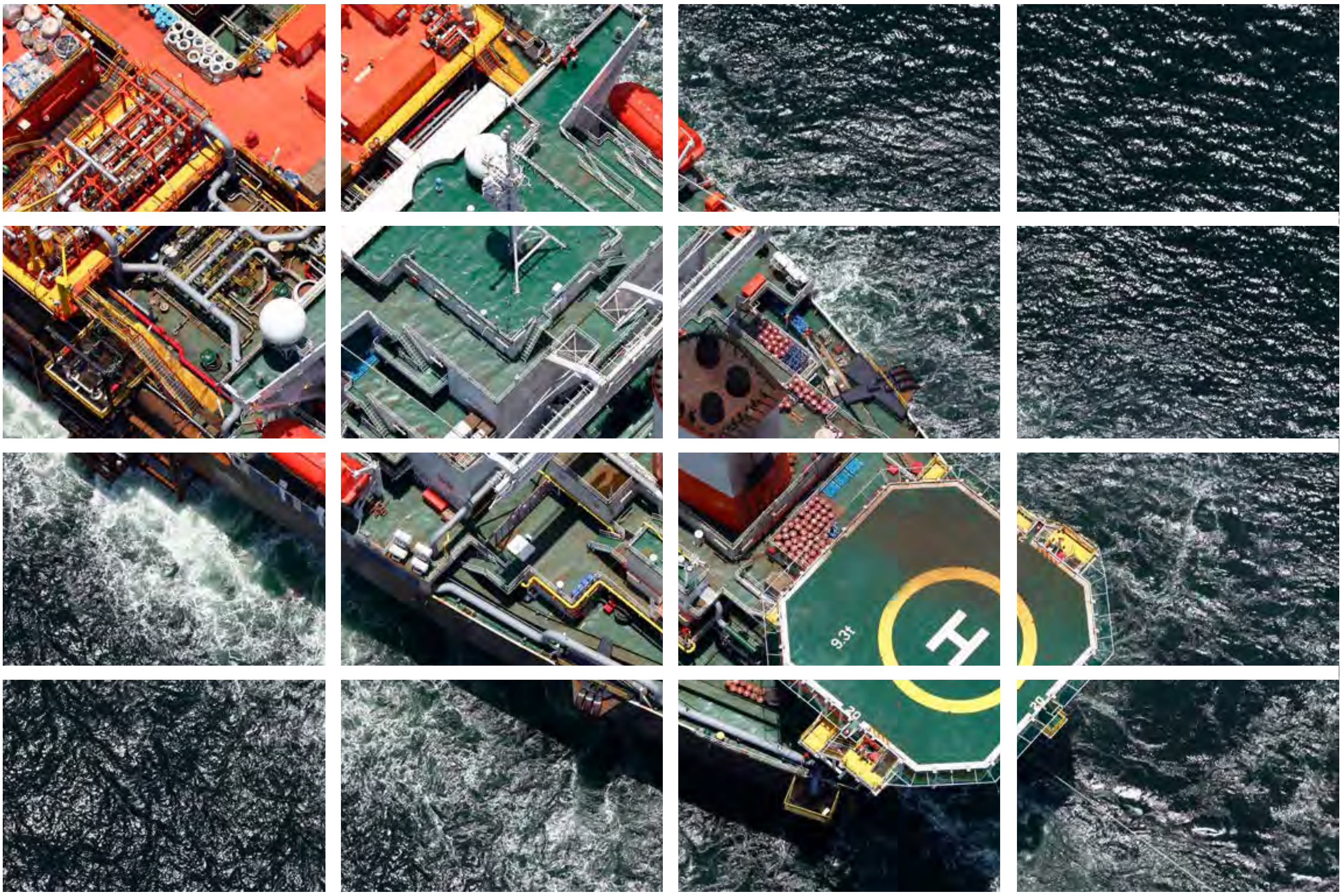


VOLUME I

Tweneboa, Enyenra, Ntomme (TEN) Project, Ghana

Final Environmental Impact Statement

Doc no: 00002-E78-ES-RPT-0007 – REV 1

5 September 2014

The world's leading sustainability consultancy

ERM

Tullow Ghana Limited

Tweneboa, Enyenra, Ntomme (TEN) Project, Ghana

VOLUME I

Final Environmental Impact Statement

Doc no: 00002-E78-ES-RPT-0007 – REV 1

EIA documentation includes the following:

Volume I: Final Environmental Impact Statement and Consultation Report

Volume II: EIS Annexes

Prepared by:

Environmental Resources Management in collaboration with ESL Consulting and SRC Consulting Limited

For and on behalf of
Environmental Resources Management

Approved by: Mark Irvine

Signed: MIrvine

Position: Technical Director

Date: 5 September 2014

CONTENTS

LIST OF ACRONYMS
NON TECHNICAL SUMMARY

1	*INTRODUCTION*	*1-1*
1.1	*PURPOSE OF REPORT*	*1-1*
1.2	*PROJECT BACKGROUND*	*1-1*
1.3	*THE EIA TEAM*	*1-6*
1.4	*PURPOSE OF EIA*	*1-7*
1.5	*EIA PROCESS*	*1-8*
1.6	*STRUCTURE OF THIS REPORT*	*1-15*
2	*LEGAL AND POLICY FRAMEWORK*	*2-1*
2.1	*INTRODUCTION*	*2-1*
2.2	*GOVERNMENT ADMINISTRATION*	*2-1*
2.3	*NATIONAL LEGISLATION*	*2-7*
2.4	*STATE, CONVENTIONS AND CLASSIFICATION REQUIREMENTS*	*2-19*
2.5	*RELEVANT INTERNATIONAL AGREEMENTS AND CONVENTIONS*	*2-21*
2.6	*GOOD PRACTICE STANDARDS AND GUIDELINES*	*2-27*
2.7	*PROJECT ENVIRONMENTAL STANDARDS*	*2-29*
2.8	*PROJECT EHS POLICIES AND STANDARDS*	*2-34*
2.9	*SUMMARY*	*2-39*
3	*PROJECT DESCRIPTION*	*3-1*
3.1	*INTRODUCTION*	*3-1*
3.2	*PROJECT OVERVIEW*	*3-1*
3.3	*PROJECT ALTERNATIVES*	*3-3*
3.4	*OFFSHORE FACILITIES AND EQUIPMENT*	*3-14*
3.5	*ONSHORE SUPPORT OPERATIONS AND ONSHORE BASE*	*3-44*
3.6	*MAIN PROJECT ACTIVITIES*	*3-50*
3.7	*PERSONNEL REQUIREMENTS*	*3-66*
3.8	*EMISSIONS, DISCHARGES AND WASTES*	*3-68*
3.9	*PERSONNEL HEALTH AND SAFETY*	*3-87*
4	*ENVIRONMENTAL BASELINE*	*4-1*
4.1	*INTRODUCTION*	*4-1*
4.2	*DATA SOURCES*	*4-1*
4.3	*CLIMATE AND METEOROLOGY*	*4-3*
4.4	*AIR QUALITY*	*4-10*
4.5	*OCEANOGRAPHY AND HYDROGRAPHY*	*4-11*
4.6	*BATHYMETRY AND SEABED TOPOGRAPHY*	*4-18*
4.7	*WATER AND SEDIMENT QUALITY*	*4-22*

4.8	*MARINE HABITATS AND SPECIES*	*4-32*
4.9	*PROTECTED AREAS FOR NATURE CONSERVATION*	*4-55*
5	*FISH AND FISHERIES BASELINE*	*5-1*
5.1	*INTRODUCTION*	*5-1*
5.2	*OVERVIEW*	*5-1*
5.3	*FISHERIES CONSULTATIONS*	*5-2*
5.4	*FISH SPECIES IN GHANAIAN MARINE WATERS*	*5-3*
5.5	*FISHING FLEETS*	*5-14*
5.6	*SUPPORTING INFRASTRUCTURE*	*5-20*
5.7	*FISH LANDINGS*	*5-25*
6	*SOCIO-ECONOMIC BASELINE*	*6-1*
6.1	*INTRODUCTION*	*6-1*
6.2	*DATA SOURCES*	*6-1*
6.3	*ADMINISTRATIVE STRUCTURES*	*6-4*
6.4	*DEMOGRAPHIC PROFILE*	*6-6*
6.5	*LAND TENURE AND LAND USE*	*6-10*
6.6	*ECONOMY AND LIVELIHOODS*	*6-12*
6.7	*EDUCATION*	*6-26*
6.8	*HEALTH CARE*	*6-28*
6.9	*UTILITIES, INFRASTRUCTURE AND SERVICES*	*6-34*
6.10	*MARINE INFRASTRUCTURE*	*6-43*
6.11	*TGL SOCIAL INVESTMENT PROJECTS*	*6-46*
7	*HEALTHIMPACT IDENTIFICATION AND ASSESSMENT*	*7-1*
7.1	*INTRODUCTION*	*7-1*
7.2	*ASSESSMENT METHODOLOGY*	*7-3*
7.3	*PROJECT FOOTPRINT*	*7-9*
7.4	*OPERATIONAL DISCHARGES*	*7-23*
7.5	*EMISSIONS TO ATMOSPHERE*	*7-60*
7.6	*GREENHOUSE GAS EMISSIONS*	*7-82*
7.7	*WASTE MANAGEMENT*	*7-86*
7.8	*FISHERIES IMPACTS*	*7-92*
7.9	*SOCIO-ECONOMIC AND COMMUNITY HEALTH IMPACTS*	*7-97*
7.10	*OIL SPILL RISK*	*7-116*
7.11	*CUMULATIVE IMPACTS*	*7-161*
7.12	*TRANSBOUNDARY IMPACTS*	*7-174*
8	*MITIGATION AND MANAGEMENT MEASURES*	*8-1*
8.1	*INTRODUCTION*	*8-1*
8.2	*SUMMARY OF MITIGATION AND MANAGEMENT MEASURES*	*8-1*

9	*PROVISIONAL MONITORING PLAN*	*9-1*
9.1	*INTRODUCTION*	*9-1*
9.2	*MONITORING APPROACH*	*9-2*
9.3	*PROVISIONAL MONITORING PLAN FOR SPECIFIC MITIGATION MEASURES*	*9-3*
10	*DECOMMISSIONING AND ABANDONMENT*	*10-1*
10.1	*INTRODUCTION*	*10-1*
10.2	*REGULATIONS AND AUTHORITY*	*10-1*
10.3	*INTERNATIONAL CONVENTIONS AND GUIDELINES*	*10-1*
10.4	*APPROVAL PROCESS*	*10-2*
10.5	*DECOMMISSIONING METHODS*	*10-3*
10.6	*POST-DECOMMISSIONING SURVEYS AND REPORTING*	*10-7*
11	*ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN*	*11-1*
11.1	*OVERVIEW AND SCOPE*	*11-1*
11.2	*GENERAL REQUIREMENTS*	*11-2*
11.3	*PLANNING*	*11-8*
11.4	*IMPLEMENTATION*	*11-16*
11.5	*CHECKING AND CORRECTIVE ACTION*	*11-25*
11.6	*COST ESTIMATES AND SCHEDULES*	*11-27*
11.7	*COMMUNITY DEVELOPMENT*	*11-27*
11.8	*ON-GOING STAKEHOLDER ENGAGEMENT*	*11-29*
11.9	*GRIEVANCE PROCEDURE*	*11-30*
12	*SUMMARY AND CONCLUSIONS*	*12-1*
12.1	*EIA PROCESS*	*12-1*
12.2	*SUMMARY OF IMPACTS AND MITIGATION*	*12-1*
12.3	*OVERALL CONCLUSION*	*12-2*
	REFERENCES	
	ATTACHMENT 1- CONSULTATION REPORT	

ACRONYMS

ACDP	Acoustic Current Doppler Profile
AHTS	Anchor Handling Tug Supply
AHV	Anchor Handling Vessel
ALARP	As Low As Reasonably Practicable
AQS	Air Quality Standard
ATBA	Area To Be Avoided
BAT	Best Available Technology
BOP	Blow-out Preventor
bpd	barrels per day
bopd	barrels of oil per day
BPEO	Best Practicable Environmental Option
BTEX	Benzene, Toluene, Ethylbenzene and Xylene [volatile aromatic compounds]
bwpd	barrels of water per day
CCMC	Chemicals Control and Management Centre
CCME	Canadian Council of Ministers for the Environment
CH_4	Methane
CHPS	Community-based Health Planning and Services
CLO	Community Liaison Officer
CO	carbon monoxide
CO_2	carbon dioxide
COLREGs	International Regulations for Preventing Collisions at Sea
CoP	Cessation of Production
CSA	CSA International Inc
CSC	International Convention for Safe Containers
CSPWD	Cape St. Paul's Wilt Disease
CSR	Corporate Social Responsibility
CSR	Corporate Social Responsibility
CTD	Conductivity, Temperature and Depth
CTD	Conductivity Temperature Depth [profile]
DAP	Decommissioning and Abandonment Plan
dBA	Decibel [sound]
DCE	District Chief Executive
DCE	District Chief Executive
DLE	Dry Low Emissions
DWT	Deep Water Tano
EBS	Environmental Baseline Survey
ECC	Equatorial Counter Current
EEZ	Exclusive Economic Zone
EHS	Environmental Health and Safety
EHS-MS	Environment Health & Safety Management System
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EITI	Extractive Industries Transparency Initiative
EMOBF	Enhanced Mineral Based Oil Fluid
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
ERM	Environmental Resources Management
ERP	Emergency Response Plan
ESL	ESL Consulting Limited
FAD	Fish Attracting Device
FAO	Food and Agriculture Organisation

FEED	Front End Engineering Design
FGD	Focus group Discussion
FPSO	Floating Production Storage and Offloading Vessel
Gardline	Gardline Environmental Limited
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHS	Ghana Health Service
GI WACAF	Global Initiative for West and Central Africa [oil spill response]
GMA	Ghana Maritime Authority
GNPC	Ghana National Petroleum Corporation
GPHA	Ghana Ports and Harbours Authority
GPRTU	Ghana Private Road Transport Union
hp	horse power
HP	High Pressure
HQ	Hazard Quotient
HUC	Hook Up and Commissioning
Hz	Hertz
IBA	Important Bird Area
ICCAT	International Commission for the Conservation of Atlantic Tunas
IEZ	Inland Exclusion Zone
IFC	International Finance Corporation
IGF	Induced Gas Flotation
ILO	International Labour Organisation
ILT	In-Line Tees
IMO	International Maritime Organisation
IMR	Norwegian Institute of Marine Research
INMARSAT	Convention on the International Maritime Satellite Organisation
IPIECA	International Petroleum Industry Environmental Conservation Association
ITCZ	Inter-topical Convergence Zone
ITDP	Integrated Tourism Development Plan
IUCN	International Union for Conservation of Nature
KII	Key Informant Interview
LDHI	Low Dosage Hydrate Inhibitors
LP	Low Pressure
LPG	Liquid Petroleum Gas
LUCF	Land-Use Change and Forestry
MARPOL	International Convention for the Prevention of Pollution From Ships
Mbbl	Million Barrels
Mbopd	Millions of barrels of oil per day
MDS	Multi-Dimensional Scaling
MEG	Monoethylene glycol
MGO	Marine Gas Oil
MMscfd	million standard cubic feet per day
MODU	Mobile Offshore Drilling Unit
MOE	Ministry of Energy
MSDS	Material Safety Data Sheet
N_2O	Nitrous oxide
NADF	Non-aqueous Drilling Fluid
NAFAG	National Fisheries Association of Ghana
NCEAS	National Centre for Ecological Analysis and Synthesis
NEAP	National Environmental protection Plan
NGOs	Non-governmental Organisation
NHIS	National Health Insurance Scheme

nmi	nautical mile
NOGAPS	Navy Operational Global Atmospheric Prediction System
NORM	Naturally Occurring Radio-active Material
NO_x	nitrogen oxides
NPA	National Petroleum Authority
OBM	Oil-based drilling muds
OCNS	Offshore Chemical Notification Scheme [OSPAR]
OCNS	Offshore Chemical Notification Scheme
OGP	International Oil and Gas Producers
OGP	Oil and Gas producers
OOB	Oil Offloading Buoy
OOL	Oil Offloading Line
OPD	Out-Patient Departments
OPRC	International Convention on Oil Pollution Preparedness, Response and Co-operation
OSCP	Oil Spill Contingency Plan
OSPAR	Oslo/Paris convention [for the Protection of the Marine Environment of the North-East Atlantic]
OSRL	Oil Spill Response Limited
PAH	Polycyclic Aromatic Hydrocarbons
PC	Process Contribution
PEL	Probable Effect Level
PER	Preliminary Environmental Report
PLET	Pipeline End Termination
PLONOR	Pose Little Or No Risk
PM	Particulate Matter
POD	Plan of Development
PTS	Permanent Threshold Shift
PVT	Pressure Volume Temperature
PWRI	Produced Water Reinjection
QRA	Quantitative Risk Assessment
RCC	Regional Coordinating Council
ROV	Remotely Operated Vehicle
RPS-ASA	RPS-Applied Science Associates
SAC	Standard Annular Combustor
SAEMA	Shama Ahanta East Metropolitan Assembly
SAR	International Convention on Maritime Search and Rescue
SBM	Synthetic-based drilling muds
SCE	Safety Critical Elements
SCS	Subsea Control System
SDU	Subsea Distribution Units
SEL	Sound Exposure Level
SEP	Stakeholder Engagement Plan
SOLAS	Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SO_x	sulphur oxides
SPL	Sound Power Level
SRC	SRC Consulting Limited
STCW	Standards of Training, Certification & Watchkeeping
STI	Sexually Transmitted Infections
STM	Sekondi-Takoradi Metropolis
STMA	Sekondi-Takoradi Metropolitan Assembly
T.O.E.S	Tullow Oil Environmental Standards
TED	Turtle Exclusion Devices
TEG	Tri-Ethylene Glycol

TEL	Threshold Effect Level
TEN	Tweneboa, Enyenra Ntomme [oilfields]
TGL	Tullow Ghana Limited
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon
TSS	Total Suspended Solid
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UTA	Umbilical Termination Assemblies
VLCC	Very Large Crude Carrier
VOC	Volatile Organic Compounds
VRU	Vapour Recovery Unit on the
WAGP	West Africa Gas Pipeline
WBF	Water Based Fluid
WCTP	West Cape Three Points [licence block]
WHO	World Health Organisation
WMP	Waste Management Plan
WOMP	Well Operations Management Plan

1 TEN PROJECT

1.1 INTRODUCTION

Tullow Ghana Limited (TGL) and its Partners, Kosmos Energy LLC, Anadarko Petroleum Corporation, the Ghana National Petroleum Company (GNPC) and Sabre Oil and Gas, known as the TEN Partners, propose to develop the Tweneboa, Enyenra (originally named Owo) and Ntomme (TEN) hydrocarbon fields offshore Ghana. The project is known as the TEN Project. The proposed TEN Project is the second major hydrocarbon development offshore Ghana after the Jubilee Field development in 2009/2010.

For projects of this type there is a legislative requirement to undertake an Environmental Impact Assessment (EIA). The Environmental Impact Statement (EIS) reports the findings of the EIA. This document is the Non-Technical Summary (NTS) of the EIS for the TEN Project. The NTS presents an overview of the EIA process, baseline environment, and impact assessment and mitigation measures.

The EIA was undertaken by Environmental Resources Management (ERM) in collaboration with two Accra-based consultancies, namely ESL Consulting and SRC Consulting jointly referred to as the EIA team.

1.2 PROJECT BACKGROUND

TGL has interests in two oil and gas licence blocks offshore Ghana, namely Deep Water Tano (DWT) and West Cape Three Points (WCTP). In 2007, TGL and its Partners discovered the Jubilee field, which straddles both blocks, and lies approximately 60 km off the coast of Ghana. The Jubilee field was subsequently developed through a joint venture partnership and first oil was achieved in late 2010.

Further exploration and appraisal drilling in the DWT block during 2009 and 2010 resulted in the discovery of the TEN hydrocarbon fields. The fields are situated approximately 20 km to the west of the Jubilee Field and lie in water depths ranging between 1,000 m and 2,000 m (see *Figure 1.1*). The TEN Project area covers approximately 450 km^2.

TGL and its TEN Partners, are proposing to develop the TEN fields. TGL is the designated operator for the DWT block and will lead the project design, execution and operation of the proposed development.

The TEN Project will consist of oil and gas production wells, water injection wells and gas injection wells. Production will be gathered through subsea manifolds and conveyed by subsea flowlines to a Floating Production Storage and Offloading (FPSO) which will be moored in the area of the TEN fields. Subsea equipment installation is planned throughout 2015 and the target for first production is mid 2016.

