-style-type: none"> • Oil and Gas leaks • Noise and vibration levels • Reduction in air quality • Degradation of surface water and sediment by spills and leaks • Danger of explosion and fire • Opportunity for contracting and employment • Oil and gas production and sales • Skills training and acquisition 	<ul style="list-style-type: none"> • Environmental pollution arising from improper disposal of lubricants and oily debris • Equipment failure and damage leading to injuries/fatality • Revenue generation to government, contractors and company • Increase in noise levels • Oil and Gas leaks
DECOMMISSIONING AND ABANDONMENT	Demolition of structures and removal of well casings Demobilization of Equipment, Materials	<ul style="list-style-type: none"> • Transportation of personnel, materials, equipment and wastes from site by water • Disengagement of local labour and 	<ul style="list-style-type: none"> • Employment and income generating opportunity • Increase in noise and vibration/levels

Project Phase	Project Activity	Project Activities/ Environmental Aspects	Potential and Associated Impacts
	and Wastes out of the project site	community contractors <ul style="list-style-type: none"> • Increase potential for road traffic volume and accidents from movement of heavy equipment from project sites • Contamination of surface water from excavation of well head and pipelines • Clearing and Disposal of solid wastes • Oil and Gas leaks • Noise and vibration levels • Reduction in air quality • Degradation of soils and surface water by spills and leaks • Danger of explosion and fire 	<ul style="list-style-type: none"> • Interference with water transport • Kidnappings • Impairment of air quality from fumes, dust, including greenhouse gases • Third party agitations • Increase potential for water traffic accidents/injury • Potential for inhalation of welding fumes • Potential for conflicts arising from labor issues • Contamination of surface water • Contamination of aquatic fauna community • Destruction of fauna population as a result of surface water and sediment pollution • Surface water and sediment degradation from spills and leaks • Injury/fatalities in workforce

5.3: Impact Risk Assessment

The Risk that an impact poses is determined using the Risk Assessment (RAM) shown in Fig. 5.2. The Environmental Consequences are defined in Table 5.2. The Impact Risk is rated as:

- 1= Low risk
- 3 = Medium/intermediate risk
- 5 = High risk

Consequences					Increasing Likelihood				
					A	B	C	D	E
Severity	People	Assets	Environment	Reputation	Never heard of in the industry	Heard of in the industry	Has happened in the Organization or more than once per year in the industry	Has happened at the location or more than once per year in the Organization	Has happened more than once per year at the Location
0	No injury	No damage	No effect	No impact					
1	Slight injury	Slight damage	Slight effect	Slight impact		Low			
2	Minor Injury	Minor damage	Minor effect	Minor Impact		Risk			
3	Major Injury or health effect	Moderate damage	Moderate effect	Moderate impact			Medium		
4	PTD or up to 3 fatalities	Major damage	Major effect	Major Impact			Risk	High	
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact				Risk	

Fig. 5.2: Risk Assessment Matrix

Table 5.2: Definition of Consequence in the Risk Matrix (RAM)

Severity	Potential Impact	Definition
0	Zero effect	No environmental damage. No change in the environment. No financial consequences.
1	Slight effect	Local environmental damage within the fence and within systems. Negligible financial consequences.
2	Minor effect	Contamination, damage sufficiently large to affect the environment. Single exceedance of statutory or prescribed criteria, single complaint. No permanent effect on the environment
3	Localized effect	Limited loss of discharges of known toxicity. Repeated

Severity	Potential Impact	Definition
		exceedance of statutory or prescribed limit. Affecting neighbourhood
4	Major effect	Severe environmental damage. The company is required to take extensive measures to restore the contaminated environment to its original state. Extended exceedance of statutory or prescribed limits
5	Massive effect	Persistent severe environmental damage or severe nuisance extending over a large area. In terms of commercial or recreational use or nature conservancy, a major economic loss for the company. Constant high exceedance of statutory or prescribed limits.

Source: SIEP (1996).

5.4: Determination of Impact Rating and Significance

The ISO 14001 methodology, for determining potential impact rating and significance, is adopted in this study. The criteria employed in evaluating the potential impacts are:

- Legal/regulatory requirements (L);
- Risk factor (R);
- Frequency of occurrence of impact (F);
- Importance of impact on an affected environmental component (I); and
- Public perception/interest (P).

Each of the criteria is weighted on a scale of 0, 1, 3 and 5 depending on the perceived significance of the impact under consideration. This is a modification of the arbitrary scale proposed by Vesilind, *et al.* (1994). The weightings are described below and are adapted from The International Organization for Standardization ISO 14001 – Environmental Management System Approach.

• **Legal/Regulatory Requirements (L) – Is there a legal/regulatory requirement or a permit required?**

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

• **Risk Factor (R) – What is the risk/hazard rating based on the Risk Assessment Matrix (RAM)?**

- 1 = Low risk
- 3 = Intermediate risk
- 5 = High risk

- **Frequency of Impact (F) – What is the frequency rating of impact?**

- 1 = Low frequency (rare)
- 3 = Intermediate frequency (likely)
- 5 = High frequency (very likely)

- The frequency of occurrence of each impact was determined from historic records and consensus of experts' opinion.

- **Public interest/perception (P) – What is the public perception and interest in the proposed project and impacts based on consultation with stakeholders?**

- 1 = Low interest/perception
- 3 = Intermediate interest/perception
- 5 = High interest/perception

The perception of the general public on each potential impact and were determined through consultation and consensus of opinions of environmental professionals.

- **Importance of affected environmental components and impacts (I) – What is the rating of importance based on consensus of opinions? Will the impact be localized or spread to cover greater areas of the environmental component?**

- 1 = Low
- 3 = Medium
- 5 = High

The importance of affected environmental component was determined through consultation and consensus of opinions.

This approach combines the following factors in assessing the overall rating of the potential impacts of the proposed project on the environment:

- The sensitivity/vulnerability of the ecosystem components;
- The productivity evaluation/rating of the ecosystem components;
- Knowledge of the possible interactions between the proposed project and the environment;
- Envisaged sustainability of the project environment;
- The economic value of the proposed project activities; and
- Projected duration of the impact of each project activity on various environmental components.

The overall impact significance rating is determined as shown in Table 5.3. The potential and associated impacts of the project are presented in Table 5.4. All impacts with the Medium and High Ranking are considered significant and will require mitigation measures. Impacts with Low ranking will be addressed by application of the SPDC HSE Policy. Impacts rated as positive do

not require mitigation and are considered beneficial. Significant and beneficial impacts are discussed in the proceeding paragraphs.

Table 5.3: Impact Value and Rating

Impact value	Cut off values	Impact Rating	Impact Significance
L+R+F+I+P	<8	Low	Not Significant
	≥8 but <15	Medium	Significant
	≥15	High	
F + I	≥6		
P	= 5		
Positive		Positive	Beneficial

Table 5.4: Ranking of Potential and Associated Impacts of Proposed EA Further Oil Development Project

Project Activity	Impacts	Impact Description				Impact Qualification				Impact Quantification						Impact Rating	
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total		F+I
Pre-construction (survey)	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
Mobilization (equipment and personnel), and Rig Move	Impairment of air quality		√	√		√		√		5	1	1	1	1	9	2	M
	Increase in noise and vibration		√	√		√		√		5	1	1	1	1	9	2	M
	Interference with fishing activities		√	√		√		√		0	1	1	3	1	6	4	L
	Interference with water transport		√	√		√		√		0	1	3	1	1	6	2	L
	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
Site preparation (piling)	Increase in noise and vibration		√	√		√	√	√		5	3	3	3	1	15	4	H
	Interference with fishing activities		√	√		√		√		0	1	3	3	1	8	4	M
	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy and kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
Fabrication, transportation, Installation and positioning of Wellhead Platform	Increase in noise and vibration		√	√		√	√	√	√	5	3	3	3	1	15	4	H
	Interference with fishing activities		√	√		√		√		0	1	3	3	1	8	4	M
	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
	Impacts of Wastes		√	√		√		√		3	1	3	3	3	13	6	H
	Impairment of air quality		√	√		√		√		5	3	3	1	1	13	4	M
	Increase in noise and vibration		√	√		√	√	√	√	5	3	3	3	1	15	4	H
Drilling	Impairment of air quality		√	√		√		√		3	1	3	1	1	9	4	M
	Noise and vibration nuisance		√	√		√		√		3	1	3	1	3	11	4	M

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Project Activity	Impacts	Impact Description				Impact Qualification				Impact Quantification						Impact Rating	
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total		F+I
	Injuries and death from blowouts		√	√		√	√	√	√	0	5	1	5	5	16	6	H
	Continuous glare from rig operations		√	√		√		√		0	1	3	1	1	6	4	L
	Opportunities for business and employment	√		√		√	√	√									P
	Increased oil production	√		√		√	√	√									P
	Increased revenue	√		√		√	√	√									P
	Surface water and sediment pollution from chemicals, drill cuttings, and mud		√	√		√		√		3	3	3	3	3	15	6	H
	Accidents and injuries		√	√		√	√	√	√	0	5	3	5	5	18	8	H
Pipeline construction (Piping/ flowlines, well hook-up)	Increase in income generating activities	√		√		√	√	√									P
	Reduction of flora and fauna population		√	√		√		√		0	1	1	3	1	6	4	L
	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
	Impairment of air quality		√	√		√		√		5	3	3	1	1	13	4	M
	Increase in noise and vibration levels		√	√		√		√		3	3	1	3	1	11	4	M
	Contamination of surface water bodies		√	√		√	√	√		3	3	1	3	5	15	4	H
	Exposure to radiation materials		√	√			√		√	3	3	1	3	5	15	4	H
	inhalation of welding fumes		√	√		√		√		3	3	1	3	3	13	4	M

EIA of EA/Eja Field Further Oil Development Project

Project Activity	Impacts	Impact Description				Impact Qualification				Impact Quantification						Impact Rating	
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total		F+I
	Soft tissues damage from welding sparks		√	√		√		√		3	3	1	3	3	13	4	M
	Conjunctivitis from welding flash		√	√		√		√		3	3	1	3	3	13	4	M
	Potential for conflicts arising from labour issues		√	√		√		√		3	5	3	3	3	17	4	H
	Stress on existing security structures		√	√		√	√	√	√	0	5	3	5	5	18	8	H
	Contamination of water from inhibited hydrotest water		√	√		√		√		3	1	1	1	1	7	2	L
Demobilization	Impairment of air quality		√	√		√		√		3	1	1	3	5	13	4	M
	Water traffic incidents		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Improper disposal of materials removed from site		√	√		√	√	√		3	3	1	3	3	13	4	M
	Increase in noise and vibration level		√	√		√		√		3	3	1	3	1	11	4	M
	Loss of employment/ income		√	√		√	√	√	√	0	5	3	3	5	16	6	H
	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
Commissioning Operations and Maintenance	Improper disposal of materials		√	√		√	√	√	√	3	3	3	3	3	15	6	H
	Equipment failure and damage leading to injuries/fatality		√	√		√	√	√	√	3	1	1	1	3	9	2	M
	Revenue generation to government and company	√		√			√	√		-	-	-	-	-	-	-	P
	Increase in noise levels		√	√			√	√		3	1	1	1	1	7	2	L
	gas flaring	√	√	√			√	√		3	3	3	5	3	17	8	H

EIA of EA/Eja Field Further Oil Development Project

Project Activity	Impacts	Impact Description				Impact Qualification				Impact Quantification						Impact Rating	
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total		F+I
																	H
	Produced water	√	√	√			√	√		3	3	5	1	3	15	4	H
	Risk of accident		√	√		√	√	√	√	3	3	3	3	3	15	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
Decommissioning and Abandonment	Employment and income generating opportunity	√		√		√		√									P
	Increase in noise and vibration		√	√		√		√		3	3	1	3	1	11	4	M
	Interference with water transport		√	√		√		√		0	1	1	1	3	6	2	L
	Impairment of air quality		√	√		√		√		3	1	1	1	1	8	2	M
	Risk of accident		√	√		√	√	√	√	0	3	3	3	3	12	6	H
	Risk of Piracy & kidnapping		√	√		√	√	√	√	0	5	3	5	5	18	8	H
	Increase potential for water traffic accidents/ injury		√	√		√	√	√	√	3	1	1	3	1	9	4	M
	Potential for conflicts arising from labour issues		√	√		√		√		0	1	3	5	5	16	8	H
	Contamination of surface water and sediment		√	√		√		√		3	1	1	1	1	7	2	L
	Destruction of aquatic fauna population		√	√		√		√		0	1	1	1	1	4	2	L
Injury/fatalities in workforce		√	√		√	√	√	√	3	3	1	3	3	13	4	H	

5.5: Potential Impacts

Table 5.4 present the potential impacts of the proposed EA further oil development project. Only the medium and high impacts are described in this subsection. The impacts rated low were not described and could be effectively addressed by routine SPDC procedures and would therefore not require mitigation.

Pre-construction (pipeline route survey)

Risk of accident

There is potential risk of accident particularly drowning during the pipeline and flowline survey. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during hydrosurveys. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Mobilization (equipment and personnel), and Rig Move

Impairment of air quality

Transportation of equipment, materials and personnel via road, air and water to site could result in the release of emissions into the environment. Despite being a brown field, all the priority air quality parameters tested (SO_x, NO_x, VOC, SPM) were within regulatory limits. However, the impairment of air quality was assessed and described as negative, direct, short-term, reversible and was rated as medium i.e. moderate impact.

Increase in noise and vibration

Noise and vibrations could increase during mobilization to site. Current noise levels at site were 45.56±1.18 dB, which is by far lower than the regulatory limits of 90 dB. However, this impact was assessed and described as negative, direct, short-term, reversible and was rated as medium i.e. moderate impact.

Risk of accident

There is potential risk of accident particularly drowning during mobilization to site. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during mobilization to site. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Site preparation (piling)

Increase in noise and vibration

Noise and vibrations could increase during site preparation particularly piling. Current noise levels at site were 45.56 ± 1.18 dB, which is by far lower than the regulatory limits of 90 dB. But during piling, high noise and vibrations beyond regulatory limits could be released. However, this impact was assessed and described as negative, direct, short-term or long-term depending on the length of the piling period, reversible and was rated as high impact.

Interference with fishing activities

Piling could affect fishing activities especially at the continental shelf. The impact was described as negative, direct, short-term, reversible and is rated a medium impact.

Risk of accident

There is potential risk of accident particularly drowning during site preparation. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during site preparation. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Fabrication, transportation, positioning and Installation of Wellhead Platform

Increase in noise and vibration

Noise and vibrations could increase during fabrication, positioning and installation of well platforms. Current noise levels at site were 45.56 ± 1.18 dB, which is by far lower than the regulatory limits of 90 dB. But during construction, high noise and vibrations beyond regulatory limits could be released. However, this impact was assessed and described as negative, direct, short-term or long-term depending on the length of the piling period, reversible and was rated as high impact.

Interference with fishing activities

Installation of the well head could affect fishing activities especially at the continental shelf. The impact was described as negative, direct, short-term, reversible and was rated medium.

Risk of accident

There is potential risk of accident particularly during site construction. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during site construction. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Impacts of Wastes

Various streams of wastes could be generated during site construction including liquid (oily wastewater, sewage and effluents from barges and houseboats/flowtels), air emissions (fumes from welding activities and generators) and solid wastes (wood wastes, iron off-cuts, plastics, cement and concrete wastes). Waste generation during construction activities could mount pressure on existing waste management infrastructure in Sea Eagle. On the other hand, poor waste management could impact the environment negatively. However, this impact was assessed and described as negative, direct, short-term or long-term depending on the length of the construction period, reversible and was rated as high impact.

Impairment of air quality

Site construction could result in the release of emissions into the environment. Despite being a brown field, all the priority air quality parameters tested (SO_x, NO_x, VOC, SPM) were within regulatory limits. However, the impairment of air quality was assessed and described as negative, direct, short-term, reversible and was rated as medium i.e. moderate impact.

Drilling

Impairment of air quality

Drilling could result in the release of emissions into the environment. Despite being a brown field, all the priority air quality parameters tested (SO_x, NO_x, VOC, SPM) were within regulatory limits. However, the impairment of air quality was assessed and described as negative, direct, short-term, reversible and was rated as medium i.e. moderate impact.

Increase in noise and vibration

Noise and vibrations could increase during drilling. Current noise levels at site were 45.56±1.18 dB, which is by far lower than the regulatory limits of 90 dB. But during drilling, high noise and vibrations beyond regulatory limits could be released. However, this impact was assessed and described as negative, direct, short-term or long-term depending on the length of the piling period, reversible and was rated as high impact.

Injuries and death from blowouts

Blowouts could occur during drilling. Today, only a few blowouts have occurred in Nigeria while drilling, but none in SPDC. Notwithstanding, injuries and death from blowouts was described as negative, direct and it could either be short- or long-term, reversible or irreversible depending on the scale and severity, hence this impact was rated high.

Opportunities for business and employment

Drilling activities in EA/EJA fields could create opportunities for business, contracting and employment. Though, this is a positive impact, it can be enhanced by using local and indigenous contractors and personnel, otherwise, it could be lead to agitation.

Increased oil production

Existing wells in the field are depleting with high water production. Drilling of additional 20 wells in the EA/EJA field could boost oil production in Nigeria and increase capacity utilization of the Sea Eagle production rig. This impacted was ranked positive.

Increased revenue

Increased oil production could result in increased revenue for SPDC and the Nigerian Government. This impacted was ranked positive as well.

Surface water and sediment pollution from chemicals, drill cuttings, and mud

Surface water and sediment pollution from chemicals, drill cuttings, and mud could occur as a result of drilling activities. Several chemicals are used during drilling and completion such as drilling mud (consisting of several additives such as barite, bentonite, potassium chloride, calcium carbonates, base oil or pseudo-oil etc), cement etc. Large volumes of wastes could be generated from the use of these chemicals. In addition, other types of wastes could be generated including effluent, sewage, food wastes and other solid wastes particularly packaging materials such as plastics. This impact was therefore described as negative, direct, short-term, reversible and was rated major.

Accidents and injuries

Accidents and injuries could arise from drilling operations. This impact was described as negative, direct, short-term, reversible and was rated high.

High COD from liquid waste

High volumes of liquid wastes could be generated from the use of chemicals and drilling mud resulting in increased COD of water thereby endangering the lives of aquatic organisms. This impact was therefore described as negative, direct, short term, reversible and high.

Pipeline construction (Piping/ flow lines, well hook-up)

Increase in income generating activities

Income generating activities (business/ contracting) could increase during pipeline construction. This impact was ranked positive.

Risk of accident

Accidents and injuries could arise from pipeline construction such as explosion, fire and drowning. This impact was described as negative, direct, short-term, reversible and was rated high.

Risk of Piracy & kidnapping

Piracy and kidnapping could occur during pipeline construction. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Impairment of air quality

Pipeline construction could result in the release of emissions into the environment. Despite being a brown field, all the priority air quality parameters tested (SO_x, NO_x, VOC, SPM) were within regulatory limits. However, the impairment of air quality was assessed and described as negative, direct, short-term, reversible and was rated as medium i.e. moderate impact.

Increase in noise and vibration

Noise and vibrations could increase during pipeline construction. Current noise levels at site were 45.56±1.18 dB, which is by far lower than the regulatory limits of 90 dB. But during drilling, high noise and vibrations beyond regulatory limits could be released. However, this impact was assessed and described as negative, direct, short-term, reversible and was rated as medium.

Contamination of surface water bodies

Surface water and sediment pollution could arise from pipeline construction activities. In addition, wastes could be generated including effluent, sewage, food wastes and other solid wastes particularly packaging materials such as plastics. This impact was therefore described as negative, direct, short-term, reversible and was rated high.

Exposure to radiation

Personnel could be exposed to radiation during pipeline construction activities especially during arc welding. Radiations are known to cause cancer. This impact was therefore described as negative, direct, short-term, reversible and was rated high.

Inhalation of welding fumes

Fumes are released during welding, which could be inhaled by welders. This impact was therefore described as negative, direct, short-term, reversible and was rated medium.

Soft tissues damage from welding sparks

Welding sparks could cause tissue damage. This impact was therefore described as negative, direct, short-term, reversible and was rated medium.

Conjunctivitis from welding flash

Conjunctivitis could result from welding flash. This impact was therefore described as negative, direct, short-term, reversible and was rated medium.

Potential for conflicts arising from labour issues

Conflicts could arise from labour related issues during pipeline construction. This impact was therefore described as negative, direct, short-term, reversible and was rated high.

Stress on existing security structures

Stress on existing security structures could arise during pipeline construction activities. Kidnapping and hostage taking is common in the Niger Delta. This impact was therefore described as negative, direct, short-term, reversible and was rated high.

Demobilization

Impairment of air quality

Emissions into the environment can occur during demobilization of equipment and personnel. Despite being a brown field, all the priority air quality parameters tested (SO_x, NO_x, VOC, SPM) were within regulatory limits. However, the impairment of air quality was assessed and described as negative, direct, short-term, reversible and was rated as medium i.e. moderate impact.

Water traffic incidents

Water traffic incidents can occur during demobilization of equipment and personnel. This impact was described as negative, direct and it could either be short- or long-term, reversible or irreversible depending on the scale and severity, hence this impact was rated high.

Improper disposal of materials removed from site

Wastes could be generated from materials removed from site during demobilization. If not well managed, these wastes could cause environmental pollution. This impact was assessed and described as negative, direct, short-term, reversible and was rated as medium

Increase in noise and vibration

Noise and vibrations could increase during demobilization. Current noise levels at site were 45.56±1.18 dB, which is by far lower than the regulatory limits of 90 dB. But during construction, high noise and vibrations beyond regulatory limits could be released. However, this impact was assessed and described as negative, direct, short-term and was rated as high impact.

Loss of employment/ income

Employment and income could be loss due to demobilization. Conflict could arise from the poor management of demobilization. This impact was assessed and described as negative, direct, short-term and was rated as high impact.

Risk of accident

There is potential risk of accident particularly drowning during demobilization from site. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during demobilization from site. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Commissioning, Operations and Maintenance

Improper disposal of materials

Several waste streams could be generated during commissioning, routine operations and maintenance. If not well managed, these wastes could cause environmental pollution. This impact was assessed and described as negative, direct, short-term, reversible and was rated high.

Equipment failure and damage leading to injuries/fatality

Equipment failure could result to damage leading to injuries and fatality. This impact was assessed and described as negative, direct, short-term, reversible and was rated medium.

Revenue generation to government and company

Operations of the production facilities could result in increased production and revenue generation for the government and SPDC. The impact was ranked positive.

Gas flaring

The impact of the project on gas flaring is ambiguous, being both positive and negative. Associated gas is typically produced along with the crude oil. Therefore, increased production arising from the EA FOD project has the potential of increased gas flaring in the area, which is a

negative impact. But the Sea Eagle has enough capacity to accommodate increased gas production, which would be sent to Bonny NLNG, hence a positive impact.

Produced water

The impact of the project on produced water is ambiguous, being both positive and negative. Produced water is associated with crude oil production. Increased oil production arising from the EA FOD project has the potential of increased produced water generation, which is a negative impact. But the Sea Eagle has enough capacity to accommodate increased produced water. The new wells drilled under the EA FOD project would have lower water cut. When they come on stream and the older wells with higher water cut are shut-in could reduce produced formation water, which is a positive impact.

Risk of accident

There is potential risk of accident particularly drowning during operations. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during operations. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Decommissioning and Abandonment

Employment and income generating opportunity

Decommissioning can create opportunity for business and employment. This impact was ranked positive.

Increase in noise and vibration

Noise and vibrations could increase during decommissioning of equipment. Current noise levels at site were 45.56 ± 1.18 dB, which is by far lower than the regulatory limits of 90 dB. But during decommissioning, high noise and vibrations beyond regulatory limits could be released. However, this impact was assessed and described as negative, direct, short-term and was rated as high impact.

Impairment of air quality

Emissions into the environment can occur during decommissioning of equipment. Despite being a brown field, all the priority air quality parameters tested (SO_x, NO_x, VOC, SPM) were within regulatory limits. However, the impairment of air quality was assessed and described as negative, direct, short-term, reversible and was rated as medium.

Risk of accident

There is potential risk of accident particularly drowning during decommissioning. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the severity of the accident. The risk of accident was rated high i.e. major.

Risk of Piracy and kidnapping

Piracy and kidnapping could occur during decommissioning. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity and length of time and was rated high.

Increase potential for water traffic accidents/ injury

Water traffic accidents such as boat accidents and drowning could occur as a result of increased transportation during decommissioning, which could result in injury or death. The risk was described as negative, direct and could either be short- or long-term, reversible or irreversible depending on the scale, severity of the accident and was rated medium.

Potential for conflicts arising from labour issues

Conflicts could arise from labour related issues during decommissioning. This impact was therefore described as negative, direct, short-term, reversible and was rated high.

Accidents/Injury/Fatalities of Workforce

Improper use of personal protective equipment (PPE), non-adherence to HSE policies and regulatory standards, system/equipment failure and human errors during decommissioning could result in injuries and fatalities. This impact was described as direct, negative, short- or long-term and reversible or irreversible and was ranked high.

5.6: Assessment of Existing Impacts

Quantification of Existing Impacts Magnitudes

Existing impacts was assessed using Rau and Wooten (1980) method. The method was used to quantify the magnitude of existing impacts using 2001 EIA values (Environmental baseline values) and 2011 EIA values (Fates and Effects study). In this method, Impact Magnitude was calculated as follows:

$$IM = \frac{2001\ EIA\ values - 2011\ EIA\ values}{2001\ EIA\ values} \times 100$$

Where,

IM = Impact Magnitude

The values obtained from such calculations for impact magnitude were therefore reduced to a scale of 1-5 and scored according to *Rau and Wooten's scheme*. Values obtained by the

computation were first expressed as a percentage, thereafter the scale was reduced to 1 – 5 as follows:

Table 5.5: Impact Evaluation and Weighting Scheme

Scale	Magnitude	Ranking	Definition (SIEP, 1996)	Significance
1	0 – 20%	Negligible	Local environmental damage within the fence and within systems. Negligible financial consequences.	Not significant
2	21 – 40%	Low	Contamination, damage sufficiently large to affect the environment. Single exceedance of statutory or prescribed criteria, single complaint. No permanent effect on the environment	Not significant
3	41 – 60%	Medium	Limited loss of discharges of known toxicity. Repeated exceedance of statutory or prescribed limit. Affecting neighbourhood	Significant
4	61 – 80%	High	Severe environmental damage. Extensive measure is necessary to restore environment to original state.	Significant
5	>80%	Severe	Persistent severe environmental damage or severe nuisance extending over a large area.	Significant

Note: Only negative values are treated as impacts while positive values are considered as not requiring mitigation measures.

Quantification and Evaluation of Existing Impacts

The impacts on seawater quality and sediments were quantified and evaluated using standard laboratory analytical methods. Interpretation of these data were benchmarked with the available data from control points, National/International standards/limits and 2001 baseline values collected during field sampling activities. Furthermore, the evaluation was used to determine the likely receptors in the environment and established the source-receptor pathways. In addition, it was used to determine the current and likely future risks posed by the existing project. Table 5.6 presents the assessment of the existing impacts of EA/Eja field and are discussed in the following subsections.

Table 5.6: Assessment of Existing Impacts

	PARAMETERS	EIA 2001	EIA 2011	Impact magnitude	Scale	Significance	Impact classification	FMEnv	DPR**
Air quality and noise	NO (ppm)	NA	<0.01	NA	NA	NA	NA		
	NO ₂ (ppm)	NA		NA	NA	NA	NA		
	SO ₂ (ppm)	NA	<0.01	NA	NA	NA	NA		
	VOCs (ppm)	NA	<0.01	NA	NA	NA	NA		
	NH ₃ (ppm)	NA		NA	NA	NA	NA		
	H ₂ S (ppm)	NA		NA	NA	NA	NA		
	SPM (µg/m ³)	NA	0.15±0.06	NA	NA	NA	NA		
	Noise, dB(A)	NA	45.56±1.18	NA	NA	NA	NA		
Water	Physicochemical								
	Temperature, °C		28.386	NA	NA	NA	NA		
	Colour, Pt-Co		6.667	NA	NA	NA	NA		
	Turbidity, NTU		0.958	NA	NA	NA	NA		
	TSS, mg/l		2.2	NA	NA	NA	NA		
	TDS, mg/l		26959.31	NA	NA	NA	NA		
	pH		7.761	NA	NA	NA	NA		
	EC, µS/cm		48034.48	NA	NA	NA	NA		
	Dissolved Oxygen (DO), mg/l	7.085	7.974	-13%	1*	Not significant	Low		
	BOD, mg/l		3.33	NA	NA	NA	NA		
	COD, mg/l		5.606	NA	NA	NA	NA		
	Alkalinity, mg/l		108.6	NA	NA	NA	NA		
	Hardness, mg/l		6898.182	NA	NA	NA	NA		
	Anions								
	Salinity (as Cl), mg/l		15037.01	NA	NA	NA	NA		
	Salinity ‰		27.11	NA	NA	NA	NA		
	Nitrate, mg/l	0.32	0.719	-125%	5	significant	Severe	10	
Phosphate, mg/l	0.07	0.158	-126%	5	significant	Severe	5		

EIA of EA/Eja Field Further Oil Development Project

	PARAMETERS	EIA 2001	EIA 2011	Impact magnitude	Scale	Significance	Impact classification	FMEnv	DPR**
	Cations								
	Calcium, mg/l	2,300	747.406	68%	NA	NA	NA		
	Magnesium, mg/l	865	769.945	11%	1	Not significant	Low		
	Ammonium, mg/l		1.984	NA	NA	NA	NA		
	Potassium, mg/l		825.895	NA	NA	NA	NA		
	Heavy metals								
	Cadmium, mg/l	0.05	0.005	90%	NA	NA	NA		
	Zinc, mg/l	0.005	0.251	-4920%	5	significant	Severe	5.0	
	Total iron, mg/l	0.175	1.036	-492%	5	significant	Severe	1.0	
	Copper, mg/l	0.005	0.137	-2640%	5	significant	Severe	0.1	
	Chromium, mg/l	0.01	0.001	90%	NA	NA	NA		
	Nickel, mg/l	0.01	0.002	80%	NA	NA	NA		
	Lead, mg/l	0.005	0.002	60%	NA	NA	NA		
	Vanadium, mg/l		0.001	NA	NA	NA	NA		
	Arsenic, mg/l		0.001	NA	NA	NA	NA		
	Barium, mg/l		0.001	NA	NA	NA	NA		
	Cobalt, mg/l		0.001	NA	NA	NA	NA		
	Mercury, mg/l		0.001	NA	NA	NA	NA		
	Organics			NA	NA	NA	NA		
	TPH, mg/l		0.002	NA	NA	NA	NA		
	PAH, mg/l		0.001	NA	NA	NA	NA		
	BTEX, mg/l		0.001	NA	NA	NA	NA		
	Hydrocarbon Utilizing Bacteria	2680	9	100%	NA	NA	NA		
	Hydrocarbon Utilizing Fungi	2800	7	100%	NA	NA	NA		
	Total Heterotrophic Bacteria			NA	NA	NA	NA		
	Total Fungi			NA	NA	NA	NA		
Sediment	pH	7.91	7.47	6%	NA	NA	NA		

EIA of EA/Eja Field Further Oil Development Project

	PARAMETERS	EIA 2001	EIA 2011	Impact magnitude	Scale	Significance	Impact classification	FMEnv	DPR**
	Temperature, °C		27.1	NA	NA	NA	NA		
	EC, µS/cm		18662.99	NA	NA	NA	NA		
	Salinity (as Cl), mg/kg		2652.08	NA	NA	NA	NA		
	Nitrate, mg/kg	4	141.17	-3429%	5	significant	Severe	-	
	Phosphate, mg/kg	47.25	170.93	-262%	5	significant	Severe	-	
	Potassium, mg/kg	1341	1286.69	4%	NA	NA	NA		
	Calcium, mg/kg	11064	453.42	96%	NA	NA	NA		
	Magnesium, mg/kg	7996.5	995.38	88%	NA	NA	NA		
	TPH mg/kg	8.4	1.15	86%	NA	NA	NA		
	PAH mg/kg		0.001	NA	NA	NA	NA		
	BTEX, mg/kg		0.001	NA	NA	NA	NA		
	Cd	0.39	0.98	-151%	5	significant	Severe		0.8-12.0
	Zn	20.1	54.74	-172%	5	significant	Severe		140-720
	Total Fe	41,900	753.61	98%	NA	NA	NA		
	Cu	3.2	12.49	-290%	5	significant	Severe		36-190
	Cr	21.5	10.63	51%	NA	NA	NA		
	Ni	37.9	13.11	65%	NA	NA	NA		
	Pb	12.8	23.28	-82%	5	significant	Severe		85-530
	Vn	1.6	0.001	100%	NA	NA	NA		
	As	NA	0.001	NA	NA	NA	NA		
	Ba	65.8	0.001	100%	NA	NA	NA		
	Co	5.7	0.001	100%	NA	NA	NA		
	Hg	0.001	0.001	0%	NA	NA	NA		

NA = Not Applicable due either to non-existent comparative value or a greater value in 2001

* Impact not negative; **DPR Target – Intervention Values.