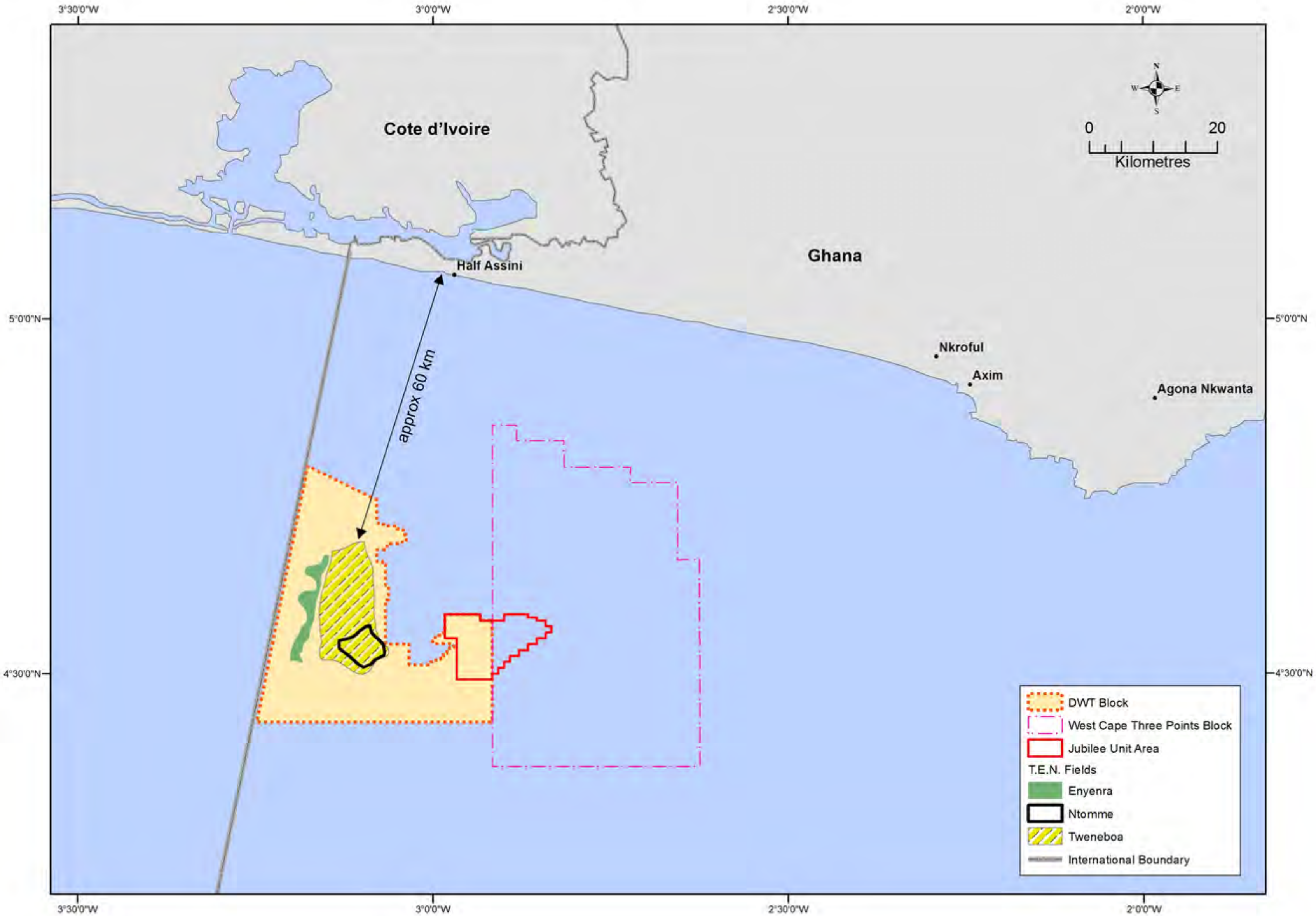
1.3 *PROJECT PURPOSE AND BENEFITS*

In 2010, the Ministry of Energy published an Energy Sector Strategy and Development Plan which defines the strategic goal for the petroleum sector as follows.

"Sustain exploration, development and production of the oil and gas endowment and also the judicious management of the oil and gas revenue for the overall benefit and welfare of all Ghanaians, present and future as well as attract increased local value-added investments in the oil and gas sector and the indigenization of knowledge, expertise and technology."

An objective of the strategy is to intensify exploration, development, production and utilisation of Ghana's oil and gas prospects. The proposed TEN Project will support this goal by developing additional oil and gas prospects. This will provide direct benefit to the Government of Ghana as a shareholder as well as generating income through royalties and taxes that will benefit of the people of Ghana.

Figure 1.1 Location of the TEN Fields



2 EIA PROCESS

This section provides an overview of the purpose of the EIA and process that was followed. For the purposes of the EIA, the project was defined as all activities necessary for the TEN Project and included development drilling, well completions, installation of subsea infrastructure and the FPSO, commissioning, operation (including production, hydrocarbon processing, crude oil offloading, and support and maintenance activities) and decommissioning.

2.1 OBJECTIVES

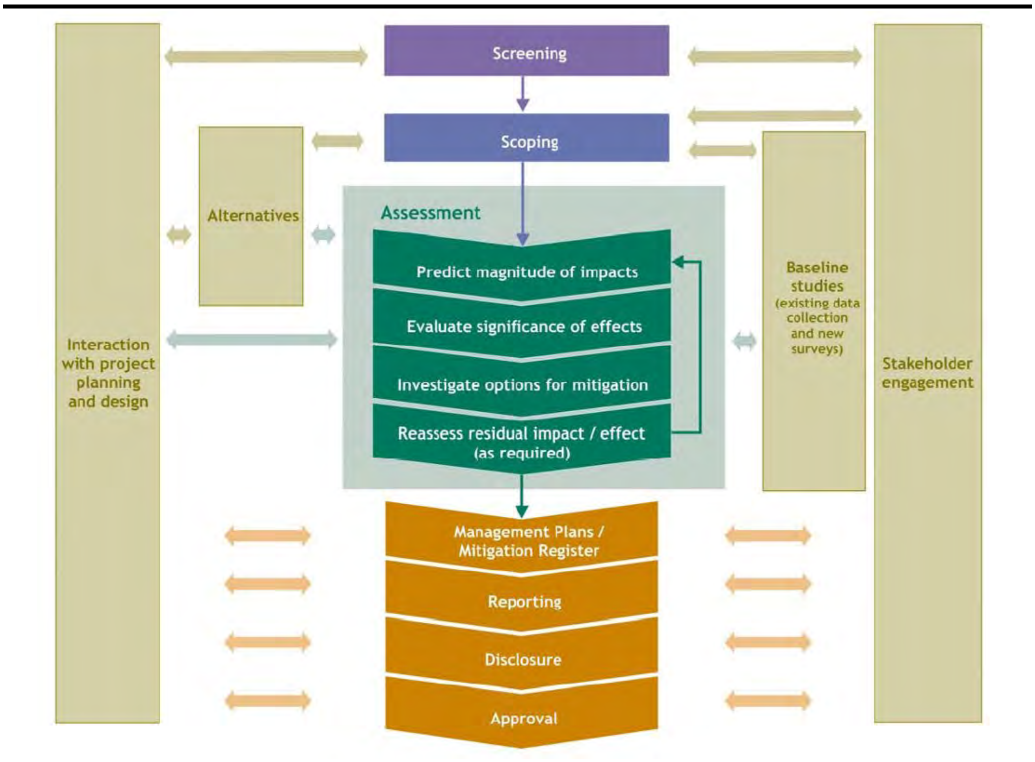
The purpose of an EIA is to provide information to regulators, the public and other stakeholders to aid the decision-making process. The objectives of an EIA are as follows.

- To define the scope of the project and the potential interactions of project activities with the environment (natural and social).
- To identify relevant national and international legislation, standards and guidelines and to ensure that they are considered at all stages of project development.
- To provide a description of the proposed project activities and the existing environmental and social conditions that the project activities may interact with.
- To predict, describe and assess impacts that may result from project activities and identify mitigation measures and management actions to avoid, reduce, remedy or compensate for significant adverse effects and, where practicable, to maximise potential positive impacts and opportunities.
- To provide a plan for implementation of mitigation measures and management of residual impacts as well as methods for monitoring the effectiveness of the plan.

2.2 EIA METHODOLOGY

The EIA for the project followed applicable Ghana regulations. The EIA process is shown schematically in *Figure 2.1.*

Figure 2.1 Overview of the Impact Assessment Process



2.2.1 *Screening and Scoping*

The proposed project was registered with the Ghana Environmental Protection Agency (EPA) in March 2011 and it was determined that an EIA was required. A Scoping Report and Terms of Reference presenting an overview of the project and outlining the key issues to be studied in the EIA was submitted to the EPA in January 2012. It was approved by the EPA in April 2012 and subsequently disclosed to the public in hardcopy and electronic forms and advertised in the local media.

2.2.2 *Baseline Data Collection*

The EIA team obtained and review existing data and primary data being collected by TGL as part of the TEN Project and from previous studies in the area. In particular, results from the following studies were used to update secondary datasets.

- Geotechnical and geophysical surveys conducted by Gardline Marine Ltd in 2011 and by Fugro Survey Ltd in 2013 provided site specific data on physical conditions in the DWT development area.

- A marine Environmental Baseline Survey was undertaken by CSA in 2010 and provided information on offshore environment within the DWT development area. This included physico-chemical data on water and sediment quality and characterisation of benthic communities.

- A fisheries study was conducted by ERM and ESL in 2010 and 2011 which provides current primary and secondary baseline data on fish and fisheries.

- Marine mammal and turtle observations were undertaken by Gardline Marine Ltd in 2010 and 2011 and provided sightings data on marine mammals and turtles. Additional sightings were made during a seismic survey in 2013.

- Socio-economic data was collected during a survey undertaken in the six coastal districts of the Western Region in March and June 2012 to supplement secondary socio-economic information. Communities were visited and data gathered through Focus Group Discussions and Key Informant Interviews.

2.2.3 *Quantitative Studies*

A number of quantitative studies were undertaken by the EIA team and TGL following stakeholder consultations, scoping and development of the project design. These have included the following.

- Modelling of oil spills potentially resulting from accidental events (*ie* collisions, ruptures, blowout *etc*).

- Aquatic dispersion modelling of operational discharges, including drill cuttings discharges and produced water discharges.

- Atmospheric dispersion modelling of project emissions to air to determine the extent of possible impacts on air quality.

Findings of the following studies were also considered in the EIA.

- A drill cuttings monitoring study provided data on drill cuttings dispersion and physico-chemical effects at the Jubilee field.

- An assessment of waste treatment and disposal options for priority waste streams was conducted by ERM for TGL in 2010 and provided information on waste management options.

- An underwater noise study undertaken of the FPSO operation and offloading at the Jubilee field provided information on underwater noise emission levels and attenuation.

- A Best Practicable Environmental Option study was undertaken evaluating options for the treatment and disposal of drill cuttings considering environmental, financial, health and safety and technical criteria.

2.2.4 *Stakeholder Engagement*

Stakeholder consultation was undertaken during the scoping and EIA phases of the EIA. The objective of this engagement was to disclose information about the proposed project and provide an opportunity for stakeholders to raise concerns and expectations.

During scoping, a series of 26 consultation meetings was held with 29 stakeholder groups or organisations in October and November 2011. Stakeholders included national, regional and district authorities, traditional leadership, Non-Governmental Organisations, the media, international organisations and fisher association.

During the EIA, local level consultations were undertaken with 34 communities in the coastal districts of the Western Region. A total of 27 community meetings, 66 Focus Group Discussions and 33 Key Informant Interviews were held and over 2,800 people participated in the consultations.

2.2.5 *Impact Assessment*

Mitigation measures that TGL has agreed to implement to avoid, reduce, remedy or compensate for potential negative impacts and the actions to be taken to create or enhance positive benefits of the project are defined in the EIS. These mitigation measures include operational controls as well as management actions.

The significance of the impacts that remain following application of the mitigation measures (also called residual impacts) was then assessed. Reporting the significance of a residual impact in the EIS is based on:

- the predicted magnitude of an impact, taking into consideration all the mitigation measures the project team is committed to that are relevant to that impact; and (where appropriate); and
- the quality/importance/sensitivity of the receptor.

Impacts were assessed as either significant or not significant. Those that were assessed as significant were further rated as being of *Minor*, *Moderate* or *Major* significance. The degree of significance attributed to residual impacts is related to the weight the EIA team considers should be given to them by the authorities in making decisions on the proposed TEN Project and developing conditions for approval.

2.2.6 *Management Plans*

The EIA process defined a range of mitigation measures, management actions and monitoring to be implemented during the project. Delivery of these will be through the project Environmental and Social Management Plan (ESMP). The EIS presents a provisional ESMP and provisional Monitoring Plan detailing the specific actions that are required to implement these controls, mitigation and monitoring measures.

2.2.7 *Reporting and Disclosure*

The outputs of the above tasks were drawn together into the draft EIS and submitted to the EPA for review. The draft EIS was advertised and made available for public review and comment for a period of 21 days and a series of Public Hearings were held in November 2013 in Takoradi, Ghana. Comments received on the draft EIS from the EPA's technical review, stakeholders written comments, and the outcome of the Public Hearings have been addressed in the Final EIS that has been submitted to the EPA for approval.

3 *LEGAL AND POLICY FRAMEWORK*

3.1 *ENVIRONMENTAL ASSESSMENT REGULATIONS*

The EIS has been compiled in compliance with the requirements of the *Environmental Assessment Regulations (LI 652, 1999) as amended (2002),* the principal enactment within the *Environmental Protection Act (Act 490 of 1994).* Schedules 1 and 2 of the Regulations provide lists of activities for which an environmental permit is required and EIA is mandatory, respectively. The EPA has issued formal guidance on regulatory requirements and the EIA process specific to oil and gas development, namely the *EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010)*.

3.2 *PETROLEUM LEGISLATION*

Relevant Petroleum Legislation includes:

- The *Petroleum Commission Act 2011 (Act 821);*
- the *Ghana National Petroleum Corporation Law (Act 64 of 1983);* and
- the *Petroleum (Exploration and Production) Law (Act 84 of 1984);*

It is recognised that in view of the developing petroleum exploration and production industry, the Ghanaian government is drafting new environmental and marine regulations and guidelines. These include the *Petroleum (Exploration and Production) Act* and new *Health Safety and Environment Regulations* for the oil and gas industry.

3.3 *OTHER RELEVANT REGULATIONS*

Other relevant Regulations include maritime, pollution control and protection of coastal and marine areas legislation. These include the following.

- *Town and Country Planning Act (Cap 84 of 1945) (as amended by Act 30 of 1958 and Act 33 of 1960).*
- *Wild Animals Preservation Act 1961 (Act 43).*
- *Oil in Navigable Waters Act (Act 235 of 1964).*
- *The Maritime Zones (Delimitation) Law (PNDCL 159 of 1986).*
- *Radiation Protection Instrument 1993 (LI 1559).*
- *The Environmental Protection Act (Act No. 490 of 1994).*
- *Wetland Management (Ramsar Sites) Regulations 1999.*
- *The Fisheries Act (Act 625 of 2002).*
- *Shipping Act (Act No. 645 of 2003) (as amended).*
- *Maritime Security Act (Act No. 675 of 2004) (as amended).*
- *The Fisheries Regulation (LI 1968 of 2010).*
- *Ghana Shipping (Protection of Offshore Operations and Assets) Regulations (LI 2010, 2012).*

3.4 *STATE, CONVENTIONS AND CLASSIFICATION REQUIREMENTS*

The regulatory requirements for the FPSO are generally set out by the coastal state or shelf state, the flag state, international conventions and the classification society. The FPSO will satisfy all of the requirements from these authorities before it is approved fit for purpose.

3.5 *RELEVANT INTERNATIONAL AGREEMENTS AND CONVENTIONS*

Various international agreements and conventions that Ghana has ratified are relevant to the project such as the United Nations Convention on the Laws of the Sea and a number of International Maritime Organisation Conventions relating to safety at sea and prevention of pollution of the marine environment.

The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) contains a number of the provisions relevant to the project. These include general requirements regarding the control of waste oil, engine oil discharges as well as grey and black waste water discharges.

3.6 *PROJECT ENVIRONMENTAL STANDARDS*

The project environmental standards were derived from the EPA's Guidelines and obligations of the various international protocols to which Ghana is a signatory, or which are recommended by industry good practice Environment Health and Safety (EHS) standards or guidelines. The TEN Project will be governed by the TGL EHS Management System under which TGL has a number of EHS-related plans, programmes and procedures that will be applicable to the TEN Project. The TEN Project, like all other projects where Tullow has operational or ownership control, will comply with the Tullow Oil Environmental Standards.

3.7 *GOOD PRACTICE STANDARDS AND GUIDELINES*

The TEN Partners have adopted the International Finance Corporation (IFC) 2012 Sustainability Framework and associated Performance Standards and EHS guidelines as part of the requirements of the IFC part-funding for the project and on the basis that they represent good industry practice. For the TEN project, the relevant EHS guidelines that would apply are:

- EHS General Guidelines;
- EHS Guidelines for Offshore Oil and Gas Development;
- EHS Guidelines for Shipping; and
- EHS Guidelines for Crude Oil and Petroleum Product Terminals.

The project has also adopted relevant good practice standards provided by:

- International Association of Oil & Gas Producers (OGP) which has established industry guidelines and standards on environmental protection and personnel safety; and

- International Petroleum Industry Environmental Conservation Association (IPIECA) on oil spill response and contingency planning for the marine environment.

4 *PROJECT OVERVIEW*

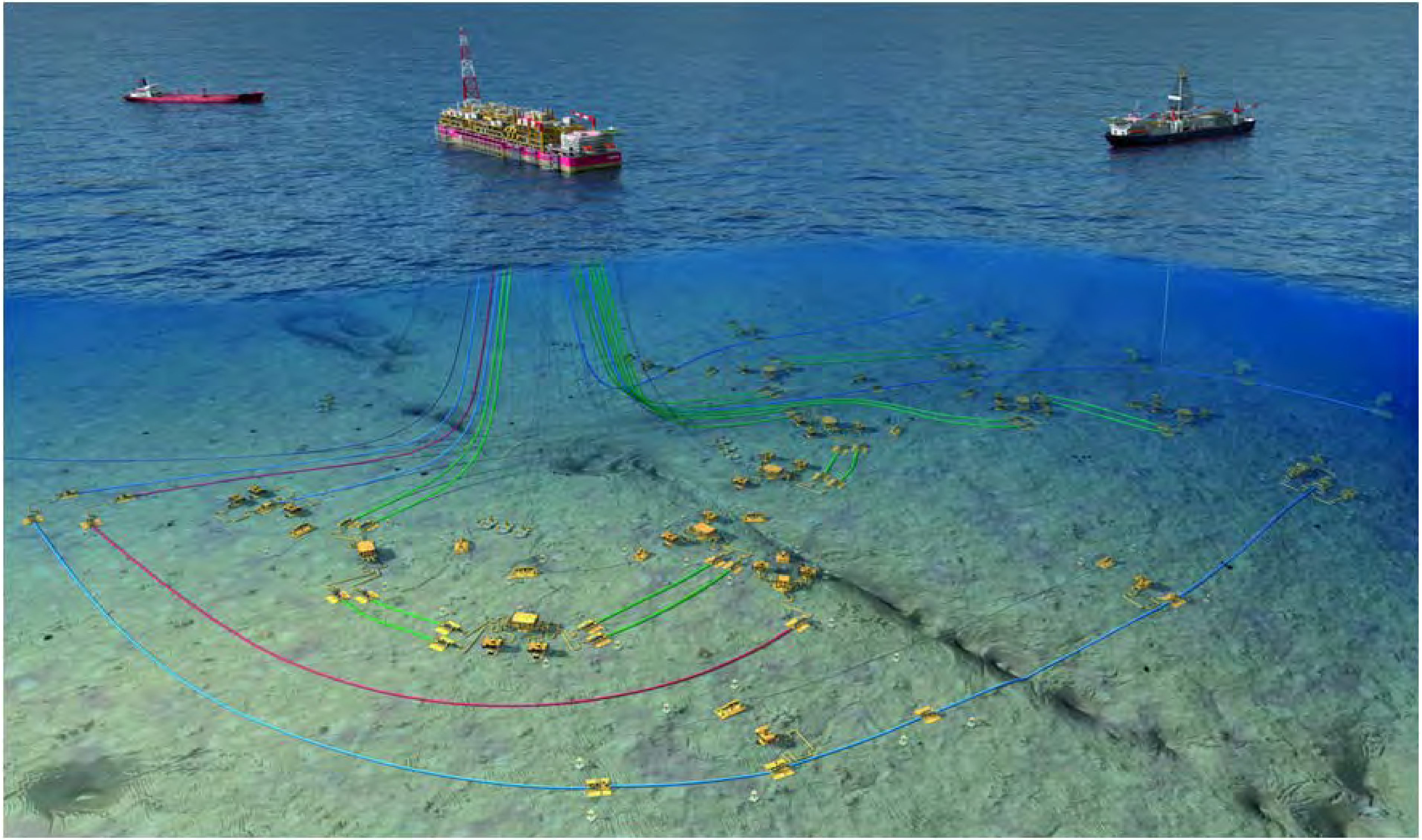
An overview of the TEN Project is shown in *Figure 4.1*.

4.1 *PRODUCTION PROFILE*

First oil production is planned for early 2016 and the field is expected to produce oil for 20 years. Average oil production in year one is forecast to be up to 52,000 barrels[1] per day (bpd), rising to a plateau rate of approximately 76,000 bpd from 2017 to 2020. A total oil and condensate recovery of 245 million barrels (Mbbl) is expected by the end of the contract term in 2035.

(1) I barrel (bbl) is approximately 159 litres.

Figure 4.1   TEN Project Overview

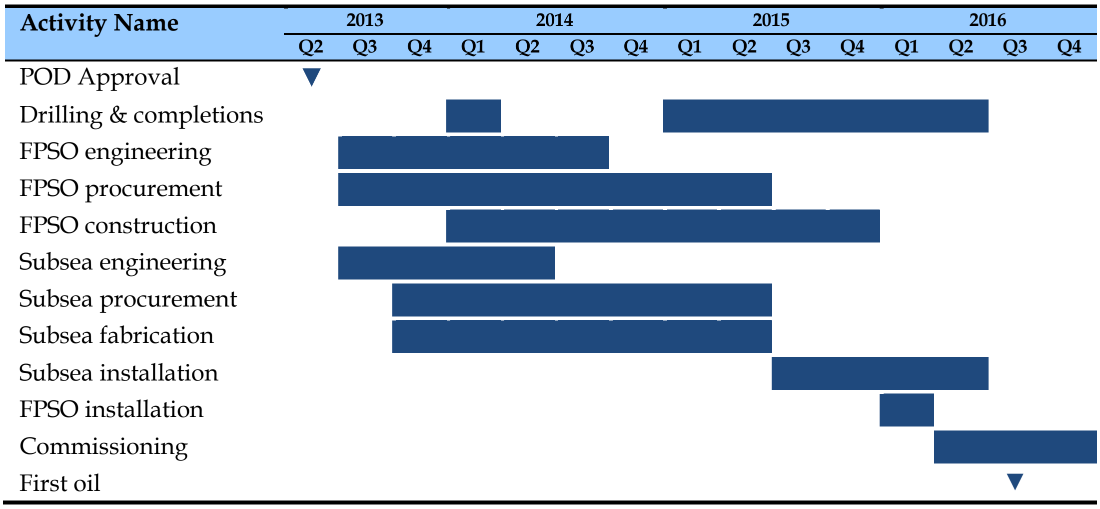


Source: Tullow 2013

4.1.1 *Project Schedule*

A provisional schedule, assuming a target date for first oil in Q3 2016, is provided in *Table 4.1*. The programme may change subject to detailed scheduling of fabrication times of various elements and the availability of drilling vessels and specialist construction vessels. The drilling and completion of the wells required for first oil will be undertaken from Q1 2014 to the end of 2015. The remaining wells required for the development will continue to be drilled following first oil until mid-2016. Subsea facilities will be fabricated from Q4 2013 and subsea installation will take place from Q3 2015 to Q2 2016. The FPSO will be installed in early 2016.

Table 4.1 Project Schedule



Note: This schedule is provisional and subject to change.

4.2 PROJECT FACILITIES

4.2.1 *Floating Production Storage and Offloading (FPSO) Vessel*

For the TEN fields, TGL will commission an FPSO vessel as the production facility (*Figure 4.1*). It is designed to receive hydrocarbons from production wells, process them and store the crude oil until it can be offloaded onto an export tanker. The FPSO vessel will be converted from an existing double hulled, 340 m long and 56 m wide Very Large Crude Carrier, the *Centennial J*. The FPSO will have accommodation facilities for a maximum of 120 persons.

The FPSO will have a storage capacity of approximately 1.7 Mbbl of oil and have a nominal capacity to process up to 80,000 bpd of oil, 65,000 bpd of produced water and 180 million standard cubic feet (MMscf) of gas.

The FPSO will be kept in position using a turret mooring system. Each of the mooring lines will be secured to the sea floor using suction piles. The FPSO will be designed and operated by a specialist FPSO contractor and TGL will lease it under a long-term contract.

Figure 4.2 Floating, Production, Storage and Offloading Vessel

FPSO Kwame Nkrumah MV21 offshore Ghana

Source: MODEC 2013

4.2.2 *Restricted Areas*

Restricted access areas, such as advisory and exclusion zones, will be enforced around offshore facilities in the development area for the safety of all sea users. These areas will be mapped on international nautical charts and formally designated by the Ghana Maritime Authority and endorsed by the International Maritime Organisation (IMO). TGL proposes to establish the following restricted areas (*Chapter 3, Figure 3.11*).

- **Area To Be Avoided (ATBA).** A 5 nautical mile (nmi) radius advisory zone centred on the FPSO indicating the presence of an oil production area where non-essential users are recommended to stay outside. Entry will not be excluded but the area will be marked on nautical charts as cautionary advice to all sea-users and specifically to the sea lane to the south.

- **Export tanker anchorage/pilotage waiting and boarding area.** A 3 nmi radius advisory area in proximity to the ATBA, providing a safe waiting area for export tankers prior to coupling for crude oil offloading.

- **Permanent safety zones.** 500 m radius safety zones surrounding the FPSO facility, endorsed by the IMO, will be legally enforceable.

- **Temporary safety zones.** 500 m radius safety zones to be applied at each of the drill centres when the Mobile Offshore Drilling Unit (MODU) is present.

Safety zones are an international standard for oil industry zoning. They will be legally enforced with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (*eg* fishermen) when potentially close to the FPSO or MODU (when present). The enforcement will also be applied by project standby and guard vessels.

4.2.3 *Subsea Systems*

A total of 10 wells will be required for first oil, comprising five oil producers, four water injectors and one gas injector. At full base case development a total of 24 wells will be required. Subsea infrastructure will be required to support production, water injection, gas injection and for system control. On the seabed, the production wells will be linked to manifolds and fluids from the production wells will flow through a series of subsea pipelines (flowlines) and through risers up to the FPSO. Dedicated subsea gas and water injection systems (including wells, flowlines and risers) will also be provided.

4.2.4 *Shore Base*

Marine vessels and helicopters will be required to support the TEN drilling, installation, production and decommissioning operations. The onshore logistics support base will be at Takoradi. Existing shore bases at Takoradi Port and the Takoradi Air Force base will be utilised. The support base will be used for dock space to serve as a loading/offloading point for equipment and machinery, provide facilities for dispatching equipment and allow for temporary storage of materials and equipment. Once the FPSO has been installed and begins operations, a supply boat will visit the FPSO on a weekly basis. In addition, two helicopter trips to the FPSO will be required daily. The TGL headquarters are located in Accra.

4.3 *PROJECT ACTIVITIES*

4.3.1 *Drilling and Completions*

A MODU will be used for drilling and completing the development wells. Drilling is expected to start with the drilling of two early wells in Q1 2014 with the commencement of the main drilling program in Q4 2014 which will continue until the end of 2017. It is assumed that it will take approximately one month to drill each well.

After wells have been drilled a process known as well completions is undertaken to install safety valves in the well to provide pressure isolation and prevent pollution in the event of damage to the wellhead and seabed surface valves. In addition, pressure and temperature gauges will be installed into producing wells to provide continuous data during the life of the wells. These valves close off the well in the event of loss of control of the reservoir fluids. Well completions will take about a month per well.

4.3.2 Installation

The FPSO will sail to site using its main engine which will then be decommissioned once arrived on site. The first step of installing the FPSO will be to install the mooring clusters. Once complete a support buoy will support each segment prior to hook up with the FPSO. The work will be undertaken by a variety of construction vessels and is expected to last 2 to 4 weeks.

4.3.3 FPSO and Subsea Systems Testing and Commissioning

Most of the commissioning and testing will be undertaken at the FPSO shipyard to minimise offshore risk and provide a timely start up. The subsea systems will be pressure tested with treated water (hydrotested) to verify system integrity. Following testing, the system will be dewatered under controlled conditions with the treated hydro-testing water discharged to sea.

4.3.4 FPSO Operations and Export Tanker Operations

Following installation and commissioning, the FPSO will receive and process fluids from the reservoirs, separating the crude oil, gas and produced water.

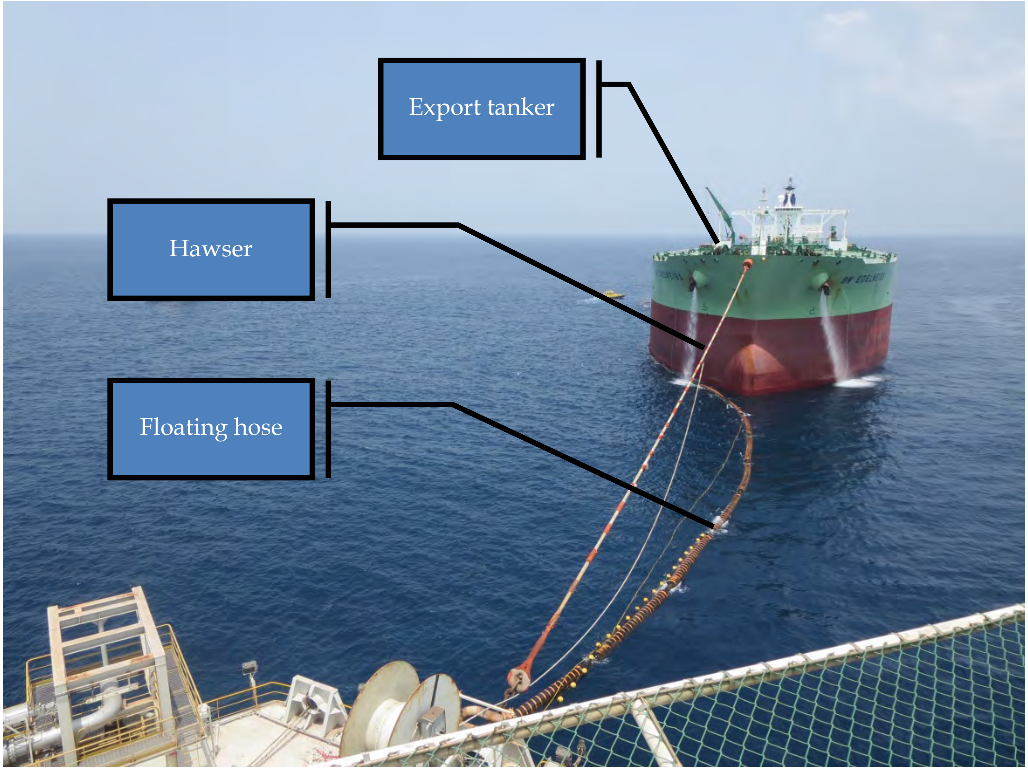
- The crude oil stored on the FPSO will be transferred to an export tanker approximately every 10 to 12 days, with offloading volumes typically being approximately one million barrels. Offloading of crude will be undertaken a tandem offloading system where the export tanker bow connects to the FPSO stern using a hawser and the oil is transferred using a floating hose (*Figure 4.2*).

- Gas will be exported to shore, via the planned GNPC Jubilee Export gas pipeline and used for energy generation on the FPSO.

- Produced water will be treated and discharged overboard.

Seawater will be treated and injected into the reservoirs to maintain reservoir pressure.

Figure 4.3 Illustrative Offloading Operations



Source: TGL

4.3.5 *Emissions to Atmosphere and Operational Discharges and Waste*

Emissions to Atmosphere

The TEN Project will generate varying amounts of air pollutants and greenhouse gas emissions such as carbon dioxide (CO_2), carbon monoxide (CO), oxides of nitrogen (NO_x), sulphur oxide (SO_x) volatile organic compounds (VOC) and particulate matter from drilling, completion, installation and operational phases.

Limited flaring will be undertaken during well testing. No continuous flaring of excess hydrocarbon gases during normal operations is planned. The intention is to avoid flaring other than under specific situations to maintain safe conditions or during limited duration activities such as process start-up and maintenance activities.

FPSO cargo tanks will be maintained in a pressurised state using a fuel gas 'blanket' to avoid the ingress of air and the potential for fire or explosion. As the cargo tanks are filled, the displaced gas and any vapours will be captured and returned to the process. If this system is unavailable, inert gas (boiler exhaust) will be used as the blanket gas and vented during cargo tank filling operations.

Discharges

Water discharges will comply with relevant Ghana standards and industry standards. Discharges to water from the TEN Project drilling, completion, installation and commissioning activities, are outlined in *Table 4.2*.

Table 4.2 ***Summary of Discharges and Treatment***

Source	Treatment
Black water (sewage)	Treat with approved marine sanitation unit Maceration and chlorination
Grey water	Remove floating solids
Food waste	Macerate to acceptable levels
Produced water	Oil-water separation (3-stage)
Deck drainage	Oil-water separation
Bilge water	Oil-water separation
Ballast water	Ballast exchange further than 200 nmi in water at least 200 m deep in accordance with the International Convention for the Control and Management of Ships Ballast Water and Sediments.
Cooling water	Filtered
Completion and workover fluids	Oil-water separation Any acids used will be neutralised prior to discharge
Riser, umbilical and pipeline commissioning	None
Drill cuttings and fluid	Non Aqueous Drilling Fluid: Recycle using Thermal Desorption Technology before discharge. Unused retuned to supplier.
Hydrate inhibitor	None
Hydraulic fluids	None
Brine	No free oil and mix with other effluent streams

Noise

The main sources of underwater sound associated with the project include vessel propellers and drilling rig thrusters, machinery noise and subsea equipment (*eg* flowlines, valves and risers).

Solid Waste

Non-hazardous and hazardous solid waste will be generated at onshore and offshore facilities during all project phases. The majority of solid waste generated offshore will be transferred from the FPSO, MODU and support vessels and appropriately managed onshore. Waste will be treated and disposed in accordance with procedures outlined in the TGL Waste Management Plan (WMP) which will be updated with specific information relating to the TEN Project.

4.3.6 *Personnel Requirements*

The project expects to employ up to 620 staff at its peak during installation and drilling phases, reducing to approximately 307 during the operational phase. The projected number of job opportunities for Ghanaians at the start of the project is also noted and this will increase over the project life. TGL and its contractors are committed to the development of national staff and capacity for the oil industry in Ghana. As of August 2013, 262 of the 291 TGL employees, *ie* 90%, were national with 29 (10%) expatriates.

4.4 *DECOMMISSIONING*

The project life is estimated as 20 years, although subsequent phases could extend this period. Decommissioning of project facilities would occur when the reservoir is depleted or the production of hydrocarbons from that reservoir becomes uneconomic. TGL will develop a project-specific Decommissioning and Abandonment Plan (DAP) early in the operational life of the project. The plan will be based on national regulations, licence requirements and international standards prevailing at the time. These currently include:

- Government of Ghana, including GNPC requirements;
- TEN Plan of Development requirements;
- international laws and conventions to which Ghana is a signatory; and
- industry good practice standards and procedures such as OSPAR decommissioning requirements.

The DAP will include decommissioning methods and procedures for individual components of the TEN facilities and infrastructure. The plan will address potential environmental and social impacts, as well as health and safety issues identified by a risk assessment. It will also include details on a post-decommissioning survey and monitoring programme.

5 *ENVIRONMENTAL, FISHERIES AND SOCIO-ECONOMIC BASELINE*

5.1 *ENVIRONMENTAL BASELINE*

5.1.1 *Climate and Meteorology*

The regional climate is controlled by two air masses: one over the Sahara desert (tropical continental) and the other over the Atlantic Ocean (maritime). These two air masses meet at the Inter-Tropical Convergence Zone (ITCZ). During boreal winter, the tropical continental air from the northern anticyclone over the Sahara brings in north-easterly trade winds which are dry and have a high dust load. During boreal summer, warm humid maritime air reaches inland over the region. In general, the region is characterised by two distinct climatic periods, namely the dry and wet seasons. The peak of the rainy season occurs from May to July and again between September and November. The maximum northern location of the ITCZ between July and August creates an irregular dry season over the region, whereby rainfall and temperatures decline.

5.1.2 *Hydrography and Oceanography*

The oceanography of the Gulf of Guinea is largely influenced by the meteorological and oceanographic processes of the South and North Atlantic Oceans. Surface water is warm (24 to 29 ºC) with the daily sea surface temperature cycle showing annual variability. The Equatorial Counter Current which flows in an eastward direction becomes known as the Guinea Current as it runs from Senegal to Nigeria.

During upwelling, cold nutrient-rich water from depths rises to the surface, resulting in increased biological productivity in the surface waters. The major upwelling season along the Ghana coast occurs from July through to September, while a minor upwelling occurs between December and January. The rest of the year is characterised by a strong temperature thermocline(1), which fluctuates in depth between 10 and 40 m. The major and minor upwellings drive important pelagic (living in the water column) species into the upper layers of the water column, thereby increasing fish catches.

5.1.3 *Bathymetry and Seabed Topography*

The TEN Project is located on the continental slope offshore Ghana in water depths of 1,000 to 2,000 m. The continental shelf has a generally regular bathymetry with isobaths running parallel to the coast. The shelf drops off sharply at about the 140 m depth contour where the slope gradient increases to nearly 10° before reducing to around 5 to 6°. Immediately following the shelf break, distinctive submarine canyons become apparent on the continental slope. These canyons measure up to 1,400 m across and are 140 m deep. The development area lies in between two of these distinctive seabed canyons.

5.1.4 *Water and Sediment Quality*

A marine baseline survey of the TEN fields was conducted as part of this EIA. The results of the survey found that water quality in the TEN fields is of good quality and comparable with other deep water surveys conducted worldwide.

Sediments in the TEN fields comprise primarily clayey silt whereas in shallower waters sediments are silty sand. Sediment quality is generally good with concentrations of metals of concern below international guideline standards for likely ecological effects.

(1) Layer of water exhibiting a marked change in temperature.

5.1.5 *Marine Habitats and Species*

Plankton

Plankton community composition and abundance is variable and depends upon water circulation into and around the Gulf of Guinea, the time of year, nutrient availability, depth and temperature stratification. Plankton biomass is highest offshore Ghana during the upwelling season which starts in July. During this upwelling, nutrient availability in surface waters in much higher leading to the increased concentrations of biomass.

Benthic Invertebrates

Benthic fauna (organisms on the sea floor) forms an important part of the marine ecosystem, providing a food source for other invertebrates and fish as well as cycling nutrients and materials between the water column and underlying sediments. The results of the TEN baseline survey found that polychaetes (worm-like organisms) and crustaceans (*eg* crabs, lobsters) were the dominant groups of benthic fauna. The composition of species across the TEN fields was largely the same and showed greater variation closer to shore.

Marine Mammals

A variety of marine mammal species have been recorded off the west coast of Africa, however, the distribution of marine mammals in Ghana is poorly understood due to the limited level of scientific studies undertaken. The majority of information on whale and dolphin species in Ghana is the result of land-based field research, mainly monitoring of fishing ports for landings of small cetacean by-catches as well as the study of stranded animals and from data obtained from operations in the Jubilee field. The results of these studies show that the whale and dolphin fauna of Ghana is moderately diverse with 18 sub-tropical pelagic species identified.

Turtles

The Gulf of Guinea serves as an important migration route, feeding ground, and nesting site for sea turtles. Five species of sea turtles have been confirmed for Ghana, namely the loggerhead, the olive ridley, the hawksbill, the green turtle, and the leatherback. All five species of sea turtles are listed by the Convention on International Trade in Endangered Species (CITES) and National Wildlife Conservation Regulations. The beaches of Ghana from Keta to Half-Assini are important nesting areas for sea turtle species. There were 45 sightings of turtles during the marine fauna observations carried out for TGL. Sightings of green, olive ridley and leatherback turtles were recorded.

Birds

The west coast of Africa forms an important section of the East Atlantic Flyway, an internationally-important migration route for a range of bird species, especially shore birds and seabirds. A number of species that breed in higher northern latitudes winter along the West African coast and many fly along the coast on migration. Seabirds known to follow this migration route include a number of tern species, skuas and petrels. Species of waders known to migrate along the flyway include sanderling and knott.