Existing impacts

Air quality and noise

The study found out that there were no impacts of the existing facilities on noise and air quality (Table 5.6). The air quality parameters were not analysed in 2001; hence there was no baseline for comparison with 2011 data. However, values recorded in 2011 fell within regulatory limits.

Water quality

About 36 water quality parameters were compared between 2001 and 2011 (Table 5.6). Of these, only 5 parameters increased significantly during this period, namely nitrate, phosphate, zinc, iron and copper. Nitrate and phosphate increased by 125% and 126% respectively over the 10 year period. The source of nitrate and phosphate may be from sewage, and overland run-off. Disposal of untreated sewage is common in the Niger Delta. Some heavy metals increased considerably from 2001 to 2011 particularly zinc (4420%), copper (2640%) and total iron (492%). The source of these heavy metals could be from overland run-off into the continental shelf and not project related impacts. Heavy metals can also originate from mining and other industrial activities. Note that the source of iron in the Niger Delta is related to the geology of the area. All the microbiology parameters (THB, TF, HUB, HUF) compared in 2001 and 2011 did not indicate any significant impacts (Table 5.6).

Sediment

Twenty four (24) sediment quality parameters were used to assess the impacts of existing EA/EJA field and Sea Eagle facilities (Table 5.6). Of these, 6 parameters were found to be significant. From 2001 to 2011, nitrate and phosphate increased in the sediments by 3429% and 262% respectively. The source of nitrate and phosphate may be from sewage, fertilizer from farm and overland run-off. Disposal of untreated sewage is common in the Niger Delta. Some heavy metals increased from 2001 to 2011 including cadmium (151%), zinc (172%), copper (290%) and lead (82%). The origin of these heavy metals may be from overland run-off and/or from drilling mud (Alimohammadi *et al.*, 2013; Neff, 2008). Hence, the current drilling exercise has the potential to further increase heavy metal in the environment. Heavy metals can also originate from mining and other industrial activities.

Comparison of Key Indicator Parameters for Oil Pollution with FMEnv Standards and DPR Intervention and Target Values

Further comparisons of the key indicator parameters of oil pollution with DPR target and intervention values (Table 5.6) showed that the parameters are generally below the target and intervention values, although some of them were classified as severe when compared with the 2001 values. The nitrate and phosphate values were also far less than the FMEnv limits. The values of these parameters are within safe limits and therefore do not pose any threat requiring mitigation, in spite of the significant difference from the 2001 values.

5.7: Cumulative Impacts

Cumulative impact was regarded as a combination of existing impacts derived from operations and maintenance of existing facilities (Table 5.6) and potential and associated impacts from the proposed project activities (Table 5.4). Table 5.7 present cumulative effects. No air quality parameter can cumulate. In water quality, only few parameters could have cumulative effect such as N, P, Zn, Fe and Cu. Sediment parameters that could have accumulative effects include N, P, Cd, Zn, Cu and Pb. Social and health issues could cumulate over time.

Table 5.7: Cumulative Effect of Existing and New Project

S/N	Environmental Components	Existing Facilities Impacts/Observations (EIA Report, 2001)	Project Potential Impacts (EER, 2011)	Cumulative Negative Impacts (Yes/ No)
1	Air quality	Priority air pollution parameters was not determined	pollutant gases were within limits	No
2	Water quality	Biophysical Environment	Biophysical Environment	Some parameters could cumulate such as N, P, Zn, Fe and Cu
3	Sediment	Biophysical Environment	Biophysical Environment	Some parameters could cumulate such as N, P, Cd, Zn, Cu and Pb
4	Socio-economics	Social environment	Social environment	Yes
5	Community health	Health environment	Health environment	Yes

CHAPTER SIX MITIGATION MEASURES

6.1: Introduction

The actions and measures that SPDC intend to take to reduce (or eliminate) negative impacts and promote positive impacts of the proposed Project are presented in this chapter. In this mitigation measures, emphases are placed on those negative impacts rated as significant (medium and high impacts). The measures are aimed at reducing these impacts to As Low As Reasonably Practicable (ALARP). The residual impacts that could arise despite these mitigation measures were also noted. None significant impacts are expected to be mitigated through effective implementation of Health, Safety and Environment (HSE) plans that will be put in place during the different phases of the project.

The mitigation measures proposed are in consonance with the following:

- Environmental Guidelines and Standards for Petroleum Industries in Nigeria (EGASPIN,1991)
- International Union for Conservation of Nature and Natural Resources (IUCN) Guidelines, 1996.
- Harmful Waste (Special Criminal Provisions) Decree, 1998.
- National Environmental Protection (Pollution abatement in industries and facilities generating waste) Regulations, 1991.
- Oil in navigation waters Act, Cap 337, Laws of the Federation of Nigeria, 1990.
- Concerns of stakeholders 2001.

The following criteria were used to define mitigation measures for the identified impacts:

Prevention - Exclude significant potential impacts and risks by design and management Measures.

Reduction - Minimize the effects or consequences of those significant associated and potential impacts that cannot be prevented, to a level as low as reasonably practicable by implementing operational and management measures.

Control - Implement operational and management measures to ensure that residual associated impacts are reduced to a level as low as reasonably practicable.

6.2: Mitigation Measures

A summary of the mitigation measures for the potential impacts is presented in Table 6.1 while those for the existing impacts are in Table 6.2. These measures are recommended to ameliorate all the significant impacts of existing facilities and significant associated and potential impacts for the proposed Project.

Table 6.1: Mitigation Measures for Significant Associated and Potential Impacts of the Proposed Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
Pre-construction (pipeline route survey)	Risk of accident	H	SPDC shall ensure <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • Only pre-mobbed water crafts are used • Daily pep talk is carried out for marine transportation, • Safety signages are deployed at strategic locations. • First aid boxes and a paramedic are in operational water crafts. • Emergency response plan is in place • Use of PPEs by the survey team. 	L
	Risk of Piracy and kidnapping	H	SPDC shall: <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
Mobilization (equipment and personnel), and Rig Move	Impairment of air quality	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre-mobbed and regularly maintained watercrafts, vessels, generators and other machines. • Use only low sulphur containing fuel and low NOx burners in large generators and turbines. 	L
	Increase in noise and vibration	M	SPDC shall use only pre-mobbed and regularly maintained equipment and water crafts.	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of premob before deployment to site. • Emergency response plan are in place. • Use of PPEs 	L
	Risk of Piracy and kidnapping	H	SPDC shall <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
Site preparation (piling)	Increase in noise and vibration	H	<ul style="list-style-type: none"> • Ensure the premob of all equipment before they are deployed to site. • Use Generators with noise levels within acceptable limits of (85 - 90 dB (A). • Provide acoustic mufflers for heavy engines with noise level above acceptable limits. • Enclose high sound energy equipment in noise insulators in line with SPDC policy. • SPDC HSE policy of wearing ear muffs/ plugs shall 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			be applied in all construction and operational sites where high noise is produced. <ul style="list-style-type: none"> • Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. • Workers with existing hearing impairment shall not be deployed to site. 	
	Interference with fishing activities	M	<ul style="list-style-type: none"> ▪ Provide timely information to stakeholders particularly fisher folks on the nature and timing of activities which may lead to direct interference with fisheries activities. 	L
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of premob before deployment to site. • Emergency response plan are in place. • Use of PPEs 	L
	Risk of Piracy and kidnapping	H	SPDC shall <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with 	M

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			employment and other worthwhile ventures like skills acquisition.	
Fabrication, Installation and positioning of Wellhead Platform	Increase in noise and vibration	H	<ul style="list-style-type: none"> Generators with noise levels within acceptable limits of (85 - 90 dB (A)) shall be used Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits High sound energy equipment shall be enclosed in noise insulators in line with SPDC policy SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is produced. Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. Workers with existing hearing impairment shall not be deployed to site. 	L
	Interference with fishing activities	M	Provide timely information to stakeholders particularly fisher folk on the nature and timing of activities which may lead to direct interference with fishing activities/operations.	L
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> Compliance with journey management policy for marine transport That only pre-mobbed water crafts are used. That daily pep talk is carried out for marine transportation Safety signages are deployed at strategic locations. Provision of first aid boxes in operational water crafts as part of premob before deployment to site. Emergency response plan are in place. Use of PPEs 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Risk of Piracy and kidnapping	H	SPDC shall <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
	Impacts of Wastes	H	Site specific solid waste management plan in line with SPDC waste management guidelines shall be put in place. <ul style="list-style-type: none"> • Waste shall be segregated at source using colour-coded bins. • Scrap metal/pipe off-cuts shall be transported to Shell Kidney Island (KI) scrap yard, Port Harcourt, for onward delivery to SPDC approved metal recycling vendor(s). • Generated glass and paper materials shall also be transported to SPDC Industrial Area (IA) waste recycling depot for onward delivery to any SPDC approved glass recycling vendor(s). • Work Vessel shall be equipped/fitted with a biological sewage treatment plant. • Spent batteries shall be taken to any SPDC approved battery re-cycling company. • Medical waste shall be collected and taken to the medical incinerator at Shell IA • Wastes are routinely transported via offshore 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			supply vessel to shore.	
	Impairment of air quality	M	<ul style="list-style-type: none"> ▪ Emissions from machinery shall be reduced by the use of standard equipment that meet existing emissions requirements (low NO_x burners) and fume catalysers provided on all suitable equipment. ▪ Ambient air quality shall be monitored in line with FMENV/DPR requirement (NO_x, CO_x, SO_x, SPM etc) ▪ There shall be regular maintenance of combustion systems (generators, cranes and welding machines . 	L
Drilling	Impairment of air quality	M	<ul style="list-style-type: none"> • Ensure that drilling equipment is of high standard and in good condition prior to mobilization. • Ensure that all emission releasing equipment shall be maintained regularly including gensets, cranes, welding machines, etc. • Ambient air quality shall be monitored in line with FMENV/DPR requirement (NO_x, CO_x, SO_x, and SPM). 	L
	Noise and vibration nuisance	M	<ul style="list-style-type: none"> • Generators with noise levels within acceptable limits of (85 - 90 dB (A)) shall be used. • Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits. • High sound energy equipment shall be enclosed in noise insulators in line with SPDC policy. • SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is produced. • Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. • Workers with existing hearing impairment shall not 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			be deployed to site.	
	Injuries and death from blowouts	H	SPDC shall ensure that <ul style="list-style-type: none"> • Only skilled personnel and certified equipment are used. • Use appropriate blowout prevention fluids. • Use appropriate mud density. • Use high quality chemicals and materials. • Ensure emergency response procedures are in place • Job hazard assessment shall be conducted. • Daily pep talks shall be conducted on identified hazards. • A Blow out Preventer (BOP) will be used when drilling. • Above mitigation measures are to insure that there is no blow outs/accidents. However in the event of blow out/accidents, emergency response in place is activated 	L
	Surface water and sediment pollution from chemicals, drill cuttings, and mud	H	SPDC shall <ul style="list-style-type: none"> • Recover oil based drilling mud for re-processing and re-use. • Wells shall be drilled with Water Based Mud in top hole. • Develop and implement waste management plans for all wastes generated in accordance with regulatory requirements and standard practice. • All industrial wastes such as plastics, metals, rubber and wood shall be segregated on site and collected in designated containers. The containers will be transported to land base for disposal 	L
	Accidents and injuries	H	<ul style="list-style-type: none"> • SPDC journey management policy for water/ air 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			transport shall be adhered to (all journey must be approved, no night journeys, speed limits on water etc); <ul style="list-style-type: none"> • Defensive driving course (DDC) for all SPDC boat drivers (including contractors and casual boat drivers); • All water/ air borne crafts shall be pre-mobilized and certificate of worthiness issued; • All personnel for water/ air borne operations shall have TBOSIET certificate. • Adequate first aid shall be maintained in all watercrafts and at site; • Use of life-vest while on transit for water borne operations; • Compensation for proven project-induced injuries accidents and fatalities on third parties; • Use only trained personnel for specified jobs; • Carry out job hazard analysis; • Daily pep-talk before each day's job; • Medevac shall be provided at site 	
	Contamination of the environment by wastes	H	SPDC shall ensure <ul style="list-style-type: none"> • Regular collection and monitoring of wastes from cradle to grave in accordance with SPDC's waste management plan. • All oily wastes shall be properly segregated and contained before disposal. • Sanitary wastes shall be treated in a sewage treatment plant. • Non-hazardous wastes shall be subjected to SPDC's waste management process. • Hazardous wastes shall be segregated and sent to 	L

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			<p>approved waste disposal sites.</p> <ul style="list-style-type: none"> • Rags (clothing, worn coveralls, shirt, trousers), shall be segregated and sent to an approved incinerator. • Miscellaneous domestic waste, old tooth brushes/disposable razors etc, / old footwear, hand gloves etc and garbage, will be segregated and subjected to SPDC's waste management procedure. • General paper waste shall be segregated and be subjected to approved SPDC's waste management guidelines. • Plastic containers shall be sent to recycling depot subjected to SPDC's waste management guidelines. • IBC tanks for chemicals shall be re-used for fresh chemical supplies to the rig while spent chemical drums shall be sent to town for incinerator. • Kitchen waste (garbage) shall be segregated and subjected to SPDC's waste management guidelines. • SPDC shall enforce adequate waste management on site. • SPDC shall ensure that disposal of drilling wastes is in line with regulatory standards (See table 3.2 in page 48). 	

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
Pipeline construction (Piping/ flowlines, well hook-up)	Risk of accident	H	<p>SPDC shall ensure:</p> <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation. • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of premob before deployment to site. • Emergency response plan are in place. • Use of PPEs 	L
	Risk of Piracy & kidnapping	H	<p>SPDC shall</p> <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
	Impairment of air quality	M	<ul style="list-style-type: none"> ▪ Emissions from machinery shall be reduced by the use of standard equipment that meet existing emissions requirements (low NOx burners) and fume catalysers provided on all suitable equipment. ▪ Ambient air quality shall be monitored in line with FMENV/DPR requirement (NOx, COx, SOx, SPM, etc) ▪ There shall be regular maintenance of combustion systems (generators etc). 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Increase in noise and vibration levels	M	<ul style="list-style-type: none"> • Generators with noise levels within acceptable limits of (85 - 90 dB (A)) shall be used. • Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits. • High sound energy equipment shall be enclosed in noise insulators in line with SPDC policy. • SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is produced. • Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. • Workers with existing hearing impairment shall not be deployed to site 	L
	Contamination of surface water bodies	H	SPDC shall <ul style="list-style-type: none"> • treat all effluents to regulatory limits before discharging into the environment. • Dispose all wastes in line with regulatory requirements. • SPDC shall activate existing oil spill contingency plans in the event of oil spill. 	L
	Exposure to radiation materials	H	<ul style="list-style-type: none"> • Health awareness training will be conducted prior to commencement of activities. • Staff shall undergo routine medical check-ups for radiation exposure. • Radiation monitors shall be provided to monitor radiation levels at site. • The use of radiography aprons to protect the body from radiation shall be enforced. • Warning signs shall be provided during radiation emitting activities to prevent trespass into such 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
		H	<ul style="list-style-type: none"> areas. Radiation emitting activity shall be carried out in line with valid NNRA license and SPDC premob certificates. 	
	inhalation of welding fumes	M	<ul style="list-style-type: none"> Awareness sessions on health risks and safety precautions of welding operations to be carried out for workers. SPDC shall enforce the use of PPEs (welder’s mask, jacket, gloves, boots and coveralls), by welders during welding. 	L
	Soft tissues damage from welding sparks	M	<ul style="list-style-type: none"> Awareness sessions on health risks and safety precautions of welding operations to be carried out for workers. SPDC shall enforce the use of PPEs (welder’s mask, jacket, gloves, boots and coveralls), by welders during welding. A functional site clinic shall be provided by the contractor and approved by SPDC. 	L
	Conjunctivitis from welding flash	M	<ul style="list-style-type: none"> Awareness sessions on health risks and safety precautions of welding operations for workers. Pre-employment medical certification the welders. Enforcement of the use of PPEs (welder’s mask, earmuffs, jacket, gloves, boots and coveralls), by welders during welding. Provision of site clinic for workers. 	L
	Potential for conflicts arising from labour issues	H	<ul style="list-style-type: none"> SPDC & her contractors shall respond to complaints by locals on the activities of her workers Deploy GMOU provisions on community labour issues. 	L

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Stress on existing security structures	H	<ul style="list-style-type: none"> • Make all necessary arrangements with Government security agents (Navy) to improve security. • SPDC shall continue to engage stakeholders in order to minimize resentment. • A security management plan shall be produced for the project before mobilization • Workers to be made aware to be security conscious • Engagement of the youths from the area on worthwhile ventures eg skills acquisition • Employment opportunities for the indigenes 	M
Demobilization	Impairment of air quality	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre-mobbed crafts • Regular maintenance of water crafts, vessels, generators and other machines. • use low sulphur containing fuel and low NOx burners 	L
	Water traffic incidents	H	SPDC shall ensure <ul style="list-style-type: none"> • compliance with her journey management policy for marine transport • Only pre-mobbed water crafts are used • daily pep talk is carried out for marine transportation • Safety signage shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts • Emergency response plan shall be in place 	L
	Improper disposal of materials removed from site	M	SPDC shall ensure: <ul style="list-style-type: none"> • all removed materials shall be properly disposed of and monitored from cradle to grave in line with the waste management plan • Scrap metals shall be collected, segregated and 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			subjected to SPDC’s waste management guidelines. <ul style="list-style-type: none"> • Plastic wastes shall be sent to an approved Recycling Waste Depot (RWD). • Radioactive wastes/materials shall be managed according to Nigerian Nuclear Regulatory Authority (NNRA) approved procedure. • SPDC waste management policy shall be enforced. 	
	Increase in noise and vibration level	M	SPDC shall use only pre-mobbed and regularly maintained equipment and water crafts	L
	Loss of employment/ income	H	SPDC Shall: <ul style="list-style-type: none"> • Strengthen existing cooperatives and encourage the formation of new ones that will engage in commercial activities to sustain the local economy • Workers shall be made aware that employment is only temporal and shall cease at the end of the contract • Support micro credit schemes that promote trade and self-sustenance • Require contractors to prepare and implement workers disengagement plans • Encourage and support skill acquisition programmes of Government, NGOs and CBOs 	L
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of premob before deployment to site. 	L

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Risk of Piracy & kidnapping	H	<ul style="list-style-type: none"> • Emergency response plan are in place. • Use of PPEs SPDC shall <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
Commissioning Operations and Maintenance	Improper disposal of materials removed from site	H	SPDC shall: <ul style="list-style-type: none"> • Ensure all oily wastes are properly segregated and contained before disposal. • Ensure all oily wastes are properly disposed of and monitored from cradle to grave. • Ensure regular clean-up of equipment at site. • Provide a drain round chemicals and liquids stores to control discharges. • Ensure the enforcement of waste management policy. • Ensure that a controlled fuelling, maintenance and servicing protocol for machinery at worksite is established and followed to minimize leaks and spills. • Ensure Spent chemicals, lube oil, grease, waste oil and detergent solutions are properly disposed of. • Ensure used chemical drums and containers are sent to an approved recyclable waste dump (RWD). 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			Small chemicals spills, crude oil and aqueous effluents shall be cleaned up promptly.	
	Equipment failure and damage leading to injuries/fatality	M	SPDC shall ensure that: <ul style="list-style-type: none"> • Only skilled personnel and certified equipment are used. • Certified first aiders shall be available at every site. • First aid boxes and emergency response procedures are in place. • Hazard assessment has been conducted. • Emergency response procedures are in place. • HSE standards are strictly adhered to. • Permit to work and proper briefing is given before any work can commence. 	L
	Gas flaring	H	SPDC shall: <ul style="list-style-type: none"> • No routine flaring of associated gas. • Send all AG to NLNG via the OGGS pipeline for processing sales for national income generation 	L
	Produced water	H	Produced water shall be treated to regulatory standards before discharge to a depth of 200feet.	L
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of pre-mob before deployment to site. • Emergency response plan are in place. • Use of PPEs 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Risk of Piracy & kidnapping	H	SPDC shall <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
Decommissioning and Abandonment	Increase in noise and vibration	M	SPDC shall use only pre-mobbed and regularly maintained equipment and water crafts	L
	Impairment of air quality	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre-mobbed crafts • Regular maintenance of water crafts, vessels, generators and other machines. • Use low sulphur containing fuel and low NOx burners 	L
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport. • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of pre-mob before deployment to site. • Emergency response plan are in place. • Use of PPEs 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
	Risk of Piracy & kidnapping	H	SPDC shall <ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M
	Increase potential for water traffic accidents/ injury	M	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with her journey management policy for marine transport • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation • Safety signage shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts • Emergency response plan shall be in place. 	L
	Potential for conflicts arising from labour issues	H	<ul style="list-style-type: none"> • SPDC and her contractors shall respond to complaints by locals on the activities of her workers. • Deploy GMOU provisions on community employment. 	L
	Injury/fatalities in workforce	H	SPDC shall ensure: <ul style="list-style-type: none"> • Daily pep talk is carried out for marine transportation • Safety signage shall be deployed at strategic locations. 	L

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation
			<ul style="list-style-type: none"> • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. 	

Table 6.2: Mitigation of Existing Impacts

Receptor Component	Impacted Parameters	Impact Ranking before Mitigation	Mitigation Measures	Impact ranking after Mitigation
Water	Dissolved Oxygen (DO), mg/l	Low	Comply with SPDC waste management guidelines. Sustain treatment of sewage before discharge and compliance monitoring of discharges. Ensure minimal dumping of organic matter such as food wastes into the open water body for monitoring of discharges. Limit the amount of treated waste water discharged through recycling and reuse.	Negligible
	Nitrate, mg/l	Severe	Comply with SPDC waste management guidelines. Sustain treatment of sewage before discharge and compliance monitoring of discharges. Ensure minimal dumping of organic matter such as food wastes into the open water body before monitoring of discharges. Limit the amount of treated waste water discharged through recycling and reuse.	Low
	Phosphate, mg/l	Severe	Comply with SPDC waste management guidelines. Sustain treatment of sewage before discharge and compliance monitoring of discharges. Ensure minimal dumping of organic matter such as food wastes into the open water body monitoring of discharges. Limit the amount of treated waste water discharged through recycling and reuse	Low
	Magnesium, mg/l	Low	<ul style="list-style-type: none"> • Apply corrosion inhibitors; • Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements. • Comply with SPDC oil spill contingency management plan. • Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements. 	Negligible
	Zinc, mg/l	Severe	<ul style="list-style-type: none"> • Apply of corrosion inhibitors, • Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements. 	Low
	Total iron, mg/l	Severe	Natural attenuation	Low
	Copper, mg/l	Severe	<ul style="list-style-type: none"> • Apply of corrosion inhibitors, • Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements. 	Low

Receptor Component	Impacted Parameters	Impact Ranking before Mitigation	Mitigation Measures	Impact ranking after Mitigation
Sediment	Nitrate, mg/kg	Severe	Comply with SPDC waste management guidelines. Sustain treatment of sewage before discharge and compliance monitoring of discharges. Ensure minimal dumping of organic matter such as food wastes into the open water body monitoring of discharges. Limit the amount of treated waste water discharged through recycling and reuse	Low
	Phosphate, mg/kg	Severe	Comply with SPDC waste management guidelines. Sustain treatment of sewage before discharge and compliance monitoring of discharges. Ensure minimal dumping of organic matter such as food wastes into the open water body monitoring of discharges. Limit the amount of treated waste water discharged through recycling and reuse.	Low
	Cadmium	Severe	Application of corrosion inhibitors; Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements; Comply with SPDC oil spill contingency management plan. Sustain treatment and monitoring of effluents/discharges in line with regulatory requirement	Low
	Zinc	Severe	Application of corrosion inhibitors; Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements; Comply with SPDC oil spill contingency management plan. Sustain treatment and monitoring of effluents/discharges in line with regulatory requirement.	Low

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Receptor Component	Impacted Parameters	Impact Ranking before Mitigation	Mitigation Measures	Impact ranking after Mitigation
	Copper	Severe	Application of corrosion inhibitors; Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements; Comply with SPDC oil spill contingency management plan. Sustain treatment and monitoring of effluents/discharges in line with regulatory requirement.	
	Lead	Severe	Application of corrosion inhibitors; Sustain treatment and monitoring of effluents/discharges in line with regulatory requirements; Comply with SPDC oil spill contingency management plan. Sustain treatment and monitoring of effluents/discharges in line with regulatory requirement.	

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN

7.1: Introduction

Environmental management is concerned with a planned and integrated program aimed at ensuring that unforeseen and unidentified impacts of a proposed project are contained and brought to acceptable minimum levels. Environmental management provides confidence on the part of project planners that a reliable scheme has been put in place to deal with any contingency that may arise during all phases of the project development, from mobilization to abandonment.

In keeping with Shell policy on the environment, considerations of environmental implications of this project began from feasibility study, conceptual design, up to the present stage of EIA and will continue throughout the project life cycle. This EIA report is part of the environmental management program, and is intended to provide an environmental input into the planning and execution of the project. The project's HSE-MS addresses the overall approach adopted for management of HSE risks through the project development phases by the project management team. The project HSE-MS document provides central guidance and co-ordination for project-wide documents - work procedures, standards, work practices, etc., and demonstrates how the Hazards and Effects Management Process (HEMP) will be applied on the project such that HSE risks are kept As Low As Reasonably Practicable (ALARP).

7.2: Objectives of EMP

Good environmental management, which is part of SPDC HSE-MS goals, has the following long term objectives:

- Ensure compliance with Legislations and Company policy;
- Achieve, enhance and demonstrate sound environmental performance built around the principle of continuous improvement;
- Provide strategy for overall planning, operation, audit and review;
- Enable project planners establish environmental priorities.

To provide assurance that the risk management and control procedures identified in this environmental impact assessment are implemented, a comprehensive EMP was developed (Table 7.2). The EMP takes cognisance of the technical implementation of the EIA findings in the design phase of project development, such that a plan of action for managing residual environmental impacts can then be evolved.

7.3: Monitoring Objectives

The following monitoring objectives are established:

- to create local data bank on the impacts of project activities on the aquatic ecosystem, for future development of predictive models;

- to compare effluent quality and quantity with design specifications, impact predictions and regulatory standards;
- to monitor emissions and discharges at all stages of project development to ensure they meet national standards;
- to determine whether environmental changes are results of development or a result of natural variations;
- to determine the effectiveness of the mitigation measures;
- to determine long term impacts.
- to determine the duration of return to normalcy of the environmental components of the project area

7.4: Environmental Audits Programme

SPDC has instituted audit scheme, as part of its programme on environmental management. The scheme is aimed at verifying the effectiveness of environmental control and highlighting areas of weakness in environmental management. The audits are focused on areas of project perceived as having the highest environmental impacts. They are carried out annually and reviewed by SPDC environmental audit committee. It is recognized that to be truly effective, these audits need to be conducted within the overall structured management systems. The structured approach is aimed at disseminating information, providing advice and assistance in its application, and at corporate assurance of performance in meeting the environmental requirement/targets.

7.5: Training and Awareness Campaign

Within SPDC, environmental protection, like safety, is a line responsibility for which staff, at all levels, have accountabilities. An environmental specialist assists the line management with advice on environmental matters, from an expert point of view. However, responsibility and accountability is clearly defined, from senior management who allocate resources and monitor environmental performance to individual contractors who have responsibility for environmentally sound practices in their workplace. All staff will be made aware of their responsibilities through induction and training courses as outlined in the projects' HSE-MS document. In addition, procedures, guidelines and notices will advise staff on how to respond in the event of an environmental emergency. The Shell Corporate Environment Department is responsible for monitoring and auditing the environmental activities of this project.

7.6: Emergency Response Programme

The SPDC strategy for the Offshore Oil Spill Contingency Plan and Emergency response are detailed in the company Emergency Response (ER) Procedure, HSEM-2000-0012. This section discusses the operational controls in place and the monitoring plan. The ER document addresses the response activities to all Tier 1, 2 and 3 spills within the Field. Also, it covers the initial response to all oil spills sighted within the Field regardless of whether or not the oil spill is known to have come from SPDC operated facilities. This is a statutory requirement under the

Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) Appendix VIII B Clause 4.0.

Oil spill incidents are classified in the same way as other emergencies and the response is appropriate to this risk-based classification. In developing their Health, Safety and Environment (HSE) Management Systems with respect to spills of oil and chemicals on land and water, Shell Companies and Business Units (BUs) are committed to compliance with the relevant legislations and the prevention of spills. Shell strives to be a leader in oil and chemical spill preparedness and response capability.

In order to achieve this, SPDC shall:

- Recognize the priority of preventing oil and chemical spills, and promote the high standards this demands among employees, contractors and others associated with handling these products.
- Seek to maintain and continuously improve their ability to minimize the impact of oil and chemical spills on the environment.
- For spills on water, SPDC shall promote the tiered response concept of the International Petroleum Industry Environmental Conservation Association (IPIECA), which classifies the need for response capabilities in terms of the size of spill and its proximity to a company's operating facilities.

Spills that are contained on a facility or vessel will be managed in accordance with the particular facility or vessel procedures. All contaminated clean-up material will be placed in suitable bags or skips and will be shipped to the onshore supply base for disposal in accordance with SPDC requirements. If onshore support is not available, then the facility or vessel OIM or Master will report the spill in accordance with the SPDC procedure (HSEM-2000-0017) for Accident and Incident Reporting, Investigation and Follow-up, after the spill has been controlled and cleaned up.

SPDC Oil Spill Policy

It is SPDC policy to:

- Clean up all hydrocarbon and chemical spills emanating from the Company's operations in a timely and efficient manner.
- Draw up contingency plans and provide resources for prevention and timely response to spills.
- Effect cleanup where the cause of the spill or the party responsible is unknown and seek to recoup costs for such services.

This plan aims to demonstrate how this policy is to be implemented for the offshore operation.

Emergency Event Classification/ Oil Spill Tier Definitions

Event classification will initially be assessed by the Oil Spill Commander (OSC). Unless the incident is clearly of a minor nature and has little or no potential for further escalation, the OSC shall consult immediately with the Asset Duty Manager.

There are three emergency event categories – A, B and C. These align generally, but not precisely, with oil spill tier classification, which is based on quantity.

Table 7.1: Oil Spill Tier Definitions

Tier	Definition
Tier 1 <2000bbls	Small spills that can be controlled by onsite resources or will rapidly disperse naturally. The spill is unlikely to involve the Offshore Operations ERT or external bodies, except for notification.
Tier 2 2000 - 10,000bbls	Larger spills requiring mobilization of the SN-ERT and which will probably require additional resources to be deployed by the SNEPCO OSRT, depending on spill trajectory, sea condition and weather. The OSRL dispersant spraying aircraft, based in Accra is also available to assist in dealing with Tier 2 spills.
Tier 3 >10,000bbls	A major or large spill requiring mobilization of the SN-ERT and probably the SNEPCO ERT, Clean Nigeria Associates and will also require response assistance at a national/international level through OSRL via Shell International Trading and Shipping Company Ltd (STASCO).. Involvement of regulators (DPR and NOSDRA) will be necessary.

Source: Bonga Oil and Chemical Spill Response Plan SNEPCO, 2012

Environmental Sensitivity

In all cases of oil and chemical spillage, the threat to environmentally sensitive areas must be formally assessed taking into account the issues discussed above. The risk is then classified and managed using the HSE risk matrix.

Unclassified/Minor

If a minor spill has occurred, the OSC may use his/her judgement to decide that the incident may not warrant formal classification as an emergency. This applies only to very small oil and chemical spills which may be managed without declaring an emergency or formally mustering the full offshore ERT. Such spills are however still reportable incidents. The OSC must inform the Asset Duty Manager and issue notification to DPR and NOSDRA via Forms A, a MARPOL notification and SPDC environmental incident notification, at the first opportunity, within 24 hours of the spill.

Category A Incidents

These are relevant to spills at the bottom of the Tier 1 range only and to an absolute maximum of 250bbbls. A Category A incident should be declared where it is judged that the incident can be effectively managed by natural dispersion.

Category A spills should be controlled using mainly EA Offshore Operations in-house resources, although they may require limited support from onshore. OSC must report such incidents to the Asset Duty Manager as soon as is practicable.

Category B Incidents

These are spills of up to an absolute maximum of 10,000bbbls (e.g. Tier 3). However, the operational threshold for escalation to Category C must be significantly reduced if the slick trajectory threatens land or other sensitive areas. In these circumstances a useful guide might be where the quantity exceeds Tier 2 (2000bbbls). These spills will require the deployment of SN-ERT and onshore assistance from SPDC OSRT should be sought to determine the risk to sensitive shorelines. This category of event will result in the full mobilisation of the SN-ERT, the SPDC OSRT and, if necessary, the SCiN Crisis Management Team (CMT). The involvement of external agencies such as Clean Nigeria Associates, and other operators in Nigeria under the OPTS mutual assistance plan, may also be necessary.

In very broad terms, larger Tier 1 oil spills are likely to result in a Category B incident. However, even quite a small amount of non-volatile oil moving on a fairly calm sea towards an environmentally sensitive coast might be appropriately classified as Category B. Conversely, Category B might also be the appropriate response for a top-end Tier 2 volume of more volatile oil moving out away from the coast in a rough sea. This is because the hazard is based upon the amount of oil likely to impact sensitive areas. Volatile oil will tend to disperse naturally and rough seas tend to break up slicks. Non-volatile oil in a calm sea will persist as a slick.