The highest concentrations of seabirds are experienced during the spring and autumn migrations, around March and April, and September and October. Waders are present during the winter months between October and March. The marine birds of Ghana include storm petrels and Ascension frigate birds. The rarity of oceanic birds may be attributable to the absence of suitable breeding sites (*eg* remote islands and rocky cliffs) off the Ghana coast and in the Gulf of Guinea.

5.1.6 Protected Areas for Nature Conservation

Several coastal habitats are important for their biodiversity as well as for rare and endangered species. However, only five coastal protected areas currently exist within the country. These areas are all located onshore and are protected under the Ramsar convention. They are the Muni-Pomadze, Densu Delta, Sakumo Lagoon, Songor Lagoon and the Anglo-Keta Lagoon complex Ramsar sites. None of these protected areas occur along the western coast. Ghana has not declared any marine protected areas. There are six Important Bird Areas (IBAs) along the coastline of Ghana, however, only one, the Amansuri Wetland, is located along the western coastline within the project area of influence.

5.2 FISHERIES BASELINE

5.2.1 Introduction

Information on fisheries was derived from published sources and through primary research undertaken in 2011 to obtain information on fish distribution and fisheries activities in TGL's areas of operation offshore the Western Region of Ghana, including the TEN Project area.

There is a long tradition of both artisanal and semi-industrial/industrial fishing in Ghana. The fishing industry in Ghana is based on resources from both marine and inland (freshwater) waters and from coastal lagoons and aquaculture. Within the marine sector, target species include pelagic, demersal and shellfish resources.

Fishing occurs year round but shows some seasonality, with periods of higher landings and periods of reduced catches through the year. Marine fishing activity in Ghana is strongly linked with the seasonal upwellings(1) that occur in coastal waters. During the upwelling periods, biological activity is

(1) An upwelling involves wind-driven motion of dense, cooler, and usually nutrient-rich water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water.

increased due to greater concentrations of nutrients in the water column that have been drawn up from deeper waters. Most fish spawn during this period and stocks are more readily available to the fishers. For the rest of the year, catches are lower and more sporadic.

Fish and fish products provide the greatest proportion of animal protein in Ghana and contribute approximately 60% of the total animal protein intake. About 75% of the total domestic production of fish is consumed locally and the per capita consumption is estimated to be about 25 kg annually.

5.2.2 *Fish Species*

The species of fish found in Ghanaian waters can be divided into four main groups, namely small and large pelagic species, demersal (bottom dwelling) species, and molluscs and crustaceans.

- The key small pelagic fish species found in the Ghanaian waters are sardinella, anchovy and chub mackerel. These species are commercially important as they represent approximately 80% of the total catch landed in the country (approximately 200,000 tonnes per annum).

- The large pelagic fish species include the tuna, billfish and some sharks. Key tuna species are skipjack tuna, yellowfin tuna) and bigeye tuna. These species are highly migratory and occupy the surface waters of the entire tropical and sub-tropical Atlantic Ocean. They are important species in the ecosystem both as predators and prey, as well as providing an important commercial resource for industrial fisheries.

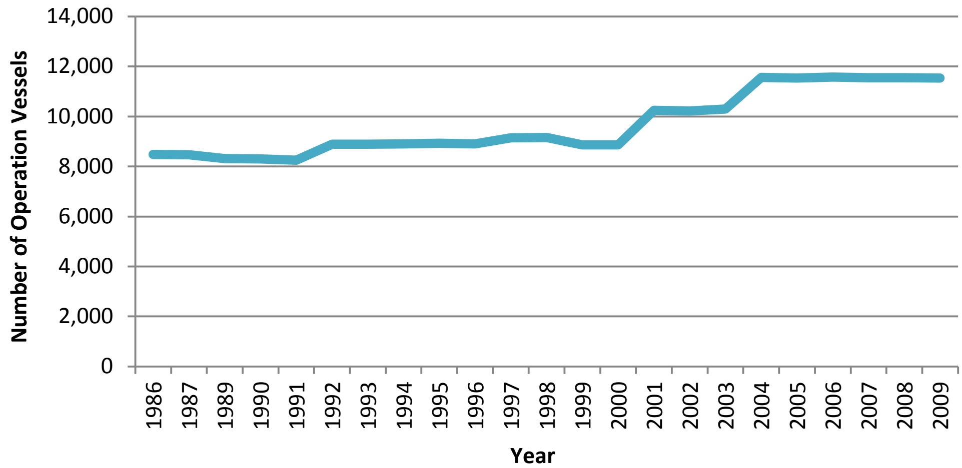
- The demersal species that are most important commercially (in terms of catch volumes) are cassava croaker, bigeye grunt, red pandora, Angola dentex, Congo dentex and West African Goatfish.

- A variety of molluscs and crustaceans are known to be present offshore Ghana. These include the common cuttlefish, pink cuttlefish, common squid, common octopus and the royal spiny lobster, deep-sea rose shrimp and other shrimps.

5.2.3 *Fishing Fleets*

The marine fishing fleet in Ghana consists of three main sectors: artisanal, inshore (semi-industrial) and industrial. The number of operational vessels from 1986 to 2009 for each of these categories is shown in *Figure 5.1*. There has been a steady increase in the number of vising vessels operating offshore Ghana. The vast majority of these vessels (more than 97 %) are involved in the artisanal sector.

Figure 5.1 Number of Operational Vessels in Ghana (1986-2009)



Note: There is no data for 1988.
Source: MFRD 2011

Artisanal Fishery

The artisanal (small scale) fisheries sector is characterised by the use of several gears including purse seine nets, beach seine net, set nets, drifting gill nets and hook and line operated from wooden canoes. Artisanal boats can range from 3 to 5 m dugouts to 12 to 18 m motorised canoes. Artisanal fishers operate anywhere in the Ghana Economic Exclusive Zone, although most operate in the inshore, shelf waters and do not venture out into deeper offshore waters. There are no traditional fishing grounds for fishing villages, instead fishermen tend to concentrate their fishing effort on a specific gear or target species. The traditional artisanal inshore fishery in Ghana is well developed and provides about 70% of the total marine fisheries production in the country.

Inshore Fishery

The inshore (or semi industrial) fishing fleet consists of locally built wooden vessels fitted within inboard engines ranging between 8 and 37 m in length. The vessels are generally multipurpose and carry both purse-seine and bottom trawl gear, exploiting both small pelagic and demersal species.

Industrial Fishery

The industrial fleet comprises large, steel-hulled, foreign-built trawlers, shrimpers, tuna baitboats (pole-and-line) and tuna purse-seiners.

- Trawlers are normally 35 m in length and mainly exploit the valuable demersals, including sole and flounders, groupers and cuttlefish as well as shrimps and pelagic tunas.

- Commercial shrimping vessels mainly target pink shrimp but in a normal trip, there are significant proportions of bycatch comprising small inshore fishes such as jacks, *g*runts, porgies, sole, flounders, croakers, *g*oatfish and cuttlefish*)*.

- The main tuna species targeted by the tuna boats of the industrial fleet, are skipjack tuna (over 50%), yellowfin tuna and bigeye tuna. Of the 39 vessels registered in April 2011, 14 were purse-seiners and 25 were pole-and-line (baitboat) vessels. Most tuna vessels operate outside the continental shelf.

5.2.4 *Supporting Infrastructure*

The Ghana Ports and Harbours Authority manages all ports and harbours in Ghana and provides facilities for bunkering, stevedoring and handling, electricity and water supplies. The main ports in Ghana are located at Tema in the east and the twin towns of Takoradi and Sekondi in the west, and provide berthing facilities for industrial fishing vessels and inshore vessels as well as large canoes.

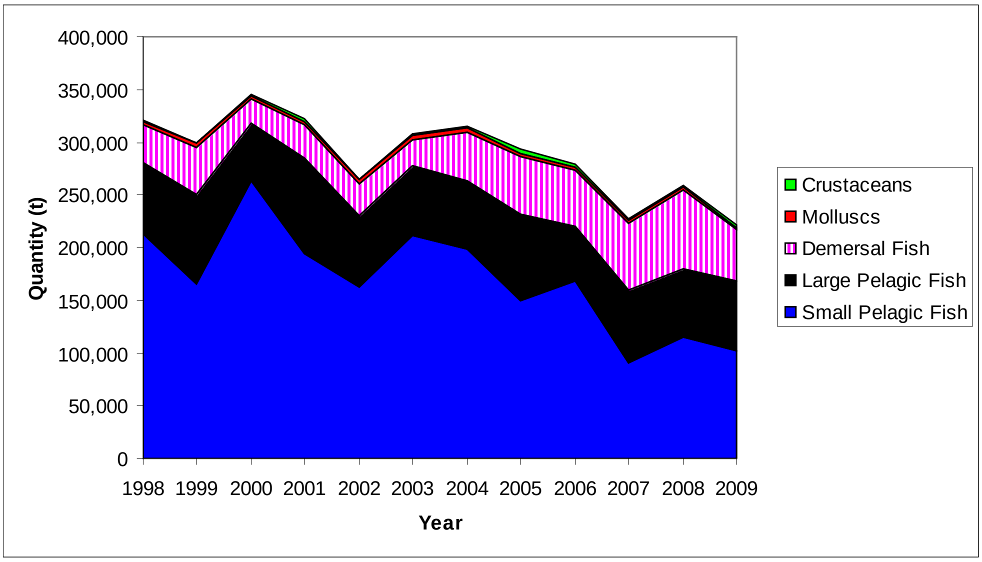
Artisanal fishers use over 300 landing sites along the coastline of Ghana. In the Western Region there are several major artisanal landing towns including Dixcove, Axim, Sekondi-Takoradi's Albert Bosomtwe-Sam Fishing Harbour, Elemina and Mumford. The typical artisanal catch landings sites are the beaches adjacent to the fishing communities.

5.2.5 *Fish Landings*

Data from 1998 to 2009 show that overall landings in Ghana are declining, particularly in the small pelagic fisheries resources (see *Figure 5.2*). Large pelagic landings have remained fairly stable, demersal species show a general increase, while landings of molluscs and crustaceans have remained consistently low.

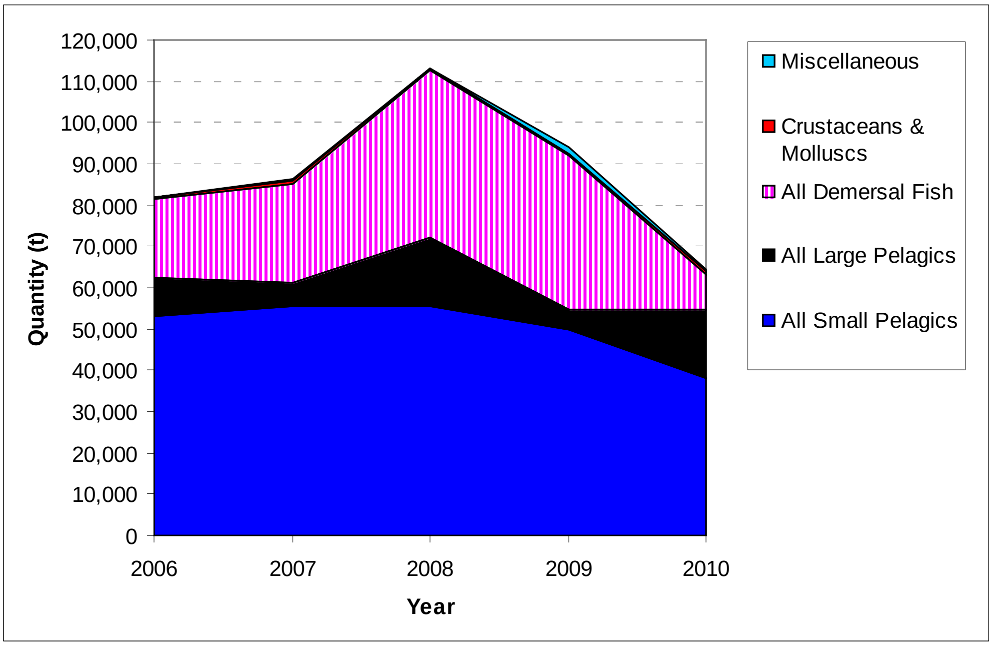
In the Western Region of Ghana, data from 2006 to 2010 also show a declining trend of overall catch. While small pelagic catches have declined slightly, there is a more marked decline in the key small pelagic species (namely round sardinella, flat sardinella, chub mackerel and European anchovy) as illustrated in *Figure 5.3*. Large pelagic landings have fluctuated quite considerably annually although landing of key large pelagic species, namely, bigeye tuna, yellowfin tuna and skipjack tuna appear to have increased slightly. Catches of demersal species show a similar trend to that seen in Ghana overall up to 2008, but then fall off sharply in 2010. As per in Ghana overall, landings of molluscs and crustaceans have remained consistently low.

Figure 5.2 Total Ghanaian Landings of Major Target Groups 1998 to 2009



Source: FAO FishStat 2011

Figure 5.3 Total Landings from Western Region of Ghana 2006 to 2010



Source: FAO FishStat 2011

5.3 *SOCIO-ECONOMIC BASELINE*

5.3.1 *Introduction*

The baseline description focused on the Western Region (the Region closest to the project) and the six coastal districts including, from west to east, Jomoro District, Ellembelle District, Nzema East District, Ahanta West District, Sekondi-Takoradi metropolis (STM) and Shama District.

The baseline draws on available secondary data (*eg* district development plans and census data) and primary data collected for the purposes of the EIA. Secondary data included the 2000 Population and Housing Census and provisional results if the 2010 Population and Housing Census.
Primary data was collected through a series of semi-structured, qualitative Focus Group Discussions and Key Informant Interviews that were undertaken at 22 communities in the coastal districts in 2012. Focus Group Discussions were undertaken with community leaders and men, fishermen and women, and Key Informant Interviews were undertaken with educators and healthcare professionals. Questionnaires were used to gather information on demographics, administrative structures and governance, local economy and livelihoods, education services, health services and local utilities and infrastructure.

5.3.2 *Administrative Structures*

The government structure in Ghana is made up of ten administrative regions subdivided into 216 metropolitan, municipal and districts areas, each with an administrative assembly comprised of a combination of appointed and elected officials. Each area has a District Chief Executive who heads the local assembly and is nominated by the President of the country and is confirmed by the assembly through balloting.

The local government is made up of the Regional Coordinating Council (RCC), four-tier Metropolitan and three-tier Municipal/District Assemblies with Urban/Town/Area/Zonal Councils Unit Committees. The RCC is the apex of the local government system. There are ten RCCs corresponding to ten regions in the country. The RCCs are non-executive bodies responsible for monitoring, coordinating and evaluating the performance of the district assemblies and any Agency of the central government. The RCC is an administrative/ coordinating system rather than a political and policy making body. The Paramount Chiefs are the traditional heads of the people and carry great influence.

The Western Region (the Region closest to the project) currently comprises 14 districts, two municipalities and one metropolis, the latter being STM.

5.3.3 *Demographic Profile*

The population of Ghana is approximately 24 million (2010 census) with the Western Region having approximately 2.3 million people. The population in the Region is estimated to have grown by 21% since the 2000 Population Census from 1.9 million to 2.3 million. This is lower than the national population growth rate of 28%, and low compared to the 66% growth between 1984 and 2000. The decline in the growth rate (compared to the previous period) may be attributed to the decrease in the numbers of people migrating into the area as well as the increase in the people migrating out of the area in search of employment.

5.3.4 *Age and Gender Distribution*

The population in the Region is relatively young, with a high concentration of people aged between 0 and 14 years. The high proportion of youth has led to a relatively high dependency level in the Region. The population in the communities consulted is also young with the majority aged between 0 and 35 years old. Consultees indicated that this trend can be attributed to the high cases of teenage pregnancy and the lack of family planning provision.

5.3.5 *Migration Pattern*

There is a high level of migration within the Region, primarily in search of employment opportunities. People migrate to areas with more employment opportunities such as Ahanta West and STM. The Region also attracts many male migrants from other Regions in Ghana due to the employment opportunities in the cocoa-growing and mining sectors within the Western Region. Seasonal migration is also a common practice, particularly amongst men who migrate to the coast during the fishing season and return to the inland areas during the farming season.

5.3.6 *Economy and Livelihood*

National Economy

Until recently, Ghana was classified by the World Bank as a low income economy, with a gross national income per capita of less than USD 1,000. On 1 July 2011 the World Bank reclassified Ghana from a low-income to lower middle-income status country. The reclassification was primarily linked to accelerated growth in Gross Domestic Product boosted by the new oil production and a recovery of the construction sector. Ghana's service sector is the largest sector of the economy, followed by agriculture (including fishing) and industry. Industry comprises manufacturing as well as mining and oil and gas sectors.

Regional Economy

The Western Region's economy currently revolves around agriculture (including fishing), mainly small landholders and artisanal fishers. Other major sources of employment include mining and quarrying and manufacturing. The Western Region has considerable natural resources, which gives it a high level of economic importance within the context of the national economy.

5.3.7 Occupations, Employment and Unemployment

More than 65% of the economically active population in all the districts are self-employed workers (75% females compared to 62% males); they have no employees. Employees who work for private and public employers constitute 32% of workers in Shama and STM, which is the highest proportion of formally employed people in the Western Region.

In the communities consulted a large portion of the population is not formally employed and is solely reliant on natural resources for their livelihoods (mainly fishing and farming). The dependency on agricultural activities has also caused a lot of seasonal unemployment whereby people who are involved in fishing and farming are unemployed during the off seasons.

5.3.8 Education

Ghana has a basic education system that is compulsory up to the age of 15. There are currently 1,320 primary schools, 694 junior secondary schools and only 42 senior high schools in the Western Region. Many children, particularly those from the rural areas, are unable to access education, especially senior high schools, due distance and affordability. Literacy levels are low with an average literacy rate of 42% in the coastal districts. This could also be attributed to high levels of employment in the agricultural and fishing sectors requiring no formal education.

5.3.9 Healthcare

The National Health Insurance Scheme was established in 2003 by the Government of Ghana to provide basic healthcare services to persons resident in the country through mutual and private health insurance schemes. Approximately 90% of the population in the Western Region live within a 5 km radius of a medical facility, with the exception of Nzema East District where some people live approximately 31 km away from the nearest hospital (*eg* Cape Three Point).

One of the main challenges facing the provision of medical services is the general lack of ambulances. This is a common problem across the coastal districts, even for some private hospitals. Malaria is the most commonly reported disease, followed by acute respiratory infections and acute eye infection. HIV prevalence was 2.0% and 2.1% for 2010 and 2011, respectively.

5.3.10 *Utilities, Infrastructure and Services*

Utilities such as water and sanitation, centralised infrastructure (*eg* roads) and services are generally more available in the urbanised areas of the Western Region.

- Approximately a third of houses in the region have access to treated piped water. The highly urbanised districts have almost 100% availability of, or accessibility to, piped water. This is in contrast to rural districts where over half of households use rivers, streams, dugouts, spring or rain water as their main source of water.

- The disposal of solid waste in gutters, open spaces and the sea has led to unsanitary conditions in some districts with over 40% of dwellings in the Western Region having no toilet facilities or having to use public toilet facilities.

- Electricity and kerosene lamps are used as the main sources of lighting in the Western Region, providing lighting needs in about 99% of the households. Charcoal and fuel wood are the main sources of cooking fuel, however liquid petroleum gas and coconut husks are also used in some districts as a source of cooking fuel. The use of electricity for cooking is limited to STM where there is more access to electricity.

- The local power plant is the Takoradi Thermal Power Plant which lies on the coast approximately 17 km east of STM, and relies on marine water for cooling purposes. The power plant started operation in 1997.

- The most common means of transport is by road where there are privately owned or state owned buses. The state owned buses usually operate within the urban areas. In the villages, private taxis and small buses owned by private individuals are operational. The road network in the Region is limited and the conditions of the roads can be very poor, particularly in the rainy season.

- Waste management is a serious issue in the Region like many others in Ghana. The predominant means of waste disposal is either by dumping, at specified sites, or indiscriminately burning or burying refuse.

5.3.11 *Marine Infrastructure*

Oil and gas drilling activities in the DWT and WCTP concession blocks are on-going during 2012 and production at the Jubilee field started in November 2010. There are several existing and planned submarine cables and pipelines although none are in the vicinity of the DWT block. Shipping in the area is associated with ports such as Abidjan (Côte d'Ivoire), Tema (Ghana), Lomé (Togo), Porto-Novo (Benin) and Lagos (Nigeria). Shipping is most intense along the busier shipping routes to the south of the DWT block.

6 IMPACT ASSESSMENT

A methodical impact assessment was then carried out to predict the magnitude of impacts and quantify these to the extent practicable. The term 'magnitude' covered all dimensions of the predicted impact (*ie* area impacted and the duration and frequency of impacts). The significance of any particular impact was determined by considering the magnitude of impact in relation to the sensitivity, importance or value of the affected resource or receptor.

The assessment of impacts took into account the mitigation measures that have been built into the project design. Additional mitigation measures were developed to reduce the severity of identified impacts to as low as reasonably practicable levels. Where impacts could not be fully eliminated by mitigation measures, the residual impact was described. The assessment addressed the impacts associated with drilling, installation, commissioning and operational phases of the development.

Impacts associated with the project are grouped under the following headings:

- Project Footprint;
- Operational Discharges;
- Emissions to Atmosphere;
- Greenhouse Gas Emissions;
- Waste Management;
- Fisheries Impacts;
- Socio-economic Impacts;
- Oil Spill Risk; and
- Cumulative and Transboundary Impacts.

6.1 SCOPING, CONSULTATION AND IDENTIFICATION OF POTENTIAL IMPACTS

In undertaking scoping, the EIA team identified key issues for further assessment in the EIA based on its knowledge of sources of potential impact associated with offshore oil and gas development and production, previous project experience and results of consultations. The outcome of the scoping consultations and impacts identified for assessment in the EIA were presented in the Scoping report, issued in January 2012. Additional issues were identified through community consultations that were held in March and June 2012. The following are some of the recurring issues and concerns that are addressed in the impact assessment.

- Communities were concerned about environmental impacts in general and, in particular, about the effect of seaweed blooms on fishing activities.

- Communities believe that the oil and gas operations have caused a decline in fishing resources.

- Fishermen are concerned about exclusion from the safety zone. They also claimed that they are harassed by the Navy, that their fishing gear is confiscated by the Navy and that their fishing gear is damaged by support vessels.

- Communities perceive a lack of community benefits and lack of employment opportunities from the oil and gas industry.

- Communities believe that TGL has not fulfilled all its promises/ commitments.

- Communities expect the oil and gas industry to improve infrastructure (*ie* schools, medical facilities, roads and electricity) and support small businesses (*eg* flexi loans especially for women).

- Communities expect the oil and gas industry to support alternative livelihoods.

6.2 PROJECT FOOTPRINT

Project footprint impacts included potential impacts of subsea infrastructure on the seabed and impacts of underwater noise on marine fauna. Impacts from the physical footprint include impacts from noise and light sources.

6.2.1 *Subsea Infrastructure*

The TEN Project will have a physical footprint on the seabed through placement of infrastructure during the construction and commissioning of subsea infrastructure and from the permanent presence of some of this infrastructure. This will result in habitat loss or disruption to defined areas of the seabed and impacts to benthos (animals living in or on the seabed) and demersal (bottom dwelling) fish.

To mitigate potential negative impacts the layout of the subsea infrastructure will be designed to avoid seabed features considered geo-hazards. This will also protect areas with potentially more diverse habitats and species. Most subsea flowlines will be laid directly on the seabed and flowline burial using methods such as dredging and jetting will be avoided to reduce suspended sediments.

The area of seabed habitat and associated species is relatively small and not considered to be of high sensitivity from the result of the baseline survey. The impacts would be long term but small scale and the overall significance of direct and indirect impacts is assessed as being of *Minor* significance.

6.2.2 *Underwater Sound and Marine Fauna*

Project generated noise includes noise from vessel propellers and thrusters, power generation units and subsea valves. Localised noise sources, if sufficiently loud, may be detrimental to certain marine species under some circumstances and may result in physical harm or behavioural changes. Of particular concern are the impacts of underwater sound on marine mammals due to the known reliance on sound for activities such as communication and navigation for some species.

Results of an underwater monitoring survey at the Jubilee field during normal operations and offloading provided an indication of the likely sound levels from the TEN FPSO. Based on the monitoring results, and an understanding of sound threshold levels for behavioural response in marine mammals, it is likely that sound levels from some activities will reach levels that could result in marine mammals avoiding an area around the source although these sound levels are likely to be limited to less than 1 to 3 km for most species and up to 6 km radius for deep diving species (*eg* sperm whales). There may be more than one source of noise in the DWT block during drilling and installation activities which will result in a larger zone of possible disturbance.

To reduce the potential for impact the project will develop and enforce a specific policy and procedures to ensure that traffic and operations of drilling vessels, support vessels and helicopters will minimise disturbance to marine mammals and turtles. Vessels will not be allowed to intentionally approach marine mammals and turtles and, where practicable, will alter course or reduce speed to further limit the potential for disturbance or collision.

Marine vessel and helicopter operators will be trained in marine mammal and turtle observation and monitoring to gather information on marine mammal and turtle distribution to inform future operations.

Noise from project activities is generally continuous or near continuous and of lower energy than from other noisy marine activities such as seismic surveys or percussive piling, that are known to have an effect on the behaviour of some marine mammals. It is considered that marine mammals that frequent the area will become accustomed to these noise sources and will avoid any areas that are detrimental to them. Overall the impact on marine mammals is assessed as being of *Minor* significance.

6.3 *OPERATIONAL DISCHARGES*

Operational discharges will occur throughout the project lifespan from routine and non-routine activities associated with drilling, commissioning and maintenance activities.

6.3.1 *Operational Discharges*

Operational discharges will include:

- black water (sewage), grey water and food waste (from FPSO, MODU, construction and supply/ support vessels);
- deck drainage and bilge water possibly contaminated with traces of hydrocarbons (from FPSO, MODU, supply and support vessels);
- ballast water (from the FPSO, MODU, supply and support vessels);
- completion fluids and occasional discharge of workover fluids (from MODU);
- cooling water (mainly from FPSO but also support vessels);
- chemically treated hydrotest waters from the subsea infrastructure during installation and commissioning;
- hydraulic fluid from subsea valve activation;
- produced water (from FPSO);
- cooling water; and
- brine discharge.

In deep water offshore areas such as the TEN fields the main environmental receptors are the waters in the vicinity of the discharges and the marine organisms that occupy these waters. The waters in the TEN fields are of good quality, as would be expected in an offshore, deep water area. The water depth, distance offshore and hydrography provides a high level of dilution and dispersion for any discharges.

Mitigation measures include the following.

- Discharge of black water, grey water and food waste will be carried out in accordance with MARPOL requirements and good industry practice.

- Black water will be treated prior to discharge to sea. Approved sanitation units onboard will achieve no floating solids, no discolouration of surrounding water and a low residual chlorine content.

- Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged more than 12 nmi from land including no floating solids or foam.

- The FPSO will be designed to enhance the dispersion of cooling water so that it will not result in an increase in ambient water temperature beyond 100 m from the source.

- The FPSO will be equipped with segregated ballast tanks and all marine vessels (including visiting export tankers) will be operated in accordance with the applicable MARPOL requirements and international requirements for ballast water exchange and management.

- Produced water will be treated through a three stage treatment process to maintain a monthly average oil concentration of less than 29 mgl^{-1} and not to exceed an instantaneous maximum of 40 mgl^{-1}.

- Selection and use of completion, hydrotest and workover fluids will be managed taking into account its concentration, toxicity, bioavailability and bioaccumulation potential with selection based on the least environmental potential hazard.

- Where possible, used completion and workover fluids will be injected into the formation, flared, or collected in a closed system and shipped to shore for recycling or treatment and disposal.

- Those completion and workover fluids that are discharged to sea will be treated to remove free oil (tested using the US EPA Static Sheen Test) and neutralised to achieve a pH of 5 to 7, prior to disposal.

- Water based, low toxicity and biodegradable hydraulic fluid will be used for subsea valve activation.

The dispersion of produced water at a concentration of 40 mgl^{-1} of oil was modelled from a surface discharge at the FPSO using hydrographic data from the TEN fields which showed that the discharge would rapidly disperse within a short distance to levels that will have not ecological effect on the marine environment.

The residual impacts for operational discharges were assessed as being of low magnitude, short term and localised and therefore of *Minor* significance.

Drilling Cuttings and Fluid

TGL commissioned a Best Practicable Environmental Option (BPEO) study with regards to the management and disposal of drill cuttings from the TEN drilling programme. The study considered a range of options for the treatment and disposal of cuttings. It recommended offshore treatment and using of advanced treatment technologies such as Thermal Desorption Technology onboard the MODU.

Discharge modelling was undertaken as part of the EIA, to quantify the transport, dispersion and bottom deposition of discharged drill cuttings and fluid. The modelling results showed that effects on the water column would be temporary and significant elevated suspended solid levels would extend to 95 m from the discharge location. Seabed depositions that, may result in smothering effects on benthic communities, will be limited to 50 m from each well site while elevated hydrocarbon levels could extend up to 1 km for each well site.

The following mitigation measures to minimise the impact of drill cuttings and fluid discharge on the marine environment will be adopted.

- Solid control systems will be used, including dryers, to reduce oil on cuttings to a target which meets the EPA (2010) discharge compliance limit.

- TGL is planning to use the more recently developed Thermal Desorption Units on its MODU to reduce oil on cuttings further prior to overboard discharge. These are proposed for wells drilled subsequent to first oil. Wells drilled prior to first oil will therefore be treated using the conventional solids control methods.

- Measures will be taken to comply with project effluent guidelines, including use of low toxicity (Group III) NADF, no free oil, and limits on mercury, cadmium and arsenic concentrations.

Given the type of drilling fluid being used, the use of improved drilling fluids and cleaning technology, the local hydrographic conditions which favour good dispersion, and the localised and temporary nature of impacts it is considered that the proposed discharges will have impacts of *Minor* significance on seabed habitats and species.

6.3.2 Onshore Bases

At the shore base, the following mitigation measures will be implemented.

- Chemical and fuel storage areas will have appropriate secondary containment and procedures for managing the containment systems. Impervious concrete surfaces will be in place at all areas of potential chemical and fuel leaks. For chemical and fuel storage, handling and transfer areas, storm water collection channels will be installed with subsequent treatment through oil-water separators.

- Loading and unloading activities will be conducted by properly trained personnel according to formal procedures to prevent accidental releases and fire and explosion hazards. Spill control and response plans will be developed in coordination with the landowners (GPHA Takoradi and Takoradi Air Force base).

Impacts from shore based operations are assessed as being *not significant*.

6.4 *EMISSIONS TO ATMOSPHERE*

Air pollutants will be emitted during all phases of the development (drilling, completions, installation, commissioning and operations). The majority of gaseous emissions from the project will occur offshore within the TEN fields. Limited gaseous emissions will occur from onshore activities *eg* from vessels visiting port, and along vessel and helicopter transport routes.

The assessment quantified potential emissions of oxides of nitrogen (NO_X), including nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs) and particulate matter from project activities and then evaluated the impacts on air quality using air dispersion modelling. Detailed air dispersion modelling was used to predict concentrations of key pollutants from emissions from TEN during drilling, completions, commissioning and operations, as well as the cumulative impacts resulting from TEN and Jubilee FPSOs. The assessment considered normal operations with no routine flaring as well as upset conditions with flaring. For the assessment, the significance of impacts was, defined in terms of the process contribution(1) and whether predicted concentrations are above or below relevant air quality standards.

The key findings of the assessment were that the potential impacts (both for short term and long term) on onshore human or ecological receptors during normal operations are *not significant.* Even considering cumulative emission, with both FPSOs operating whist drilling is taking place, there will be no air quality standards exceeded in any circumstance at any onshore locations.

During flaring events, only in the worst case event of all equipment being operated simultaneously, and flaring occurring simultaneously at both TEN and Jubilee is there predicted to be a *Moderate* significant impact from short-term SO_2 concentrations. Otherwise, impacts from flaring events are *not significant*.

With regard to impacts on transient receptors offshore, there are predicted to be significant impacts (mainly short term exceedances) in close proximity to the FPSO and the MODU(2) when in use. On this basis, exclusion of unauthorised vessels from the 500 m safety zones around the FPSO and MODU, these receptors will not be exposed to excessive air pollution.

The following specific mitigation measures will be implemented to minimise the impact of the TEN Project on air quality.

- A 500 m safety zones will be implemented around the FPSO and MODU to avoid exposure of transient receptors (*ie* fishing vessels) to excessive air pollution.

(1) This is the impact arising solely from project related emissions.

(2) The dispersion modelling considered two MODUs operating simultaneously as a worst case.

- The FPSO and MODU, construction/installation and support/supply vessels will comply with MARPOL 73/78 Annex VI standards with regards to air emissions.

- TGL will use of low-sulphur diesel fuel.

- Methods for controlling and reducing leaks and fugitive emissions, such as the use of fuel gas (*ie* reservoir gas processed for power generation on board the FPSO) for crude oil storage tank blanketing together with a vapour recovery unit, will be implemented in the design, operation and maintenance of the offshore facilities.

- Routine flaring will be avoided and non-routine flaring will be kept to minimum to maintain safe conditions or during short-duration activities such as start-up, re-start and maintenance activities.

- Routine inspection and maintenance of engines, generators, and other equipment will be carried out to maximise equipment fuel efficiency and minimise excess air emissions.

- A Vapour Recovery Unit (VRU) will be installed to collect the vapours from the gas treatment system's Tri-Ethylene Glycol (TEG) dehydration reboiler unit to mitigate the venting of aromatic hydrocarbon compounds that can be released by these units.

6.5 GREENHOUSE GAS EMISSIONS

Project activities will emit varying amounts of Greenhouse Gases (GHGs), *eg* carbon dioxide and methane, believed to contribute to global climate change. The principal sources of GHGs from the project will include: the main power generation systems on the FPSO and MODU; flaring during commissioning and engine emissions from project installation/construction vessels and supply/support vessels.

The mitigation measures aimed at reducing GHG emissions are generally built into the design of the FPSO through focus on:

- optimisation of overall energy efficiency;
- reduction in flaring; and
- reduction in venting.

TGL will use efficient and effective GHG emissions avoidance and mitigation technologies and practices, therefore, these emissions are assessed as being of *Minor* significance.

To monitor the effectiveness of measures to reduce the levels of emissions, the project will quantify annual GHG emission in accordance with internationally recognised methodologies and reporting procedures and benchmark data to establish the relative level of energy efficiency and GHG emissions.

6.6 WASTE MANAGEMENT

The project will generate both non-hazardous wastes and hazardous wastes that will require disposal in a manner protective of the natural and human environment. The potential impacts of waste associated with the project throughout the three stages of the waste management process are outlined below.

6.6.1 *Waste Segregation and Storage*

Procedures for controlling wastes, including segregation and storage, will be contained in the TGL WMP which will be updated with specific information relating to the TEN Project. Proper segregation of waste will facilitate the re-use and recycling of suitable waste streams as identified in the WMP. Designated areas for the temporary storage and segregation of waste will be available on the FPSO, MODU and supply vessels. The onshore bases at the Takoradi Port and the Air Force base will also have secure waste reception and storage facilities.

The WMP will cover both offshore and onshore facilities and assuming the mitigation measures defined in the WMP are implemented, the risk of significant accidental discharge or spillage will be minimised. The impacts of waste storage and segregation are predicted to be *not significant*.

6.6.2 *Transport of Wastes*

Waste will be transported to waste treatment and disposal locations in accordance with operational controls outlined in the WMP. Mitigation of potential impacts of waste transport will be by the following operational controls.

- Wastes will be transported in a safe manner, in accordance with the associated Material Safety Data Sheet information for spent chemicals and other industry packaging and transport advice.

- Appropriate containers will be used, including skips and bins for specific types of solid or liquid waste. Overfilling of containers will be avoided.

- Waste will be transported using properly maintained, legally compliant and suitable vehicles and vessels that are driven/crewed by appropriately trained operators.

- Vehicles and vessels to be used for the transport of wastes will be assessed and approved to meet minimum standards and TGL vehicle policy.

With these good practice controls in place the residual impacts are assessed as being *not significant*.

6.6.3 *Waste Treatment and Disposal*

Project generated waste will require recycling, treatment or disposal in a manner that avoids significant environmental impacts. Suitably EPA approved companies providing waste treatment and disposal services will be selected by review and evaluation in line with international good practice. TGL will undertake periodic audits of third-party waste facilities and sites to verify that wastes are being managed in line with standards and methods agreed in TGL waste contracts. The WMP will include waste tracking procedures to allow waste consignments to be tracked from source of generation to end point.

Most project wastes will be non-hazardous and will either be recycled (*eg* scrap metal), reused (*eg* wood) or disposed of at landfill sites in Ghana (*ie* general domestic waste that cannot be recycled). TGL will continue to work with waste contractors to identify opportunities for further recycling of waste to reduce quantities of waste sent to landfill.

Where feasible, hazardous waste such as used off-spec oil and slops will be recycled back into the production crude stream on the FPSO. Other hazardous waste including used oil from maintenance activities will be sent to an approved waste contractor for treatment. Where facilities currently do not exist in Ghana to treat certain types of hazardous waste (*eg* batteries, oily rags and fluorescent light tubes), TGL will store small quantities of these waste at a secure holding area at their onshore bases. TGL is working with the EPA on these issues and with its waste contractor to provide additional waste treatment services.

TGL, will verify, through audits that waste is treated and disposed of in accordance with international good practice, therefore, this impact is assessed to be of *Minor* significance. TGL will continue to work with waste contractors to facilitate the continuous improvement and upgrading of facilities.

6.7 *FISHERIES IMPACTS*

6.7.1 *Impacts of FPSO Presence on Local Fish Populations*

Large pelagic fish species (*ie* tuna and billfish) and deepwater species will be present in the TEN Project area. Pelagic species, that inhabit the surface layers of the water column, are likely to be impacted by the presence of the FPSO and MODU as many pelagic fish species are known to associate with floating objects. Safety zones around this infrastructure will provide some protection to these species from fishing activity. Deepwater fish communities are likely to be affected by installation and presence of subsea infrastructure.

The main pelagic species that are targeted by fishermen are highly migratory and will not be permanent residents in one area an those attracted to the offshore installations will not likely spend significant periods of time at these facilities. Although fish species will be afforded some protection from fishing activity by the safety zones around the FPSO and MODU, the benefit to fish ecology is assessed as of *Minor* significance.

During the night fish species may be attracted by artificial light from vessels, increasing the prey availability for other species, however, the positive impact will be *not significant* given its limited scale. Negative impacts due to disturbance during installation of subsea equipment may occur, however, this is assessed as *not significant* as fish are sufficiently mobile to avoid temporarily impacted areas.

6.7.2 Impacts on Fisheries

The TEN Project area is in an offshore area where the water depth precludes trawling or other bottom fishing activities. Therefore, fishing for oceanic large pelagic species using passive gear (long lines) and active gear (pole and line, purse seines) is the only fishing activity in the area. Potential impacts on fisheries can arise from three main sources:

- loss of access to the area due to vessel presence and safety zones;
- attraction of fish to the FPSO and MODU; and
- disturbance to fishing activities and damage to fishing gear from project support vessels and supply vessels transiting to and from Takoradi.

The following mitigation measures will be implemented to minimise any potential impact on the fishing industry.

- TGL Community Liaison Officers (CLOs) will liaise between fishermen and the project and provide information to fishing communities regarding TGL's activities and notify them of the requirement to keep away from the operations for safety reasons. The CLO will also deal with any claims for gear damage through TGL's grievance mechanism.

- The project and contractors will notify mariners of the presence of the FPSO and other marine operations within the TEN fields and the safety and advisory areas will be marked on nautical charts as cautionary advice to all sea users.

- A vessel transit route will be agreed with the Ghana Maritime Authority and communicated to fishermen and other marine users through the CLOs.

- The safety zones will be monitored with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (*eg* fishermen). A code of practice (based on UN voluntary principles of security and human rights) and training for those responsible for maintaining the safety zones will be developed.

- TGL will continue to liaise with the Fisheries Commission to identify opportunities to improve understanding of current fishing activities within the Ghana waters and investigate ways to reduce potential conflict between the oil and gas industry and fishing industry.

The impact on fisheries is expected to be small given the low numbers of vessels likely to fish in the offshore, deepwater area where the TEN fields are located, the small areas where fishing activities will be excluded from and the limited additional vessel movement as a result of the project.

The residual impact on fishing activities was assessed as being of *Minor* significance with the exception of fishing activities using passive fishing gear (*eg* long lines), in which case the impact is assessed as *not significant* given the limited use of passive gear offshore Ghana.

6.8 SOCIO-ECONOMIC AND HEALTH IMPACTS

Socio-economic and health impacts include those impacts that may be reasonably expected to affect Ghana at a national level and those that are likely to be experienced at a more regional and local scale, for example the coastal districts in the Western Region, including communities in the vicinity of the onshore bases. Impacts on fisheries are discussed in *Section 6.7*.

The assessment was made with a number of considerations.