Category C

Note: The threshold for declaring a Category C event will be determined by the SPDC ERC and Asset Duty Manager in conjunction with the OSC. Category C is applied only to serious emergencies. SN-ERT shall assume control as soon as is practicable.

Category C incidents require the involvement of wide-ranging Company resources, and of government and external agencies. This category of event will result in the immediate notification and mobilization of the SN-ERT and SPDC OSRT, who will mobilize the SCiN CMT and appropriate international assistance. The event has the potential for one or more of the following:

- Death and/or serious injury
- Significant environmental damage
- Substantial damage to assets and/or third-party property

- Attracting major media interest
- Technical, press, public affairs and personnel implications which require immediate assistance from SPDC ERT and the CMT, and possibly from management at national and international level.

Tier 3 spills almost always equate to Category C incidents. However, a Tier 2 volume of non-volatile oil in a calm sea moving towards a sensitive coastline could be appropriately classified as Category C.

Oil Spill Tracking

If a spill occurs in the sea, it must be tracked until such time that it has evaporated or broken up and dispersed.

Emergency Response Management

The guiding principles for Emergency Response Management System in EA are;

- Create awareness of emergency situations and how they could arise from operations. That is: What hazards exist; What consequences can be expected; What level of response may be required; and How can operations be returned safely to normal as soon as possible.
- Develop an organization, based on the internal line structures, of teams and individuals with defined responsibilities, and where appropriate with good linkages to relevant regulatory authorities and industry support based on tiered response.
- Provide the resources required to fulfill these responsibilities and support all aspects of the emergency response.
- Define procedures that will deliver an effective and appropriate level of response that should include the emergency coordinator's dossier, together with the contingency plans for the specific response situations.
- Conduct training, practice and review activities to test the effectiveness of procedures and provide learning and feedback of experience on a regular basis.

Other elements of the SPDC emergency response (in addition to this procedure) are described below.

HSE Management System

This provides a demonstration of how SPDC HSE policies and objectives are met. Facility/Asset Emergency Response Procedure addresses facilities, wells and equipment emergency response required to protect the public, employees, the environment and company equipment in the event of an emergency incident.

Spill Prevention and Response

This addresses effective and prompt response to spills of oil or chemicals in order to minimize adverse environmental effects and reduce production losses.

Incident Notification and Reporting

This describes procedures for reporting incidents in order to ensure compliance with regulatory requirements for incident notification.

Compliance Reporting

The requirements of the revised 2002 DPR Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (PART VIII-B: Contingency Planning for the Prevention, Control and Combating of Oil and Hazardous Substances Spills) shall be strictly adhered to.

Emergency Response Organization

The emergency response process begins with the recognition of the incident by an observer at any site or operation unit. The process is initiated by notifying the site supervisor of the incident, who then assesses the situation and decides what category such incident can be classified. Where it is categorized as higher than that which the site or operation can handle, the Duty Manager shall be called in for support. Incident category at a higher level would involve intervention of the SPDC Emergency Response Team (SN-ERT) with SCiN interface and SCiN EP Directorate, etc, depending upon the level of response considered appropriate. SPDC emergency response organization consists of line senior staff from various disciplines (Figure 7.1).

For permanently manned areas, there shall be local emergency teams, responsible for managing all operational response activities during minor emergencies. In addition, the SN-ERT, led by a senior manager, as the Emergency Response Commander, shall assist the Duty Manager in external response activities in case of a major emergency situation.

The Emergency Response Commander (ERC) has immediate support at all times drawn from staff with broad knowledge and at the right level of skills in the following disciplines: Well Engineering, Engineering, Production Operations, Logistics, Human Resources, External Relations, Security, Information Management, Human Resources and General Services, and Health, Safety and Environment. He also has authority to draw support from SCiN, third parties and government agencies as required.

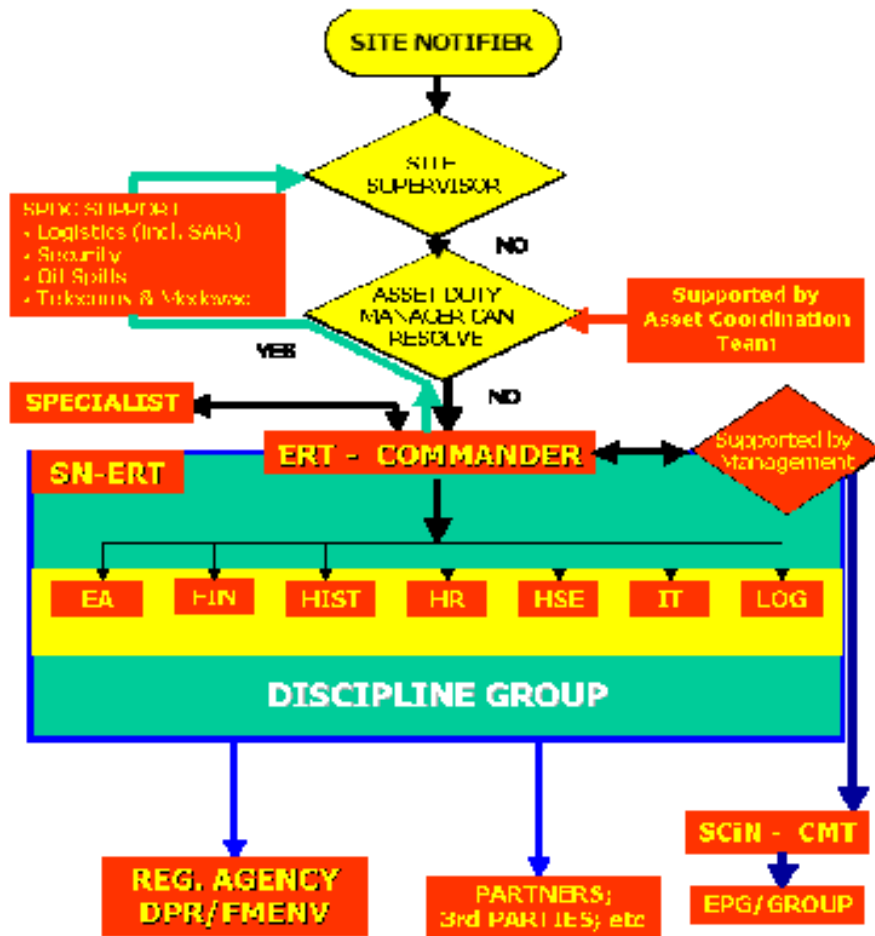


Fig. 7.1: Flowchart of the Call out Sequence and SN-ERT Organization.

Emergency Escalation Process

In line with Company requirements, Emergency Escalation Process progresses as: follows:

Site Supervisor → Asset Duty Manager → ERT Commander → Chief Executive

Escalation is based on the value judgment of the responsible personnel to ensure that:

- There is sufficient senior management awareness of the emergency,
- Teams are alerted/activated on a precautionary basis whilst a full assessment of the situation is made,
- Clear ownership of the emergency is established quickly,
- Potential escalation triggers are identified,
- There is awareness of the problem at the level above which it is being managed, and
- Information is shared internally to all relevant teams in a timely manner

Waste management

Wastes shall be managed in line with Shell EA/Eja Field (Appendix 5) waste management guideline summarized as follows:

- Synthetic Based Mud (SBM) cuttings are treated to $<$ or $=$ 5% oil on cuttings and discharged offshore as per DPR environmental waste discharge permits
- Water based mud cuttings are discharged offshore as per DPR environmental waste discharge permits
- Oily rags and oil filters (collected in dedicated containers), Filters crushed on the rig and together with the rags are manifested and transported to land for incineration.
- Oily waste, used lubricants and hydraulic oil, will be collected in drums, with plastic lids, sealed and sent to town for re-conditioning / re-use
- Spent fluorescent tubes will be crushed using the tube eater on the rig and when filled, sealed and sent to Onne for incineration.
- Batteries – sent to land for appropriate disposal.
- Medical wastes - stored and transported in puncture proof plastic drums / sealed boxes and transported to land for incineration.
- Empty oil and chemical drums – Back loaded to land to the chemical companies.
- Sewage: In compliance with regulatory requirements (sewage treatment and chlorination before discharge) and proper measures to be put in place to check increase in coliforms levels.

7.7: Environmental Management Plan

The developed environmental management plan is as presented in Table 7.2.

Table 7.2: Environmental Management Plan

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
Pre-construction phase (survey)	Risk of accident	H	SPDC shall ensure <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signages shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. • Use of PPEs by the survey team. 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates of vessels • Pep-talk records • Accident records 	Monthly	SPDC /FMEnv/ MEnv.	5000
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management 	Monthly	SPDC /FMEnv/ MEnv.	10, 000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			awareness/drills are conducted for the workforce <ul style="list-style-type: none"> • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 		procedure <ul style="list-style-type: none"> • Record of security situation/ updates • Site Inspection records 			
Mobilization Phase (Equipment and personnel, and Rig Move)	Impairment of air quality	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre-mobbed and regularly maintain watercrafts, vessels, generators and other machines. • Use only low sulphur containing fuel and low NOx burners in large generators and turbines. 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records • Compliance Monitoring Reports 	Monthly	SPDC/FME nv/MEnv.	5000
	Increase in noise and	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre-mobbed 	L	<ul style="list-style-type: none"> • Premob certificates 	Monthly	SPDC/FME nv/MEnv.	10, 000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
	vibration		and regularly maintained equipment and water crafts. • Use PPEs such as ear muff.s Equipment with low noise rating (85 - 90 dB (A)).		• Maintenance records			
	Risk of accident	H	SPDC shall ensure • Compliance with SPDC journey management policy for marine transport including TBOSIET. • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of pre-mob before deployment to site. • Emergency response plan are in place.	L	• Journey management records • Premob certificates • Pep-talk records • Accident records	Monthly	SPDC /FMEnv/ME nv.	5000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Use of PPEs • SPDC shall • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management procedure • Record of security situation/ updates • Site Inspection records 	Weekly	SPDC	5000
Execution Phase (Site preparation-) piling	Increase in noise and vibration	H	<ul style="list-style-type: none"> • Ensure the premob of all equipments before they are deployed to site. • Use Generators with noise levels within 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records 	Monthly	SPDC/FME nv/MEnv.	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			acceptable limits of (85 - 90 dB (A)). <ul style="list-style-type: none"> • Provide acoustic mufflers for heavy engines with noise level above acceptable limits. • Enclose high sound energy equipment in noise insulators in line with SPDC policy. • SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is produced. • Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. • Workers with existing hearing impairment shall not be deployed to site. 					
	Interference with fishing	M	Provide timely information to	L	Records of engagement	Monthly	SPDC/FME nv/MEnv.	5000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
	activities		stakeholders particularly fisher folks on the nature and timing of activities which may lead to direct interference with fisheries activities.		sessions,			
	Risk of accident	H	SPDC shall ensure: <ul style="list-style-type: none"> • Compliance with journey management policy for marine transport • That only pre-mobbed water crafts are used. • That daily pep talk is carried out for marine transportation • Safety signages are deployed at strategic locations. • Provision of first aid boxes in operational water crafts as part of premob before deployment to site. • Emergency response plan are in place. • Use of PPEs. 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Monthly	SPDC / FMEnv/ME nv.	5000
	Risk of Piracy and kidnapping	H	SPDC shall <ul style="list-style-type: none"> • Develop adequate 	M	<ul style="list-style-type: none"> • Security Management 	Monthly	SPDC and Regulators	10, 000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			security strategy for the project. <ul style="list-style-type: none"> • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 		procedure <ul style="list-style-type: none"> • Journey management procedure • Record of security situation/ updates • Site Inspection records 			
Fabrication, Installation and positioning of Wellhead Platform	Increase in noise and vibration	H	<ul style="list-style-type: none"> • Generators with noise levels within acceptable limits of (85 - 90 dB (A)) shall be used. • Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits. 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records 	Monthly	SPDC/FME nv/ MEnv.	10, 000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<ul style="list-style-type: none"> • High sound energy equipment shall be enclosed in noise insulators in line with SPDC policy • SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is produced. • Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. • Implement hearing conservation programme for all workers. 					
	Interference with fishing activities	M	Provide timely information to stakeholders particularly fisher folk on the nature and timing of activities which may lead to direct interference with fishing activities.	L	Records of engagement sessions,	Quarterly	SPDC FMEnv MEnv.	10, 000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
	Risk of accident	H	SPDC shall ensure <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signage shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. Use of PPEs by the survey team.	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Monthly	SPDC /FMEnv /MEnv	5000
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management procedure • Record of security situation/ updates 	Monthly	SPDC /FMEnv /MEnv.	10, 000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>Government security agents (Navy) to improve security.</p> <ul style="list-style-type: none"> • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 		<ul style="list-style-type: none"> • Site Inspection records 			
	Impacts of Wastes	H	<p>Site specific solid waste management plan in line with EA (Sea Eagle) waste management guidelines shall be put in place. These include:</p> <ul style="list-style-type: none"> • Waste shall be segregated at source using colour-coded bins. • Scrap metal/pipe off-cuts shall be transported to Shell Kidney Island (KI) scrap yard, Port Harcourt, for onward delivery to SPDC approved 	L	<ul style="list-style-type: none"> • SPDC Waste management plan • Waste consignment note • Environmental Compliance Monitoring Reports • Site inspection Reports 	Monthly	SPDC FMEnv MEnv.	20,000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			metal recycling vendor(s). • Generated glass and paper materials shall also be transported to SPDC Industrial Area (IA) waste recycling depot for onward delivery to any SPDC approved glass recycling vendor(s). • The camp site shall be equipped/fitted with a biological sewage treatment plant. • Spent batteries shall be taken to any SPDC approved battery re-cycling company. • Medical waste shall be collected and taken to the medical incinerator at Shell IA, Port Harcourt.					
	Impairment of air quality	M	▪ Emissions from machinery shall be reduced by the use of standard equipment that meet existing	L	• Premob certificates • Maintenance records	Monthly	SPDC /FMEEnv /MEnv.	10, 000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>emissions requirements (low NOx burners) and fume catalysers provided on all suitable equipment.</p> <ul style="list-style-type: none"> ▪ Ambient air quality shall be monitored in line with FME_{env}/DPR requirement (NO_x, CO_x, Sox and SPM). <p>There shall be regular maintenance of combustion systems.</p>		<ul style="list-style-type: none"> • Compliance Monitoring Reports 			
Drilling	Impairment of air quality	M	<ul style="list-style-type: none"> • Ensure that drilling equipment is of high standard and in good condition prior to mobilization. • Ensure that all emission releasing equipment are maintained regularly. • Ambient air quality shall be monitored in line with FME_{env}/DPR requirement (NO_x, 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records • Compliance Monitoring Reports 	<ul style="list-style-type: none"> • Continuous • Monthly 	SPDC and Regulators	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			COx, SOx and SPM).					
	Noise and vibration nuisance	M	<ul style="list-style-type: none"> Generators with noise levels within acceptable limits of (85 - 90 dB (A)) shall be used Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits High sound energy equipment shall be enclosed in noise insulators in line with SPDC policy SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is produced. Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. Implement hearing 	L	<ul style="list-style-type: none"> Premob certificates Maintenance records 	Weekly	SPDC and Regulators	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			conservation programme for all workers.					
	Injuries and death from blowouts	H	SPDC shall ensure that: <ul style="list-style-type: none"> • Only skilled personnel and certified equipment are used. • Use appropriate blowout prevention fluids. • Use appropriate mud density. • Ensure high quality chemicals and materials are used. • Ensure emergency response procedures are in place. • Job hazard assessment shall be conducted. • Daily pep talks shall be conducted on identified hazards. • A Blow out preventer shall be utilised during drilling 	L	<ul style="list-style-type: none"> • Certification of workforce • MSDS and Technical specification • Emergency response plan • HAZID register. • Pep-talk records • Site inspection Reports 	Weekly	SPDC and Regulators	5000
	Surface water and sediment pollution from	H	SPDC shall: <ul style="list-style-type: none"> • Recover oil based drilling mud for re- 	L	<ul style="list-style-type: none"> • Drill cutting treatment 	Monthly	SPDC and Regulators	50,000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
	chemicals, drill cuttings, and mud		<p>processing and re-use.</p> <ul style="list-style-type: none"> • Wells shall be drilled with Water Based Mud in top hole. • Develop and implement waste management plans for all wastes generated in accordance with regulatory requirements and standard practice. • All industrial wastes such as plastics, metals, rubber and wood shall be segregated on site and collected in designated containers. The containers will be transported to land base for disposal. 		<p>records</p> <ul style="list-style-type: none"> • Drilling mud recovery record • Environmental Compliance Monitoring Report • Waste consignment note 			
	Accidents and injuries	H	<ul style="list-style-type: none"> • Creating awareness amongst local communities on the potential of increased traffic on waterways and the need for extra precautions. • SPDC journey management policy for water/ air 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Monthly	SPDC and Regulators	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>transport shall be adhered to.</p> <ul style="list-style-type: none"> • Defensive driving course (DDC) for all SPDC boat drivers (including contractors and casual boat drivers). • All water/ air borne crafts shall be pre-mobilized and certificate of worthiness issued. • All personnel for water/ air borne operations shall have TBOSIET certificate. • Adequate first aid shall be maintained in all watercrafts and at site. • Use of life-vest while on transit for water borne operations. • Use only trained personnel for specified jobs. • Carry out job hazard analysis; • Daily pep-talk before each day's job. 					

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<ul style="list-style-type: none"> • Medevac shall be provided at site. 					
	Contamination of the environment by wastes	H	<p>SPDC shall ensure:</p> <ul style="list-style-type: none"> • Regular collection and monitoring of wastes from cradle to grave in accordance with SPDC's waste management plan. • All oily wastes shall be properly segregated and contained before disposal. • Sanitary wastes shall be treated in a sewage treatment plant. • Non-hazardous wastes shall be managed in line with SPDC's waste management process. • Hazardous wastes shall be segregated and sent to approved waste disposal sites. • Rags (clothing, worn coveralls, shirt, trousers), shall be segregated and sent to 	L	<ul style="list-style-type: none"> • SPDC Waste management plan • Waste consignment note • Environmental Compliance Monitoring Reports • Site inspection Reports 	Weekly	SPDC and Regulators	50,000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>approved incinerator.</p> <ul style="list-style-type: none"> • Miscellaneous domestic waste, old tooth brushes/disposable razors etc/old footwear, hand gloves etc and garbage, will be segregated and managed in line with SPDC's waste management procedure. • General paper waste shall be segregated and managed in line with SPDC's waste management guidelines. • Plastic containers shall be sent to recycling depot and managed in line with SPDC's waste management guidelines. • IBC tanks for chemicals shall be re-used for fresh chemical supplies to the rig while spent chemical drums shall 					

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>be sent to town for incinerator.</p> <ul style="list-style-type: none"> • Kitchen waste (garbage) shall be segregated and managed in line with SPDC’s waste management guidelines. • SPDC shall enforce adequate waste management on site. SPDC shall ensure that disposal of drilling wastes is in line with regulatory standards (See section on mitigation of wastes). 					
Pipeline construction (Piping/ flowlines, well hook-up)	Risk of accident	H	<p>SPDC shall ensure</p> <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signages shall be deployed at strategic locations. 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Monthly	SPDC /FMEnv /MEnv.	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<ul style="list-style-type: none"> • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. • Use of PPEs. 					
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management procedure • Record of security situation/ updates • Site Inspection records 	Weekly	SPDC /FMEnv /MEnv.	10, 000
	Impairment of air quality	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre- 	L	<ul style="list-style-type: none"> • Premob certificates 	Monthly	SPDC / FMEnv	10, 000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>mobbed and regularly maintained watercrafts, vessels, generators and other machines.</p> <p>Use only low sulphur containing fuel and low NOx burners in large generators and turbines.</p>		<ul style="list-style-type: none"> • Maintenance records • Compliance Monitoring Reports 		/MEnv.	
	Increase in noise and vibration levels	M	<ul style="list-style-type: none"> • Generators with noise levels within acceptable limits of (85 - 90 dB (A)) shall be used. • Acoustic mufflers shall be provided for heavy engines with noise level above acceptable limits. • High sound energy equipment shall be enclosed in noise insulators in line with SPDC policy. • SPDC HSE policy of wearing ear muffs/ plugs shall be applied in all construction and operational sites where high noise is 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records 	Weekly	SPDC / Regulators.	10, 000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>produced.</p> <ul style="list-style-type: none"> • Sufficient separation distances shall be provided for sources of high-energy sound to reduce noise levels. • Implement hearing conservation programme for all workers. 					
	Contamination of surface water bodies	H	<p>SPDC shall</p> <ul style="list-style-type: none"> • Treat all effluents to regulatory limits before discharging into the environment. • Dispose all wastes in line with regulatory requirements. • SPDC shall activate existing oil spill contingency plans in the event of oil spill. 	L	<ul style="list-style-type: none"> • Effluent monitoring records • Waste Consignment note • Environmental Compliance Monitoring Reports 	Monthly	SPDC /Regulators.	10, 000
	Exposure to radiation materials	H	<ul style="list-style-type: none"> • Health awareness training will be conducted prior to commencement of activities. • Staff shall undergo routine medical check-ups for 	L	<ul style="list-style-type: none"> • Minutes of toolbox meetings/safety briefings. • Site inspection reports. 	Monthly	SPDC /Regulators.	5000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			radiation exposure. <ul style="list-style-type: none"> • Radiation monitors shall be provided to monitor radiation levels at site. • The use of radiography aprons to protect the body from radiation shall be enforced. • Warning signs shall be provided during radiation emitting activities to prevent trespass into such areas. • The radiation emitting activity shall be carried out in accordance with standard construction specifications. 		<ul style="list-style-type: none"> • Radiation levels record at work site • Records of medical checks. 			
	inhalation of welding fumes	M	<ul style="list-style-type: none"> • Awareness sessions on health risks and safety precautions of welding operations to be carried out for workers. • SPDC shall enforce the use of PPEs (welder's mask, 	L	Records of PPEs issuance and usage Records of awareness sessions Site clinic records	Weekly	SPDC /FMENV/ MEnv.	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			jacket, gloves, boots and coveralls), by welders during welding.					
	Soft tissues damage from welding sparks	M	<ul style="list-style-type: none"> Awareness sessions on health risks and safety precautions of welding operations to be carried out for workers. SPDC shall enforce the use of PPEs (welder's mask, jacket, gloves, boots and coveralls), by welders during welding. A functional site clinic shall be provided by the contractor. 	L	<p>Records of PPEs issuance and usage</p> <p>Records of awareness sessions</p> <p>Site clinic records</p>	Weekly	SPDC FMEnv/ MEnv.	5000
	Conjunctivitis from welding flash	M	<ul style="list-style-type: none"> Awareness sessions on health risks and safety precautions of welding operations for workers. Pre-employment medical 	L	<p>Records of PPEs issuance and usage</p> <p>Records of awareness sessions</p>	Weekly	SPDC /FMEV /MEnv.	5000

EIA of EA/Eja Field Further Oil Development Project

Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			certification the welders. • Enforcement of the use of applicable PPEs. • Provision of site clinic for workers.		Site clinic records			
	Potential for conflicts arising from labour issues	H	• SPDC & her contractors shall respond to complaints by locals on the activities of her workers • Deploy GMOU provisions on community labour issues.	L	Records of employment Records of issues settled	Monthly	SPDC FMEnv/ MEnv.	5000
	Stress on existing security structures	H	• Make all necessary arrangements with Government security agents (Navy) to improve security • SPDC shall continue to engage stakeholders in order to minimize resentment. • Latch on to the existing security	M	• Security Management procedure • Journey management procedure • Record of security situation/ updates • Site Inspection records	Weekly	SPDC /FMEnv /MEnv.	10, 000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			management plan for the project. <ul style="list-style-type: none"> • Conduct regular security awareness and periodic drill with workers. • Engagement of the youths from the area on skills acquisition ventures. 					
Demobilization	Impairment of air quality	M	SPDC shall: <ul style="list-style-type: none"> • Use only pre-mobbed and regularly maintained watercrafts, vessels, generators and other machines. • Use only low sulphur containing fuel and low NOx burners in large generators and turbines. 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records • Compliance Monitoring Reports 	Weekly	SPDC /FMEnv /MEnv.	5000
	Water traffic incidents	H	SPDC shall ensure <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk 	Weekly	SPDC FMENV/ MEnv.	10, 000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			water crafts are used. <ul style="list-style-type: none"> • Daily pep talk is carried out for marine transportation. • Safety signage shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. • Use of PPEs. 		records <ul style="list-style-type: none"> • Accident records 			
	Improper disposal of materials removed from site	M	SPDC shall ensure: <ul style="list-style-type: none"> • All removed materials shall be properly disposed of and monitored from cradle to grave in line with the waste management plan. • Scrap metals shall be collected, segregated and subjected to SPDC's waste management guidelines. • Plastic wastes shall be sent to approved Recycling Waste Depot (RWD). 	L	<ul style="list-style-type: none"> • SPDC Waste management plan • Waste consignment note • Environmental Compliance Monitoring Reports • Site inspection Reports 	Weekly	SPDC /FMEnv/ MEnv.	20,000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<ul style="list-style-type: none"> Radioactive wastes/materials shall be managed according to Nigerian Nuclear Regulatory Authority (NNRA) approved procedure. SPDC waste management policy shall be enforced. 					
	Increase in noise and vibration level	M	SPDC shall Use only pre-mobbed and regularly maintained equipment and water crafts.	L	<ul style="list-style-type: none"> Premob certificates Maintenance records 	Weekly	SPDC	5000
	Loss of employment/ income	H	SPDC Shall: <ul style="list-style-type: none"> Strengthen existing cooperatives and encourage the formation of new ones that will engage in commercial activities to sustain the local economy. Support micro credit schemes that promote trade and self sustenance. Require contractors to prepare and implement workers 	L	Evidences of workers disengagement plans, Records of skill acquisition, Evidence of support for micro-credits	Monthly	SPDC /FMEnv /MEnv.	50, 000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			disengagement plans. • Encourage and support skill acquisition programmes of Government, NGOs and CBOs.					
	Risk of accident	H	SPDC shall ensure • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signages shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. • Use of PPEs.	L	• Journey management records • Premob certificates • Pep-talk records • Accident records	• As required • At purchase of materials • Monthly • Monthly/For each activity	SPDC / FMEnv /MEnv.	5000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management procedure • Record of security situation/ updates • Site Inspection records 	Monthly	SPDC	10, 000
Commissioning Phase (Operations and Maintenance)	Improper disposal of materials removed from site	H	SPDC shall: <ul style="list-style-type: none"> • Ensure all oily wastes are properly segregated and contained before disposal. • Ensure all oily wastes 	L	<ul style="list-style-type: none"> • Waste consignment note • Site Inspection reports 	Monthly	SPDC /FMEEnv /MEnv.	10,000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<p>are properly disposed of and monitored from cradle to grave.</p> <ul style="list-style-type: none"> • Ensure regular clean-up of equipment at site. • Ensure her waste management policy shall be enforced • Ensure that a controlled fuelling, maintenance and servicing protocol for machinery at worksite is established to minimize leaks and spills. • Ensure spent chemicals, lube oil, grease, waste oil and detergent solutions are properly disposed of. • Ensure used chemical drums and containers are sent to an approved Recyclable Waste Dump (RWD). • Small chemicals spills, crude oil and aqueous effluents shall be cleaned up 					

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			promptly.					
	Equipment failure and damage leading to injuries/fatality	M	SPDC shall ensure that: <ul style="list-style-type: none"> • Only skilled personnel and certified equipment are used. • Certified First Aiders shall be available at every site. • First aid boxes and emergency response procedures are in place. • Hazard assessment has been conducted. • Emergency response procedures are in place. • HSE standards are strictly adhered to. • Permit to work and proper briefing is giving before any work action. 	L	<ul style="list-style-type: none"> • Premob certificates • Maintenance records. • Certification of work force • First Aid box inventory • HAZID register • Records Tool box meeting • HSE inspection records. • Emergency response procedure. 	Monthly	SPDC /FMEnv /MEnv.	10, 000
	Gas flaring	H	SPDC shall: <ul style="list-style-type: none"> • Not routinely flare associate gas. • Associated gas shall be sent to NLNG via the OGGS. 	L	Records of gas produced, Records of gas flared, Records of gas	Quarterly	SPDC	10,000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
					sent to NLNG			
	Produced water	H	SPDC shall: Treat produced water to regulatory standards before discharge.	L	Environmental Compliance Monitoring Reports	Monthly	SPDC /FMEnv /MEnv.	10,000
	Risk of accident	H	SPDC shall ensure <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signage shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. Use of PPEs by the survey team.	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Monthly	SPDC and Regulators	5000
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management 	Weekly	SPDC /FMEnv/ MEnv.	5000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			awareness/drills are conducted for the workforce • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition.		procedure • Record of security situation/ updates • Site Inspection records			
Decommissioning and Abandonment phase	Increase in noise and vibration	M	SPDC shall: • Use only pre-mobbed and regularly maintained equipment and water crafts.	L	• Premob certificates • Maintenance records	Weekly	SPDC /FMEnv / MEnv.	5000
	Impairment of air quality	M	SPDC shall: • Use only pre-mobbed and regularly maintained watercrafts, vessels, generators and other machines. Use only low sulphur	L	• Premob certificates • Maintenance records • Compliance Monitoring Reports	Monthly	SPDC /FMEnv /MEnv.	5000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			containing fuel and low NOx burners in large generators and turbines.					
	Risk of accident	H	SPDC shall ensure <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signages shall be deployed at strategic locations. • Provide first aid boxes in operational water crafts. • Emergency response plan shall be in place. • Use of PPEs. 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Monthly	SPDC /FMEnv /MEnv.	5000
	Risk of Piracy and kidnapping	H	<ul style="list-style-type: none"> • Develop adequate security strategy for the project. • Ensure that security orientation and awareness/drills are conducted for the workforce 	M	<ul style="list-style-type: none"> • Security Management procedure • Journey management procedure • Record of security 	Weekly	SPDC /FMEnv /MEnv.	10000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			<ul style="list-style-type: none"> • Make all necessary arrangements with Government security agents (Navy) to improve security. • Develop security management plan for the project before mobilization. • Engage neighbouring community youths with employment and other worthwhile ventures like skills acquisition. 		<ul style="list-style-type: none"> • situation/ updates • Site Inspection records 			
	Increase potential for water traffic accidents/ injury	M	<p>SPDC shall ensure</p> <ul style="list-style-type: none"> • Compliance with SPDC journey management policy for marine transport including TBOSIET. • Only pre-mobbed water crafts are used. • Daily pep talk is carried out for marine transportation. • Safety signage shall be deployed at strategic locations. • Provide first aid boxes in operational 	L	<ul style="list-style-type: none"> • Journey management records • Premob certificates • Pep-talk records • Accident records 	Weekly	SPDC FMEnv/ MEnv.	10000

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Project Activities	Description of Impacts	Impact Rating Before Mitigation	Mitigation Measures	Impact Rating After Mitigation	Parameter for Monitoring	Frequency of Monitoring/ Formal Reporting	Responsible / Action Party	Estimated Budget for Implementation (Dollars)
			water crafts. • Emergency response plan shall be in place. Use of PPEs by the survey team.					
	Potential for conflicts arising from labour issues	H	SPDC shall: • Implement GMOU provision for end of contract. • Respond to complaints.	L	Records of employment	Monthly	SPDC /FMEnv/ MEnv.	5000
	Injury/fatalities in workforce	H	SPDC shall ensure: • Daily pep talk is carried out for marine transportation. • Safety signage shall be deployed at strategic locations. • Provision of first aid boxes in operational watercrafts • Emergency response plan is in place.	L	• Certification of workforce • Emergency response plan • MSDS and Technical specification • HAZID register. • Pep-talk records	Weekly	SPDC /FMEnv/ MEnv.	10,000

7.8: Environmental Monitoring Plan (EGASPIN, 2002)

Compliance environmental monitoring is required during all the phases of the proposed project. Accordingly, a compliance monitoring plan is included in this EMP. The parameters to be monitored will help to provide information on the quality of the environment as the project progresses. The Monitoring Plan is presented in Table 7.3., and it specified the component of the environment to be monitored, the parameter required, location of monitoring, frequency and the method to be deployed for data collection.

Table 7.3: Environmental Monitoring Plan for the EA Project – Sources of Impact Monitoring

SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
Sanitary wastewater	DPR EGASPIN II E 3.5.6.1(h) – Table II-6 Limitation on treated sanitary wastewater and DPR EGASPIN II E Table II-8	Maximum daily discharge rate Residual CI < 1.5 mg/l BOD ₅ < 45 mg/l Faecal coliform 400 MPN/100ml DO 4.0-5.0 mg/l	Daily rate Residual chlorine BOD ₅ Faecal coliform MPN/100ml DO	Discharge point from chlorinating unit (i.e. after treatment)	Weekly (apart from daily discharge rate)	Analysis of grab sample
Deck drainage	EGASPIN II E Table II-8	Monitor	Volume of deck drainage	Discharge point	Hourly when discharging	Estimate
			THC in deck drainage	Discharge point	Daily when discharging	Analysis of grab sample
Hydrocarbon release	DPR EGASPIN VIII B and C	Notification within 24 hours using Form A Report investigation finding within 1 week using Form B Report response/clean up within 4 weeks using Form C	Oil Spill Contingency Response Readiness (procedures and plans at the rig site). Oil spill investigation and reporting	Rig drilling points	Monthly	Analysis of grab sample and water sample
Use of Stuck radioactive tool	DPR EGASPIN II E 3.7.2 and 3.7.3.2	Monitor radiation levels during operations	Radiation in circulating fluid mud system, environment, equipment and personnel	Rig	Hourly	Radiation monitor
		Weekly and End-of-Well reports of radiation levels Report stuck RA tool within 24 hours	Reporting	Documentation	Weekly, on completion of wells and when there is a stuck tool	Assurance of documentation

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
Discharge of drilling waste (drilling fluids, cuttings, sand)	DPR EGASPIN II E 3.5.4.2 (Discharge of toxic substances during drilling)	<ul style="list-style-type: none"> ▪ Daily minimum and monthly average 96hrLC50 of 30,000 ppm for <i>Palaemonetes africanus</i> in 9:1 seawater to drilling fluid suspended particulate phase ▪ Maximum discharge rate of 1,000 bbls/hr EXCEPT drilling fluid discharges that are shunted to the bottom 	96 Hour LC ₅₀ for drilling fluid and drill cuttings Discharge rate	Rig	Once a month and at end of well (after	Laboratory analysis
	DPR EGASPIN II E 3.5.6.1 and DPR EGASPIN II E Table II-8 MARPOL 93/98	No discharge into inland or nearshore waters No visible oil sheen for WBM No more than 5% oil on cuttings for SBM No more than 1% oil on cuttings for LTOBM No more than 10 g of oil on Kg (dry weight) of solid pH Metals Petroleum Hydrocarbons	Oil on cuttings pH Metals Petroleum Hydrocarbons Total hydrocarbons PAH	Every 305 m From the lowest section of well (NOT in pay zone)	Every 305 m	Sampling of treated drill cuttings and analyses of samples to be carried out by a DPR-accredited laboratories.

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/Standard	Requirements/Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
	DPR EGASPIN II E Table II-8	Monitoring	Free oil	Surrounding waters	Weekly during discharge	Visual check
			THC in drilling fluid	Every 305 m From the lowest section of well (NOT in pay zone)	Every 305 m	Laboratory analysis
	DPR EGASPIN II E 3.5.6.2 (g) and DPR EGASPIN Appendix II-4	Post-drill Environmental Seabed Survey	THC, TPH/PAH, particle size, major & trace metals, benthic organisms	100, 200, 500, 800, 1,200, 2,500 & 5,000 m from well + 3 clean stations	One off. (After 5 wells OR 9 months after drilling)	Seabed and water column sampling and analysis and <i>in situ</i> measurements
Other liquid waste (waste oils, paint, chemicals, BOP, well treatment and work over fluids)	DPR EGASPIN VIII C	Categorise and quantify waste	Categorisation of waste and management from cradle to grave	Waste discharge points	Continuous	Record quantity in each category of waste
	DPR EGASPIN II E Table II-8	Monitor specified parameters	Volume of BOP fluid	Discharge point	Hourly during discharge	Measure/Estimate
			Volume of well treatment and	Discharge point	Daily during discharge	Measure OR estimate
Other liquid waste (waste oils, paint, chemicals, BOP, well treatment and work over fluids) cont'd	DPR EGASPIN II E Table II-8 cont'd	Monitor specified parameters cont'd	Volume, pH, Chloride and THC for work over fluids and wastes	Discharge point	Daily during discharge	<i>In situ</i> measurements AND/OR Laboratory analysis
			Hg & Cd	Mud	Ice per new stock of barite/ new well	Laboratory analysis
Well drilling casing and well completion	DPR EGASPIN II E 3.5.6.2 (g)	Post drill survey after every 5 wells OR after 9 months	For sediment: TPH, PAH, Particle size, TOC, Redox Potential, Major & Trace metals, Benthic	100m; 200m; 500m; 800m; 1,200m; 2,500m; and 5,000m from each well	After every 5 wells OR 9 months after drilling	In-situ measurements AND Laboratory analysis

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/Standard	Requirements/Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
			micro & macro For ocean water: THC, Major & Trace metals			
Combustion	DPR EGASPIN III E 4.4.2 Gaseous point sources emission monitoring	1-hour mean ($\mu\text{g}/\text{m}^3$) $\text{CO}^{(3)} = 30$ $\text{SO}_2 = 350$ $\text{NO}_2^{(3)} = 400$ Total SPM = 150-230	Volume of fuel/gas consumed Emissions rate CO, CO ₂ , SO _x , NO _x , THC, VOC, SPM from emissions	Emission point	Continuous readings – record daily	Normal operations flow meter is read daily.
	DPR EGASPIN III E 4.4.5 Table III-3 National Ambient Air Quality Standards	Daily average mean ($\mu\text{g}/\text{m}^3$) $\text{CO}^{(3)} = 10$ $\text{SO}_2 = 100-150$ $\text{NO}_2^{(3)} = 150$ Total SPM = 60-90	Particulates, ozone, H ₂ S, heavy and trace metals in ambient air	Emission point	Weekly (DPR) Monthly (TBC)	Calculate using emission factors for fuel consumed
Gas flaring	DPR EGASPIN III E 3.8.8.1	Gas flaring is prohibited except an appropriate waiver /permit is granted by DPR	Flare volume	Prior to HP and LP flare tips (automatic online system)	Daily during flaring (recorded from CCR)	All vented gas into the HP and LP Flare Systems are measured and totaled prior to entering flare tip.
		Smoke Relative density < 2 Ringlemann No. (1hr period)	Smoke	Flare tip	Daily during flaring	Smoke-Ringlemann No.

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
		Allowable heat radiation (ground level) 6.31 kw/m ² during max. flaring (60m from flare base - ground level)	Temperature	Each of the mooring structures and highest point of Compression Pallet	Daily during flaring (recorded from CCR)	Temperature probe or temperature transmitters OR both
Gas flaring contn'd	DPR EGASPIN III E 3.8.8.1 cont'd	Noise levels at 60 m from base of flare stack shall be within threshold of pain (80 – 100 dB(A)). Lower and upper limits of 78 and 83 dB(A) and max limit of no more than 85 dB(A)	Noise	Points 60 m from base of flare stack	Weekly	Noise meter
VOC/inert gas (IG) venting during well testing/ commissioning	Internal SIEP requirement	SIEP requirements	VOC	Venting points	Quarterly	Estimation
Fugitive (hydrocarbon) emissions	Internal SIEP requirement	SIEP requirements	VOC		Quarterly	Estimated using component emission factors or use Empirical model based upon hydrocarbon throughput

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
Oily water, sand and oily sludge discharges	DPR EGASPIN III E 3.6.2 b Disposal of produced formation water/oily water offshore /deepwater AND DPR EGASPIN III E 3.8.2 Required quality of produce/oily waters from offshore production operation	No more than 40mg/l monthly average for oil in produced water to be discharged offshore OR ELSE disposal must be via re-injection	O&G content of produced water to be discharged offshore	Discharge line for treated produced water	Continuous monitoring	Online oil in water analyser (record daily max., and monthly average in mg/l)
Oily water, sand and oily sludge discharges cont'd	DPR EGASPIN III E 4.1.1)	Complete chemical assay/analysis of the constituents of produced formation water; and 96-hr LC50 toxicity testing, for produced water as may be specified			As may be specified by DPR	Laboratory analysis using appropriate species
	DPR EGASPIN III E 4.1.2 Table 111-2 Other monitoring requirements and SNEPCo Waste Management Procedure	Monitor	Volume/discharge rate for produced water	Produced water discharge outfall downstream of last treatment equipment	Daily – during discharge	Read off from flow meter (record max. daily rate) for produced water Calculate for slop tank and bilge water

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/Standard	Requirements/Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
			Free oil from produced water	Surrounding sea surface	Daily – during discharge	Visual observation for sheen on water (record as no. days sheen observed)
			Volume/discharge rate for oily water Physico-chemical parameters (pH, Temperature, THC, Cl ⁻ , Turbidity, TDS, TSS, COD, BOD ₅ , Pb ²⁺ , Fe (total), Cu ²⁺ , Cr ⁶⁺ , Zn ²⁺) for oily water	Discharge point for effluent from slop tanks	Weekly	Estimation for discharge rate Analysis of grab samples for physico-chemical parameters
			Quantity/weight of produced sand and oily sludge	Sand bag, drum, or cuttings box	During drilling	Estimate
			Quantity/weight of solids containing LSA/NORM	Sand bag, drum, or cuttings box	During drilling	Estimate
			Background radiation levels and average of highest and lowest radiation	Sand bag, drum, or cuttings box	During drilling	Radiation monitor
			DPR EGASPIN III E 3.6.4.2 Disposal of sands containing LSA/NORM	Alert DPR within 24hrs when LSA/NORM present at levels 50micro rems/hr > background reading or 30 pci/gm	LSA/NORM background radiation (record average of highest and lowest readings)	Production tubing, vessels, pumps/valves, scales, produced sand

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SOURCE OF IMPACT	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
Oily water, sand and oily sludge discharges cont'd	DPR EGASPIN III E 3.8.6.1 Limitation on the quality of offshore recipient water bodies for permitted discharge	The notional mixture shall meet the following requirement relative to undisturbed sea water: Oil content $\leq \pm 1$ pH $\leq \pm 1$ HCO ₃ ⁻ + Cl ⁻ + SO ₂ ⁻ $\leq 20\%$ NO ₃ ⁻ + NH ₄ ⁺ ≤ 25 mg/l Temperature $\leq \pm 5^{\circ}\text{C}$ DO $\leq 4\text{mg/l}$ assuming conc. in undisturbed water is 7 mg/l	Oil in water pH HCO ₃ ⁻ Chloride (Cl) SO ₄ ²⁻ NO ₃ ⁻ NH ₄ ⁺ Temperature Dissolved oxygen (for notional mixture)	Sampling of seawater (mid-depth and 500m from discharge point)	Monthly	Sample collection and analysis in an external approved lab. Calculated as notional mixture (3.8.6.1)

Table 7.4: Environmental Monitoring Plan for the EA Project – Receptor of Impacts Monitoring

Receptor	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
Recipient surface water	DPR EGASPIN III E 3.8.6.1 Limitation on the quality of offshore recipient water bodies for permitted discharge		Physico-chemical parameters (pH, Temperature, THC, Cl ⁻ , Turbidity, TDS, TSS, COD, BOD ₅ , Oil in water HCO ₃ ⁻ , Chloride (Cl ⁻) SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , Temperature, Dissolved oxygen TPH, PAH, BTEX, Heavy metals and other metals (Ni, Zn, Cu, Fe, Mn, Cd, As, Ba, Pb, Ca, Na, Mg, Co, Ag, Cr, Na, K, Hg, V Total Heterotrophic Bacteria, Total fungi, Hydrocarbon utilizing Bacteria, Hydrocarbon utilizing Fungi, Total Coliforms, Faecal coliforms	500m and 1000m upstream down stream	Monthly	Sample collection and analysis in an external approved lab.

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Receptor	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
Recipient sediment	DPR EGASPIN III E 3.8.6.1 Limitation on the quality of offshore recipient water bodies for permitted discharge		Physico-chemical parameters (pH, Temperature, THC, Cl ⁻ , Turbidity, TDS, TSS, COD, BOD ₅ , Oil in water, HCO ₃ ⁻ , Chloride (Cl ⁻), SO ₄ ²⁻ , NO ₃ ⁻ , NH ₄ ⁺ , Temperature, Dissolved oxygen, TPH, PAH, BTEX, Heavy metals and other metals (Ni, Zn, Cu, Fe, Mn, Cd, As, Ba, Pb, Ca, Na, Mg, Co, Ag, Cr, Na, K, Hg, V) Total Heterotrophic Bacteria, Total fungi, Hydrocarbon utilizing Bacteria, Hydrocarbon utilizing Fungi, Total coliforms, Faecal coliforms, Sulphate Reducing Bacteria	500m and 1000m upstream down stream	Monthly	Sample collection and analysis in an external approved lab.
Air Quality	DPR EGASPIN III E 4.4.2 Gaseous point sources emission monitoring	1-hour mean (µg/m ³) CO ⁽³⁾ =10 SO ₂ = 350 NO ₂ ⁽³⁾ = 400 Total SPM = 150-230	Volume of fuel/gas consumed Emissions rate CO, CO ₂ , SO _x , NO _x , THC, VOC, SPM from emissions	Emission point	Continuous readings – record daily	Normal operations – flow meter is read daily.

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Receptor	ASSOCIATED LIMITATIONS		MONITORING PROGRAMME			
	Regulation/ Standard	Requirements/ Limits	Parameters to be monitored	Sampling Location	Frequency	Data collection method
	DPR EGASPIN III E 4.4.5 Table III- 3 National Ambient Air Quality Standards	Daily average mean ($\mu\text{g}/\text{m}^3$) $\text{CO}^{(3)} = 10$ $\text{SO}_2 = 100-150$ $\text{NO}_2^{(3)} = 150$ Total SPM = 60-90	Particulates, ozone, H_2S , heavy and trace metals in ambient air	Emission point	Weekly (DPR) Monthly (TBC)	Calculate using emission factors for fuel consumed

CHAPTER EIGHT

CONCLUSION

The EIA of EA FOD project was carried out in accordance with relevant local, national and international regulations based on FMENV approved terms of reference. The methodology applied for the study involved desktop studies, review of existing two season field data and community consultations. To achieve this objective, a multi-disciplinary approach was adopted in the assessment of the environmental status and sensitivities of the various biophysical, social and health components.

The magnitude of the anticipated impacts of the project activities on the environmental components: air, water, soils, sediment, vegetation, fauna, fisheries, land use, waste management, social, economic and health issues were assessed, ranked and rated. The EIA of the project shows that it would have a significant beneficial impact on both local and national economy. The identified adverse impacts were generally short-term and can be prevented, reduced, ameliorated, or controlled if the recommended mitigation measures are implemented.

Mitigation measures were proffered to reduce the magnitude of identified adverse impacts, to a level as low as reasonably practicable (ALARP), while the positive impacts were enhanced. These mitigation measures are incorporated in the Environmental Management Plan developed specifically for this project, and Environmental Monitoring Plan for the cumulative impacts, applicable to the entire lifespan of the project.

With the implementation of the EMP/Monitoring Plan, GMoU, respect for socio-cultural values, applicable legal and administrative frameworks and SPDC corporate policies and strict adherence to HSE provisions and other corporate best practices and design codes, this EA FOD project could be implemented sustainably. It is concluded that the execution of the EA FOD project will not cause serious damage to the environment if the EMP is implemented.

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APPENDICES

APPENDIX 3.1

DESCRIPTIONS OF WELLS RE-ENTRY/WORKOVER AND NEW WELL DRILLING, WELL DESIGN, CASING, WELL DEPTH MUD SCHEME AND TREATMENT OF DRILL CUTTINGS

Proposed workflow (rig activity)

- ✓ Kill well, Nipple Down Xmas tree and install BOP.
- ✓ Retrieve the existing completions, including CAMCO 'HRP-1-SP' PACKER at 5251 ftah.
- ✓ Clean up the cased hole up to cement plug @ 5429 ftah.
- ✓ Carry out Carbon-Oxygen logging to determine present OWC and GOC in the well.
- ✓ Install CH-ESS for sand control on the D5.000X interval.
- ✓ Recomplete well as SSS producer on the D5.000X using 3 ½" N80, 9.3 ppf tubing with SCSSSV, PDHG and GLMs installed.
- ✓ Clean out the well and Stimulate the D5.000X ex-completion with coiled tubing.
- ✓ Nipple Down BOP and install XMAS Tree. Hand over well to Production.

Note:

- A workover decision tree to be followed is attached to this proposal.
- LCM to be provided on site
- A contingency sidetrack proposal will be available during the execution of the work scope above in the event that the packer could not be pulled and the milling/fishing is not possible within the specified days.

PROPOSED WORKFLOW (RIG ACTIVITY)

1. Kill well, Remove Xmas tree and install BOP
2. Retrieve short string from 3½" snap latch seal assembly.
3. Retrieve long string with A5 dual packer.
4. Retrieve Model D Production packer at 5790 ftah bdf
5. Log USIT to check casing integrity and cement bond behind relevant production intervals
6. Squeeze off existing perforations on D8000K and D5000X
7. Perforate the D6000 sand from 5692 – 5712 ftah bdf
8. Perforate the D5000 sand from 5605 – 5616 ftah bdf
9. Re-complete well as Two String Dual (TSD) on D5000X and D6000K intervals with 3-½" tubings, SCSSSV's, GLMs, CaTS gauges and CH-ESS for sand control.
10. Remove BOP and install Xmas tree.
11. Reinstate well for operations

Note: A workover decision tree to be followed is attached to this proposal.

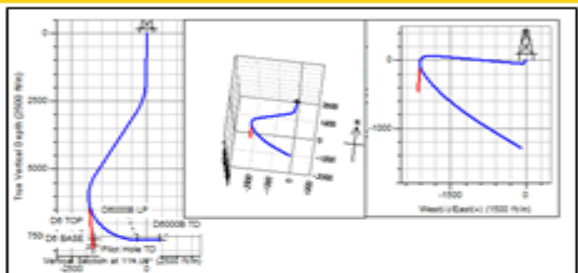
1. Drilling work Flow Sample Process

Key Operational steps: Type 1 Well.

- Install and function test the complete Diverter system.
- Drill 8- 1/2" Pilot Hole to 13- 3/8" casing setting depth.
 - ◊ Stop to log if there are any indication of HC.
- If No HC, open hole to 16" and run/cement 13- 3/8" casing in place.
- If HC present, Plug back hole to Top of the HC sand.
- Open Hole to 16" and run/cmt 13- 3/8" csg to revised casing depth.
- Install WH and BOP.
- Drill 12- 1/4" hole to section TD and run/cmt 9- 5/8" casing in place
- Install WH.
- Drill 8- 1/2" Hole section and install 7" Liner.
- Drill 6" hole section and install 4- 1/2" Reslink.
- Complete well as planned

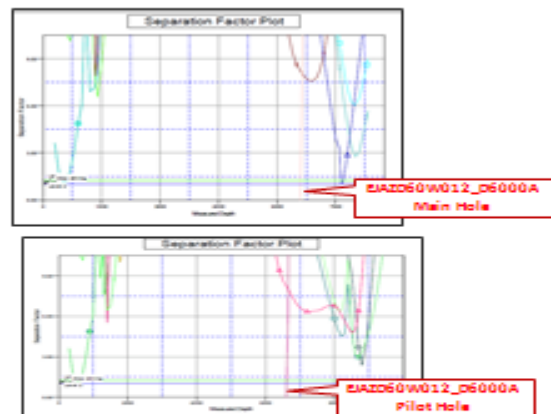
3. Well design, Casing, well depth, mud scheme and treatment of drill cuttings.

EJAD60W012 – D6000B



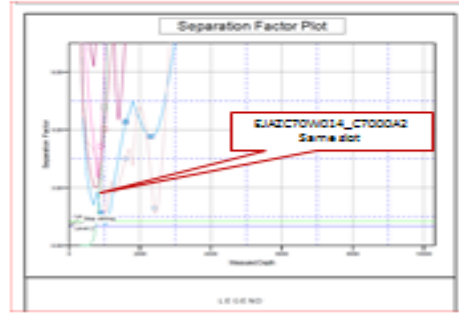
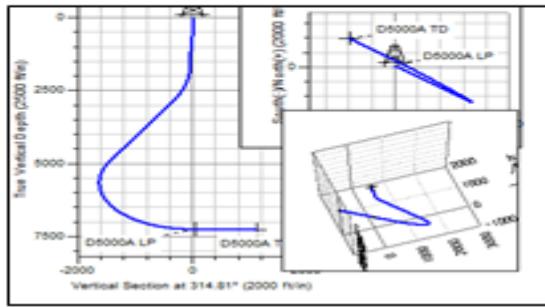
MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Se c (ft)	DLS (°)	Tgt
450	0	0	450	350	0	0	
900	8	150	898	778	-19.8	1.8	
1000	8	150	997	877	-28.1	0	
1100	0	0	1097	977	-32.4	8	
1200	0	0	1197	1077	-32.4	0	
2271	23	288	2256	2116	200.7	2	
5575	23	288	5542	5422	1615	0	
6641	14	226	6270	6150	1847	2	D6000 Top
8255	14	226	7814	7694	2182	0	D6000 Base
8326	14	226	7906	7786	2202	0	D6000 TD

Direction of S_{pmax} – 315° NW – 135° SE



MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Se c (ft)	DLS (°)	Tgt
6600	14.45	252	6221	6101	305	0	
7958	35	124	7559	7259	750	4.3	
8779	89.77	113	7811	7491	1047	4.3	
9550	89.77	113	7814	7494	1288	0	

EJAZ008T – D5000A



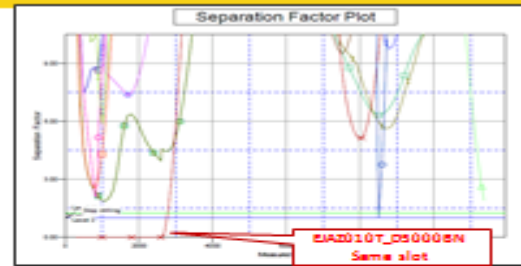
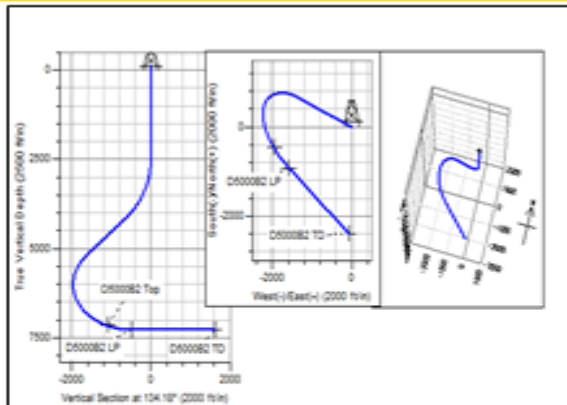
MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V_Sec (ft)	DLS (°)	Tgt
720	0	0	720	600	0	0	
1220	7	90	1219	1099	-21.6	1.4	
1310	7	90	1308	1188	-29	0	
1720	0	0	1717	1598	-43.3	1.4	
1820	0	0	1817	1698	-43.3	0	
3020	28.46	127	2968	2849	-332	2.3	
5371	28.46	127	5038	4918	-1442	0	
8314	78.47	310	7331	7212	-370	3.6	
8742	89.41	307	7377	7257	52	2.6	D5000LP
9818	89.41	307	7388	7268	1118	0	D5000TD

Direction of S_{Hmax} – 315° NW – 135° SE

EA/EJA FOD: Concept Design Endorsement

2

EJAZ009T – D5000B



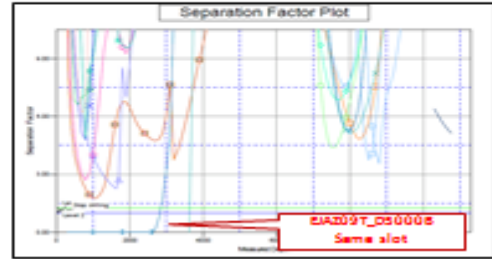
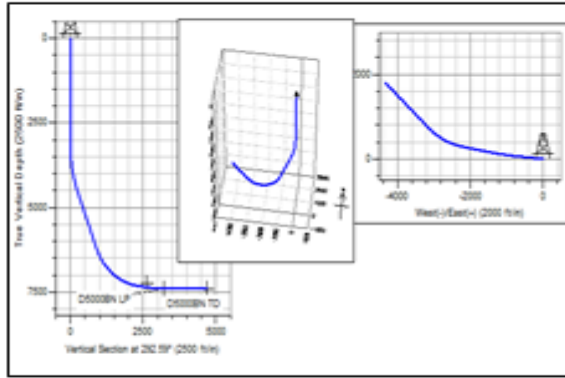
MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V_Sec (ft)	DLS (°)	Tgt
2620	0	0	2620	2500	0	0	
4473	45	296	4289	4169	-657	2.4	
5720	45	296	5171	5051	-1495	0	
6022	45	279	5383	5263	-1685	3.9	
9255	89.9	134	7401	7281	-499	3.9	D5000B2LP
11364	89.9	134	7402	7282	1609	0	D5000B2TD

Direction of S_{Hmax} – 315° NW – 135° SE

EA/EJA FOD: Concept Design Endorsement

3

EJAZO 10T – D5000BN



Well	# of MD	# of TVD	Offset MD	Offset TVD	C-C	S.F
EJAZO10T	2900	2780	2896	2776	18.6	1.8

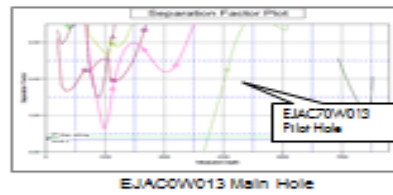
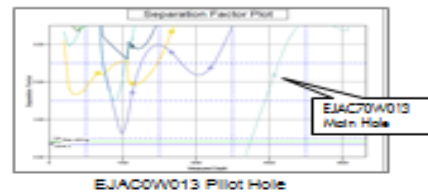
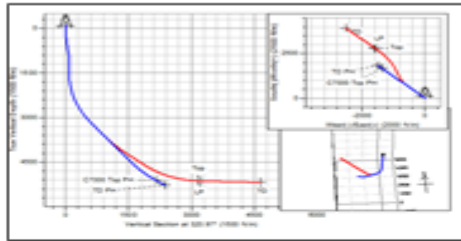
Direction of S_{Hmax} – 315° NW – 135° SE

MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Sec (ft)	DLS (°)	Tgt
3120	0	0	3120	300	0	0	
4620	22	275	4583	4463	272	1.47	
6370	22	275	6206	6086	399	0	
8169	79	280	7297	7177	2199	3.2	
9199	89.89	312	7395	7275	3205	3.2	D5000B2LP
10787	89.89	312	7395	7278	4684	0	D5000B2TD

EA/EJA FOD: Concept Design Endorsement

4

EJAC70W013 – C7000A1



MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Sec (ft)	DLS (°)	Tgt
900	8	320	897	777	62	0.9	
1000	8	320	996	876	76		
1100	0	0	1096	976	82		
1650	0	0	1646	1526	83		
3442	35.8	320	3323	3203	625	2	
5051	35.8	320	4528	4508	1657		
5903	53	320	5235	5115	2161	2	C7000A1_Top
6167	53	320	5394	5274	2371	0	C7000A1_TD

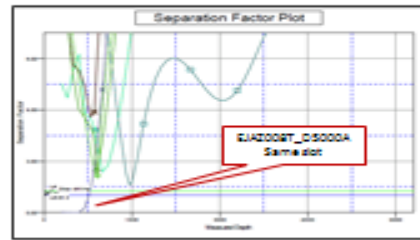
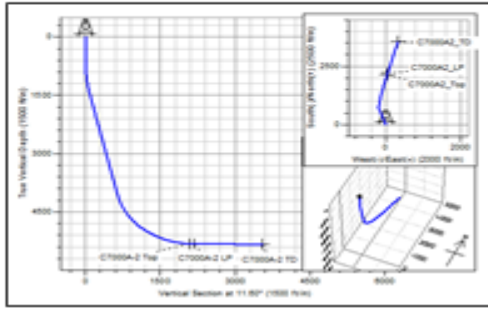
MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Sec (ft)	DLS (°)	Tgt
4000	35.84	320	3775	3655	945		
4703	50.21	343	4291	4171	1416	3	
5413	50.21	320	4745	4625	1939	0	
6360	83	320	5256	5136	3255	3	C7000A1_LP
8481	83	320	5299	5179	4664	0	C7000A1_TD

Direction of S_{Hmax} – 315° NW – 135° SE

EA/EJA FOD: Concept Design Endorsement

5

EJAC70W014 – C7000A2



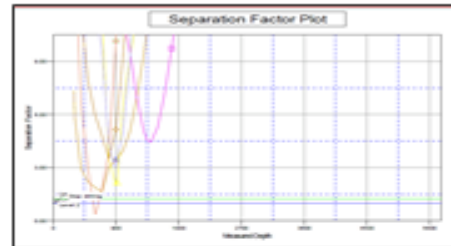
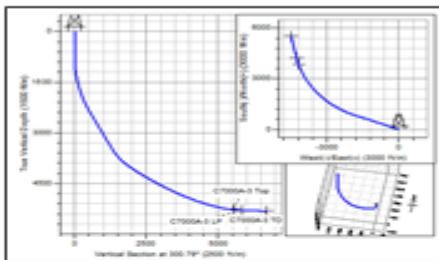
MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Sec (ft)	DLS (°)	Tgt
620	0	0	620	500	0	0	
1520	14	345	1511	1392	94	1.5	
3970	14	345	3894	3774	608	0	
4048	14	358	3988	3847	622	3.6	
4204	14	358	4121	4001	659	0	
6292	89	12	5324	5204	2176	3.6	C7000-A2 LP
7662	89	12	5332	5212	3546	0	C7000-A2 TD

Direction of S_{Hmax} – 315° NW – 135° SE

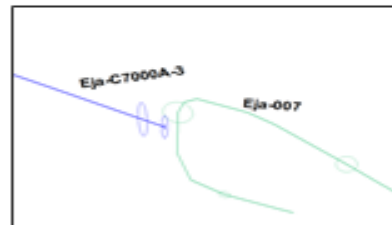
EA/EJA FOD: Concept Design Endorsement

6

EJAC70W015 – C7000A3



MD (ft)	Inc (°)	Azi (°)	TVD (ft)	TVD (ftss)	V.Sec (ft)	DLS (°)	Tgt
720	0	0	720	600	0	0	
2500	35	295	2387	2267	532	2	
3800	35	295	3444	3324	1285	0	
4638	60	293	3999	3879	1900	3	
9305	89	349	5297	5177	5828	1.3	C7000-3 LP
10629	89	349	5315	5195	6696	0	C7000A-3 TD



Direction of S_{Hmax} – 315° NW – 135° SE

Min Fault distance - 75ft @ 2908ft (A9000)

EA/EJA FOD: Concept Design Endorsement

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2. Mud Program

EJA DPJ Platform Wells Proposed Mud Program

Well Name	Well Code	Mud Weight/Type			
		16" WBM	12 1/4" OBM	8 1/2" OBM	6" OBM
EJA D6000B	EJAZD60W012T	0.47-0.54	0.54-0.59	0.59-0.61	0.51-0.55
EJA D5000B	EJAZ009T	0.47-0.54	0.54-0.59	0.59-0.61	0.51-0.55
EJA D5000BN	EJAZ010T	0.47-0.54	0.54-0.59	0.59-0.61	0.51-0.55
EJA D5000A	EJAZ008T	0.47-0.54	0.54-0.59	0.59-0.61	0.51-0.55
EJA C7000A2	EJAZC70W014T	0.47-0.54	0.54-0.59	0.51-0.55	
EJA C7000A1	EJAZC70W013T	0.47-0.54	0.54-0.59	0.51-0.55	
EJA C7000A3	EJAZC70W015T	0.47-0.54	0.54-0.59	0.59-0.61	0.51-0.55

Optiwell Predicted Mud Gradients

EA/EJA FOD: Concept Design Endorsement

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EA-EJA WELL SUMMARY

Well Name	Well Code	Deviation	HOLE SECTIONS/CASING SCHEMES (ft/m/ft/s)				
			16" 13-3/8" Csg	12-1/4" 9-5/8" Csg	8-1/2" 7" Liner	8-1/2" 6-5/8" Reslink	6" 4-1/2" Reslink
EJA D5000BN	EJAZ010T	Horizontal	3070	6277	9199		10767
EJA D5000B	EJAZ009T	Horizontal	3073	6935	9255		11364
EJA C7000A1	EJAZC70W013	Horizontal	3141	7105		8525	
EJA C7000A3	EJAZC70W015	Horizontal	3339	7291	9305		10629
EJA C7000A2	EJAZC70W014	Horizontal	3123	6299		7662	
EJA D5000A	EJAZ008T	Horizontal	3135	6490	8742		9823
EA B5000A	EAZB40W0565 /EAZ2056L	Horizontal	2220	5515		7615	
EA B7000A	EAZZ059T /EAZZ060T	Horizontal	2282	5816		7210	
EA D7000M	EAZZ070W078	Horizontal	2065	5634	10123		11123
EA D4000P	EAZ2055T	Horizontal	2153	4844	7300		8670
EA B8000C/C5000C	EAZZ880W068 /EAZZC50W070 (TSO)	Horizontal	2058	5402		6302	
EA C7000C	EAZ2026T	Horizontal	2135	6656		7399	
EA B 8000C1	EAZZ880W067	Horizontal	2618	7623		8623	

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April 17, 2016

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APPENDIX 4.1 STUDY APPROACH/ METHODOLOGY

Study Approach

The study approach was based on acquisition of data via field and laboratory analysis and a review of literature including previous environmental studies carried out in the area. The fieldwork for gathering this environmental data was carried out between January 17th to 20th 2011 for the dry season and July 29th to 1st August 2011 for the wet season. The environmental data gathering thus covered the dry and wet season.

For the purpose of this study, the impact indicators selected are the qualitative as well as quantitative or measurable characteristics of the various environmental components indicated in Appendix Table 4.1.