- The project operations are primarily located offshore and there will be few direct interactions with other human activities.

- The majority of the deepwater offshore infrastructure will be transported to the field by sea from international locations, and the shore base operations in Ghana will be limited to routine project support, supply runs, equipment and materials storage and waste handling.

The project is, however, expected to have associated indirect and induced effects.

6.8.1 Increased Government Revenue

The oil production from the project will contribute to the Government of Ghana's revenue through its share of direct sales as well as taxes and royalties. Government revenue will be increased by the payment of royalties and taxes and other incomes in relation to production once the project is operational. The revenues generated by the project will be a valuable source of finance for the government with the potential to facilitate investment in the country's socio-economic development.

Ghana's ability to benefit from the economic gains that the project offers at a national level will depend on good governance and fiscal management. The government will be solely responsible for the allocation of revenues based on the requirements of the *Petroleum Revenue Management Act (Act No. 815 of 2011),* internal government policies, and by the country's development needs. TGL has limited ability to directly optimise or manage potential impacts on the national economy but will contribute to impact mitigation and optimisation by working with Government of Ghana and other stakeholders throughout the life of the project to develop measures that align with the objectives of on-going government programmes.

Both Ghana and TGL are signatories to the Extractive Industries Transparency Initiative which is a global standard for transparency in oil, gas and mining. The absolute value of the revenue from oil can be unpredictable as it depends on market prices and the management of the revenues requires good fiscal policy. Overall, the impact of increased government revenue is predicted to be positive, long term and experienced at a national level and is therefore assessed to be of *Moderate* significance.

6.8.2 Employment and Skills Development

Direct employment by the project and indirect employment through contractors and suppliers will have a positive impact on those people employed, their families and their local communities from wages and other benefits. In general, the oil industry is not a large employer in relation to the revenues it can generate, therefore, the spread of money through wages into the wider local economy is less than that experienced for similar sized industries such as manufacturing or service-based industries. Realising the potential benefits from direct and indirect employment will require enhancement of relevant skills in the local workforce.

The TEN Partners will employ Ghanaian personnel as far as reasonably possible and provide opportunities for employment for such personnel. TGL's local content strategy aims to enhance sustainable economic and social development in Ghana by creating employment opportunities in the oil and gas industry. TGL has in place, and will continue to implement, local employment and skills development policies for the recruitment, training and development of national staff in its operations.

TGL will require contractors to apply the same local employment and skill development requirements. TGL's recruitment practices will be based on ability, objectivity and fairness and employment opportunities will be advertised widely and, where relevant communicated to communities in the coastal districts of the Western Region by the CLOs.

In recognition of the current skills shortage in the Western Region and Ghana, TGL will, through its Social Investment (SI) Framework, investigate partnering with Non-Governmental Organisations and training organisations to support primary, secondary and tertiary level education.

Overall the impacts from direct and indirect employment will be long term, localised and relatively small scale and is assessed as being of *Minor* significance.

6.8.3 Procurement of Goods and Services

Impacts from procurement of goods and services are likely to be positive through stimulating small and medium sized business development with investments in people (jobs and training) and generation of profits. Business investment in new and existing enterprises that provide goods and services can provide the basis for their longer term sustainable growth as they diversify to provide goods and services to other industries. Secondary wealth generation from the development and use of local providers of goods and services can be reasonably expected to have a positive impact through the generation of revenue able to flow into the local economy.

TGL's existing local content strategy is aimed at building the capacity and capability of Ghanaians and Ghanaian businesses to support the long-term development of the emerging oil and gas sector. TGL has already demonstrated a commitment to local procurement in its current operations, where an average of 77% of contracts was awarded to Ghanaian companies in the first six months of 2011. In particular, the following measures, many of which are already being done by TGL, will be taken to enhance procurement of goods and services from companies in Ghana.

- Contracting companies to establish longer term commitments to the businesses which will promote sustainable long term growth and help new businesses become established.

- Conduct contractor screening and develop contract conditions to ensure the requirement for local content (nationalisation) is passed to contractors, so goods are purchased locally where possible, and employment rights and conditions are respected.

- Working with suppliers to help them meet the required standards in areas such business awareness, employee rights, training, environment and health and safety.

- TGL will partner with organisations to develop a programme for strengthening the capacity of Ghanaian businesses to deliver identified goods and services to the industry.

TGL will also monitor pressures on local goods and services through community consultations to determine if project related demand is creating a significant effect on the communities.

Positive impacts will be long-term, relatively small scale and localised and are assessed as being of *Minor* significance.

6.8.4 Influx of Job-Seekers into the Region

During the EIA scoping consultation, stakeholders reported an influx people into the Western Region in search of employment since the discovery of oil in 2007. There appears to be a general perception in Ghana that, with the developing oil industry, the Region offers more employment opportunities. According to stakeholders consulted, the influx has resulted in an increase in the cost of living, specifically property rents, negative social effects (*eg* prostitution and drug use), road traffic and informal settlements. Mitigation of the impact of influx of job seekers will focus on reducing incorrect public perceptions about potential job opportunities and on addressing public expectations about project related job opportunities.

TGL will develop a Stakeholder Engagement Plan to provide on-going engagement with the public and the communities in the six coastal districts in the Western region from project implementation to decommissioning. Mitigating the effect of the influx of job seekers will involve working with government in delivering SI projects that could support infrastructure projects in the coastal districts.

Even with better communication on the limits of potential jobs by TGL, it is likely that the levels of in-migration of job-seekers into STM will continue due to the perceived job opportunities and economic benefits. The impacts will be indirect in nature as the influx will be linked primarily to job-seekers, not to workers. The impact is localised and small scale therefore the overall the impact is assessed to be of *Minor* significance.

6.8.5 Issues with Heightened and Unmet Expectations

During the consultation process undertaken in March and June 2012, it was evident that stakeholders have high expectations of TGL, in terms of economic benefits, infrastructure development and general improvements to living conditions expected from the oil and gas industry. The communities also expressed their dissatisfaction related to its unmet expectations linked to the Jubilee project and the manner in which TGL addressed problems that arose.

Means to manage people's expectation are focussed on aligning the project's social benefits and community investments with government programme and community needs and with clearly communicating project plans and actions. TGL will address unmet expectations of communities through on-going communication in accordance with its Stakeholder Engagement Plan. TGL will also consider regional and district development plans and priorities in developing their SI Framework, programmes and projects and consult with government agencies and communities prior to its implementation. TGL will support Ghanaian businesses through their local content strategy and SI programmes and projects that are aimed at enterprise development. These measures may not eliminate these issues but will serve to improve relations between TGL and stakeholders through pro-active management of issues and concerns.

Stakeholders' exceptions and perceptions can change and TGL will continually engage with the stakeholders in order to remain aware of these perceptions and expectations so that they can respond to issues as they arise.

Heightened expectations are primarily localised to communities in the six coastal districts but may persist in the long term depending on the situation and the manner in which TGL resolves the on-going issues. Overall, the impact is assessed as being of *Minor* significance taking into account the awareness raising activities being conducted by the CLOs.

6.8.6 *Commercial Shipping*

The main potential source of impacts to existing navigation and shipping traffic in the area are likely to arise as a result of the additional vessel movements associated with the project, in particular during the installation of the project offshore as more significant numbers of vessels will be involved. The main shipping routes through the Gulf of Guinea are just south of the DWT block. The larger commercial ships that pass through the area and the project related vessels themselves will be well equipped with radar, navigation equipment and ship-to-ship communications. Safety zones will be designated around each installation.

The notification and liaison measures outlined in *Section 6.7* to manage the potential impacts to fishing will be equally applicable to reducing the risk of collision between shipping vessels and project vessels. Communication and navigation equipment of the FPSO and project vessels and vessel operations will be in accordance with international maritime safety requirements. The residual impacts on commercial shipping are assessed as being of *Minor* significance.

6.8.7 *Onshore Operations*

While increased or sustained economic activity and employment at the onshore bases will generally be a positive socio-economic impact there is also the potential for some negative impacts associated with the proposed onshore activities for example additional traffic and noise. These impacts will not all be a direct result of the project as they are associated with the existing activities at the port, nevertheless the project activities will contribute to these impacts. The potential exists for a negative impacts on the capacity of the utilities (*eg* water supply) and infrastructure (*eg* roads) that supply the existing base and consequential impacts on surrounding communities that share these.

The environmental and social performance at the shore based locations that the project operates will be covered by the project EHSMS. This will ensure EHS policies and procedures are in line with project expectations, particularly regarding community impacts such as interactions with neighbours, noise abatement, traffic management and storage of wastes.

A grievance procedure will be implemented and made known to the surrounding communities and the general public. Given the location of the shore base at an existing port and the scale of employment and service industry requirements the residual impacts of the project activities at the shore base and surrounding areas are assessed as being *not significant.*

6.8.8 Community Health

The onshore presence of the project could result in health and wellbeing of local communities through worker-community interactions resulting in increased disease transmission, increased traffic movements and increased pressure and possible drawdown on health care resources. TGL will ensure strict compliance with pre-employment and regular screening protocols for employees (including contractors and subcontractors), training and adherence to a Worker Code of Conduct which includes guidelines on worker-community interactions and alcohol and drug use, and continue to implement a programme of stakeholder engagement with a grievance procedure.

The size of the workforce housed onshore will be small, and the supply base in Takoradi and offices in Accra have been established for some time. Therefore the impact of communicate and sexually transmitted infections is considered *not significant*. The supply base is located in an industrial zone and any project related traffic will likely only represent a small uplift in overall traffic using existing routes. The risk of an accident leading to a serious injury is assessed as *Minor* significance on the community level when appropriate journey management is followed.

Due to the relatively small size of the workforce and the measures that will be implemented to minimise transmission of diseases, promote workforce health and the provision of project health care facilities it is considered unlikely that there will be significant levels of increased pressure on health care resources. In the event of a pandemic or a major incident it may be difficult for existing health care facilities to cope with any increased demand of medical care. This would, however, be very short-term whilst alternative health care provision is provided to the workforce, alleviating any increased pressure on existing public facilities, and as such the impact would be of *Minor* significance.

6.9 IMPACTS FROM OIL SPILLS

6.9.1 *Oil Spill Risk*

The risk of an oil spill (including crude oil and fuel oil) into the marine environment is inherent in all offshore oil developments. The likelihood (probability) of significant oil spills (*ie* those that can reach the coastline or other sensitive areas) from FPSO operations is very low (*eg* 1 in 2,000 years) with oil spills that do occur being very small and having only limited environmental effects. The assessment of risk therefore requires consideration of the likelihood of a particular type and size of spill event occurring and the environmental consequences in the event of a particular spill.

A representative range of credible oil spill events were identified based on the conclusions of the Jubilee Phase 1 Quantified Risk Assessment (QRA). Evaluation of frequency, size and nature of historic spills indicated that 99% of spills result from small leaks and spills. The most likely source of a spill is from a transfer hose during oil unloading from the FPSO. Based on historical data a spill of this kind is predicted to occur twice every ten years. It would be a relatively small spill of less than 1 tonne. Large spill events such as a blowout are highly unlikely to occur for example once every 2,000 years.

Based on the identified events, scenarios were developed for oil spill simulations as part of a modelling study to predict the likely trajectory and fate of an oil spill if it occurred and to give an indication of the likelihood of a particular location area of sea or coast being affected.

6.9.2 *Modelling Results*

The oil spill modelling used to predict the consequences of the various oil spill scenarios in the event that a spill required information on the nature of the oil spilled, the location and duration of the spill, the behaviour of the oil in the marine environment, and its transport from the spill site to other marine and coastal areas. Six spill scenarios were simulated with the aim of assessing the impact of oil on nearby surface water and shorelines from potential oil spills. Four of the scenarios simulated small surface spills (crude and marine gas oil) between 900 and 1,100 barrels from a riser leak (with and without protective system), a transfer house release and a release during fuel bunkering. The other two scenarios simulated very large blowouts at two well locations (600,000 barrels over 60 days). The conclusions from the modelling are summarised as follows.

- For the four surface oil spill scenarios, oil would predominantly travel towards the northeast following the predominant winds and easterly currents.

- The potential for shoreline oiling from the surface spills is low (less than 25%). The highest probability of oiling is around Axim. The minimum time for oil to reach the shore from these scenarios range between 28 and 32 hours.

- On average, at the end of simulations, approximately 60 to 65% of the initial spilled volume of crude oil could remain on the shoreline, whereas only 12% of marine gas oil is predicted to remain.

- The predominant transport direction of the two blowout scenarios is towards the east-northeast. The scenario located closer to shore has a higher probability of reaching the coastline. The coastline between Half Assini and Axim has the highest probability of impact (90 to 100%).

- Both blowout scenarios showed oil being transported throughout the Gulf of Guinea, with oil making landfall in Liberia, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea and São Tome and Principe.

- There are high probabilities of shoreline impact in Côte d'Ivoire from both blowout scenarios. There is a lower probability of impacting shorelines in Togo, Benin and Nigeria and very low probability (less than 10%) of impacting coastlines of Liberia, Cameroon, Equatorial Guinea and São Tome and Principe.

- The average time for oil to reach the shore from a blowout scenario ranges between 5 and 8 days, depending on which well and its distance from shore. A maximum of just less than 50% of the spilled oil could be washed ashore.

6.9.3 Mitigation Measures

Mitigation of oil spill incidents for the TEN Project will be addressed through the implementation of oil spill prevention and oil spill preparedness measures. The primary mitigation measure for avoiding the impacts of an oil spill is to prevent any such spill taking place in the first place. This will be done through technology applications as well as operational controls.

TGL has designed the project facilities with a range of inherent measures designed to minimise the risk of potential of oil spills.

Oil spill prevention measures that will be implemented as part of the design of the project will include the following.

- Blow-Out Preventers and subsea valves will be permanently installed on the wells during well completions, and the double mechanical barrier system will be used during production and injection operations.

- Wells, subsea flowlines, risers, emergency shutdown systems and FPSO topsides will be designed to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to ensure that performance standards are met.

- The FPSO deck and drainage system will be designed to contain spills on the FPSO (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release.

- Specific procedures will be developed for offloading crude from the offloading buoy onto the export tankers. These will include vetting of tankers involved in offloading, management of offloading activities by trained and experienced personnel, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (including contingencies for any engine failures), and the continuous monitoring and actions to be taken in the event of any non-routine events or equipment failures.

Despite the prevention measures and management procedures built into the design of the project there is always a risk that an oil spill can occur. TGL will update its Oil Spill Contingency Plan to include the TEN project phases. The OSCP contains detailed procedures that will be taken in the event of small, medium and large oil spills (known as Tier 1, 2 and 3). This includes access to international scale response capabilities including trained personnel, clean up equipment and dispersant capabilities.

6.9.4 Impact Assessment

In the event of an oil spill there will be localised impacts to water quality, however, the more significant impacts would be on marine biodiversity, and in particular those species that frequent the sea surface, including seabirds, marine mammals and turtles. Fish species and larger invertebrates in deeper water can be expected to be less exposed to impacts from oil spills as they will tend to avoid the sea surface or leave the impacted area in the event of a spill.

For large spills and assuming the prevailing wind is from the southwest there is a possibility that secondary impacts would be experienced on the coastline if the oil beaches. If oil reached the coastline, impacts could include contamination of sensitive coastal habitats such as mangroves, wetlands, lagoons and turtle nesting beaches and impacts on species that frequent such habitats such as coastal birds and fish. An additional impact of oil reaching the coastline would be the potential impacts on local communities, for example from the damage or even loss of fishing grounds.

The likelihood of a large spill is very low, however, the consequences if the spill reaches the coast are very high. Given the likelihood of a large spill is approximately one in every 2,000 years the residual significance is assessed as *Moderate* significance.

6.10 *CUMULATIVE IMPACTS*

Cumulative impacts can result from individually slight but collectively significant activities taking place over a period of time. An assessment of cumulative impacts requires consideration of other plans or projects that may act cumulatively with the proposed project to cause environmental and social impacts. Consideration of other plans or projects in a cumulative impact assessment is usually restricted to those plans or projects occurring at the same time, those that have been consented but not yet completed, or those that are under consideration by the determining authority.

Within the TEN Project area the main potential cumulative impacts will be from the Jubilee field operations, on-going exploration and appraisal drilling and any future phases of the development in the DWT block. In the adjacent licence blocks the main cumulative impacts will be from planned exploration and appraisal drilling and potential future development projects. Cumulative impacts from increases in the level of shipping and helicopter traffic servicing other oil and gas field exploration and development programmes in the area will also occur. Onshore, the project will interact with other current and future activities at the logistics bases/ports and will result in an increase of activity at Takoradi port and the Air Force base airport and heliport.

TGL has the ability to mitigate potential impacts associated with the TEN Project and other operations where it is the designated operator. It has a more limited ability to manage or influence activities by others which may result in cumulative impacts. Management of impacts from a range of different activities will in large part depend on the measures put in place by the government, oil and gas companies and other stakeholders in the coming years. The general approach for mitigating and managing potential cumulative impacts will therefore require coordination of all the relevant industries, the private sector and agencies under the direction of the Government of Ghana.

Strategies that could help manage potential future cumulative impacts are outlined below.

- A government-led Strategic Environmental Assessment (SEA) would enable a comprehensive consideration of potential impacts that may result from the development of the oil and gas sector in Ghana.

- Build capacity of local administration to plan effectively for future development in the area.
- Companies (especially those engaged in the oil and gas sector) operating in the Western Region and the Government should collaborate to agree on common standards and approaches for managing cumulative impacts.

- A structured programme of data gathering and monitoring studies led by government would allow for the proactive management of negative trends that could arise over time.

- The environmental standards should be collectively applied by the government on all businesses operating in Ghana and especially the Western Region.

- Collaboration of the oil and gas industry, shipping interests and the Government of Ghana to develop and support an integrated approach to oil spill response including shared resources and expertise and joint training and exercises.

Cumulative impacts from other current and planned projects are assessed as *Minor*. In future, emissions of GHGs from the TEN Project and other oil and gas developments will likely result in a significant increase in national emissions relative to current emissions. Onshore, the developing oil and gas industry is expected to have positive benefits by increased revenue to the Government of Ghana and infrastructure development.

6.11 TRANSBOUNDARY IMPACTS

No significant transboundary impacts are expected to occur as a result of normal operations. However, modelling simulations of a large crude oil spill showed oil being transported throughout the Gulf of Guinea, with oil making landfall in Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, and Equatorial Guinea. Dealing with transboundary oil spill incidents is not within TGL's remit and the response to any such spills will be by the Government of Ghana.

The Government of Ghana is currently working closely with the other contracting parties of the Abidjan Convention to seek and finalise formal arrangements for dealing with transboundary oil spill incidents. Due to the high sensitivity of resources and receptors but the low probability of large transboundary spills the impact is assessed as being of *Moderate* significance.

7 *MITIGATION AND MONITORING*

A key objective of the EIA was to develop and describe practical, commensurate and cost effective mitigation and management measures that avoid, reduce, control, remedy or compensate for negative impacts and enhance positive benefits. The objectives of mitigation have been established through legal requirements or industry good practice standards and where standards were not available, project-specific standards have been established.

The approach taken to defining mitigation and management measures is based on a hierarchy of decisions and measures (*Box 7.1)*. The majority of mitigation and management measures fall within the upper two tiers of the hierarchy and are effectively built into the design of the project. *Section 6* summarises the key mitigation measure proposed by TGL.

A series of monitoring programmes are proposed to obtain data to verify project performance against agreed standards (*eg* discharge limits) to record trends to aid continuous improvement (*eg* flaring volumes, employment levels and responses to complaints), to obtain information to verify prediction (*eg* seabed monitoring of the effects of drill cuttings) and to gather additional data where there are identified data gaps (*eg* marine mammal distribution).

Mitigation measures and monitoring requirements will be maintained in TGL's Commitments and Legal Database. A separate Monitoring Plan dealing with the environmental and social monitoring requirements will be produced for the TEN Project and implemented by TGL and its contractors. The plan will be implemented prior to first oil (planned for early 2016), although certain elements will be in place earlier than this.

Box 7.1 Mitigation Hierarchy

THE MITIGATION HIERARCHY FOR PLANNED PROJECT ACTIVITIES
Avoid at Source; Reduce at Source **Avoiding or reducing at source is designing the project so that a feature causing an impact is designed out (eg a waste stream is eliminated) or altered (*eg* reduced waste volume).**
Abate on Site **This involves adding something to the design to abate the impact *eg* pollution controls.**
Abate at Receptor **If an impact cannot be avoided, reduced or abated on-site then measures can be implemented off-site (*eg* noise or visual screening at properties).**
Repair or Remedy **Some impacts involve unavoidable damage to a resource, *eg* land disturbance. Repair essentially involves restoration and reinstatement type measures.**
Compensate in Kind **Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss or damage might be appropriate.**

Implementation of the findings and outcomes of the EIA process are described in the provisional ESMP for the TEN Project. The elements of this provisional plan will be taken forward and incorporated into a separate TEN Project ESMP that will be used to deliver the project's environmental regulatory compliance objectives and other related commitments. With respect to the significant impacts identified by the EIA, the ESMP provides the linkage between each significant impact, the relevant mitigation measures and the monitoring approach.