Appendix Table 4.1: Environmental sensitivities likely to be affected

Biophysical environment	
	Air quality
	Level of noise
	Surface water quality
	Sediment quality
	Biodiversity (aquatic flora and fauna)

The study methodology and approach focused on the acquisition of data in the biophysical environment in order to be able to evaluate and assess the actual effects on the environment vis-a-vis the earlier studies carried out on Fate and Effects of Produced Water Discharge and Chronic Effects of Produced Water Discharge in relation to the mixing zone and fate of components of produced water within the extended 5000 meters from the EA FPSO.

Literature Review

Extensive review of available literature was undertaken to acquire background information and baseline data on the physical, chemical and biological characteristics of the project area. Materials reviewed included previous studies reports, textbooks, compliance monitoring reports, journal articles, survey maps and aerial photographs. The literature review focused on the following:

- Relevant Federal and State regulations;
- History of the Sea Eagle FPSO and the EA/Eja field;
- Site layout diagrams and location of facilities;
- Climatic conditions including rainfall pattern;
- Previous environmental studies carried out in the area:
- EIA Report of EA Sea Eagle;
- Report of Produced Water discharge study for EA/Eja Field; and
- Report from Compliance Monitoring.

General Study Area

The EA field is located in Offshore Mining License (OML) 79, offshore Nigeria. The field lies in approximately 26.5 meters water depth. The EA field assets comprises of the Sea Eagle, a Floating Production Storage and Offloading (FPSO) unit permanently anchored on a Soft Yoke Mooring Platform (SYMP), three (3) unmanned Drilling/wellhead Platforms A, B, J, and a Gas Riser Platform (RP-A). The Sea Eagle FPSO has been designed to exploit the EA and EJA fields in the South-East corner of OML-79, 15 km South-West of the mouth of the Dodo River and 90 km South-East of Warri.

Production from the respective platform wellheads is manifolded and tied back to the SYMP using flowlines and risers. The well fluids are transferred from the SYMP to the topsides of the FPSO via a swivel stack and jumper hoses. Associated gas produced from the field is compressed and exported via the gas riser platform and a tie-in to the Offshore Gas Gathering System (OGGS) to the Bonny LNG Plant.

All of the production and safety systems of the FPSO and the SYMP are monitored and controlled from a central control facility on the FPSO. The drilling platforms are also interfaced to the ICSS for certain monitoring and control purposes.

The EA/Eja field in OML 79 came on stream (i.e. first oil) on December 14, 2002 and was producing until early 2006 when oil production from the field was paralyzed due to insecurity and militancy within the region; this led to the facility being shut down. Following re-entry activities which commenced in September 2007, production was restarted in July 2, 2009 ahead of schedule without any lost time injury. Production is currently ramping up towards 120 000 bbls/day and gas export of 50mmscf/day to NLNG.

Accommodation on the Sea Eagle FPSO, life support and Escape, Evacuation and Rescue (EER) facilities are provided for maximum Persons on Board (POB) of 80.

Supplies to the Sea Eagle FPSO originate from Onne Supply base near Port Harcourt, which is located about 180 miles from the FPSO. There is a dedicated field supply vessel that delivers the supplies in ten day intervals.

Geology

The geology of the EA/Eja Field area consists of sedimentary deposits of the Cenozoic age (about 160 million years) namely Benin, Agbada, and Akata formations. The sediments were eroded from Basement Complex rocks in the hinterland of the West African sub-region. The area is characterized by fairly uniform geomorphology and lacks geological features like mountains, and rock outputs.

Hydrography of the Area

The hydrography of the region is greatly influenced by the tides of the Atlantic Ocean (which move in and out through the estuaries) and the flood regime of the major rivers (Dodo, Ramos,

and Pennington). The area is affected by the Guinea current which flows at a speed in the range of 1.0 – 1.3 knots (0.51 – 0.66m/s) from the west to east direction and is typically a warm current. The sea heights in offshore location show significant direct correlation with wind speed but this relationship is affected by water depth. In general, the magnitude of seaswells tends to increase towards the shore in the EA offshore area. As the Guinea currents flow eastwards to the Bright of Biafra, they are joined by the Equatorial counter currents which carry cold Atlantic central water to the warm waters of the Gulf of Guinea.

The equatorial counter currents in the area result from the convergence of the different currents in the Gulf of Guinea, and is characterized by turbulent and eddy flows. Its speed can be as high as 1.0 – 1.7 knots (0.51 – 0.87m/s) in the wet season, but subsides to 0.7 – 1.1 knots (0.36 – 0.56 m/s) in the dry season. Wind and ocean current speeds taken along a sea profile in OML 79 are shown in Appendix Table 4.2

Appendix Table 4.2: Wind and Ocean Current Speeds along the Sea Profile of OML 79

DIRECTION FROM (DEGREES TRUE MEAN)									
Wind Speed (ms ⁻¹)	OMNI	020	065	110	155	200	245	290	335
1-Hour sustained	15.0	9.5	9.3	10.1	12.8	15.0	15.0	12.8	10.1
3-second gusts	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Ocean Current (ms ⁻¹)									
Surface	1.0	0.8	0.5	0.8	1.0	0.8	0.5	0.8	1.0
25% of Depth	0.8	0.6	0.4	0.6	0.8	0.6	0.4	0.6	0.8
75% of Depth	0.6	0.5	0.3	0.5	0.6	0.5	0.3	0.5	0.6
Near Bottom	0.5	0.4	0.3	0.4	0.5	0.4	0.3	0.4	0.5

Source: SPDC, 2006

The North East harmattan wind of the dry season and the South-West warm wind of the rainy season are the predominant seasonal winds in the area.

Climate

Prevailing climate in the area is typically tropical with two distinct climatic seasons, dry and wet. The dry season lasts from November to March and is characterized by the North East trade wind which brings in harmattan in November and December. The wet season begins in April and ends in October and is characterized by the South West trade winds laden with moisture from the Atlantic Ocean.

Specific meteorological information for the EA/Eja Field are contained in Appendix Table 4.3. Minimum wind gusts of 4-6.56 m/s to 4.7 m/s are usually recorded during the dry season (November to February) when mean wind direction is north-east.

Appendix Table 4.3: Specific Meteorological Information for EA/Eja Field

Wind Speed	
Minimum	4 – 6.56 m/s
Maximum	17 – 20 m/s
Directions	Mainly South Western
Temperature	
Mean daily temperature	28.6 °C
Maximum recorded temperature	31 °C
Temperature range	27 - 31 °C
Atmospheric Pressure	
Mean daily pressure	1011.4 mbs
Semi –diurnal variation of	2 – 4 mbs
Seabed Current	
Generally	SE
On reverse	NW flow
Maximum seabed current	0.39 m/s
Average seabed current	0.25 m/s
Surface Current	
Generally	NW
On reverse	SW
Maximum surface current	0.78 m/s

Source: SPDC, 2006

Extreme MetOcean Criteria for EA/Eja Field

The average annual wave heights and their occurrence at the site (OML 79) are within the range of 0.75 m for 98% of the time. Wave heights of <1.25 m predominate with occurrences of 58.7 percent of the time. About 54.3 percent of the waves have a peak period within the range of 8.0 – 11.0 seconds. Within this range, wave periods of < 9.0 seconds represent 16.7 percent, 9.0 – 10.0 seconds equal 19.6 percent, while >10.0 seconds account for 18.0 percent of the wave occurrence at the site.

The waves that have their peaks within the above mentioned ranges are $\geq 2.25\text{m}$. The waves are northward 88 percent of the time and north-north east for another 9.9 percent of the time.

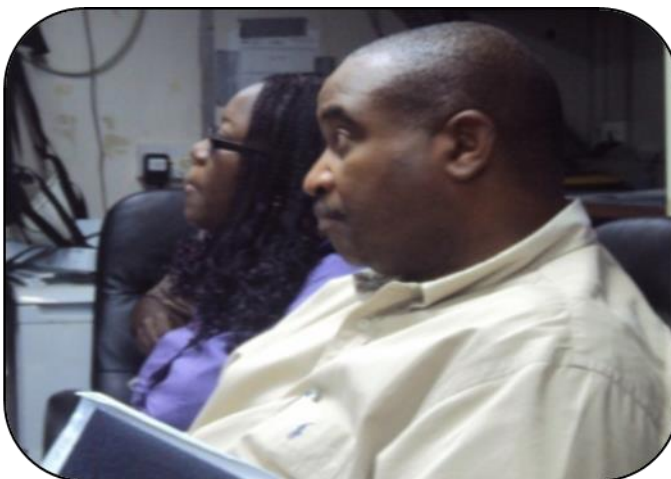
Pre-mobilization/Mobilization

An initial pre-mobilization meeting was held in Lagos between representatives of SNEPCO, SPDC, vessel operators and consultants of Thermosteel Nigeria Limited (TNL) (Appendix **Plates 4.1, 4.2, 4.3**). Issues discussed at the meetings amongst others include:

1. Security and safety issues.
2. Wet and Dry Season Sampling.
3. Sampling Strategies and associated risks
4. Environmental variables to be sampled at each sample location and the parameters to be analysed.



Appendix Plate 4.1: Pre-sampling induction in Survey vessel (MV Askalade)



Appendix Plate 4.2: Some participants at the induction



Appendix Plate 4.3: Some more participants at the induction. First left is the captain of the vessel, second left is the surveyor

3.5 The Vessel

An ocean going utility vessel “MV ASKELADE” was used for the dry and wet season sampling fieldwork. Equipment vessel was equipped with an electric powered winch to enable

deployment and recovery of the water sampler for sampling water at various depths and grab used for the seabed sampling.

The vessel specifications are as follows:

CALL SIGN:	J8RR5
MMSAI:	376137000
FLAG:	St Vincent &Grenadines
HOME PORT:	KINGSTOWN
OFFICIAL No.:	7728467
Register No.:	BUREAU VERITAS
TYPE OF SHIP:	RESEARCH VESSEL
GRT/NRT:	236/70 RT
LOA/LBP:	33,48 / 29,37 MTRS
BREADTH:	7.8 MTRS
MOULDER DEPTH:	3.7MTRS
SUMMER DRAFT:	3.5M
FREE BOARD:	0.2M
AIR DRAFT:	17.00M
LIGHT SHIP:	273.76M
DWT/DISPLACEMENT:	119.98 / 385.74MT
YAR & PLACE OF BUILD:	1979/Moen slip & mek.verksted AS– KOLVEREID
OWNER:	EMS INTERNATIONAL N. V., BORGERHOUT, BELGIUM
OPERATOR:	Chapman International Ltd
Certificate of Registry	N. 7131/N

The vessel was also equipped with firefighting equipment, Echo sounder, compass, auto pilot, life saving equipment (life crafts, vests, jackets etc.)

Sampling Design

For the purpose of determining the fate of discharges from the FPSO and assessing the impact of Sea Eagle’s activities on the environment, samples were taken at stations approximately 100; 200; 500; 800; 1,500; 2,500; and 5,000 metres from the Sea Eagle FPSO in the direction of the most persistent bottom current (Appendix II-4 of DPR’s EGASPIN, 2002). In addition, three (3) stations each were located at radii of 200; 800; 2,500 and 5,000 metres from the Sea Eagle FPSO. Four of the 12 points were stationed on the transect of the most persistent bottom current, while the other eight were stationed on the perpendicular axis. Samples were collected from eight (8) sites which were randomly distributed outside the outermost radial transect. Three (3) control stations were sited at least 6,000 metres away from the FPSO (Appendix II-4 of DPR’s EGASPIN, 2002). Figure 3.1 presents the sampling map for this study.

A total of thirty (30) stations (three control stations inclusive), were sampled for sediment and water (Figure 3.1). At least 3 stations along the predominant wind direction were sampled for ambient air. Each sampling points were geo-referenced and were navigated, using a GPS.

Marine Navigation and Positioning Services

The co-ordinate of each sampling point is presented in Table 3.4 below. However, in order to maintain a safe distance of 500m from Sea Eagle some of the sample points were relocated.

Appendix Table 4.4: Coordinates of Sample points

Stations	Eastings	Northings
1	320749.4960	88734.4566
2	320678.9564	88805.2469
3	320467.4103	89017.7818
4	320255.8856	89230.2369
5	319973.8006	89513.5637
6	319135.6402	90510.4008
7	317294.1741	92205.0188
8	324363.2409	92191.3996
9	322591.5765	90427.5153
10	321492.5329	89333.6085
11	320961.6267	88804.7233
12	320960.9999	88522.0176
13	321384.3422	88096.8081
14	322583.7924	86892.0677
15	324347.6760	85120.4039
16	320678.2602	88522.6012
17	320253.0855	88099.2935
18	319048.3688	86899.8672
19	317276.6307	85135.9095
20	315311.0735	93753.8816
21	320849.9574	93992.6511
22	326426.2139	93484.6300
23	327523.0042	89021.8770
24	326921.3487	84919.8915
25	319407.7915	83230.5308
26	315284.9603	83979.1362
27	314978.9702	88224.9097
Control 1	324134.8087	94560.9585
Control 2	313409.3781	83092.0895
Control 3	328257.0119	83056.0274

Appendix Fig. 4.1: Sampling map of the study location

Data Acquisition Method

Preliminary data acquisition was made through review of existing reports (EIA of the EA/Eja field and Fate and Effect Study of the Sea Eagle FPSO), maps and literature. This was followed by detailed environmental sampling (including in situ determinations) and laboratory analyses. Locations of sampling points are given in Appendix Figure 3.1. The multi-disciplinary field study involved data acquisition on topography, climate/meteorology, air quality and noise, and aquatic systems including ecology and fisheries in accordance with Federal Ministry of Environment regulations (FMENV) and Department of Petroleum Resources (DPR) Guidelines and Standards Part VIII D (2). Apart from random sampling for sediment and water samples, benthos investigations were carried out at designated spots along transects.

Standard methods and procedures have equally been strictly adhered to in the course of this study. QA/QC procedures were implemented during sample collection, labelling, analyses and data verification. Chain of custody procedures including sample handling, transportation, logging and crosschecking in the laboratory have also been implemented.

Details of the sampling methodology adopted and locations are summarized below. All analyses were carried out at the laboratory of Thermosteel Nigeria Limited which is accredited by DPR and FMENV. The methods of analyses used in this study were those specified in EGASPIN (2002) and other internationally accepted analytical procedures. In addition to ensuring the reliability and integrity of the data obtained, *in-situ* measurements of some surface water parameters were carried out in the field. Heavy metals were analysed using Atomic Absorption Spectrophotometer (AAS). Details of the analytical procedures for all the parameters are also summarized below in this chapter.

Meteorology, Air Quality & Noise

Meteorology

The climatic information is based on the data collected from the study area during the field work and analysis of long term historical data collected from the report of the produced water discharge study in EA/Eja field carried out between 2005 and 2006

Air quality and noise data acquisition sites were first identified and marked on the field map for maximum coverage. Measurements were then undertaken at the locations specified on the sampling map. Noise measurements were taken in designated points within the field. The climatic information is based on the data collected from the weather observatory in Sea Eagle (**Appendix Plates 4.4 and 4.5**). Air quality and noise data acquisition activities were measured in 9 sampling points (including 3 control points) within the EA/Eja field using calibrated and standardized equipment.



Appendix Plate 4.4: A display of Air quality measuring equipment



Appendix Plate 4.5: Measuring in-situ air quality

Equipments used for the sampling were properly calibrated and digital samplers tabulated as follows:

Appendix Table 4.5: Environmental Parameters and Equipment used for measurement during field studies

Environmental Component	Parameter	Equipment	Unit
Meteorology			
	Temperature	Thermometer	°C
	Windspeed & Direction	Ketrel 4000 (Anemometer and wind vane)	m/s
	Relative Humidity	Ciba-Corning hygrometer	%
Air Quality			
	Nitrogen Oxides	NO meter	µg/m ³
	Sulphur Oxides	SO meter	µg/m ³
	Carbon Monoxides	CO meter	µg/m ³
	VOC	VOC meter	µg/m ³
	SPM		
	BTEX		
	PAH		
Noise			

Environmental Component	Parameter	Equipment	Unit
	Noise	Sound Level Meter	dB(A)

On site meteorological data measured include;

1. Air Temperature
2. Wind velocity and direction
3. Rainfall Pattern/ Distribution

Air Quality parameters measured included:

1. Nitrogen Oxides
2. Sulphur Oxides
3. Carbon Monoxide
4. Volatile Organic Carbon
5. SPM
6. BTEX
7. PAH

Air quality, meteorological and noise parameters were measured at three locations within 1km of the facility along the predominant wind direction. The parameters measured for air quality included CO, SO_x, NO_x, VOC, SPM, BTEX and PAH.

Noise

The noise parameter measured in this study is L_{Aeq,90}. An Integrating Sound Level meter was used for measurement at a height of 1.5m above ground level. Noise measurement was carried out in all the specified locations during the dry and wet season field survey.

Aquatic Studies

The aquatic/ hydrobiological studies covered the environmental components specified below:

1. Physico-chemistry of water
2. Physico-chemistry of bottom sediment
3. Microbiological properties of surface water and bottom sediments
4. Phytoplankton
5. Zooplankton
6. Macrobenthic fauna

Surface water samples were collected from the sea at the Sea eagle FPSO study location and preserved in line with DPR EGASPIN (2002) for surface water quality assessment. *In situ* measurements were recorded for temperature, TDS, conductivity and pH. Samples for phytoplankton, zooplankton and macrobenthic invertebrates as well as sediment samples were also collected from the same sampling points where field *in-situ* measurements were taken.

A total of thirty (30) aquatic stations were sampled for the parameters listed above. The study areas, sampling stations and number of samples taken are summarized in Table 4.6:

Appendix Table 4.6: Sampling protocol

S/N	Environmental component	No. of sampling points	Description of sample point
1	Surface Water	30	Samples were taken at stations approximately 100; 200; 500; 800; 1,200; 2,500; 5,000 metres in that order from the Sea Eagle FPSO along the directions of most persistent bottom current plus twenty additional samples (12 on radial transect and 8 randomly distributed outside the radial transects)
2	Sediment	27	Sediments were taken at stations approximately 100; 200; 500; 800; 1,200; 2,500; 5,000 metres in that order from the proposed transect location along the directions of most persistent bottom current plus twenty additional samples (12 on radial transect and 8 randomly distributed outside the radial transects)
3	Ambient Air Quality	3	3 sampling points within 1km of the facility along the predominant wind direction.
4	Benthic organisms	27	Taken at approximately 100; 200; 500; 800; 1,200; 2,500; 5,000 metres in that order from the proposed transect location along the directions of most persistent bottom current plus twenty additional samples (12 on radial transect and 8 randomly distributed outside the radial transects)

Water sampling and in-situ analyses

In each of the stations, water depth was established using the echo-sounder. Water samples were collected at three depths viz; sub-surface (5m), middle and near bottom. The water sampler was lowered to the required depth using an electric powered winch (**Appendix Plate 4.6**).



Plate 4.6: Setting the water sampler for launch

Water samples for physico-chemical analyses were collected and stored in appropriately labeled 1-liter plastic cans while those for heavy metal analyses were collected in 1 liter cans. Samples for heavy metal analysis were acidified to pH of 2 using dilute trioxonitrate (V) acid (HNO_3). Samples for hydrocarbon analyses were collected in wide-mouthed bottles acidified with dilute tetraoxosulphate (VI) acid (APHA, 1998 (**Appendix Plate 4.7**)). Samples for hydrocarbon analyses were stored and transported in chilled condition before analyses (**Appendix Plate 4.8**). The following measurements, pH, temperature, dissolved oxygen, electrical conductivity, turbidity, were done in-situ (**Appendix Plate 4.9**).



Appendix Plate 4.7: Acidification of water samples (Heavy metals and THC)

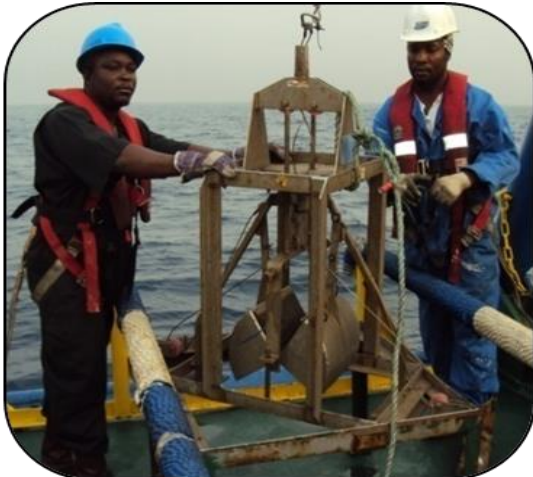


Appendix Plate 4.8: Water samples in Preservation chamber



Appendix Plate 4.9: Calibrated equipment for measurement of *in-situ* water quality Sampling for Sediment/Benthos

A Day Grab was used for the seabed sampling (**Appendix Plate 4.10**). One (1) successful grab was obtained at each sample station.



Appendix Plate 4.10: Setting the empty grab for Launch

The content of the grab was sub-sampled for physico-chemical, microbiological, benthic and hydrocarbon analyses. Samples for macro-benthic fauna were sieved on-board through a 0.5mm mesh and transferred into 500ml wide-mouth plastic containers. Benthic organisms were put in 500ml plastic containers and preserved in 40ml of 5% formalin. Samples were transported to the laboratory for enumeration and identification.



Plate 4.11: Sediment-filled grab on retrieval

Sediment samples for hydrocarbon analysis were collected in aluminium foil and stored in the vessel's refrigerator on board for onward transfer to the laboratory for analysis. Samples for physico-chemical analysis were collected in polythene bags, while samples for microbiological samples were collected in sterilized sachets and stored in the cold room (at 4 °C) on board the vessel.

Phytoplankton and Zooplankton

Phytoplankton and zooplankton were collected using a 55µm mesh size plankton net with a 10cm diameter. The net was towed for 5 minutes at ...knots. The samples were collected at the depth of about 50cm below water surface (**Appendix Plate 4.12**). Sample collection was by means of a 55µm mesh tow net with a diameter of 10cm). The net was also towed just beneath (50cm) the water surface.



Appendix Plate 4.12: Plankton sampling (making a vertical haul with plankton net)

Field and Laboratory Analysis

Sampling and handling of samples were carried out in accordance with DPR Environmental Guidelines and Standards for Petroleum Industries in Nigeria (EGASPIN), 2002 (Part VIII D (2) sampling and handling of samples) for the enhancement of quality of results. All samples,

after collection, were immediately labelled using ineffaceable markers, giving details of sampling procedures and sample characteristics.

To reduce error, measurements were replicated and numbers of specially distributed samples were composited before sub-sampling for analyses. To avoid samples contamination and deterioration, sampling tools and containers were pre-sterilized, pre-treated and preserved on transit in ice-cooled chest (<4 °C) and transported to the laboratory. They were stored in refrigerator pending subsequent analyses especially for parameters having short holding times such as total hydrocarbon, microbiological and heavy metal analyses.

Water Chemistry

Some parameters required for the water samples were determined *in situ* as is required to ensure the accuracy of the measurement. These are presented in **Appendix Table 4.7**

Appendix Table 4.7: Methods adopted for In situ Measurements

Parameter	Method
pH	Determined with a Field pH meter
TDS	Determined with a field TDS meter
Conductivity	Determined with a field Conductivity meter
Temperature	Determined with a simple mercury-in- glass thermometer
Dissolved Oxygen (DO)	Determined with a field DO meter

After *in-situ* determinations, proper records of the reading for each sample were immediately written into the field notebook. Samples were analysed in the laboratory using the appropriate standards methods for each parameter as specified by DPR (1991), ASTM (1982) and APHA (1981). All appropriate analytical procedures (see Table 4.7 and 4.8) and the associated QA/QC protocols for the different parameters were strictly adhered to.

Appendix Table 4.8: Laboratory Methods Adopted in Analysis of the Water Samples

Parameter	Method
Turbidity	Turbidimetry
TSS	Filtration/Gravimetry
DO	Winkler's Titrimetry
BOD	DO meter/Winkler's Titrimetry – Dilution Method
COD	Tritrimetry/Visible Spectrophotometry
Alkalinity	Titrimetry
Hardness	EDTA Titrimetry
Salinity	Titration(Argentometry)
Nitrate	Visible Spectrophotometry(Brucine method)
Phosphate	Visible Spectrophotometry
Heavy metals	AAS
TPH, PAH and BTEX	Gas Chromatography

Water Microbiology

Heterotrophic bacterial and total fungal counts were enumerated by inoculating plates in duplicate with 0.1 ml aliquot of serially diluted sample in peptone water. 1 ml was transferred into 9 ml sterile peptone water to make a 10 fold dilution. Inoculum was taken from the 10^{-3} dilution.

Sterile molten nutrient agar was aseptically poured into the bacteria plates to support bacterial growth while sterile molten sabouraud dextrose agar was aseptically poured into the fungi plates to support fungal growth. The plates were incubated at 28°C for 24hrs.

Hydrocarbon utilizing bacteria and fungi were enumerated by inoculating plates in duplicate with 0.1 ml aliquot of serially diluted sample in peptone water. 0.1 ml solution of tetracycline was added into the fungi plates to inhibit bacterial growth while 0.1 ml solution of flagyl was added into bacterial plates to inhibit fungi growth.

Sterile molten mineral salt agar of Mills et al. (1978) was aseptically poured into all the plates. The hydrocarbon source was supplied through the vapour phase by placing filter papers (Whatman No 1) impregnated with 1ml of filter sterilized Bonny light crude oil on the lids of the plates. The plates were incubated at 30°C for 7 days.

Bottom Sediment

The laboratory methods used in the analysis of bottom sediment samples are described in details in the following references APHA (1985), Day (1967), Allison (1965) and Bray & Kurtz (1945).

Testing Sediments for Physico-Chemical Parameters

Samples collected were spread on plastic trays in a ventilation room and air-dried. The air-dried sediment aggregates were gently crushed using mortar and pestle and sieved through 2 mm mesh size sieve. Particles larger than 2 mm were discarded. The resultant sieved sediment samples were bagged in Polythene bags and re-labelled prior to analysis. Portions of the labelled samples were ground to powder on "Agate mortar" and stored for organic carbon.

Sediment physico-chemical Analyses

i) pH

This was measured in 1:1 sediment to water suspension with a glass electrode pH meter. Similar measurement was also made in 1:1 sediment to 1.0 M KCl suspension. The pH meter used was bench CIBA Corning/Kent/EIL 7055 (1990) with a sensitivity of ± 0.01 .

ii) Electrical Conductivity (EC)

This was measured in the 1:1 sediment to water suspension after the pH measurement using a bench/field Corning portable conductivity meter-(1990) with a sensitivity of $\pm 0.5\%$, $0.2 \mu\text{S}$ at 5 mg/L ionic strength. The results were expressed in milli-siemens (mS) per cm.

iii) Phosphate

The available phosphate in the sediment was extracted with Brain P1 solution (NH_4F 0.03N + HCl 0.02 N) and analysed using the ascorbic acid- molybdenum blue colour method of Murphy and Riley (1962) on a bench Technicon-Auto-Analyser II.(1980/1985) with a sensitivity of 0.001 ppm.

iv) Nitrate (NO_3^-)

The NO_3^- in the sediments were determined by shaking 5.0g of representative sediment sample with 50ml of 1.0 N K_2SO_4 and extracted, using Morgan's reagent. The NO_3^- forms were assayed using the Brucine method of Greweling and Peech (1964).

v) Heavy Metals Analyses

The heavy metals (Fe, Mn, Zn, Cu, Cr, Cd, Ni, V, Pb, Hg) were extracted using a mixture of equal volumes of analytical grade of a 1:10 sediment to water ratio, shaken for 1h and followed by filtration. Fe, Mn, Zn, Cu, Cr, Cd, Ni, V, Pb and Hg were determined by Flame Atomic absorption spectrometer (AAS) using air-acetylene flame. Vanadium was determined by AAS, but using nitrous oxide-acetylene flame. Hg was analysed by the flameless AAS using the cold vapour method.

Sediment Microbiology

Sediment microorganisms were estimated by the sediment dilution plate method in which serial dilution of all the sediment samples in sterile normal saline were plated on a surface agar medium. 10 g of each sample was aseptically added to 90 ml of sterile normal saline and shaken vigorously to give a 10-fold dilution (10^{-1}). Transferring 1 ml of the sediment suspension to 9ml of the diluent then made 10-fold serial dilutions. Up to 10^{-4} aliquots (0.1 ml) of appropriate dilutions were then spread/ plated in duplicate on surface nutrient agar (Oxoid cm 13), MacConkey agar (Oxoid cm 7) and Sabouraud dextrose agar (SDA). The nutrient agar and MacConkey agar plates were incubated at 37°C for 24 hours, while the Sabouraud agar plates were incubated at ambient temperature ($28-30^\circ\text{C}$) for 3 - 7 days. Chloramphenicol was added to differentially isolate fungi. The plates with sediment extract were incubated at 30°C for 96 hrs for fungi species.

Population counts of hydrocarbon degrading bacteria and fungi were carried out using the methods of Mills *et al.* (1978). The prepared media were autoclaved at 121°C for 15 minutes. Each inoculated plate was inverted over sterile filter paper, which was moistened with Bonny light blend crude oil, placed in the lid of the petri dish for 4 days. The resulting hydrocarbon biodegrading bacteria and fungi were recorded and their counts expressed as a percentage of the total heterotrophic bacteria or fungi.

Aquatic Ecology

i) Phytoplankton and Zooplankton

The phytoplankton species were identified using a Leitz Orthoplan Universal Wide-Field Research Microscope equipped with tracing and measuring devices. Enumeration of cells per m³ was computed using the following formula:

$$\text{Number of cells/m}^3 = \frac{NX1000}{\text{Initial volume of water filtered}}$$

Where N = Cells counted per sample.

That is;

$$\frac{\text{Counts x Fraction}}{\text{No. of fields counted}} \times \frac{1}{\text{Volume of Chamber}} \times \frac{100}{1}$$

Sorting and identification of the Zooplankton were performed using a Wild-Lietz Stereo Zoom dissecting microscope and an Olympus Universal Vanox Research microscope with drawing attachment. Representative specimens were mounted in 100% glycerine after dissection of relevant taxonomic parts. Identifications were made to the lowest possible taxonomic level using relevant identification keys. Individuals of each identified taxon in each sample were enumerated using the counting chamber, and the Zooplankton density expressed in numbers per m³ using the formula:

$$\text{Number of individuals per m}^3 = \frac{\text{Initial volume of water filtered}}{NX1000}$$

where N = total number of zooplanktons per sample.

Where Subsamples from the original 100ml concentrated samples were used, 'N' was first computed from the original sample before estimating the density.

ii) Benthos

Benthic analysis was carried out using the Binocular Dissecting Microscope and the compound microscope for sorting, dissecting, slide preparation, identification and counting.

Faunal densities were computed in numbers per m² by multiplying the counts in the bank-root biotope by 4 and those of the bottom sediment by 44.4.

Indices of diversity and evenness were used to characterize the biotic communities. The following indices were used.

Margalef's index (d) of taxa richness

$$d = \frac{S - 1}{\ln N}$$

where S = number of taxa
 N = total number of individuals/cell.

Shannon-Wiener index (H) of general diversity

$$H = \frac{N \log N - \sum f_i \log f_i}{N}$$

Where N = total number of individuals/cell
 f_i = Number of individuals/cell in species 'i'

(c) Evenness Index (E)

$$E = \frac{H}{H_{\max}}$$

Where $H_{\max} = \log S$

Evenness measures the degree of uniformity in the distribution or spread of individuals among the species (Odum 1971, Zar 1983).

Fisheries

Fish and shellfish identified from local fish catches. The information is based on the available literature and is applicable to wider regions than the EA/Eja field and its area of influence.

Quality Assurance and Control

In this study measures were taken to ensure that,

- The best available methods for the analysis of sediment, water and aquatic ecology were used.
- The services of qualified and competent consultants, and technical personnel for sample / data collection and chemical analysis were engaged.
- Standard sampling techniques were used and samples were preserved in appropriate manners.
- Reproducibility of scientific data was achieved

i) Sample collection and handling

This was carried out in accordance with DPR Guidelines and standards (Part viii D (2) sampling and handling of samples). To prevent contamination, all sampling materials and containers were sterilized. All water samples were properly handled and fixed depending on the type of analysis to be carried out. For heavy metal determination, sampling bottles used were rinsed with a solution of one part nitric acid to four parts of water, followed by copious amounts of distilled water. Water samples for BOD₅ determinations were collected in black oxygen bottles and kept away from light by wrapping them in black polythene bags and incubated at 20°C prior to analysis. Field instruments were frequently calibrated against international standards.

ii) Sample Preservation

All water samples were properly handled and fixed depending on the type of analysis to be carried out since some determinations were likely to be affected by storage before analysis.

Parameters such as temperature, pH, turbidity, electrical conductivity and dissolved oxygen were determined *in situ* because of their rapid change on storage. Samples for physico-chemical analysis were fixed differently employing, pH adjustment using HNO₃, H₂SO₄ for cations and anions respectively, Winkler solutions, for DO, and ice cold containers for TSS, salinity, etc. Other sets of samples were left unfixed but also kept under refrigeration. Water and sediment meant for microbiological analysis were also kept in ice-cooled chests immediately after collection, and later kept in refrigerators in the laboratory to maintain the “cold - chain.”

iii) Analytical Quality Control

The possible sources of errors in the laboratory include: lack of calibration of equipment, errors in data reporting, lack of sensitivity of instruments, as well as contamination/degradation of reagents. To avoid these identified sources of errors, the following precautions were taken:

- Only analytical grade reagents and chemicals were used in preparing reagents and standards.
- The use of control materials, standard / certified reference materials, spiked control materials and inter - laboratory tests to control bias and precision and ensure quality of results.
- Compliance with sound principles of laboratory practice and organization.
- The use of analytical methods capable of producing data of required quality.
- The use of professionals to handle all analysis and continuous training and re - training of laboratory staff.

iv) Data Verification, Evaluation, Storage and Treatment.

The reporters recognize that every stage of data handling increases the risk of introducing errors. Thus to reduce such errors, direct electronic recording and data transfer processes were used. Where data were hand written, they were checked against the original records for typing errors. To guard against loss of data due to accidental erasure of computer files, a file was kept for all results and reports. Secondly, uninterrupted power supply (UPS) system was acquired for all computers, which were used for this project. Back-up files were also created for all reports from consultants and these were regularly updated.

Data verification was carried out at various points of the collection and analysis process. Field data sheets were inspected daily and data, which did not fall within expected ranges, were noted and given special attention. Furthermore, outlier values (values which did not fall within expected ranges) were deleted from the replicate data before calculations for mean concentrations. A quick visual or graphical identification of results, which deviated from normal trend, was carried out on all water samples based on the relationships stated below, and samples showing results, which deviated from normal trends re-analysed.

TDS \approx $\frac{1}{2}$ Electrical Conductivity
 TDS > Salinity
 COD > BOD

All typed results were cross - checked for typographic errors.

The slops system is pressurised and re-circulated prior to discharge from the starboard slops tank. This enables a manual sample to be taken and analysed for oil in water content. If this value is below 25 mg/l (as per DPR approved permit), overboard discharge proceeds. Samples are taken during the discharge to find an average oil in water content for the specific volume discharged.

Once discharge post-IGFU occurs, only oily wastewater (defined as all other oily wastewater that is not produced water) will be discharged from the starboard slops tank. Currently the composition of water in the slops tanks is predominantly produced water with <2% originating from the topsides process (oily wastewater).

The sea surface is monitored in the central control room (CCR) via CCTV for presence of sheen during and following discharge of produced water.

Produced Water Modelling

The produced water modelling was researched from the report of Chronic Effect Study and the interpretation of the Mixing Zone analysis in 2004 as well as the CORNIX Modelling Study carried out as part of Fate and Effect Study of Produced Water discharge carried out in 2006. A key concept in the application of Environmental Quality Standards (EQS) for the protection of aquatic life is that they are applied after an initial phase of dispersion and dilution in an area called the mixing zone. The mixing zone can be defined as:

The area of water surrounding a discharge in which initial dilution and mixing of effluent occurs to the extent that, outside the zone, no other use of the water body is compromised, and relevant environmental quality standards are not exceeded. The mixing zone applied in the study was 500 m from the point of discharge.

Ecotoxicity Studies of EA FPSO Produced Water

Ecotoxicity study was carried out by extrapolation of the 2006 Fate and Effects Study finding. A comparative analysis of data gathered throughout the period of operation gave indication of any possible impact on the aquatic life within the discharge zone.

APPENDIX 4.2

Appendix Table 4.2.1: Water Sample Analyses Results

PARAMETERS	SW2	SW3	SW4	SW5	SW6	SW7	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
Physico-chemical														
pH	7.81	7.64	7.67	7.77	7.68	7.85	7.77	7.68	7.85	7.83	7.75	7.69	7.82	7.51
Temperature, oC	26.4	26.6	26.8	26.7	26.6	26.4	26.7	26.6	26.4	26.6	26.7	26.6	26.8	26.3
Dissolved Oxygen (DO), mg/l	8.3	7.47	8.08	8.21	7.47	7.33	8.21	7.47	7.33	7.85	8.77	8.11	8.22	8.85
Colour, Pt-Co	Colourless (0)			Colourless (0)			Colourless (0)			Colourless (0)			Colourless (0)	
Electrical Conductivity (EC), µS/cm	49800	47560	50440	52790	52410	41960	52790	52410	41960	45490	46480	45090	42800	50440
Turbidity, NTU	0.06	0.06	1.33	2	0.66	0.66	2	0.66	0.66	0.66	1.33	1.33	0.03	0.66
Total Suspended Solids (TSS), mg/l	<1.00	<1.00	2	3	1	1	3	1	1	1	2	2	<1.00	1
Biochemical Oxygen Demand (BOD), mg/l	3.44	3.44	2.92	3.98	3.46	3.46	3.98	3.46	3.46	3.42	2.9	3.02	3.4	2.94
Chemical Oxygen Demand (COD), mg/l	5.4	5.76	5.16	5.52	6	5.44	5.52	6	5.44	5.6	5	5.64	6.56	6.53
Alkalinity, mg/l	139.99	119.9	99.99	99.99	99.2	56.4	99.99	99.2	56.4	139.99	79.99	99.99	139.99	119.99
Hardness, mg/l	6920	10080	5800	5380	9920	5640	5380	9920	5640	9600	9920	5320	5480	9920
Mortality	None	None	None	None	None	None	None	None	None	None	None	None	None	None

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PARAMETERS	SW2	SW3	SW4	SW5	SW6	SW7	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
LC50@96hrs	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD	CBD
Total Dissolved Solids (TDS), mg/l	29390	26160	27740	29040	28830	28080	29040	28830	28080	25280	25560	24800	23540	27740
Anions														
Salinity (as Chloride), mg/l	16162	15729	16528	15128	15195	14728	15128	15195	14728	13862	14462	14862	14462	15328
Salinity ‰	29.14	28.36	29.80	27.28	27.40	26.55	27.28	27.40	26.55	24.99	26.07	26.80	26.07	27.64
Nitrate, mg/l	0.26	0.2	0.18	1.15	0.2	0.18	1.15	0.2	0.18	0.24	0.16	1.33	0.53	1.21
Phosphate, mg/l	0.3	0.9	0.23	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.02	0.15	0.2	0.03
Cations														
Calcium, mg/l	726.5	741.6	821.3	792.8	831.3	839.5	792.8	831.3	839.5	685.05	683.78	685.1	761.5	855.5
Magnesium, mg/l	362.3	365	364.3	6580	362	363.7	6580	362	363.7	363.6	367	365.2	363.5	364.8
Ammonium, mg/l	1.22	1.52	2.7	1.18	2.86	2.3	1.18	2.86	2.3	1.33	2.98	0.8	1.53	1.67
Potassium, mg/l	925.05	918.31	913.25	924.79	894.7	912.38	924.79	894.7	912.38	911.99	922.84	913.42	925.17	914.74
Heavy metals														
Cadmium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, mg/l	0.166	0.181	0.218	0.186	0.22	0.416	0.186	0.22	0.416	0.205	0.256	0.199	0.235	0.233
Total iron, mg/l	1.765	0.747	0.64	0.596	0.724	1.16	0.596	0.724	1.16	1.718	1.626	1.676	0.635	1.822
Copper, mg/l	0.119	0.162	0.108	0.124	0.122	0.161	0.124	0.122	0.161	0.147	0.149	0.148	0.108	0.098
Chromium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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PARAMETERS	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
Nickel, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lead, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Organics											
Total Petroleum Hydrocarbons (TPH), mg/l	0.001	<0.001	<0.001	0.001	0.002	<0.001	0.001	0.002	<0.001	<0.001	<0.001
Polycyclic Aromatic Hydrocarbons (PAH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Microbiology											
Hydrocarbon Utilizing Bacteria, x102 Cfu/ml	Nil	Nil	Nil	Nil	0.56	Nil	Nil	0.56	Nil	Nil	Nil
Hydrocarbon Utilizing Fungi, x102 Cfu/ml	Nil	Nil	Nil	Nil	0.32	Nil	Nil	0.32	Nil	Nil	Nil

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PARAMETERS	SW2	SW3	SW4	SW5	SW6	SW7	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12
Total Heterotrophic Bacteria x103 Cfu/ml	0.84	0.68	0.81	0.97	0.85	0.93	0.97	0.85	0.93	0.5	0.87	0.6	0.91	0.83
Total Heterotrophic Fungi, x103 Cfu/ml	0.58	0.55	0.63	0.64	0.81	0.66	0.64	0.81	0.66	0.69	0.96	0.56	0.86	0.78

Appendix Table 4.2.1: Water Sample Analyses Results Contnd.

PARAMETERS	SW13	SW14	SW15	SW16	SW17	SW18	SW19	SW20	SW21	SW22
Physico-chemical										
pH	7.84	7.73	7.9	7.72	7.59	7.86	7.77	7.84	7.76	7.88
Temperature, oC	26.4	27.51	32.47	32.7	26.4	26.5	26.6	26.4	26.4	26.3
Dissolved Oxygen (DO), mg/l	7.8	7.89	8.07	8.65	7.6	8.03	8.19	7.46	7.48	8.19
Colour, Pt-Co		Colourless (0)			Colourless (0)			5	5	10
Electrical Conductivity (EC), µS/cm	47550	47510	32490	52700	51720	58440	46090	42000	50240	48210
Turbidity, NTU	0.66	0.08	0.05	0.03	1.24	0.06	0.04	3.68	2.96	5.22
Total Suspended Solids (TSS), mg/l	1	1	<1.00	<1.00	4	1	<1.00	5	4	7
Biochemical Oxygen Demand (BOD), mg/l	3.3	3.52	3	3.45	3.52	3.06	3.02	3.34	3.36	2.9

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PARAMETERS	SW13	SW14	SW15	SW16	SW17	SW18	SW19	SW20	SW21	SW22
Chemical Oxygen Demand (COD), mg/l	6.44	5.72	5.4	5.4	5.48	5.4	5.2	5.36	5.26	4.82
Alkalinity, mg/l	119.99	139.99	79.99	119.9	79.99	199.9	199.9	119.9	119.9	79.99
Hardness, mg/l	9600	9600	5280	5920	5720	5600	5440	5720	5400	8320
Mortality	None	None	None	None	None	None	None	None	None	None
LC50@96hrs		Cannot be determined			Cannot be determined			Cannot be determined		
Total Dissolved Solids (TDS), mg/l	26150	26130	17870	28990	29000	32140	25350	26110	24990	26590
Anions										
Salinity (as Chloride), mg/l	14862	15261	13595	15528	14562	14795	15195	17564	16061	14862
Salinity ‰	26.80	27.52	24.51	28.00	26.25	26.67	27.40	31.67	28.96	26.80
Nitrate, mg/l	1.37	0.49	0.65	0.74	1.2	0.68	1.06	1.24	0.85	1.37
Phosphate, mg/l	<0.001	0.02	0.02	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cations										
Calcium, mg/l	840.5	833.4	776.3	848.8	791.9	85.16	80.19	845.7	840.8	790.9
Magnesium, mg/l	368.4	367.1	361	363.4	362.4	3.626	3.668	364.4	365	364.6
Ammonium, mg/l	1.49	3.06	2.34	1.91	1.41	1.25	2.24	1.57	1.49	1.72
Potassium, mg/l	925.69	918.26	925.25	912.45	925.26	913.71	922.99	11.68	12.88	9.33
Heavy metals										
Cadmium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, mg/l	0.377	0.188	0.224	0.401	0.309	0.299	0.366	0.2	0.212	0.161
Total iron, mg/l	0.964	0.656	0.467	1.186	0.975	1.848	1.07	0.781	1.46	0.843
Copper, mg/l	0.106	0.123	0.134	0.153	0.212	0.156	0.118	0.115	0.162	0.127
Chromium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Lead, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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PARAMETERS	SW13	SW14	SW15	SW16	SW17	SW18	SW19	SW20	SW21	SW22
Arsenic, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Organics										
Total Petroleum Hydrocarbons (TPH), mg/l	0.001	0.004	0.001	0.003	<0.001	<0.001	<0.001	0.003	0.002	<0.001
Polycyclic Aromatic Hydrocarbons (PAH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Microbiology										
Hydrocarbon Utilizing Bacteria, x10 ² Cfu/ml	Nil	0.43	Nil	0.44	Nil	Nil	Nil	0.41	0.33	Nil
Hydrocarbon Utilizing Fungi, x10 ² Cfu/ml	Nil	0.47	Nil	0.36	Nil	Nil	Nil	0.44	0.2	Nil
Total Heterotrophic Bacteria x10 ³ Cfu/ml	0.85	0.97	0.8	0.75	0.93	0.81	0.84	0.85	0.78	0.84
Total Heterotrophic Fungi, x10 ³ Cfu/ml	0.63	0.75	0.64	0.71	0.81	0.86	0.84	0.93	0.83	0.8

Appendix Table 4.2.1: Water Sample Analyses Results Contnd.

PARAMETERS	SW23	SS24	SW25	SW26	SW27
Physico-chemical					
pH	7.74	7.92	7.62	7.81	7.78
Temperature, oC	26.7	26.3	27.2	26.6	26.5
Dissolved Oxygen (DO), mg/l	8.19	8.09	8.02	8.01	7.9
Colour, Pt-Co	Colourless (0)			Colourless (0)	
Electrical Conductivity (EC), μ S/cm	48210	48410	50940	48210	47860
Turbidity, NTU	0.54	0.89	0.09	0.07	0.08
Total Suspended Solids (TSS), mg/l	1	2	<1.00	<1.00	<1.00
Biochemical Oxygen Demand (BOD), mg/l	3	3.5	3.4	3.4	3.52
Chemical Oxygen Demand (COD), mg/l	5.68	5.6	5.24	5.2	6.8
Alkalinity, mg/l	79.99	119.9	79.99	79.99	79.99
Hardness, mg/l	7520	5600	10080	9280	5318
Mortality	None	None	None	None	None
LC50@96hrs	CBD	CBD	CBD	CBD	CBD
Total Dissolved Solids (TDS), mg/l	28910	26620	28020	26520	26320
Anions					
Salinity (as Chloride), mg/l	20043	19710	16994	16261	15528
Salinity ‰	36.15	35.55	30.64	29.32	28.00
Nitrate, mg/l	0.48	0.63	1.1	0.43	1.38
Phosphate, mg/l	<0.001	0.002	<0.001	0.01	<0.001
Cations					
Calcium, mg/l	843.1	719	874.8	818.5	798.2
Magnesium, mg/l	362	355	366.2	367.2	427.3

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PARAMETERS	SW23	SS24	SW25	SW26	SW27
Ammonium, mg/l	4.58	1.47	2.08	2.26	2.23
Potassium, mg/l	911.81	918.05	920.37	925.95	988.76
Heavy metals					
Cadmium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, mg/l	0.233	0.162	0.364	0.141	0.314
Total iron, mg/l	0.807	0.788	1.318	0.562	0.729
Copper, mg/l	0.178	0.143	0.186	0.092	0.114
Chromium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002
Lead, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002
Vanadium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Organics					
Total Petroleum Hydrocarbons (TPH), mg/l	0.002	0.001	0.001	<0.001	0.003
Polycyclic Aromatic Hydrocarbons (PAH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
Microbiology					
Hydrocarbon Utilizing Bacteria, x10 ² Cfu/ml	0.41	0.19	0.16	Nil	Nil
Hydrocarbon Utilizing Fungi, x10 ² Cfu/ml	0.28	0.22	0.1	Nil	Nil
Total Heterotrophic Bacteria x10 ³ Cfu/ml	0.88	0.63	0.86	0.84	0.96
Total Heterotrophic Fungi, x10 ³ Cfu/ml	0.85	0.68	0.78	0.89	0.61

- **CBD= Cannot be determined**

Appendix Table 4.2.2 EA EER Surface Water Sampling Station controls 2-4 (SWctrl 2-4) Analysis Results (Wet season 2011)

PARAMETERS	SWCtrl 1	SWCtrl 2	SWCtrl 3	SWCtrl 4	MIN	MAX	MEAN	SD
Physico-chemical								
pH	7.78	7.82	7.53	7.91	7.53	7.91	7.760	0.163
Temperature, oC	26.5	28.2	27.1	26.1	26.1	28.2	26.975	0.914
Dissolved Oxygen (DO), mg/l	7.53	8.29	7.89	8.26	7.53	8.29	7.993	0.358
Colour, Pt-Co		Colourless (0)						
Electrical Conductivity (EC), µS/cm	49750	40290	49060	50880	40290	50880	47495.000	4861.567
Turbidity, NTU	0.05	0.2	0.07	0.04	0.04	0.2	0.090	0.074
Total Suspended Solids (TSS), mg/l	<1.00	1	<1.00	<1.00	1	1	1.000	#DIV/0!
Biochemical Oxygen Demand (BOD), mg/l	3.22	3.52	3.56	3.42	3.22	3.56	3.430	0.152
Chemical Oxygen Demand (COD), mg/l	5.6	5.8	6.76	6	5.6	6.76	6.040	0.507
Alkalinity, mg/l	99.99	119.9	99.99	119.9	99.99	119.9	109.945	11.495
Hardness, mg/l	9280	9992	5640	5600	5600	9992	7628.000	2336.845
Mortality	None	None	None	None				
LC50@96hrs		Cannot be determined						
Total Dissolved Solids (TDS), mg/l	27360	22160	26910	27960	22160	27960	26097.500	2660.005
Anions								
Salinity (as Chloride), mg/l	19213	14928	16061	16528	14928	19213	16682.500	1815.841
Salinity ‰	34.649	26.915	28.960	29.803	26.915	34.649	30.082	3.248
Nitrate, mg/l	1.26	0.65	1.48	1.26	0.65	1.48	1.163	0.357
Phosphate, mg/l	<0.001	<0.001	<0.001	<0.001	0	0	<0.001	<0.001
Cations								
Calcium, mg/l	789.9	779.4	726.4	865.3	726.4	865.3	790.250	57.234
Magnesium, mg/l	365.2	360	364.1	366.8	360	366.8	364.025	2.903
Ammonium, mg/l	0.12	1.12	0.84	1.65	0.12	1.65	0.933	0.637
Potassium, mg/l	913.31	918.11	924.12	956.65	913.31	956.65	928.048	19.574
Heavy metals								
Cadmium, mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.000
Zinc, mg/l	0.167	0.14	0.182	0.241	0.14	0.241	0.183	0.043

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PARAMETERS	SWCtrl 1	SWCtrl 2	SWCtrl 3	SWCtrl 4	MIN	MAX	MEAN	SD
Total iron, mg/l	0.683	0.862	0.635	1.125	0.635	1.125	0.826	0.222
Copper, mg/l	0.171	0.131	0.124	0.121	0.121	0.171	0.137	0.023
Chromium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Nickel, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.000
Lead, mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.000
Vanadium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Arsenic, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Barium, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Cobalt, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Mercury, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Organics								
Total Petroleum Hydrocarbons (TPH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Polycyclic Aromatic Hydrocarbons (PAH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
BTEX, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.000
Microbiology								
Hydrocarbon Utilizing Bacteria, x102 CfU/ml	Nil	Nil	Nil	Nil	0	0	0	0
Hydrocarbon Utilizing Fungi, x102 CfU/ml	Nil	Nil	Nil	Nil	0	0	0	0
Total Heterotrophic Bacteria x103 CfU/ml	0.6	0.66	0.98	0.8	0.6	0.98	0.760	0.169
Total Heterotrophic Fungi, x103 CfU/ml	0.82	0.64	0.94	0.87	0.64	0.94	0.818	0.128

Appendix Table 4.2.1 Sediment Samples Analysis Results

	EA EER SD 2	EA EER SD 3	EA EER SD 4	EA EER SD 5	EA EER SD 6	EA EER SD 7	EA EER SD 8	EA EER SD 9	EA EER SD 10	EA EER SD 11	EA EER SD 12	EA EER SD 13	EA EER SD 14
Physico-chemical													
pH	7.6	7.65	7.69	7.7	7.74	7.69	7.4	7.7	7.81	7.58	7.65	7.75	7.6
Temperature, °C	26.8	28.2	27.6	26.3	27.2	25.4	25.9	26.6	27.7	27	27.3	26.7	25.8
Colour	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish
Electrical conductivity, µS/cm	9010	95067	9450	8700	89010	10900	8420	8970	8030	9090	8770	8260	8500
Anions													
Salinity (as Chloride), mg/kg	3665	3732	3824	3331	3332	2332	3095	2865	2665	2765	2731	2066	2665
Nitrate, mg/kg	69.08	89.65	29.89	165.05	49.41	109.35	26.44	23.6	139.72	12.12	31.57	146.33	179.69
Phosphate, mg/kg	89.65	128.13	184.61	147.37	78.04	109.35	81.23	122.74	119.71	80.49	108.4	68.54	141.35
Cations													
Potassium, mg/kg	1432	1256	828	998	932	848	422	790	685	1396	930	904	1017
Calcium, mg/kg	1442	1376	1179	2260	1294	1234	1053	1160	1451	1166	2232	2251	1435
Magnesium, mg/kg	1324	860.45	743	1078	1039	984	826.18	802.2	829.9	1079	1052	1026	954.6
Organics													
Total Petroleum Hydrocarbon, mg/kg	1.16	2.04	0.89	1.11	1.83	1.04	2.19	3.11	2.05	1.2	0.866	1.38	5.14
Polycyclic Aromatic Hydrocarbon (PAH), mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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	EA EER SD 2	EA EER SD 3	EA EER SD 4	EA EER SD 5	EA EER SD 6	EA EER SD 7	EA EER SD 8	EA EER SD 9	EA EER SD 10	EA EER SD 11	EA EER SD 12	EA EER SD 13	EA EER SD 14
Heavy Metals													
Cadmium, mg/kg	4.95	3.42	2.25	8.32	7.36	7.73	5.24	5.22	7.06	1.62	1.97	4.26	2.38
Zinc, mg/kg	31.35	28.28	34.88	47.17	73.94	56.84	44.63	10.88	28.86	25.58	31.73	38.28	45.06
Total iron, mg/kg	932	930.4	1987	1954	1966	1399	1691	982.7	1921.6	1804	1708	1904	1936
Copper, mg/kg	8.12	4.79	6.08	11.23	10.8	18.69	10.89	5.44	9.48	8.26	8.05	11.71	5.96
Chromium, mg/kg	27.81	10.54	21.93	29.12	26.42	35.97	28.68	13.36	38.86	20.97	23.48	29.31	18.76
Nickel, mg/kg	46.67	18.87	7.88	29.3	<0.002	39.65	42.95	25.4	49.53	26.76	22.85	24.19	16.24
Lead, mg/kg	28.2	43.16	46.67	37.56	34.27	35.12	25.15	30.24	30.24	34.9	53.34	52.34	45.55
Vanadium, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, mg/kg	0.48	1.26	0.86	0.89	0.29	0.84	0.71	0.46	0.81	0.64	0.59	0.66	0.96
Mercury, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Microbiology													
Hydrocarbon degrading bacteria, x10 ² Cfu/g	0.45	0.61	0.76	1.04	1.08	0.81	1.1	2.28	1.08	1.06	0.9	0.61	2.11
Hydrocarbon degrading fungi, x10 ² Cfu/g	0.11	0.48	0.46	0.55	0.6	0.59	0.64	0.96	0.81	0.88	0.84	0.68	1.06

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	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER
	SD 2	SD 3	SD 4	SD 5	SD 6	SD 7	SD 8	SD 9	SD 10	SD 11	SD 12	SD 13	SD 14
Total Heterotrophic Bacteria, x10 ⁴ Cfu/g	1.17	1.15	1.39	1.83	1.28	1.65	1.8	1.16	1.09	1.09	1.02	1.14	1.13
Total Heterotrophic Fungi, x10 ⁴ Cfu/g	1.13	1.08	1.27	1.75	1.25	1.48	1.66	1.13	1.03	1.01	1.04	1.1	1.1

Appendix Table 4.2.1 Sediment Samples Analysis Results Contnd

	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER	EA EER
	SD 15	SD 16	SD 17	SD 18	SD 19	SD 20	SD 21	SD 22	SD 25	SD 26	SD 27	Ctrl 1	Ctrl 3	Ctrl 4
Physico-chemical														
pH	7.7	7.53	7.77	7.65	7.27	7.2	7.57	7.5	6.2	6.12	7.01	7.77	7.8	7.6
Temperature, °C	25.1	26.9	26.5	26.2	25.9	27	27.1	27.3	26.1	25.2	25.3	28	25.7	24.9
Colour	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish	Grayish
Electrical conductivity, μS/cm	7730	9460	9940	10210	9780	9600	9100	6490	8640	9510	10170	8560	8290	12040
Anions														
Salinity (as Chloride), mg/kg	3668	2399	3998	2799	3998	3332	2599	1799	2598	2665	4998	3065	3199	5998
Nitrate, mg/kg	6.29	9.76	22.66	90	98.02	96.61	24.89	49.88	81.82	184.41	191.33	36.98	131.7	27.85
Phosphate, mg/kg	172.09	88.66	96.47	128.13	111.38	137.82	102.63	79.02	96.84	137.43	81.23	169.45	145.02	168.87
Cations														
Potassuim, mg/kg	993	1118	1068	1155	1006	1992	745	1164	1465	835	480.8	790.1	893	1852

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	EA EER SD 15	EA EER SD 16	EA EER SD 17	EA EER SD 18	EA EER SD 19	EA EER SD 20	EA EER SD 21	EA EER SD 22	EA EER SD 25	EA EER SD 26	EA EER SD 27	EA EER SD Ctrl 1	EA EER SD Ctrl 3	EA EER SD Ctrl 4
	Calcium, mg/kg	2147	1252	1273	1886	1163	1057	1197	1163	1145	2276	2463	1404	1478
Magnesium, mg/kg	1782	1180	1093	1440	1033	695	447	1022	620	1350	628.9	1327	1321	1324
Organics														
Total Petroleum Hydrocarbon, mg/kg	3.68	4.3	0.17	0.64	1.23	<0.001	0.884	<0.001	<0.001	0.25	1.38	<0.001	<0.001	<0.001
Polycyclic Aromatic Hydrocarbon (PAH), mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BTEX, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heavy Metals														
Cadmium, mg/kg	1.84	7.3	2.82	6.49	0.81	3.5	3.01	6.37	2.78	3.07	6.68	3.33	5.79	3.55
Zinc, mg/kg	51.07	45.94	21.24	38.37	19.65	87.12	51.73	40.44	21.57	47.69	29.54	30.72	24.76	13.07
Total iron, mg/kg	1607	1940	1908	1442	1819	1796	1817	1898	1710	1747	1299	1093	1150	1905
Copper, mg/kg	9.54	9.06	8	8.87	7.92	15.33	9.25	8.19	7.29	10.28	10.71	12.5	8.05	8.11
Chromium, mg/kg	29.28	27.48	19.8	25.01	27.91	29.66	24.17	20.28	25.57	32.69	43.2	28.59	24.4	23.13
Nickel, mg/kg	<0.002	16.55	23.27	42.37	17.25	35.88	9.96	25.41	12.67	28.96	27.17	38.89	33.63	56.26
Lead, mg/kg	51.85	41.51	45.82	39.01	46.45	39.17	46.43	27.02	49.05	29.6	39.96	33.31	28.49	27.61
Vanadium, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

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	EA EER SD 15	EA EER SD 16	EA EER SD 17	EA EER SD 18	EA EER SD 19	EA EER SD 20	EA EER SD 21	EA EER SD 22	EA EER SD 25	EA EER SD 26	EA EER SD 27	EA EER SD Ctrl 1	EA EER SD Ctrl 3	EA EER SD Ctrl 4
	Barium, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, mg/kg	0.84	0.41	1.12	1.22	0.64	0.61	0.49	0.11	0.42	0.42	0.29	0.24	0.22	0.36
Mercury, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Microbiology														
Hydrocarbon degrading bacteria, x10 ² Cfu/g	2.17	1.35	1.51	0.79	0.91	Nil	1.02	Nil	Nil	1.66	6.82	Nil	Nil	Nil
Hydrocarbon degrading fungi, x10 ² Cfu/g	Nil	0.73	0.47	0.77	0.63	Nil	0.69	Nil	Nil	0.7	2.1	Nil	Nil	Nil
Total Heterotrophic Bacteria, x10 ⁴ Cfu/g	1.68	1.33	1.79	1.27	1.46	1.18	1.28	1.21	1.74	1.09	1.17	1.88	1.59	2.01
Total Heterotrophic Fungi, x10 ⁴ Cfu/g	1.65	1.29	1.38	1.2	1.5	1.2	1.3	1.18	1.66	1.07	1	1.76	1.54	2

APPENDIX 4.3

**EA/EJA FIELDS FURTHER OIL DEVELOPMENT (FOD) SCOPING WORKSHOP
PROCEEDINGS**



**Shell Petroleum Development Company of Nigeria (SPDC) Limited
EA FOD SCOPING WORKSHOP**

VENUE : MATHO-CRYSTAL HOTEL YENAGOA DATE : SEPTEMBER 5, 2013	PROCEEDINGS OF THE EA FOD SCOPING WORKSHOP	
ATTENDANCE	EXTERNAL STAKEHOLDERS 1. EA neighboring Communities 2. Regulators & Govts (DPR, FMENV, NIWA, SMENV,LGA) 3. NGOs SPDC 4. Community Relations Team inclu. CLOs 5. Impact Assessment Team 6. EA Project Team Please see attendance list below	
MINUTES		
<p><u>Introduction</u> The workshop commenced at about 0955hrs with the accreditation of representatives of various stakeholders in attendance.</p> <p>Richard Michael declared the workshop open at 1035hrs by stating the ground rules and HSE briefings. This was followed with the introduction of the various community representatives and the regulators. Some observers were also present (refer to attendance list for full details of the communities and regulators).</p> <p>The representative of the Minister for environment queried why there is no ‘high table arrangement’ for the event. Clarification was made on this and thereafter came suits of presentations.</p> <p>(i) Importance of scoping: Peter Claver (rep. Head, Impact Assessment) made a presentation on above highlighting what impact assessment is, impact assessment partnerships, scoping - objective and importance, key stakeholders including EA neighboring communities.</p> <p>(ii) EA FOD The Engineering Design lead for the EA/Eja FOD (Oghenethoja Umuteme) made a technical presentation on the present status of the EA/Eja field and the proposed further oil development..</p> <p>A few questions hat emanated from the technical presentation were addressed.</p> <p>TEA BREAK : 1105hrs to 1123hrs</p> <p>(iii) Impact Assessment scope and methodology: Presentations were made to the audience on the impact assessment scope and methodologies for carrying out the studies by:</p> <ul style="list-style-type: none"> • Richard Michael (Biophysical Impact Assessment), • Godswill Bornu (Health Impact Assessment) and 		

<ul style="list-style-type: none"> • Prof Ike Nwachukwu (Social Impact Assessment). <p>Questions also followed the presentation which were also addressed.</p>	
<p>(iv) Impact Identification: The section provided opportunity for stakeholders to participate in the identification of likely envisaged project impacts based on the suits of presentations made. A listing of anticipated impacts and comments is articulated and attached below for incorporation/consideration during impact assessment and management/mitigation plans.</p>	
<p>(v) Closing: The audience was full of life and urged SPDC to do better by providing basic infrastructures and employment for the youths of the host communities.</p> <p>The workshop ended at about 1610hrs</p>	
<p>LUNCH BREAK: 1600hrs</p>	



scoping wkshop
attendance list.pdf



Pix.docx



EA Workshop
Comments.docx

APPENDIX 4.4
EA/EJA FIELD WASTE MANAGEMENT PLAN



**The Shell Petroleum Development Company
of Nigeria Limited**
Operator for the NNPC/Shell/Agip/Elf Joint Venture

EA FIELD WASTE MANAGEMENT PLAN

Version 4.0

OD-SA03-003

March 2014


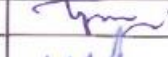


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Version	Date	Pages	Reason
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Version 2.2	August 2009	All	Review
Version 3.0	August 2011	All	Review
Version 4.0	March 2014	All	Reviewed to align with the SEPCIN Waste Mgt. Guide

1.1 Ownership and Authorship

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Reviewed by	Chidi Madufor / Adedeji Adetuyi	UIO/G/POS UIO/G/SHPO		25/03/2014
Authorised by	Akintunde Atanda	UIO/G/POS		25/03/14

1.2 Review and Update

This document shall be subject to 24-monthly review and update.

However, the document control system allows for continuous update of this document. As such, any user may at any time identify an error or suggest an improvement using an amendment Proposal which is available on the SPDC Livelink or from the Document Control Center (DCC) Supervisor.

All holders of this document are registered so that they can be sent updates and be kept informed of changes or reviews.

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ACRONYMS AND DEFINITIONS

DPR	Department of Petroleum Resources
EGASPIN	DPR Environmental Guidelines and Standards for the Petroleum Industry in Nigeria
EIA	Environmental impact assessment
EP	Exploration and production
FEPA	Federal Environmental Protection Agency (now FMENV)
FMENV	Federal Ministry of the Environment
FPSO	Floating, production, storage and offloading vessel
FSV	Field support/standby vessel (infield)
IA	Industrial area
IWMF	Integrated waste management facility
LSA	Low specific activity
MSDS	Material safety data sheet
NORM	Naturally occurring radioactive material
NNPC	Nigerian National Petroleum Company
OD	Offshore Division
ODZ	Offshore discharge zone defined in DPR EGASPIN 2002 as <i>the offshore area 12 nautical miles away from the shoreline and of water depth greater or equal to 200 feet where regulated discharges are allowed.</i>
OU	Operational unit
PPE	Personal protection equipment
RPS	Radiation Protection Specialist
RWD	Recyclable Waste Depot (Shell IA, Port Harcourt)
SHOC	Safe handling of chemicals
SNEPCO	Shell Nigeria Exploration and Production Company Ltd
SPDC	Shell Petroleum Development Company of Nigeria Ltd
SV	Security vessel (infield)
TDU	Thermal desorption unit
WCN	Waste consignment note

1 INTRODUCTION

The purpose of this EA Waste Management Plan is to ensure that all waste streams generated by onshore and offshore assets are managed in accordance with SPDC HSE Policy. The plan is based on the SPDC HSE Procedure for Waste Management (ref. 1) and Shell Group Guidelines for Waste; (ref. 2) and (ref. 3).