The TEN Project ESMP will provide an outline of the procedures and processes that will be incorporated into project activities to check and monitor compliance and effectiveness of the mitigation measures to which TGL has committed. The key element of the TEN Project ESMP will be a series of Environmental Management and Monitoring tables. TGL will manage key contractor parties to ensure that the ESMP is implemented and monitored.

From commencement of operations the TGL Environmental, Health and Safety Management System (EHSMS), certified to an international standard, will also be applied to the TEN Project. The TEN Project ESMP will be a component of TGL's overall EHSMS. Appropriate plans, procedures and programmes will be implemented during the course of the project to ensure that key elements of the EHSMS management expectations are met.

Other project management plans will include the following:

- Social Investment Framework and Plan;
- Emergency Response Plan;
- Helicopter Operations and Logistics and Transport Plans;
- Human Resources Strategy and Plans;
- Local Content Plan;
- Marine operations Plan;
- Oil Spill Contingency Plan;
- Preventative Maintenance Plans;
- Stakeholder Engagement Plan (including grievance procedure); and
- Waste Management Plan.

9 SUMMARY OF IMPACTS AND CONCLUSION

Table 9.1 summarises the key issues and residual impacts. The conclusions of the EIA are that with the proposed mitigation and management measures in place during the design, installation, operation and decommissioning stages of the TEN Project all impacts of *Major* significance can be avoided and impacts of *Moderate* and *Minor* significance reduced to as low as reasonably practicable levels.

Table 9.1 Summary of Residual Impacts

Issue	Resources and Receptors	Residual Impact
Project Footprint (physical presence noise and light)	Subsea infrastructure	**Minor**
	Underwater noise	**Minor**
Operational Discharges (routine, drill fluid and cuttings and non-routine)	Water quality	**Minor**
	Seabed habitats	**Minor**
	Marine organisms	**Minor**
Emissions of atmospheric pollutants and Greenhouse gases	Air quality	**Not significant**
	Greenhouse Gas Emissions	**Minor**
Waste Management (storage, transport and disposal)	Water quality, soil quality and human health from storage and transportation	**Not significant**
	Water quality, soil quality and human health from poor disposal facilities	**Minor**
Fisheries	Fish populations	**Not significant**
	Disturbance to fishing activities	**Minor**
	Fishing gear	**Not significant**
Impacts from Oil Spills	Water quality, coastal resources and economic activities from medium and large crude oil spill	**Moderate**
Socioeconomic and Community Health Impacts	Revenues to the Government of Ghana	**Moderate Positive**
	Employees and skills development	**Minor Positive**
	Drawdown of skills	**Not significant**
	Procurement of goods and services	**Minor Positive**
	Influx of job seekers	**Minor**
	Issues with heightened and unmet expectations	**Minor**
	Commercial shipping	**Minor**
	Disturbance effects on communities and use of public utilities near onshore base	**Minor**
	Spread of disease, road traffic accidents, draw down on community health facilities	**Minor**
Cumulative Impacts	Water quality, air quality, habitats, species and human receptors	**Minor**
Transboundary Impacts (including major oil spills)	Water quality, air quality, habitats, species and human receptors	**Moderate**

1 INTRODUCTION

1.1 PURPOSE OF REPORT

Tullow Ghana Limited (TGL) and its Partners, Kosmos Energy LLC, Anadarko Petroleum Corporation, the Ghana National Petroleum Company (GNPC) and Sabre Oil and Gas, known as the TEN Partners, propose to develop the Tweneboa, Enyenra (originally named Owo) and Ntomme (TEN) hydrocarbon fields located in deep water approximately 60 km offshore Ghana (*Figure 1.1*).

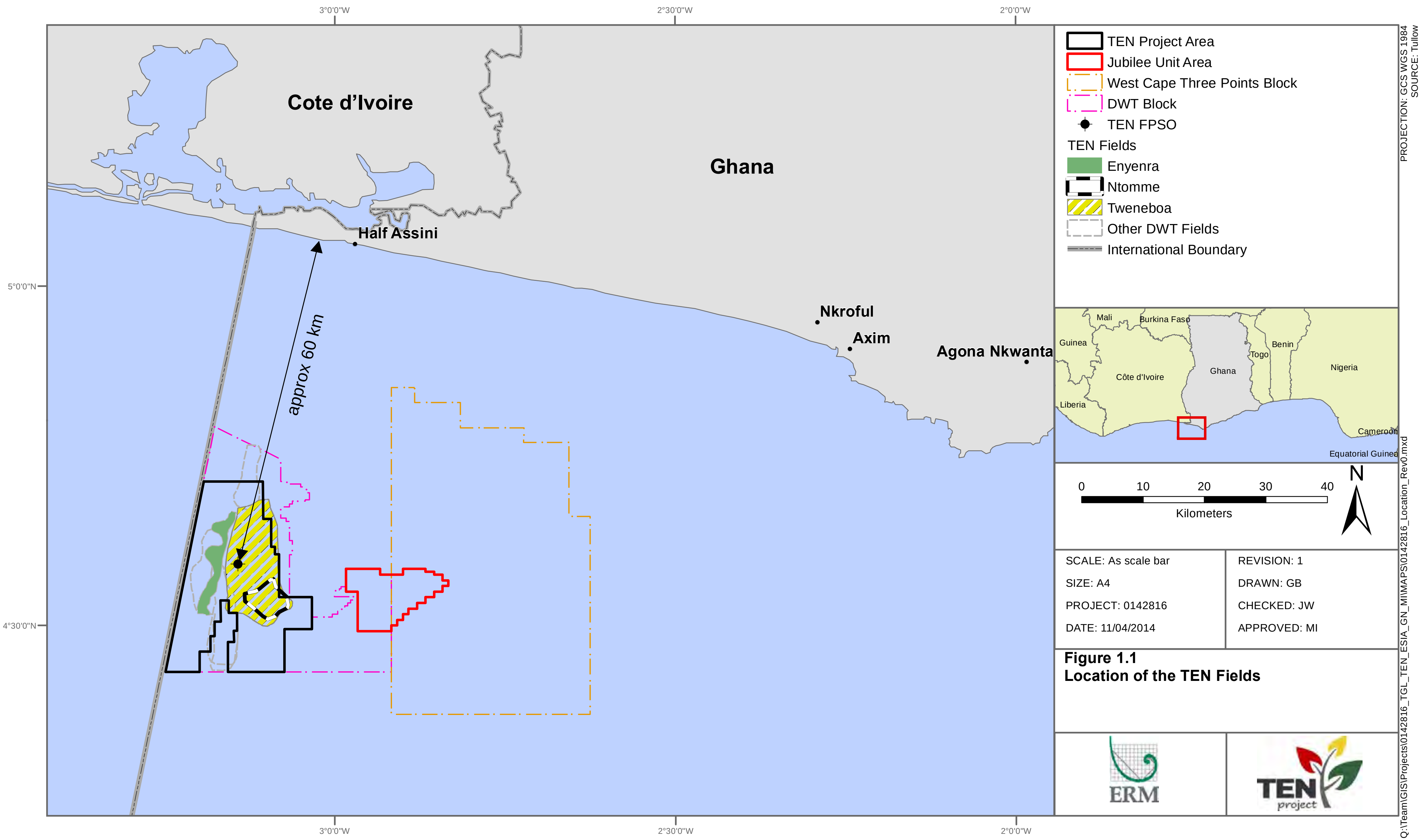
The proposed TEN Project is the second major hydrocarbon development offshore Ghana after the Jubilee Field development in 2009/10. For projects of this type there is a legislative requirement to undertake an Environmental Impact Assessment (EIA) and to report the findings in an Environmental Impact Statement (EIS). The draft EIS is then disclosed for public comment and review by the Ghana Environmental Protection Agency (EPA) and other government regulators.

An EIA is a systematic process that predicts and evaluates the potential impacts a proposed project may have on aspects of the physical, biological, socio-economic and human environment. Mitigation measures are developed as part of the project plan to eliminate, minimise or reduce adverse impacts and, where practicable, to enhance benefits.

This introductory chapter presents an overview of the project, provides details of the EIA team, outlines the approach taken to undertake the EIA and presents the structure of the remainder of the EIS.

1.2 PROJECT BACKGROUND

TGL has interests in two exploration blocks in Ghana, namely the Deep Water Tano (DWT) and West Cape Three Points (WCTP). TGL is the operator of the Jubilee field, which straddles both blocks, and lies approximately 60 km off the coast of Ghana. The Jubilee field was discovered in 2007 and is a large oil field with estimated recoverable resources of up to one billion barrels. The Jubilee development was the first major oil field development offshore Ghana and first oil was achieved in November 2010.



SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 11/04/2014	APPROVED: MI

Figure 1.1
Location of the TEN Fields

ERM

TEN project

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_TGL_TEN_ESIA_GN_MI_Location_Rev0.mxd

Since 2009, TGL has continued with exploration and appraisal drilling in the DWT block which led to the discovery of the TEN fields. Each field consists of a number of pools containing separate hydrocarbon accumulations based on pressure data and fluid composition. There are ten hydrocarbon reservoirs (pools) that have been defined within the TEN fields, five oil and five gas condensate (*Table 1.1*). Five of the reservoirs are considered commercial and are the subject of the TEN Project. The outline of the TEN fields and pools are shown in *Figure 1.2*.

Table 1.1 ***Hydrocarbon Pools within the TEN Fields***

Enyenra		Tweneboa (NAG)*		Tweneboa		Ntomme	
EO1	**Oil**	**TG1**	**Gas**	TO1	Oil	**NO1**	**Oil**
EO2	**Oil**	TG2	Gas			NG1	Gas
EO3	**Oil**	TG3	Gas				
		TG6	Gas				

Note: These pools are designated EO1, TG1 *etc* where the first letter gives the field name, the second is either G for gas or O for oil and the number is the pool number. Bolded pools form part of the TEN Project development. NAG = Non-Associated Gas.

1.2.1 *Enyenra Field*

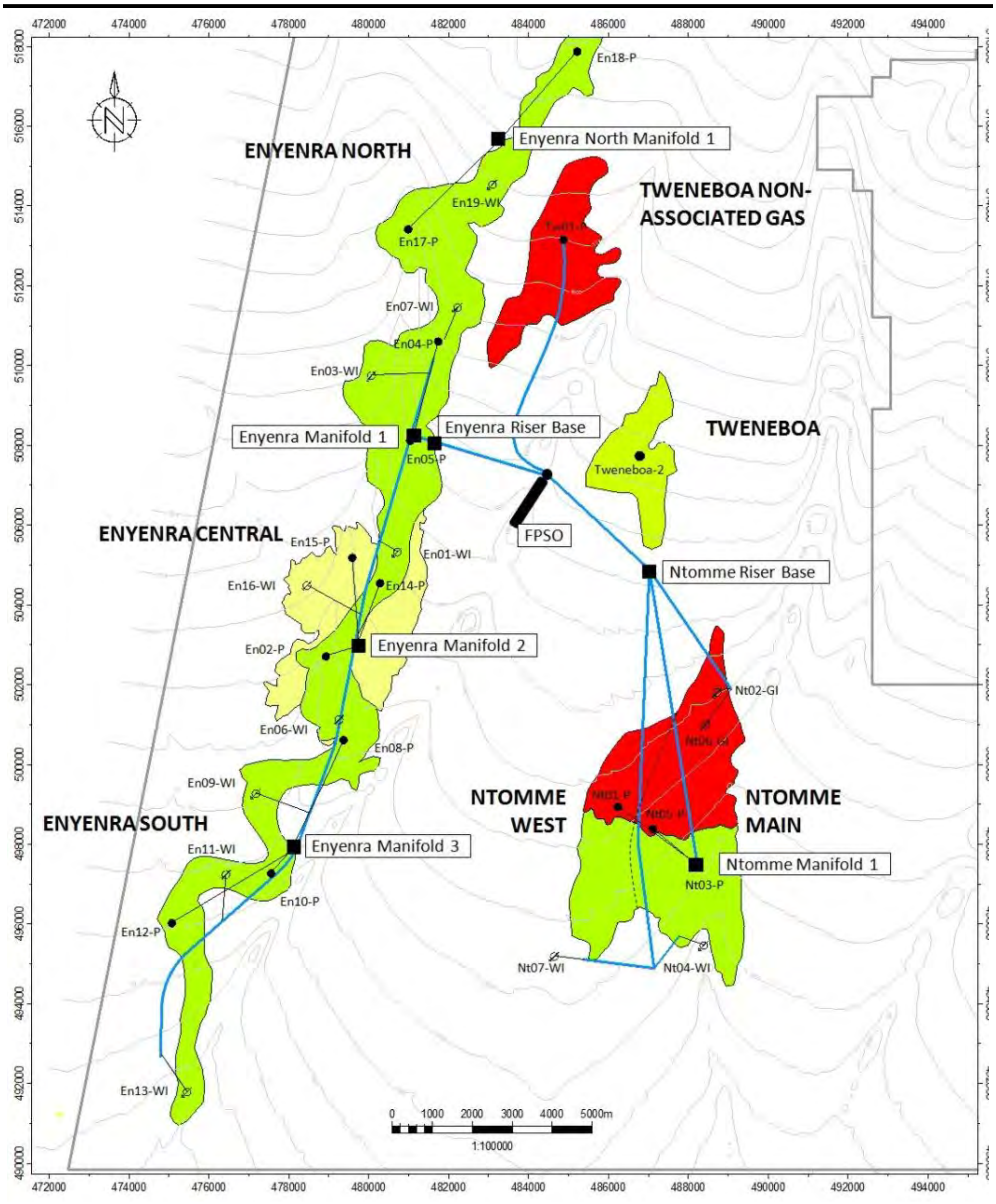
The Enyenra field was discovered by exploration well Owo-1 and its sidetrack Owo-1ST. The wells were drilled in 2010 and encountered oil in EO1and EO2 (*Figure 1.2*). Sidetrack well Owo-1ST encountered oil in the EO2 pool and gas condensate in the EO3 pool. Appraisal well Enyenra-2A was drilled in 2011 and encountered oil in the EO1 and EO2 pools and an oil-water contact in the EO3 pool. Enyenra-3A was drilled in 2011 and found oil in the EO1 reservoir.

Owo-1RA was a re-drill of Owo-1 at a location approximately 400 m south of the original hole. The well encountered oil in the EO1 and EO2 pools and gas in EO3. Enyenra-4A was drilled 6.5 km south of Enyenra-2A and was planned to appraise the southern extent of the EO1 pool.

1.2.2 *Tweneboa Field*

The Tweneboa field was discovered by exploration well Tweneboa-1 which was drilled between January and March 2009. The well discovered gas condensate in pool TG1 which was thought to be part of a larger hydrocarbon accumulation. Appraisal well Tweneboa-2 was drilled in 2009/2010, 6 km southeast of Tweneboa-1. The well encountered gas-condensate in zones TG2 and TG3 and oil in zone TO1. Appraisal wells Twenenboa-3 and Tweneboa-3ST discovered separate gas condensate accumulations now called the Ntomme field (see below). Appraisal well Tweneboa-4 was drilled between in 2011, approximately 4 km southwest of Tweneboa-2 and 3 km northeast of Owo-1. The well encountered gas-condensate on pool TG6.

Figure 1.2 TEN Fields and Pools in the DWT Block



Source: TGL 2013

1.2.3 *Ntomme Field*

The Ntomme field was discovered by Tweneboa appraisal well, Tweneboa-3, and its sidetrack, Tweneboa-3ST (*Figure 1.2*). They were drilled in 2010, 6 km southeast of Tweneboa-2. Tweneboa-3 encountered gas condensate in NO1 and NG1. Sidetrack Tweneboa-3ST encountered gas condensate in NO1 and NO2. Ntomme-2A was drilled in 2011/ 2012 6 km south of Tweneboa-3ST and encountered oil in the NO1 pool.

1.2.4 *Development Proposal*

The TEN fields are situated approximately 60 km offshore, 20 km to the west of the Jubilee Field and lie in water depths ranging between 1,000 m and 2,000 m. The TEN Partners are proposing to develop the TEN fields. TGL is the designated operator for the DWT block and will lead the project design, execution and operation of the proposed TEN Project.

The TEN Project will consist of oil and gas production wells, water injection wells and gas injection wells. Production will be gathered through subsea manifolds and conveyed by subsea flowlines to a Floating Production Storage and Offloading (FPSO) vessel which will be moored in the area of the TEN fields. The target for first production in mid 2016. It is expected that the field will be decommissioned after 20 years of operation *ie* after 2036, although subsequent appraisal and development of the reservoirs may extend this period significantly. A full description of the project is provided in *Chapter 3.*

1.2.5 *Need for Project*

The Ministry of Energy (MoE) oversees the development of oil and gas extraction from Ghana's natural reserves. Under the Ghana National Petroleum Act, 1983, MoE is charged with the responsibility to:

(a) promote the exploration and the orderly and planned development of the petroleum resources of the Republic; and (b) ensure that the Republic obtains the greatest possible benefits from the development of its petroleum resources.

MoE grants oil exploration, appraisal and production licenses with the goal to develop and exploit these resources for commercial purposes. In 2010, the MoE published an Energy Sector Strategy and Development Plan (MoE, 2010). The Strategy is underpinned by Ghana's vision for the energy sector. The vision is to ensure availability of and universal access to energy services and capacity to export by 2020. The document covers strategies, programmes and projects intended to support the national economic development agenda of the government of Ghana in the following sub-sectors.

- *Power:* electricity generation, transmission, distribution, and efficiency and conservation.
- *Petroleum:* upstream, midstream and downstream.
- *Renewable energy*: renewable energy resource exploitation, development and use.

The Strategy and Development Plan defines the strategic goal for the upstream and mid-stream petroleum sector as follows.

Sustain exploration, development and production of the oil and gas endowment and also the judicious management of the oil and gas revenue for the overall benefit and *welfare of all Ghanaians, present and future as well as attract increased local value-added investments in the oil and gas sector and the indigenization of knowledge, expertise and technology.*

An objective of the strategy is to intensify exploration, development, production and utilisation of Ghana's oil and gas prospects. The proposed TEN Project will support this goal by developing additional oil and gas prospects for the benefit of the project's shareholders which include Government of Ghana (through participation of the GNPC) as well as commercial entities. The Government of Ghana would generate additional income through royalties and taxes.

1.2.6 Project Benefits

The purpose of the project is to develop Ghana's natural resources that lie within TEN fields in a safe, environmentally sound and commercially viable manner. The project will benefit the people of Ghana by contributing to the Ghanaian economy. Income to the government from the project will facilitate economic development and growth, further benefiting Ghana directly from the project and indirectly through development of supporting and related enterprises. The TEN Project will generate further employment and training opportunities directly in the offshore oil and gas industry. The project will also generate opportunities indirectly through service, supply and support industries. Further details regarding the expected benefits of the project are presented in *Chapter 7.*

1.3 THE EIA TEAM

Environmental Resources Management (ERM), ESL Consulting (ESL) and SRC Consulting (SRC) jointly referred to as the EIA team, were appointed by TGL in August 2011 to undertake an EIA for the TEN Project. The team comprises independent environmental and social specialists with a combination of experience in undertaking EIAs for FPSO projects and other projects in Ghana and in other countries. The core team members from ERM, ESL, SRC and specialist sub-consultants that have contributed to this report are listed in *Table 1.2*.

1.3.1 Tullow Project Team

The EIA was carried out with input from specialists from the Tullow design team. Input included providing details on the project's technical aspects as well as with the development of mitigation measures and environmental management plans. Tullow's Environment Health and Safety (EHS) and Social Performance (SP) teams also provided support and input, in particular during fieldwork. Key contributors include the following.

- Tullow Oil Plc team: Peter Lawrence, Roger Charles, Martin Casson, Khatira Morrison, James Gilmour, Joe Hughes, Adam Norman, Mehrdad

Mansour, Graham Guy, Liria Araujo, Martin Hayes, Patricia Arrayo and Oliver McCredie.

- TGL HSE and SP team: Phil Wahwerit, Glenn Bestall, Okyeame Ampadu-Agyei, Ken McGhee, Yaw Amoyaw Osei, Emmanuel Benjamin Arthur, Patrick Ampong and Elijah Boye Ampah.