It describes the practical requirements needed to undertake waste management in the EA Asset and sets out tasks and responsibilities for appropriate storage, segregation, disposal and tracking methods for wastes generated by EA operations.

1.1 Scope

The EA Field covers the floating, storage, production and offloading (FPSO) vessel, soft yoke mooring platform (SYMP), drilling platforms A, B and J (DP-A, DP-B, DP-J), riser platform A (RP-A) and the permanent infield field support/standby vessel (FSV). The permanent infield security vessel (SV) currently manages its waste under its own waste management plan. This is currently under review with a plan to broaden the scope of the EA Waste Management Plan to include the security vessel.

1.2 Objectives of the SPDC Waste Management as per the HSE Control Framework

- To assume that EA Field has an adopted Control Framework in place for managing waste from cradle to grave. Meaning EA Field has adopted a "Duty of Care" by planning waste management activities.
- To provide a framework to control the risks associated with the management of wastes in EA Field ensuring continuous operational excellence.
- To enable the disposal of waste in a cost effective and environmentally acceptable manner, with the ultimate objective of minimizing the impact on the environment and avoiding future liabilities, as well as the health and safety of individuals at all stages of waste management process. For each asset/ facility to set out a site/ location specific waste management plan, to show how waste is managed (and tracked as it is transferred to others) at each stage of its life from generation to final disposal.
- To provide an enabling environment to comply with applicable statutory regulations, international treaties and conventions Nigeria is signatory to and the Group HSSE & SP Control Framework. And in the event of inquiries by regulatory authorities, EA Field would be able to demonstrate through consistent waste management practices and the retention of information, that a "Duty of care" was followed.
- To provide staff and contractors with a comprehensive reference source and an understanding of their roles in waste management.

2 WASTE DEFINITION, CLASSIFICATION AND HIERARCHY

2.1 Definitions

Waste is defined as:

- Any unavoidable material resulting from EA operations for which there is no immediate economic demand by the generator and which must be disposed of
- An unwanted product which must be managed from 'cradle to grave'

- An unwanted material that must be managed as a finished product.

2.2 The Waste Hierarchy

The increasing costs of waste disposal, together with increasing costs of raw materials and more stringent legislation, act as a stimulus to finding methods for decreasing quantities of waste arising from EA operations.

The waste hierarchy shows the principles of waste management, i.e.:

- Prevention e.g. elimination or reduction in operation practices
- Source reduction, e.g. adoption of efficient practices
- Reuse materials e.g. containers
- Recycle/recover e.g. conversion to usable material
- Treatment, e.g. detoxification, destruction, etc.
- Responsible disposal e.g. landfill.

2.2.1 The Five R's

If elimination of a waste is not possible through plant, equipment and facilities design, then ways of minimising the amount of waste generated should be investigated. Responsible waste management may be accomplished through hierarchical application of the practices of Remove, Reduce, Reuse, Recycle and finally Residue treatment and disposal. These terms are defined as follows.

2.2.1.1 Remove : *Removing waste means prevention or avoidance of waste generation. This may be achieved through equipment or technology modification, process or procedure modifications, reformulation or redesign of products.*

2.2.1.2 Reduce : *This is known as "reduction at source". Source reduction occurs prior to reuse, recycle, treatment or disposal as a result of raw material optimization, and improvements in housekeeping, maintenance, training or inventory control. Source reduction is often the most cost effective way to manage waste.*

2.2.1.3 Reuse : *The re-use of materials in their original form such as Chemical containers.*

2.2.1.4 Recycling / Recovery : *This is the conversion of wastes into usable materials and /or extraction of energy or materials from waste. Recycling opportunities exist in EA field for used oil, scrap metal, food, paper, glass and plastics. Other examples of recycling opportunities include*

- Re-conditioning drilling mud and solvents
- Using oily waste for road construction and stabilization
- Using cleaned drill cuttings and crushed clean concrete for road construction material and hard standing.
- Recovering oil from tank bottoms.

2.2.1.5 Residue Treatment

The destruction, detoxification and/or neutralisation of residues through processes such as:

- Biological methods; composting, Land farming, Biodegradation, Extended aeration, Activated sludge process.
- Thermal methods; Incineration, Thermal desorption, Evaporation.
- Chemical methods; Neutralisation, Stabilisation, Fixation
- Physical methods; Filtration, Centrifugation, compaction or Shredding.

2.2.2 Disposal

Depositing wastes on land or in water using methods appropriate for a given situation. Disposal methods include:

- Landfill
- Burial
- Surface discharge
- Land spreading or land farming
- Underground injection.

2.3 Waste Hazard Identification, Characterization and Classification

In order to avoid the risks associated with handling and disposal of hazardous waste, all hazards associated with each identified waste stream must be identified and appropriate mitigation measures put in place before wastes are collected, stored, transported or disposed. Once a waste stream has been identified, the properties of the waste stream shall be analysed to enable a sound classification of waste type into a compatible group. Wastes shall be classified into Hazardous and Non-Hazardous wastes categories

- Priority shall be given to identifying properties, which render a waste Hazardous e.g explosive, oxidizing, highly flammable, corrosive, toxic to humans, radioactive, harmful to the environment (ecotoxic).
- An unknown waste should be regarded as Hazardous until it is characterized and classified otherwise. No attempt should be made to dispose an unknown waste stream until it is clearly characterised and all regulatory implications of its disposal are understood.
- Note that a mixture of Non Hazardous waste and Hazardous waste should be classified as Hazardous brings with it the associated additional difficulties /costs of handling and disposal.

Examples of expected wastes from each category (domestic, office, industrial and hazardous) are shown in Table 1.



Table 1: Expected waste streams by category

2.4 Appendix 2: SEPCIN Waste Categories and Their Approved Disposal Routes

S/No.	Waste Name	Category	Major Source	Approved Disposal Options													
				Recycle			Treatment				Disposal						
				Reuse/recycle	Use as fuel	Composting	Return to Supplier	Incineration	Chemical Conversion	Evaporation	Waste Water System	Land treatment	Solidification/Stabilisation	Thermal Desorption Unit (TDU)	Inject to subsurface	Discharge to surface	Land fill
1.	Absorbents(Include Contaminated Polyethylene & Jute Sacs)	Hazardous	Oil spill response, production/ maintenance														
2.	Air Filters	Non-Hazardous	Maintenance/workshop; transportation														
3.	Asbestos	Hazardous	Infrastructure(Renovation of buildings)														
4.	Ashes	Non-Hazardous	Waste Incineration														
5.	Batteries (dry & wet)	Hazardous	Maintenance/workshop; transportation														
6.	Cables	Non-Hazardous	Electrical/telecoms Maintenance														
7.	Cans and Tins	Non-Hazardous	Catering services														
8.	Cartons	Non-Hazardous	Logistics warehouse/ FLBs														
9.	Ceramics	Non-Hazardous	Infrastructure														
10.	Construction and Demolition Debris	Non-Hazardous	Infrastructure														
11.	Contaminated Soil (Oil & Chemical)	Hazardous	Oil Spills														
12.	Electric Bulbs	Non-Hazardous	Infrastructure														
13.	Fan Belts	Non-Hazardous	Maintenance/workshop														
14.	Fluorescent Tubes/ Bulbs	Hazardous	Infrastructure														
15.	Food Waste	Non-Hazardous	Catering														
16.	Furniture Waste	Non-Hazardous	Infrastructure maintenance														
17.	Garbage	Non-Hazardous	Office/Domestic														
18.	Garden Waste	Non-Hazardous	Domestic/Industrial gardening														
19.	Glass Waste	Non-Hazardous	Catering														
20.	Grit (Blasting)	Non-Hazardous	Tank Maintenance/ Rehabilitation														
21.	Medical Waste	Hazardous	Hospitals/Clinics														
22.	Oil & Fuel Filters	Hazardous	Maintenance/workshop; transportation														
23.	Oil-Rags	Hazardous	Maintenance/workshop														
24.	Oil Sludge/Tank Bottoms	Hazardous	Production operations, Tank farms/Terminals)														
25.	Packaging Materials	Non-Hazardous	Logistics Warehouse/ FLBs														

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	Waste Name	Category	Major Source	Approved Disposal Options													
				Reuse/recycle	Use as fuel	Composting	Return to Supplier	Incineration	Chemical Conversion	Evaporation	Waste Water System	Land treatment	Solidification/Stabilisation	Thermal desorption (TDU)	Inject to subsurface	Discharge to surface	Land fill
26	Paper Waste	Non-Hazardous	Office operations	●													
26	Pigging Waste	Hazardous	Pipelines operations										●				
27	Plastics (include Drums)	Non-Hazardous	Office operations	●													
28	Printer Cartridges and Toner	Hazardous	Office operations	●													
29	SEMI Cuttings	Hazardous	Drilling operations										●				
30	Scrap Metals (include Drums)	Non-Hazardous	Drilling, Pipelines, operations maintenance	●													
31	Sewage	Hazardous	Domestic/office								●						
32	Spent / Obsolete Chemicals	Hazardous	Production operations, Drilling	●		●	●				●						
33	Spent Chemicals Containers	Hazardous	Production operations, Drilling														
34	Spent Lube Oil	Hazardous	Production Maintenance, Land Logistics operations(Maintenance)	●			●										
35	Tyres and Tubes	Non-Hazardous	Land Logistics operations(Maintenance)	●													
36	Water Filters	Non-Hazardous	Office/ domestic	●													●
37	WBM Cuttings	Non-Hazardous	Drilling operations										●				
38	WBM(Water Based Mud)	Non-Hazardous	Drilling operations	●									●		●		
39	WEEE	Hazardous	Office operations	●													
40	Work Over/ Completion Fluids	Non-Hazardous	Drilling operations										●				

 Most Acceptable Option
 Acceptable Option

2.4.1 Hazardous Waste

Hazardous waste is also known as 'special waste', 'toxic waste' and 'chemical waste'. The term hazardous waste is used because it is generally understood within Shell Operating companies and is used in Shell Group documents.

Hazardous waste is defined as...

'any gaseous, liquid or solid waste, which because of its quantity, physical, chemical or infectious characteristics can result in hazards to human health or the environment when improperly handled, stored, transported, treated or disposed'.

Handling, storage and transportation of hazardous wastes are covered in Section 5.3.

3 WASTE SEGREGATION

Segregation and characterisation of waste is required to determine similar wastes that can be combined to simplify storage, transportation, treatment, recycling and/or disposal. Waste segregation is established and maintained on the FPSO through the provision of labelled bins and skips.

Waste is quantified under each individual waste stream and per category to enable waste reduction targets to be set for specific areas. Table 1 listed the expected waste streams generated by EA per category.

There are labelled skips on the Production Deck; one each for metals, paper/packaging, wood, plastics and air/oil/fuel filters; and a plastic drum to store spent fluorescent tubes – all located in the starboard aft crane laydown area. A covered skip (without drainage holes) for oil-contaminated waste has been ordered to improve the storage and transport of these materials. The skips are backloaded directly onto supply vessels for transportation to Onne Port.

Waste from specific areas is collated separately to enable quantification of the different categories of waste, e.g. domestic and industrial plastics are quantified separately. This facilitates setting of waste minimisation targets for specific areas.

All compactor bags used for storing and transferring waste are approved lifting bags. Non-rated bags used for storage of waste are transferred to the Production Deck skips using a lifting belt.

3.1 Galley Area

Wastes from the Galley are stored in labelled compactor bags on the aft C-Deck prior to backload to supply vessels unless otherwise stated in the following sections.

3.1.1 Food

There are two labelled bins for collecting waste food within the galley for waste generated during food preparation and one labelled bin in the mess room by the galley hatch for plate scrapings. The majority of waste food is macerated and disposed overboard as slurry. The waste food bins are weighed and recorded on a weekly basis following each meal (both day and night shifts) prior to maceration and disposal overboard. The log (Appendix 1) is sent to the Waste Management Coordinator on a monthly basis (Section 7).

3.1.2 Cans and Tins

The galley contains one labelled bin for collecting waste cans and tins. When the bin is full, the cans and tins are transferred to the compactor bag labelled 'cans and tins' on the aft C-Deck.

3.1.3 Cartons/Packaging

There are two labelled bins for collecting waste cartons, one within the galley and one in the mess room by the drinks fridge. When the bins are full, the cartons are compacted with other packaging wastes in the Galley compactor and stored in compactor bags on the aft C-Deck.

3.1.4 Glass

The galley contains one labelled bin for collecting waste glass. When the bin is full, the glass is transferred to the compactor bag labelled 'glass' on the aft C-Deck.

3.1.5 Plastics

There are two labelled bins for collecting waste plastics, one within the galley and one in the mess room by the drinks fridge. When the bins are full, the waste plastic is transferred to the compactor bag labelled 'plastics' on the aft C-Deck.

3.1.6 Aerosols

Spent aerosols are stored in a labelled bucket in the Steward's cleaning lockers. When the bin is full it is taken to the aft machinery space (AMS), Deck 3, Main Stores for storage awaiting backload.

3.1.7 Paper

Galley paper is compacted alongside other accommodation paper (Section 4.2.3) and stored in a compactor bag on the aft C-Deck.

3.2 Office/Accommodation Areas

3.2.1 Glass

Waste glass from the office/accommodation areas is collected in the compactor bag with galley waste glass (as Section 4.1.4).

3.2.2 Plastics

Waste plastic from the office/accommodation areas is stored alongside galley waste plastic (as Section 4.1.5).

3.2.3 Paper and Packaging

Paper/packaging (predominantly paper) from the offices is weighed prior to compacting and the weight logged against the date as 'office paper'. All other paper/packaging from the accommodation area/Galley (domestic waste, mainly packaging waste) is compacted. Therefore, office paper, domestic paper and domestic packaging are quantified separately. Compactor bags are stored on the aft C-Deck.

3.2.4 Aerosols

Spent aerosols are stored in a labelled bucket in the Steward's cleaning lockers. When the bin is full it is taken to the aft machinery space (AMS), Deck 3, Main Stores for storage awaiting backload.

3.2.5 Spent Batteries

There is a collection bin in the mess room (C-Deck) for spent batteries. When full, this is transferred to the AMS Main Store (Deck 3) for storage prior to disposal.

3.2.6 Fluorescent Tubes

Spent fluorescent tubes are taken to the labelled plastic bin on AMS Deck 3.

3.2.7 IT Wastes

IT wastes, e.g. toners, cartridges and computer-related materials are collected for recycling in the Telecoms Room, F-Deck.

3.2.8 Medical Waste

There are plastic medical sharps bins in the HOSPITAL, labelled 'SHARPSAFE DANGER contaminated sharps destroy by incineration' for medical wastes, e.g. needles, used dressings, biological samples, waste prescription drugs and all potentially pathogenic material

The bins have a hazardous warning sign on them. Once full, these are sealed and taken to the AMS Main Store, Deck 3. The Medic completes the 'Medical Waste' form (Appendix 2) and sends this with the sealed bin.

3.2.9 Sharps

There are wall mounted sharps bins on E- and F-Decks to collect used razors and razor blades. Once full, these are sealed and taken to the AMS Main Store, Deck 3.

3.2.10 Sewage Sludge

Sewage onboard the FPSO is treated in the sewage treatment plant on AMS Deck 4 prior to being pumped overboard as a slurry.

3.3 Aft Machinery Space

3.3.1 Aerosols

Spent aerosols are stored in the Deck 3 Main Store..

3.3.2 Spent Batteries

Spent batteries are taken to the Deck 3 Main Store.

3.3.3 Fluorescent Tubes

Spent fluorescent tubes are stored on Deck 3 in a labelled plastic bin.

3.3.4 Scrap Metal

There is a labelled drum for scrap metal in the mechanical workshop on Deck 3.

3.3.5 Oily Rags

There is a labelled blue plastic drum on each deck within the AMS for oily rags. If rags are saturated with oil, see Section 4.3.7.

3.3.6 Oil/Air/Fuel Filters

There is a labelled blue plastic drum on each deck within the AMS for oil/air and fuel filters.

3.3.7 Oil-contaminated Materials

Materials that are saturated with, or badly contaminated with oil, are taken to the sealed skip at the Production Deck starboard aft crane laydown area for adequate containment prior to backload.

3.4 Laboratory

3.4.1 Glass

The laboratory has a labelled box for broken and waste glass.

3.4.2 Spent Solvents

Waste solvents from the laboratory are separated into 3 containers. There is a drum for chlorinated solvent waste (labelled 'crude oil and chlorinated solvents only'), one for non-chlorinated solvent waste ('crude oil and non-chlorinated solvent only') and a third for oily waste only ('crude oil only'). The drums of chlorinated and non-chlorinated solvents are backloaded as hazardous wastes and sent for incineration. The oily waste is emptied into the hazardous drains system (routed to the port (dirty) slops tank). The waste solvent drums are labelled as hazardous waste.

The waste solvents are shipped with a completed copy of EGASPIN Appendix VIII-C2, *Waste Material Data Sheet*. An electronic copy is completed by the Laboratory Technician and handed to the Senior Materials Controller when the drums are full (Appendix 3).

A log of all oil/solvent wastes generated is kept in the laboratory.

3.4.3 Oily Rags

There is a metal bin for collecting oily rags. Once full, this is transferred to the oily rags drum on the Production Deck.

3.5 Production and Upper Decks

3.5.1 Plastics

Waste plastic is stored in the plastic skip on the Production Deck starboard aft crane laydown area.

3.5.2 Paper and Packaging

Waste paper/packaging is stored in the paper/packaging skip on the Production Deck starboard aft crane laydown area.

3.5.3 Fluorescent Tubes

Spent fluorescent tubes are stored in the plastic drum on the Production Deck starboard aft crane laydown area.

3.5.4 Scrap Metal

Waste metal is stored in the metal skip on the Production Deck starboard aft crane laydown area.

3.5.5 Oily Rags

There are blue plastic drums labelled 'oily rags only', one at each of the aft and forward ends of the deck. The Upper Deck has one labelled blue plastic drum at the forward end.

3.5.6 Oil Filters

There are blue plastic drums labelled 'oil filters only', one at each of the aft and forward ends of the deck (adjacent to the 'oily rags only' drums). The Upper Deck has one labelled blue plastic drum located amidships.

3.5.7 Oil/Air/Fuel Filters

The skip on the Production Deck contains waste oil, air and fuel filters. Fuel and oil filters are packaged and placed into the skip.

3.5.8 Oily Sand/Sludge

Oil sand/sludge is sampled and bagged for disposal onshore. Oily sands/sludges are subject to monitoring requirements under EGASPIN (ref. 4) as stated in the EA Environmental Monitoring Plan (ref. 5).

3.5.9 Oil-contaminated Materials

Materials that are saturated with, or badly contaminated with oil, are taken to the sealed skip at the Production Deck starboard aft crane laydown area for adequate containment prior to backload.

3.5.10 Waste Industrial Oils

Spent lubricant, hydraulic or pneumatic oils are disposed off into the port slops tanks (approximately 1m³ per month), from where oil is skimmed off and routed back into the process.

3.6 Infield Vessel Waste

The infield standby/support vessel (FSV) is permanently in the EA Field and as such their waste management falls under this plan. The infield waste consignment note (WCN) is completed for segregated waste backloaded to the Sea Eagle, recorded as being accepted and then treated as per Sea Eagle waste for backload to Onne Port (Section 6.2 and Appendix 4).

The FSV stores oily wastewater (bilge water) in a tote tank (2m³), which is backloaded to the FPSO and decanted into the hazardous drains system (this drains into the port slops tank). The volume of oily wastewater is recorded and monitored as part of the overboard discharges from the Sea Eagle (ref. 5).

4 ROLES AND RESPONSIBILITIES

4.1 Roles and Responsibilities

All personnel are responsible for ensuring that waste disposal activities undertaken in each area of responsibility are compliant with this waste management plan.

Care must be taken when handling wastes and appropriate personal protection equipment (PPE) and manual handling equipment, e.g. for transfer of waste to Production Deck skips, must be used where necessary.

Table 2 details the roles and responsibilities for EA personnel. An overview of waste management is explained as part of the induction process and it is mandatory that all personnel attend the EA Waste Management Plan Awareness workshop.

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Table 2: Roles and Responsibilities for EA Field Personnel

Responsible Party/ Shell Extension	Responsibility/Action
All personnel	Ensure that all waste disposal activities carried out in their area (s) of responsibility are compliant with this plan.
Marine Safety Supervisor (53319)	Ensure that communication of specific waste management issues is undertaken, via use of HSE notice boards, toolbox talks and safety meetings.
	Ensure all staff, contractors and inspectors have access to this procedure and that it is regularly audited for compliance.
	Overall responsibility for waste management and waste segregation onboard FPSO.
	Review this EA Waste Management Plan and ensure that it is comprehensive and up to date.
Marine Supervisor (53319) /Contract Holders	Ensure that all contractors and sub-contractors are compliant with this plan.
Waste Management Co-ordinator (29895)	Act as onshore focal point for waste management within SEPCiN.
	Set annual targets for waste reduction.
	Maintain a log of individual waste types/categories backloaded to shore.
	Ensure Medic and Laboratory personnel are aware of the hazardous nature of their wastes and that they inform the Senior Materials Controller when wastes need to be backloaded.
	Ensure that the waste from EA operations is being managed in accordance with this EA Waste Management Plan..
Trainer (53321)	Ensure that all personnel have undergone SPDC waste management/safe handling of chemicals (SHOC) training courses and the EA waste management plan awareness workshop
	Run the EA Waste Management Plan Awareness Workshops for all personnel on the Sea Eagle, FSV and those based at Onne Port (including the Waste Transportation Contractor (WTC)).
	Ensure periodic review and update of this procedure – with input from the Senior Materials Controller, Marine Safety Supervisor and Environmental Advisor.
	Ensure that reporting of waste is undertaken as per Section 7.

Responsible Party/ Shell Extension	Responsibility/Action
	Undertake regular audits of the EA Waste Management Plan.
Senior Materials Controller (53470/53371)	Act as offshore focal point for waste management within SPDC and liaise with the onshore Waste Management Co-ordinator and HSE Advisor as directed by this plan.
	Ensure that waste storage areas are compliant with this procedure and all containers and collection areas are clearly labelled.
	Ensure that all waste for backload is secure and labelled appropriately – pay particular attention to hazardous waste consignments.
	Ensure that any deficiencies in compliance with this plan or with the activities in operation are sent to the Waste Management Co-ordinator and Marine Supervisor.
	Ensure that all hazardous waste is packed securely and is clearly labelled prior to backload.
	Ensure that all hazardous waste is accompanied by the applicable hazardous waste data sheets; e.g. for waste solvents Appendix 3 is completed by the Laboratory Technician, for medical waste, Appendix 2 is completed by the Medic. Complete the Dangerous Goods form when backloading hazardous wastes, Appendix 5.
	Ensure that the WCN (Appendix 6) is accurately completed (Section 1) and attached to the Shipping Manifest prior for transportation to Onne Port. File yellow copies of all WCNs in the WCN file.
	Ensure that the FSV submits its waste to the FPSO (for backload to shore) with the infield waste consignment note. Sign the infield WCN as proof of receipt.
	Complete an SPDC WCN (Appendix 6) for the infield vessel waste and attach the signed infield WCN to the yellow copy of the WCN and file. Waste from the FPSO and infield vessels can be mixed on the same WCN only if the wastes are to be transported to the same final destination.
	Ensure that all accompanying forms (from the Medic, Laboratory, FSV, etc) are filed alongside the appropriate yellow copy of the WCN.
	Ensure that the FPSO has sufficient WCNs and waste collection containers. Order supplies when necessary (contact the Waste Management Co-ordinator for WCNs).
	Maintain the offshore wastes database and submit a copy to the Waste Management Co-ordinator at the beginning of each new month (see also Section 7.2).
Deck Foreman	Responsible for collection of waste from the AMS containers/Production and Upper Deck drums to the Production Deck skips.
	Ensure that all skips/containers holding waste are adequately packed and secure prior to backload. Inspect for non-complying items that have been packed into the skip/container.
	Ensure that all waste containers are clearly labelled. Replace labels when appropriate.

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Responsible Party/ Shell Extension	Responsibility/Action
Medic (53359)	Ensure that all medical wastes, e.g. syringes, needles, swabs/ cotton wool contaminated with blood/urine, etc. are packaged in the provided medical waste drums. Inform the Senior Materials Controller when the drum is full and ready for backload onshore (complete the Medical Waste Data Sheet (Appendix 2)).
Laboratory Technician (53442)	Ensure that the solvent waste drums are kept labelled for 'chlorinated solvent waste', ' non-chlorinated solvent waste' and 'oily waste (no solvent)'.
	Maintain the laboratory database for waste solvents handed over to materials for backload to shore (including volumes of 'crude oil only' waste disposed to the hazardous drains system).
	Contact the Senior Materials Controller when the drums are full and complete and submit the EGASPIN waste material data sheets (Appendix 3) to the Senior Materials Controller.
Camp Boss (53328)	Ensure that waste food is weighed on a weekly prior to being macerated – record this on the weekly log (Appendix 1). Submit the log to the HSE Co-ordinator on a monthly basis (see also Section 7.2).
	Ensure that all waste containers and compactor bags in the galley, mess room and the aft C-Deck are clearly labelled.
	Ensure that waste cooking oil is stored and taken back to the catering contractor's head office, when full.
	Ensure that all domestic paper is weighed prior to being compacted and mixed with domestic paper/packaging. Maintain the database for weights and submit to the HSE Co-ordinator on a monthly basis.
	Ensure that the sharps waste from D- and E-Decks are treated as hazardous waste and transferred to the AMS, Deck 3, main Store when full (ensure bins are sealed prior to moving).
Radiation Safety officer (RSO)	Measure and handle all NORM-contaminated material for operations personnel and on behalf of the Senior Materials Controller.
	Ensure that the radiation detection instrument is calibrated as per Manufacturer's recommendation.
	Where produced sand/sludge exceeds the levels set by DPR (Section 6.3.1) undertake the removal and packaging of a sample of produced sand/sludge.
Infield vessel (FSV)	Ensure that waste is segregated in accordance with this EA Waste Management Plan.
	Complete the infield WCN and send it to the FPSO with segregated waste (applicable to all wastes, including oily wastewater).

Responsible Party/ Shell Extension	Responsibility/Action
Onne Port Supervisor/Expeditior (21322, 21321, 21327)	Ensure safe removal of waste from supply vessel at Onne Port and into appropriate storage area (if necessary) awaiting removal by the WTC.
	Once waste is received from offshore, complete Section 2 of the WCN to state that the waste has been received at Onne Port.
	Ensure that the WTC completes Section 3 of the WCN prior to departure from Onne Port with the waste and is aware of the destination of the waste. File pink copy of the WCN.
	Ensure the blue copy of the WCN is returned by the WTC. File the complete signed blue copy of the WCN with the pink copy. This provides an audit trail for disposal of the waste.
	Check the WCN file on a weekly basis to ensure that all blue WCNs have been received from the WTC. Contact the WTC immediately if any WCNs are missing and notify the Waste Management Co-ordinator.
	If the WTC is experiencing problems with the end facility accepting the waste, contact the Waste Management Co-ordinator for confirmation of this re-direction. In all instances of doubt, ensure that the WTC returns the waste to Onne Port and await further instructions from the Waste Management Co-ordinator.
Waste Transportation Contractor (WTC)	For all waste generated at Onne Port, follow the instructions in Section 6.2.3 for completion of the WCN.
	Complete and sign Section 3 of the WCN to state that the waste was received at Onne Port (on behalf of the contractor) ready for transportation to the relevant waste management facility.
	Transport waste to the relevant waste management facility. Hand over the WCN to personnel at the site who will sign Section 4 of the WCN to state that they have received the waste. Ensure the blue copy of the WCN is returned to the Onne Port Supervisor/ Expeditior
	If there are problems with the end facility accepting the waste, contact the Onne Port Supervisor immediately and return the waste to Onne Port. Do not follow instructions issued by the end facility re-directing the waste, particularly to Eneka dumpsite. Obtain confirmation from the Onne Port Supervisor/Expeditior.

5 WASTE TRANSPORTATION AND DISPOSAL FACILITIES

EA waste originating from offshore and Onne Port is transported to SPDC Eastern Division waste management and disposal facilities or their approved contractors. Waste is segregated on the Sea Eagle and backloaded to Onne Port. All shipments of waste from the Sea Eagle to Onne Port must always be accompanied by the appropriate waste consignment note (WCN).

5.1 Eastern Division Facilities

Wastes are transported to waste management facilities in the Eastern Division depending on their nature. The WCN states where the waste should be transported for disposal (Table 3).

Many items for recycling are held at the Shell IA recyclable waste depot (RWD) prior to sending to third party contractors for recycling.

Table 3: Waste management facilities

Facility	Location	Status
Recyclable Waste Depot	Shell Industrial Area, Port Harcourt	Operational – materials held awaiting transport to third party contractors.
Comprehensive Remediation Technology Ltd (CRT)	Onne	Operational
Eneka Dumpsite	Eneka, Port Harcourt	Operational
Medical Incinerator	Shell Industrial Area, Port Harcourt	Awaiting final EIA approval from the Nigerian Government.

Table 4 is reproduced as a poster in the Main Store to aid the Senior Materials Controller in completing the WCNs as it shows the destination of the end facility for each specific type of waste. If there is any doubt concerning the destination, the Senior Materials Controller contacts the Waste Management Co-ordinator.

Table 4: Final destination facilities for individual waste streams

S/N	Waste Stream	Treatment Method	Final Destination
1	Domestic Waste		
1.1	Catering waste (non-biodegradable)	Incineration	CRT
1.2	Glass waste	Stockpiled for recycling	CRT/ IA
1.3	Paper waste	Stockpiled for recycling	CRT
1.4	Plastic waste	Stockpiled for recycling	CRT
1.5	Wood waste	Dumpsite	Eneka / CRT
2	Industrial/Hazardous Waste		
2.1	Batteries (Dry and Wet) (Haz 8)	Incineration	CRT
2.2	Scrap Metal (Tins/Cans)	Stockpiled for recycling	CRT
2.3	Fluorescent tubes, bulbs and fittings	Stockpiled for recycling	CRT
2.4	Waste Oil (bulk) (Haz 4) Oily sand/ sludge	Incineration	CRT
2.5	Oily waste (Haz 4) (rags, fuel filters, etc)	Incineration	CRT
2.6	Grit, Empty chem./ Oil drums and Bulk Hoses	Recycling / Incineration	CRT
2.7	Medical waste (Haz 6)	Incineration	CRT

Notes

**Food currently macerated and dumped overboard.*

*** Sewage treated onboard and currently discharged overboard.*

5.2 Waste Consignment Notes

For the EA Field, the Electronic Manifest System shall be used for waste tracking. The format and nomenclature of the manifest shall conform to SEPCiN WCN. A copy of the Manifest shall be sent electronically to the Receiver, HSE Focal Point and the Transport before the vessel sails. Once the waste arrives the receiving facility, the receiver shall verify the quantities on the manifest and print out the manifest, sign off, scan the signed copy and send to the originator at the Sea Eagle. The originator will send the waste data to the HSE Focal Point, who will collate for reporting in ENDAMS.

5.2.1 WCN from the FPSO

SPDC WCNs detail the waste to be backloaded to Onne Port for disposal onshore. It covers all types of waste but additional information is required for transportation and disposal of hazardous waste onshore (Section 6.3).

5.2.1.1 Originator – Sea Eagle (Senior Materials Controller)

Each SPDC WCN consists of 4 copies. The FPSO Senior Materials Controller, the ‘Originator’, completes Section 1 of the SPDC WCN. The shipping manifest reference number is added to the ‘remarks’ box on the SPDC WCN. The Senior Materials Controller then files the yellow copy of the WCN. A separate SPDC WCN is used for each end location of waste (Section 5.1) as a signature is required from each end facility.

Waste is packed according to its final end destination (as per Table 4) to permit ease of unloading and onward transportation.

5.2.1.2 Onne Port

Once the backload is received at Onne Port, the Onne Supervisor/Expeditior signs Section 2 of the WCN to state that the waste has been received from offshore.

5.2.1.3 Waste Transportation Contractor

The Waste Transportation Contractor (WTC) signs Section 3 of the WCN to state that the waste has been picked up from Onne Port for onward shipment to the relevant waste management facility. The pink copy of the WCN is filed at Onne Port once Section 3 has been signed by the WTC.

5.2.1.4 End Receiver of Waste

The WTC takes the waste to the relevant SPDC designated waste facility as marked on the WCN. Upon arrival at the facility, the person accepting the waste shipment on behalf of the facility signs Section 4 of the WCN. Only when this section has been signed is the blue copy of the WCN returned to the Onne Supervisor/Expeditior.

The process of completing each section of the WCN and retaining copies is summarised in Figure 1.

5.2.2 Waste from Field Standby/Support Vessel

An infield WCN (Appendix 4) is onboard the field standby/support vessel which details segregated waste to be backloaded to the FPSO. The Senior Materials Controller then signs and returns a copy of the infield WCN to provide proof of transfer. The Senior Materials Controller then fills in the SPDC WCN as Originator as per Section 6.2.1.1 and attaches a copy of the infield WCN to the yellow copy of the SPDC WCN to be filed.

5.2.3 Waste from Onne Port

Transportation of waste generated at Onne Port follows the same principle as detailed in Section 5.2.1. The Onne Supervisor, as Originator, completes and signs Section 1, Section 2 is crossed

through and the WTC signs Section 3. The yellow and pink copies of the WCN are stapled together and filed at Onne port.

Onward transportation of the waste follows Section 5.2.1.4.

The process of completing each section of the WCN and retaining copies is summarised in Figure 2.

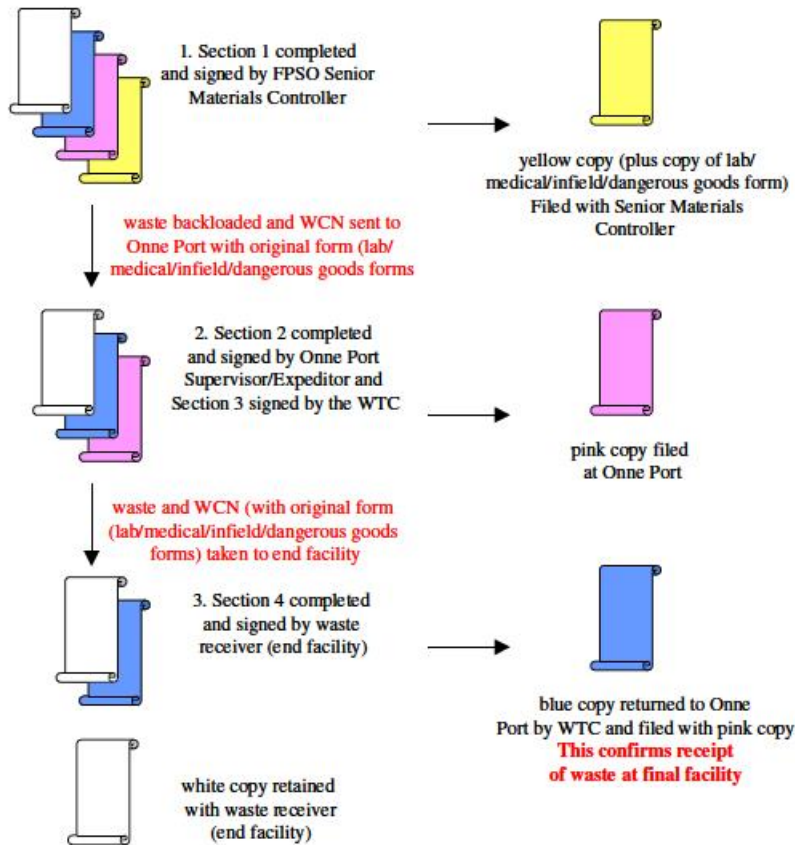


Figure 1: Summary of WCN completion and copy retention (Originator – Sea Eagle)

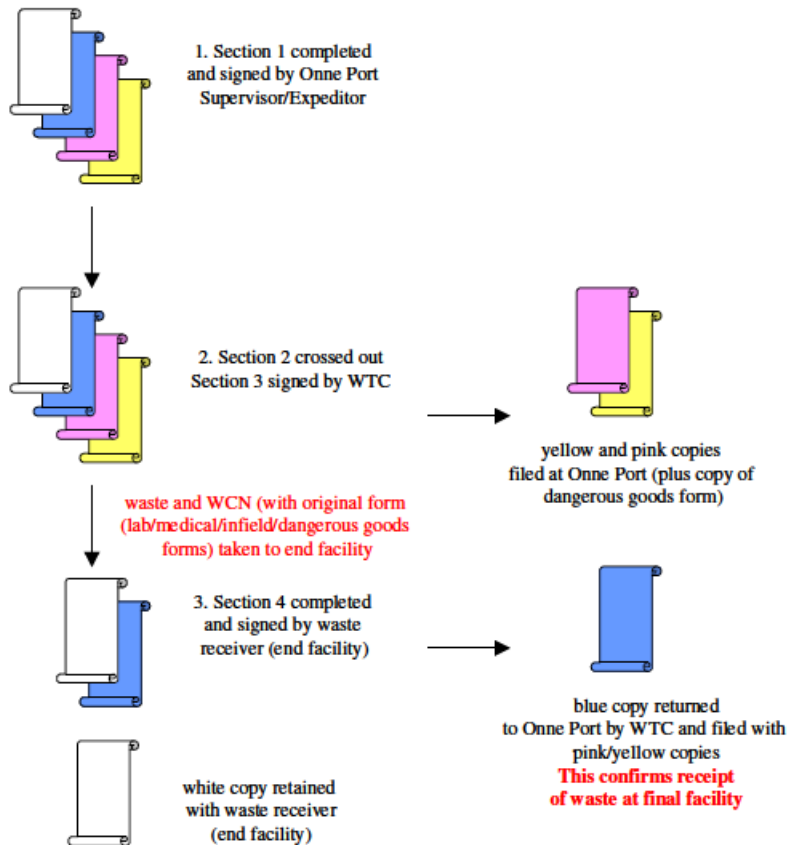


Figure 2: Summary of WCN completion and copy retention (Originator – Onne Port)

5.3 Hazardous Waste Transportation and Disposal

Under EGASPIN Part III, Section 4.0 *Chemical/Hazardous Wastes/LSA or NORM*, Section 4.1 states that *these materials and wastes shall be treated and disposed of in accordance with the provisions of Part VIII-C. Encapsulation in abandoned well bores and injection into depleted reservoirs on a case-by-case basis (as appropriate) shall be the preferred options.*

All transporters of hazardous waste must be registered with DPR. If there is a discharge of hazardous material or waste during shipment, the generator and transporter must take immediate action to:

- Protect human health and the environment
- Inform the DPR within 24 hours
- Activate the hazardous substance spill control measures plan
- The generator and transporter are responsible for cleaning up any discharge

All hazardous waste goes to an SPDC/DPR approved/licensed site and is backloaded to shore accompanied by a dangerous goods form (Appendix 5). The WTC is a DPR licensed transporter of all types of waste.

All waste is clearly labelled as hazardous waste for transportation onshore. Additional precautions required are detailed in the following sections. Radioactive wastes are treated as special categories of hazardous waste (Section 6.3.1).

5.3.1 Handling, Storage and Disposal of NORM-contaminated Material

Naturally occurring radioactive material (NORM) can be produced during vessel/tank and pipeline cleaning, desludging and change out activities. The radioactive elements and their daughter products, primarily radium-226 and radium-228 can be leached from geological formations by reservoir fluids and transported to the surface with produced water, oil and gas.

NORM has not been detected in EA operations to date and as such is unlikely to be present in the future. This section describes the procedure to determine the presence of NORM and subsequent action to handle and dispose of NORM-contaminated material.

NORM exists in at least two forms:

1. A heavy dense cement-like mixture of barium, strontium and radium sulphates. This material is precipitated in production tubing, the well tree and the flow lines. It tends to settle out in low parts of the line and in the gas-liquid and oil-water separators.
2. A carbonate/silicate material usually referred to as formation sand. These materials precipitate out in the process stream when there is a decrease in flow rate, change of direction and usually found in thick loosely consolidated lumps in the bottoms of tanks, separators, heater treaters and sumps.

Both types of NORM can be found in sand and sludge that accumulates at the bottom of oil tanks and vessels and in water treatment equipment, e.g. in filters used to clean produced water prior to discharge. Personnel directly involved with the handling and disposal of NORM-contaminated waste must be trained in the handling of NORM.

The radiation detection instrument should measure gamma radiation and be capable of measuring 1 micro-roentgen per hour, and shall be calibrated at intervals not exceeding 12 months.

Background radiation is to be measured prior to measurements being taken of the produced sand/sludge. Levels of gamma radiation on the sand/sludge are to be measured prior to the sand/sludge being removed from the vessel **if at all possible**.

If radiation is present at levels of 50 micro rems/hr above background concentrations or 30pci/gm (specific activity) notify the HSE Advisor immediately.

Transfer the sand/sludge into a metal drum and take a grab sample of the sand/sludge (approx. 2kg) and seal into a glass jar. The sample is to be securely packaged, labelled as HAZARDOUS SAMPLE and sent onshore to Onne Port. The Environmental Advisor (61040/61037) is to be notified of sample transfer to enable collection and analysis of the sample.

The metal drum is to be sealed and labelled as HAZARDOUS WASTE. Ensure that the drum is stored on an open deck away from activities and other storage. Barrier off the area with radioactive tape and ensure personnel are warned to stay away from the area.

In the storage location, measurements for background radiation and radioactivity on the external surface of the metal drum should be taken, recorded and sent to the Environmental Advisor together with an estimate of the volume/weight and form of sand/sludge in the metal drum, e.g. dry solid, slurry, etc.

Disposal of the NORM contaminated sand/sludge will be with Well Engineering, Port Harcourt, who run a re-injection programme with the waste NORM-contaminated materials and who are DPR compliant.

If radiation is NOT present at levels of 50 micro rems/hr above background concentrations or 30pci/gm take a grab sample of the sand/sludge (approx. 2kg) and seal into a glass jar. The sample is to be securely packaged, labelled as HAZARDOUS SAMPLE, and sent onshore to Onne Port. The Operations HSE Group (61040/61037) is to be notified of sample transfer to enable collection and analysis of the sample. Transfer the sand/sludge into a bag or drum and seal awaiting results of the grab sample.

The grab sample is analysed in an external laboratory for:

- Total hydrocarbon content;
- Metals (mercury, cadmium, iron, vanadium, nickel, chromium, lead, copper and barium).

Once results are known, the disposal option can be determined. A permit application has been lodged with DPR for disposal of sand/sludge in the offshore discharge zone (depending on absence of NORM and low hydrocarbon and metal content).

5.3.1.1 Summary of Disposal Options for NORM-contaminated Material

If NORM is present above the background level, the sand/sludge is to be shipped to shore (marked as HAZARDOUS WASTE) and transported to SPDC Well Engineering, Port Harcourt for reinjection.

If NORM is present at or below the background level/not present and any of the parameters for hydrocarbon and metals content are exceeded, the sand/sludge is to be shipped to Bonny Terminal TDU for disposal (marked as HAZARDOUS WASTE).

If NORM is present at or below the background level/not present and both hydrocarbon and all metals content of the sand/sludge are below all target limits, the sand/sludge can be transported to the offshore discharge zone and disposed to sea (awaiting DPR approval for this option).

Until such time as DPR approval has been granted for ODZ disposal, all waste sands/sludges, etc are sent to DPR approved TDU for disposal.

Figure 3 summarises the disposal paths for NORM-contaminated material.

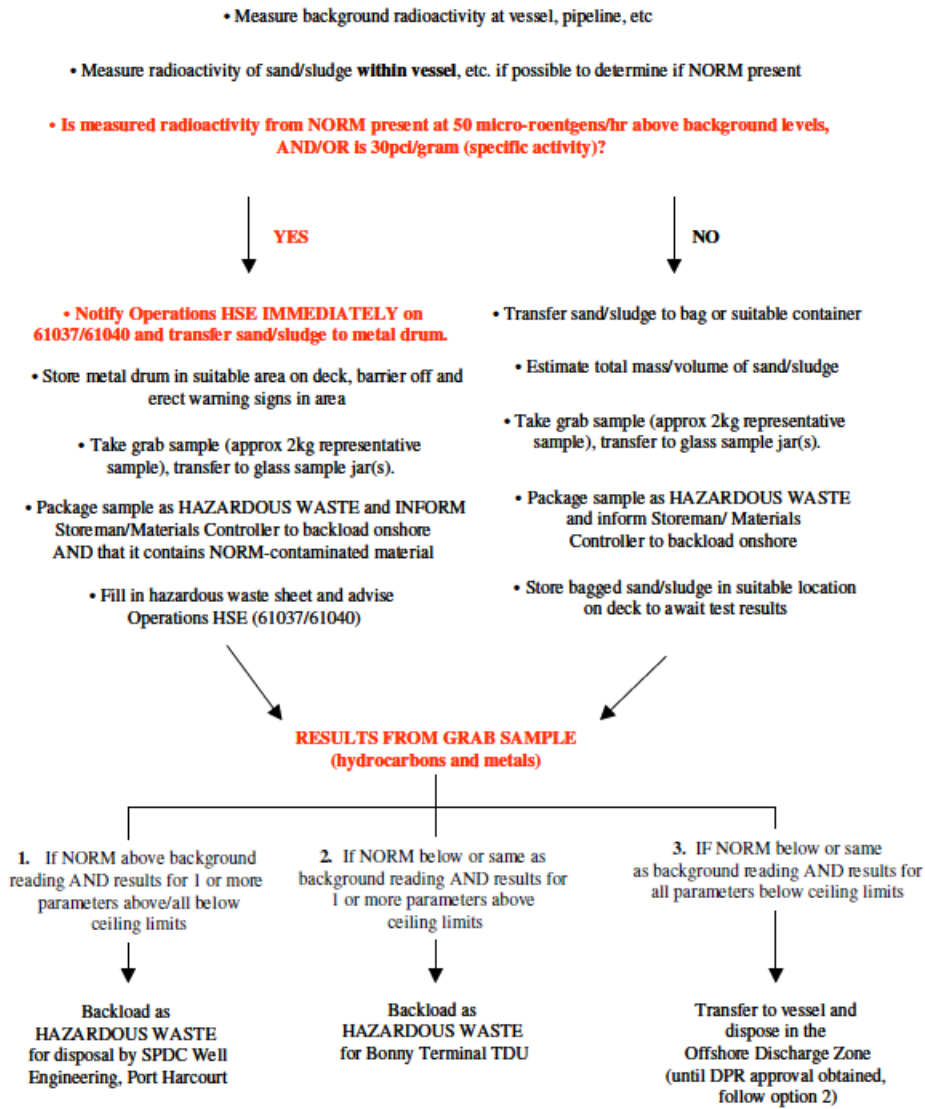


Figure 3: Disposal options for NORM-contaminated materials

6 WASTE RECORDING AND REPORTING

6.1 Documentation and Record Keeping

Quantification and recording of waste identifies opportunities to improve practices towards effective waste management and enables targets for waste reduction to be set.

6.2 Internal Monthly Waste Reports

The quantities of waste streams generated on a monthly basis are submitted to Corporate SPDC by the 7th of each month. **It is the responsibility of the Waste Management Co-ordinator to supply the HSE Advisor with monthly figures for each type and category of waste generated.**

To facilitate this collection of information, the Senior Materials Controller submits a summary of waste backloaded on a monthly basis to the Waste Management Co-ordinator. This includes WCN reference, shipping manifest reference, individual waste type, quantity and end facility location. The data is entered into the in-house waste management database.

The Camp Boss submits the waste food log on monthly basis to the Waste Management Co-ordinator

6.3 DPR Reporting Requirements

In the monthly environmental report to DPR, information on the generation of hazardous wastes is reported, as stated in EGASPIN VIII C 2.1.1.

6.4 Annual Inventory

Under EGASPIN Part VIII-C, Section 4.0 *Waste Release Inventory*, Section 4.1 states that *All licencees, shall on an annual basis (end of the year) submit to the DPR, releases of on-site (point source) effluent discharges to:*

- *Air (any fugitive or stack emission);*
- *Water (discharge to any surface water body);*
- *Land (discharge made onsite to surface impoundments, land treatment, landfills, etc);*
- *Underground injection.*

It is the responsibility of the Waste Management Co-ordinator to supply the Environmental Advisor with annual figures for each type and category of waste generated.

7 ENVIRONMENTAL PERFORMANCE INDICATORS FOR WASTE

The EA Environmental Monitoring Plan (ref. 5) details the environmental performance indicators (EPIs) for waste management. The EA internal quarterly environmental performance reports (ref. 6) publishes the EPIs.

REFERENCES

- 1 SPDC HSE Procedure for Waste Management, SNHS-2000-0016, Version 2.0.
- 2 SIEP 95-0390, Waste Management Guidelines, 1995
- 3 SIEP 95-0391, Classifying Waste 1995

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- 4 EA Environmental Monitoring Plan, OD-SA03-017
 - 5 The Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) 2002.

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Appendix 3: DPR EGASPIN Appendix VIII-C2 waste material data sheet (1 of 2)

Waste Material Data Sheet (complete a separate sheet for each waste stream)
EGASPIN Appendix VIII-C2

Company: SNEPCO Plant location: OML 79
Mailing address: 17 Ugal Ayorinde St Plant ID no. Sea Eagle FPSO
Victoria Island, Lagos Competent Person Env. Advisor

Description of material: waste chemicals Phone: 61040

Quantity: Litres

Process requiring hazardous material: -
Process producing waste stream: expired chemical (SAND STOP PRE FLUSH)
CONTAINS epoxy resin and 1-methoxy-2-propanol

Products manufactured: -
Check appropriate boxes or list values if known

Physical state at 70°F/21.1°C

Odorous	<input type="text"/>	Slightly	<input type="text"/>
Odourless	<input type="text"/>	Extremely odorous	<input type="text"/>
Flashpoint (°C)	<input type="text"/>	70	<input type="text"/>
	<0.0	>70	<input type="text"/>
	32		<input type="text"/>
Sulphur (wt%)	<input type="text"/>	trace	<input type="text"/>
	none	other	<input type="text"/>
	0.5		<input type="text"/>
TOC	<input type="text"/> mg/l	Melting point	<input type="text"/>
BOC	<input type="text"/> mg/l	Boiling point	<input type="text"/>
COD	<input type="text"/> mg/l		
Solid	<input type="text"/>	Liquid	<input type="text"/>
		Semi-liquid	<input type="text"/>
Phase or layers			
None	<input type="text"/>	Bilayered	<input type="text"/>
		Multilayered	<input type="text"/>
Specific gravity at 20°C			
0.8	<input type="text"/>	0.8-1.0	<input type="text"/>
1.2-1.4	<input type="text"/>	1.4-1.7	<input type="text"/>
		1.0-1.2	<input type="text"/>
		>1.7	<input type="text"/>
Velocity at 70F (21.1C)			
1.5	<input type="text"/>	500-1000	<input type="text"/>
		>1000	<input type="text"/>
Heat value (thousands of BTU)	<input type="text"/>		
Suspended solids			
<5%	<input type="text"/>	5-20%	<input type="text"/>
		>20%	<input type="text"/>
		weight	<input type="text"/>
		volume	<input type="text"/>
Dissolved solids by weight			
<4.5%	<input type="text"/>	5-20%	<input type="text"/>
		>20%	<input type="text"/>
Does this stream contain Sodium, Phosphorous, Titanium or Silicon?			<input type="text"/>
If yes, list on next page 'Chemical composition of stream'			<input type="text"/>
Protective equipment			
eye	<input type="text"/>	gloves	<input type="text"/>
		respirator	<input type="text"/>
		other	<input type="text"/>

Complete the 'Chemical composition of stream' form. Information MUST be supplied. To the best of my knowledge and ability to determine, this is a complete and accurate description of this waste material.

SIGNATURE: TITLE: Laboratory Technician DATE:

Individual Material safety data sheet attached?

Original copy to DPR (via Waste Management Co-ordinator)

Appendix 4: Infield waste consignment note (transfer of waste to the Sea Eagle) (page 1 of 2)

1	Originator (Vessel Name)	
1.1	Vessel Name:	
1.2	Personnel Name:	
1.3	Signature:	
1.4	Date:	
1.5	Time:	
2	Receiver at the Sea Eagle	
2.1	Name:	
2.2	Ref. Ind.	
2.3	Signature	
2.4	Tel. No.	
2.5	Date:	
2.6	Time:	
3	WCN Ref.	

Appendix 4: Infield waste consignment note (transfer of waste to the Sea Eagle) (page 2 of 2)

5	WASTE NAME	QTY (KG/LITRES)
5.1	Absorbents	
5.2	Asbestos	
5.3	Ash	
5.4	Air Filters	
5.5	Batteries (wet and dry)	
5.6	Cans and Tins	
5.7	Cables	
5.8	Carton	
5.9	Construction Debris	
5.11	Computer Scraps/Consumables	
5.12	Drums	
5.13	Electric Bulbs	
5.14	Fan Belts	
5.15	Food	
5.16	Fire Extinguisher Cylinder	
5.17	Fuel filters	
5.18	Furniture	
5.19	Fluorescent Tubes	
5.20	Garbage	
5.22	Glass	
5.23	Inkjet/Toner Cartridges	
5.24	Medical Waste	
5.25	Oil Filters	
5.26	Oily sludge	
5.27	Oily Rags	
5.28	Paper	
5.29	Packaging Materials	
5.30	Plastic	
5.31	Pigging waste	
5.32	Restaurant Waste Water	
5.33	Scrap Metals	
5.34	Sewage	
5.35	Spent Lube Oil	
5.36	Spent Chemicals	
5.37	Tyres	
5.38	Tubes	
5.39	Water Filters	
5.40a	Oily waste water (bilge)	
5.40b	Other – please specify	
5.40c	Other – please specify	
5.40d	Other – please specify	
5.40e	Other – please specify	

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Appendix 5: Dangerous Goods Form (to accompany hazardous waste)

DANGEROUS GOODS, MARINE POLLUTANT, AND CERTIFICATE OF PACKING DECLARATION <small>(To comply with the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1990 SI 2605)</small>									
PACKING LIST NUMBER:			PAGE:			1 OF 1			
VESSEL NAME:			DEPARTURE DATE:						
PLACE OF DEPARTURE:			DESTINATION:						
PROPER SHIPPING NAME	BRAND NAME	CLASSIFICATION	U.N. No.	HAZARD CLASSIFICATION	PACKAGING TYPE	ITEM NET VOL/WEIGHT	EMS No.	MFAQ No.	SHIPPING UNIT ID
			N UN	N/A					
CONTAINER PACKING CERTIFICATE/VEHICLE DECLARATION <small>It is declared that the packing of the container has been carried out in accordance with the provisions of Section 12 (1)(3,7), of the General Introduction to the I.M.D.G. Code.</small>					GENERAL DECLARATION <small>It is declared that the contents of this consignment are fully and accurately described above by the correct technical name(s), proper shipping name(s), and are classified, packaged, marked and labelled/placarded, in accordance with the I.M.D.G. Code, and are in a proper condition for carriage by sea and in the case of marine pollutants are in a proper condition for carriage to minimize the hazard to the marine environment</small>				
SHIPPER'S NAME: _____					SHIPPER'S NAME: _____				
POSITION: _____					POSITION: _____				
SIGNATURE: _____					SIGNATURE: _____				
DATE: _____					DATE: _____				

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Appendix 6: SPDC waste consignment note

1 ORIGINATOR	5 WASTE NAME	QTY (Kg / Litres)	DISPOSAL / RECYCLING FACILITY
1.1 Name:	5.1 Absorbents		EAST
1.2 Ref. Ind.	5.2 Asbestos		Eneka Dump Site
1.3 Signature:	5.3 Ash		Waste Recycling Depot
1.4 Ref. No.	5.4 Air Filters		Medical Incinerator
1.5 Loading Point:	5.5 Batteries (wet and dry)		Bonny TDU
1.6 Date:	5.6 Cans and Tins		Osige W/19
1.7 Time:	5.7 Cables		Other (Specify)
2 DISPATCHER	5.8 Carton		Waste Water Treatment Plant
2.1 Name:	5.9 Construction Debris		WMF Umuakuru
2.2 Ref. Ind. or Company	5.1 Contaminated Soil		
2.3 Signature:	5.11 Computer Scraps/Consumables		
2.4 Ref. No.	5.12 Drums		
2.5 Date:	5.13 Electric Bulbs		
2.6 Time:	5.14 Fan Belts		
3 DRIVER/VEHICLE	5.15 Food		
3.1 Name:	5.16 Fire Extinguisher Cylinder		
3.2 Signature:	5.17 Fuel Filters		
3.3 Company:	5.18 Furniture		
3.4 Vehicle/Vessel No.	5.19 Fluorescent Tubes		
3.5 Date:	5.2 Garbage		
3.6 Time Started:	5.21 Garden		
3.7 Time Completed:	5.22 Glass		
4 END RECEIVER OF WASTE	5.23 Inkjet/Toner Cartridges		
4.1 Name:	5.24 Medical Waste		
4.2 Ref. Ind.	5.25 Oil Filters		
4.3 Signature:	5.26 Oil sludge		
4.4 Ref. No.	5.27 Oil Rags		
4.5 Date:	5.28 Paper		
4.6 Time:	5.29 Packaging Materials		
REMARKS	5.3 Plastic		
	5.31 Pipping waste		
	5.32 Restaurant Waste Water		
	5.33 Scrap Metals		
	5.34 Sewage		
	5.35 Spent Lube Oil		
	5.36 Spent Chemicals		
	5.37 Tyres		
	5.38 Tubes		
	5.39 Water Filters		
	5.4 Other		

Note: Distribution of Copies

Original (white copy) Waste Receiver	1st (blue copy) Line HSE Focal Point*	2nd (pink copy) Dispatcher	4th (yellow copy) Originator
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* After signature by waste receiver

**APPENDIX 4.5
FISH SIZE EQUATION**

The relationship between the length (h) and weight (w) of fish was expressed by the equation:

$$W = al^b \tag{1}$$

Where:

- W = weight of fish in (g)
- L = total length (TL) of fish in (cm)
- a = constant (intercept)
- b = the length exponent (slope)

The “a” and “b” values are obtained from a linear regression of the length and weight of fish. The correlation (r^2) that is the degree of association between the length and weight was computed from the linear regression analysis.

$$R = r^2 \tag{2}$$

The values of a and b were given a logarithm transformation according to the following formular

$$\log W = \log a + b \log L \text{ (Pauly, 1983)} \tag{3}$$

The intercept “a” in the formular was estimated with the formular:

$$a = \left[\frac{\sum y}{n} - \frac{b \sum x}{n} \right] \tag{4}$$

Or logarithm transformed as:

$$a = \left[\frac{\sum \log W^y}{n} - \frac{b \sum \log W^x}{n} \right] \tag{5}$$

While the slope “b” was estimated by the formular

$$b = \frac{\sum xg - \frac{(\sum x)(\sum y)}{n}}{\frac{(\sum x)^2}{n}} \tag{6}$$

$$\text{or } b = \frac{n \sum xy - (\sum x)(\sum y)}{n \sum x^2 - (\sum x)^2} \tag{7}$$

or log transformed as:

$$b = \frac{n \sum \log x - \log_{10} Y - (\sum \log_{10})(\sum \log_{10} Y)}{n \sum \log_{10} x^2 - \sum \log_{10} (x)} \quad (8)$$

Where

X = Length of fish

Y = Weight of fish

N = Number of fish (sample size)

The correlation i.e. the degree of association between the variables were determined by computing the correlation co-efficient (r) using the relationship.

The condition factor of the experimental fish was estimated from the relationship

$$K = \frac{100}{L^3} \quad (9)$$

Where:

K = Condition factor

W = Weight of fish

L = Length of fish (cm)

APPENDIX 4.5

EA/EJA FIELDS CORPORATE SOCIAL RESPONSIBILITY PLAN

Social Performance Plan:

The Social Performance plan for the EA FURTHER Oil Development (EA FOD) project articulates in a structured manner, a clear strategy for managing the impact of EA FOD project on the people and the environment. It sets a clear picture of the social environment, key stakeholder, and how the likely impact from the execution of the project activities will be managed to minimize negative impact and maximize benefits to stakeholders and communities. It also focuses on managing non- technical risk already identified by implementing agreed mitigation plan and monitor progress of proposed mitigation interventions through the project phases. This is achieved by identifying, ranking and providing mitigating measures to address the identified concerns.

A stakeholder engagement plan has been developed and all stakeholders especially communities and government agencies will be engaged in a proactive manner to engender participation and secure enabling environment for the execution of the project.

Social Investment Strategy:

The overall objective is to improve sustainable livelihoods of host communities and projects under social investment consideration must meet the following criteria:

- Be sustainable, delivering lasting benefits and be self –supporting after start up.
- Involve local support and have a measurable positive impact,
- Meet community needs and aligned with project foot print and social impact.

The social investment strategy has three aspects:

- GMoU led community development programmes
- Strategic Social investment for foot print projects for community clusters e.g. enterprise development (livewire). And access to energy (clean cook stoves) skills acquisition and others
- Regional Legacy Social Investment (SI) projects.

In strategic terms the focus areas include Shell Global SI themes namely: Enterprise Development, Access to Energy and Road Safety and at the local level, community development.

The Global Memorandum of Understanding (GMoU); sets out a community driven mechanism for the delivery of social benefits to the communities. It aims to achieve more equitable distribution of project benefits through community empowerment that enables each community trust and or trust to manage their own development at their own pace using dedicated grants that have been provided. The mechanism also ensures that no new legacies are accumulated by SPDC.

Key Elements of the SI Delivery strategy under the GMoU include:

- Framework for implementing Sustainable Development and Social Investment initiatives in communities.
- Agreement is based on available funding for community development programmes in support of steady state operations with additional funding provided in the event of the introduction of a major project in the area.
- Agreed funding deposited in a dedicated accounts jointly managed by the communities and SPDC.
- Community decides sustainable development projects/programmes to be funded from the account based on priorities identified through PRAs and set out in CDP. This will likely cover such areas as human capacity development, basic social infrastructure – electricity, water and roads provision, among others.

Social Investment Activities:

SPDC's Social Performance intent is to proactively manage social issues to minimize the potential negative aspects, maximize positive effects, and ensure that then communities surrounding our activities benefit from our presence.

Community Content:

Local content will be a critical issue in our agreement with local communities. The Community content aspiration of the project is to enhance participation of local communities in various aspects of project execution in line with both the Nigeria Content Directive of the Federal Government and SPDC's Community Content Strategy. This entails the following:

- Sustained consultations with communities during project maturation to identify and capture local capabilities for employment, sub-contracting and other services in the project.
- Systematic programme to enhance /build and use local capability to deliver services to project.
- Set NCD/Community Content expectations of project a part of minimum requirements for both technical qualification and contract award.
- Identification and classification of specific employment and sub-contracting opportunities exclusive to community workers and sub-contractors.

EA/Eja fields (OML 79) are offshore fields; however, we have accommodated twelve (12) recognized main communities and interface with them under the GMOU umbrella. The lists of communities enumerated either are duplications, breakaway, satellite or fishing ports of the main the communities.

EIA of EA/Eja Field Further Oil Development Project

EA FOD HOST COMMUNITIES							
S/N	COMMUNITY	Oil Field	LGAs	POPUL.	COMMUNITY LEADERSHIP & STRUCTURES	ECONOMIC ACTIVITIES & POTENTIAL	GMOU CLUSTER
1	Agge	EA	Ekeremor	4000	Elected CDC Chairman; Administrative Head, Appointed but life HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Kou
2	Ogbeintu	EA	Ekeremor	4000	Elected CDC Chairman; Administrative Head, Appointed HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Kou
3	Orobiri	EA	Ekeremor	3500	Elected CDC Chairman; Administrative Head, Appointed but 4yrs tenure HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Kou
4	Azamabiri	EA	Ekeremor	3200	Elected CDC Chairman; Administrative Head, Appointed HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Kou
5	Amatu-I	EA	Ekeremor	4800	Elected CDC Chairman; Administrative Head, Appointed but life HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Iduwini
6	Amatu-II	EA	Ekeremor	4500	Elected CDC Chairman; Administrative Head, Appointed but life HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Iduwini
7	Bisangbene	EA	Ekeremor	3500	Elected CDC Chairman; Administrative Head, Appointed but life HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing, Timbering, Trading, O&G services	Iduwini

EIA of EA/Eja Field Further Oil Development Project

S/N	COMMUNITY	Oil Field	LGAs	POPUL.	COMMUNITY LEADERSHIP & STRUCTURES	ECONOMIC ACTIVITIES & POTENTIAL	GMOU CLUSTER
8	Letugbene	EA	Ekeremor	5000	Elected CDC Chairman; Administrative Head, Appointed but life HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing , Timbering, Trading, O&G services	Iduwini
9	Bilabiri-I	EA	Ekeremor	4300	Elected CDC Chairman; Administrative Head, Appointed HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing , Timbering, Trading, O&G services	Mein
10	Bilabiri-II	EA	Ekeremor	4500	Elected CDC Chairman; Administrative Head, Appointed HRH; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing , Timbering, Trading, O&G services	Mein
11	Ezetu	EA	Southern Ijaw	4800	Elected CDC Chairman; Administrative Head, Appointed HRM; Traditional Head; Elected CT Chairman, Elected Youth President and Women Leader	Fishing , Timbering, Trading, O&G services	Bassan-West
12	Ekeni	EA	Southern Ijaw	4900	Elected CDC Chairman; Administrative Head, Appointed HRH; Traditional Chairman Council of Chiefs; Elected CT Chairman, Elected Youth President and Women Leader	Fishing , Timbering, Trading, O&G services	Bassan-West