Table 1.2 The EIA Team

Name	Organisation	Role	Qualifications and Experience
EIA PROJECT MANAGEMENT TEAM			
Henry Camp	ERM	Partner in Charge	BA, 30 years
Mark Irvine	ERM	Project Director	BSc, MSc, 27 years
John Ward	ERM	Project Consultant	BSc, MSc, 3 years
Ayaa K Armah	ESL	ESL Project Director	MPhil, MSc, 33 years
Anthony Bentil	ESL	ESL Project Consultant	BSc, MPhil, 6 years
EIA SPECIALISTS			
Adu-Nyarko Andorful	SRC	Consultation	BSc, MPhil, 11 years
Bright Yeboah	ESL	Consultation	BA MA, 11 years
Daniel Abbrey	SRC	Consultation	BA, MA, 13 years
Michael Cobb	ERM	EMP and EMS	BSc, MSc, 18 years
Kerryn McKune- Desai	ERM	Socio-economic lead	BA, MA, 11 years
Janet Mkhabela	ERM	Social and consultation	BA, MA, 6 years
Samantha Button	ERM	Social and consultation	BA, MPhil, 6 years
Peter Braithwaite	ERM	Waste management	BSc, MSc, 14 years
SPECIAL TOPIC EXPERTS			
Dr Chris Hazell-Marshall	ERM	Air quality	MSc, PhD, 6 years
Yves Verlinden	ERM	Air quality	BEng, 5 years
Rachel Antil	ERM	Benthic ecology	BSc, MSc, 6 years
Dr Eric Comerma	RPS ASA	Discharge modelling	MEng, PhD, 12 years
Nicholas Cohn	RPS ASA	Discharge modelling	BA, 6 years
Craig Reid	ERM	Fish and fisheries	BSc, 16 years
Francesca Zino	ERM	Fish and fisheries	BSc, MSc, 6 years
Kevin Kinsella	ERM	Risk and safety	BSc, 31 years
Pen Lewis	ERM	Risk and safety	BEng(Chem), 21 years

1.3.2 *Acknowledgements*

Acknowledgements go to the Ghana EPA for providing guidance on the EIA process and to those consultees listed in *Attachment I* that provided information for the EIA, raised issues and made comments on the project. In addition, project description and baseline information from studies undertaken by Aquatera Ltd (Aquatera), Continental Science Associates International Inc (CSA), Fugro Survey Ltd, Gardline Environmental Ltd and Gardline Geosurvey Ltd have been used in this EIA and is gratefully acknowledged.

1.4 PURPOSE OF EIA

Under the Ghanaian *Environmental Assessment Regulations (1999*) (LI 1652), oil and gas field development is an undertaking for which an EIA is mandatory. Guidance on how to undertake the EIA is provided in the *Environmental Assessment in Ghana Guidelines (1995)*. The undertaking also requires registration and authorisation by the Ghana EPA.
The purpose of the EIA is to provide information to regulators, the public and other stakeholders to aid the decision making process. The main objectives of the EIA are therefore as follows.

- To define the scope of the project and the potential interactions of project activities with the natural and social (including socio-economics and health) environment that should be defined and assessed during the EIA.

- To review national and international legislation, standards and guidelines, to ensure that all stages of the proposed project through its complete lifecycle take into consideration the requirement of Ghanaian legislation, internationally accepted environmental management practices and guidelines, and project-related EHS policies and standards.

- To provide a description of the proposed project activities and the existing physical, chemical, biological, socio-economic and human environment that these activities may interact with.

- To assess the potential environmental and social impacts resulting from the project activities and identify viable mitigation measures and management actions that are designed to avoid, reduce, remedy or compensate for any significant adverse environmental and social impacts and, where practicable, to maximise potential positive impacts and opportunities that may arise due to the project.

- To provide the means by which the mitigation measures will be implemented and residual impacts managed, through the provision of a provisional Environmental Management Plan (EMP). This will also require the development of monitoring plans for various environmental and social impacts and a mechanism for audit, review and corrective action.

1.5 EIA PROCESS

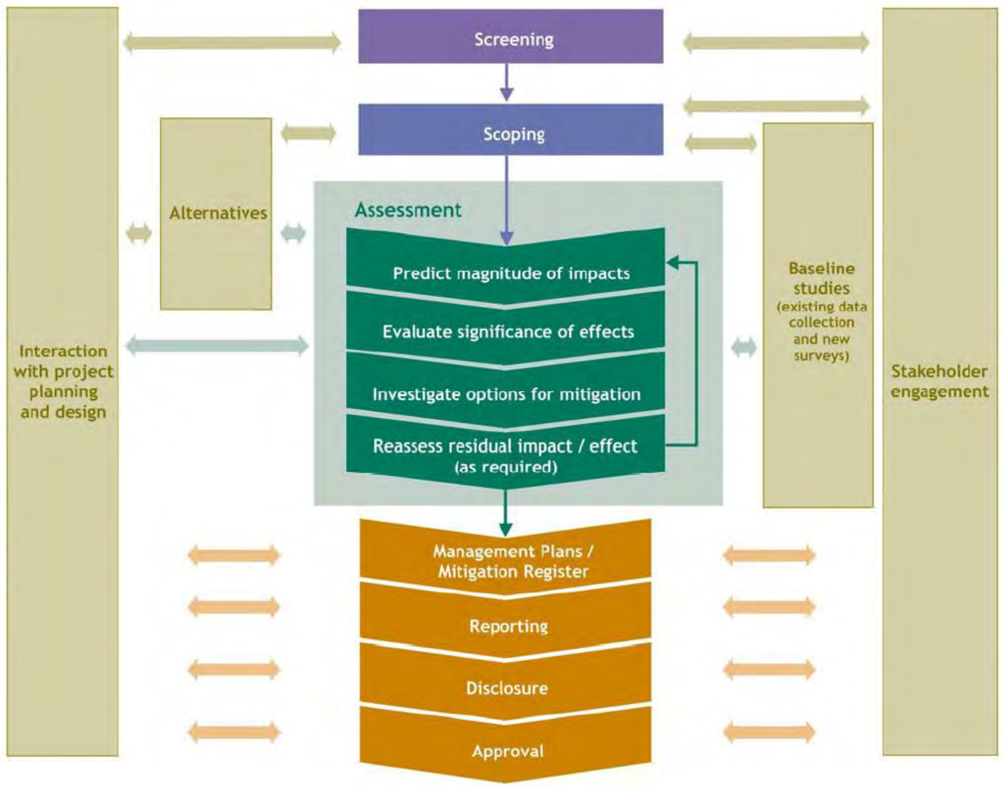
1.5.1 *Overview*

The overall EIA process is shown schematically in *Figure 1.3* and the following key steps are described in the subsequent sections.

- Screening and Registration.

- Scoping.
- Baseline Data Collection.
- Project Planning and Design.
- Stakeholder Engagement.
- Impact Assessment.
- Management and Mitigation Plans.
- Reporting and Disclosure.

Figure 1.3 Overview of the Impact Assessment Process



1.5.2 *Project Registration*

Undertakings likely to have significant impacts on the environment (*eg* those listed in Schedule 1 and Schedule 2 of the *Environmental Assessment Regulations* must register with the EPA and obtain an environmental permit before commencement of construction and operations. The proposed TEN Project was registered on 4 March 2011 with registration number EPA-CE-1828-02057.

1.5.3 *Project Screening*

According to the *Environmental Assessment Regulations*, within 25 days from the time a registration form is received the EPA will place the development at the appropriate level of assessment. The EPA has determined that the development falls into the category of undertakings (Regulation 3) for which full EIA is required.

1.5.4 *Scoping*

The aim of scoping is to identify environmental and social sensitivities and those project activities with the potential to contribute to, or cause, impacts to environmental resources and social receptors. The term 'resources' is used to describe features of the environment such as water resources, habitats and species which are valued by society for their intrinsic worth and/or their social or economic contribution. The term 'receptors' is used to define individuals and communities that may be affected by the project.
At the scoping stage it is necessary to identify and understand the key issues to a level that allows the remainder of the impact assessment to be planned. An important part of this process is identifying and consulting with a range of stakeholders including representatives of government, civil society groups, and community to identify key issues and sources of information.

For the purposes of the EIA the project is defined as all activities which are a necessary part of the TEN Project and have been included in the Plan of Development (POD) approved by the Government of Ghana on the 29th May 2013. These include well drilling, completions, subsea infrastructure and FPSO installation, commissioning and operation (including production, hydrocarbon processing, crude oil offloading, and support and maintenance activities) and decommissioning at the end of the commercial life of the field. The area of influence of these activities will vary depending on the type of impact being considered. The main areas of influence include the TEN Project area (seabed footprint and exclusion zone), support vessel and helicopter routes and the onshore supply base. For some potential impacts the area of influence may extend beyond the area directly affected by the project, *eg* socio-economic impacts or pollution event impacts.

A Scoping Report and Terms of Reference was completed in line with Regulation 11 of the *Environmental Assessment Regulations* and submitted to the EPA on 25 January 2012. A report provided an overview of the project and outlined the key issues to be addressed in the EIA. The Scoping Report and Terms of Reference was approved by the EPA on 11 April 2012. The report was advertised in the press, placed in a number of locations in Accra and in the Western Region of Ghana and made available on a project website (www.erm.com/ten). Details of the consultation process are included in *Attachment I*.

1.5.5 *Baseline Data Collection*

The EIS provides a description of the existing environmental and socio-economic conditions as a basis against which the impacts of the project can be assessed. The baseline includes information on receptors and resources that were identified during scoping as having the potential to be significantly affected by the proposed project. It also includes technical information, such as hydrographic conditions, that has been used in the assessment and for modelling studies.

The description of the baseline has the following main objectives.

- To identify the key environmental and socio-economic resources and conditions in areas potentially affected by the project and highlight those that may be vulnerable to aspects of the project.

- To describe, and where possible quantify, their characteristics ie their nature, condition, quality and extent.
- To provide data to aid the prediction and evaluation of possible impacts.

- To inform judgements about the importance, value and sensitivity or vulnerability of resources and receptors.

For this EIA, baseline data was obtained from research and academic organisations and published sources, and the following sources in particular.

Environmental Baseline

- Geotechnical and geophysical surveys conducted by Gardline Marine Services in 2011 and Fugro Survey Ltd in 2013 provided site specific data on physical conditions in the DWT development area (Gardline 2011a; Fugro 2013).

- A marine Environmental Baseline Survey (EBS) was undertaken in 2010 and provided information on offshore environment within the DWT development survey area (CSA 2011a). This included physico-chemical data on water and sediment quality and characterisation of benthic communities.

- A fisheries study was conducted by ERM and ESL in 2010 and 2011 which provides current primary and secondary baseline data on fish and fisheries (ERM 2011).

- Marine mammal and turtle observations undertaken in the TEN and Jubilee fields and compiled into reports by Gardline Environmental Ltd in 2010 and 2011 provided sightings data on marine mammals and turtles (Gardline 2011b; Gardline 2012). Additional observations data were made available following a seismic survey of the Jubilee field in 2013.

Socio-economic Baseline

Primary socio-economic data was collected during a survey undertaken in the six coastal districts of the Western Region in March and April 2012 to supplement secondary socio-economic information. Twenty-two villages were visited and data gathered through Focus Group Discussions (FGD) and Key Informant Interviews (KIIs).

1.5.6 *Quantitative Studies*

A number of quantitative studies were undertaken by the EIA team and TGL following stakeholder consultations, scoping and development of the project design. These have included the following.

- Modelling of oil spills potentially resulting from accidental events (*ie* collisions, ruptures, blowout *etc*).
- Aquatic dispersion modelling of operational discharges, including drill cuttings discharges and produced water discharges.
- Atmospheric dispersion modelling of project emissions to air to determine the extent of possible impacts on air quality.

Findings of the following studies were also considered in the EIA.

- A drill cuttings study was conducted by CSA in 2011 and provided data on drill cuttings dispersion and physico-chemical effects at the Jubilee field (CSA 2011b).
- An assessment of waste treatment and disposal options for priority waste streams was conducted by ERM for TGL in 2010 and provided information on waste management options.
- Underwater noise from an FPSO operation and offloading at the Jubilee field was measured by Gardline in 2011 and provided information on underwater noise emission levels and attenuation (Gardline 2011c).
- A Best Practicable Environmental (BPEO) study was conducted in 2012 evaluating options for the treatment and disposal of drill cuttings considering environmental, financial, health and safety and technical criteria (Aquatera 2012).

1.5.7 *Project Planning and Design*

The project description in *Chapter 3* provides details of the various activities that would occur during the drilling, installation, commissioning and operational phases of the project to a level that allows those activities with the potential to cause environmental and social impacts to be identified (*eg* physical presence, emissions, wastes and discharges). The project decommissioning phase is described separately in *Chapter 10.* Project planning, decision making and refinement of the project description continued throughout the assessment process as a result of the development of the project and in response to the identified potential impacts. A key step in the EIA process is the incorporation of agreed mitigation measures to project design, operation, monitoring and decommissioning. The *Environmental*

Assessment Regulations require that alternatives to the undertaking are considered in the EIA. Justification of the options is provided in *Chapter 3*.

1.5.8 Stakeholder Engagement

Stakeholder consultation starts at the scoping stage of the project, runs throughout the EIA and then continues through the operational phase of the project. The objective of this engagement is to ensure that sources of existing information and expertise are identified, legislative requirements are met and that stakeholder concerns and expectations are addressed.
A series of 26 consultation meetings was held with 29 stakeholder groups or organisations in October and November 2011. Stakeholders included national, regional and district authorities, traditional leadership, fisher associations and Non-Governmental Organisations (NGOs).

During the EIA, local level consultations were undertaken at 22 communities in the coastal districts of the Western Region. A total of 22 community meetings were held and over 2,135 people attended the consultations in March 2012. Approximately three FGDs and KIIs were conducted at each community.

The objectives of scoping and EIA consultations were to share project information, collect baseline data and understand key stakeholder concerns. The consultation report, including a list of stakeholders who were consulted and a register of issues raised is provided in *Attachment I.*

1.5.9 Impact Assessment

Impact assessment and development of mitigation measures is an on-going process that commences during the scoping stage and continues throughout the EIA process. The key objectives of this process are as follows.

- To analyse how the project may interact with the baseline in order to define, predict and evaluate the likely extent and significance of environmental and social impacts that may be caused by the project.

- To develop and describe acceptable and cost effective mitigation measures that avoid, reduce, control, remedy or compensate for negative impacts and enhance positive benefits.

- To evaluate the predicted positive and negative residual impacts of the project.

- To develop a system where mitigation measures are integrated into the project design and taken forward as commitments that are delivered through an Environmental Management Plan.

The impact assessment process is illustrated in *Figure 1.4* and has the following four main steps.

1. Prediction of what will happen as a consequence of project activities.

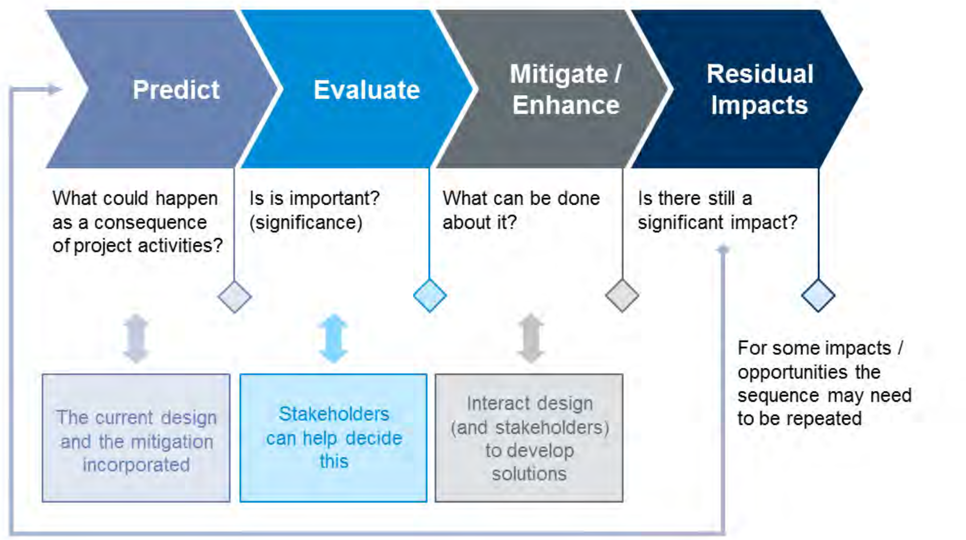
2. Evaluation of the importance and significance of the impact.

3. Development of mitigation measures to manage significant impacts where practicable.

4. Evaluation of the significance of the residual impact.

Where significant residual impacts remain, further options for mitigation may be considered and impacts re-assessed. This approach takes into account the technical and financial feasibility of mitigation measures.

Figure 1.4 ***Prediction, Evaluation and Mitigation of Impacts***



In addition to predicted impacts from planned activities, those impacts that could result from an accident or unplanned event within the project (*eg* pollution event from a fuel or oil spill) are taken into account. In these cases the likelihood (probability) of the event occurring is considered. The impact of non-routine events is therefore assessed in terms of the risk, *ie* taking into account both the consequence of the event and the probability of occurrence.

Uncertainty

Even with a detailed and fixed project design and an unchanging environment, predictions are by definition uncertain. In this EIS, predictions have been made using methods ranging from qualitative assessment and expert judgement to quantitative modelling. The accuracy of predictions will depend on the methods used and the quality of the input data on the project and the environment. Where assumptions have been made, the nature of any uncertainties which stem from these are presented.

Uncertainty can also arise as a result of the stage reached in the design process at the time of preparation of an EIS. Where details of the project description are not fully defined at the EIA stage assumptions are required to be made[(1)]. These are based on the expertise and previous project experience of the project and EIA teams. Where uncertainty may affect the assessment of impacts this is acknowledged and a conservative (*ie* reasonable worst case) approach to assessing the likely residual impacts is adopted with mitigation measures developed accordingly.

1.5.10 *Management Plans*

The range of different measures to mitigate impacts identified through the EIA process is reported in the EIS within the project description and assessment chapters. In accordance with the requirements of the *Environmental Assessment Regulations* these have been brought together in a provisional Environmental Management Plan for the project (*Chapter 11*).

The provisional EMP consists of the set of management, mitigation, and monitoring measures to be taken during implementation of the project to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. The plan details the specific actions that are required to implement the controls and mitigation measures that have been agreed through the EIA process. Other key related plans (*eg* Oil Spill Response Plan, Waste Management Plan and Emergency Response Plan) are already in place for the offshore drilling operations and will be updated and implemented by TGL and its contractors specifically for this project prior to the start of construction activities.

1.5.11 *Reporting and Disclosure*

The outputs of the above key step were drawn together into the draft EIS and submitted to the EPA for review. The draft EIS was advertised and made available for public review and comment for a period of 21 days and a series of Public Hearings were held in November 2013 in Takoradi, Ghana. Comments received on the draft EIS from the EPA's technical review, stakeholders written comments, and the outcome of the Public Hearings have been addressed in this Final EIS that has been submitted to the EPA for approval. The comments received on the Draft EIS and the sections in the EIS where each comment has been addressed are presented in *Attachment I*.

(1) This EIA was undertaken during early project design. Although significant changes that may influence the findings of this EIA are not expected there is nevertheless an element of uncertainty regarding the final project design and implementation strategy. Gaps and uncertainties regarding the project and the EIA process will be addressed through a clear and transparent 'Management of Change' procedure.

1.6 *STRUCTURE OF THIS REPORT*

The structure of the EIS follows that provided by Ghana EPA. The report comprises two volumes; *Volume 1* contains the EIS and Consultation Report, while supporting annexes are included in *Volume 2*. The detailed contents are of each volume is summarised in *Table 1.3* and *Table 1.4*.

Table 1.3 Volume I - EIS Report Structure

Chapter	Title	Contents
	Non-Technical Summary	Summary of the EIS written in non-technical language.
1	Introduction	Introduction to the project; purpose and need for project; EIA team and introduction to impact assessment methodology.
2	Legal and Policy Framework	An overview of relevant national and international legislation, and industry standards and guidelines.
3	Project Description	Technical description of the project; alternatives considered; applicable legislation and standards.
4	Environmental Baseline	Description of the relevant environmental existing conditions.
5	Fish and Fisheries Baseline	Description of the relevant fish and fisheries existing conditions.
6	Socio-economic Baseline	Description of the relevant social and health existing conditions.
7	Impact Identification and Assessment	Evaluation of potential impacts; proposed mitigation measures and identification of residual impacts.
8	Mitigation and Management Measures	Summary of mitigation measures including those built into the design and identified through the EIA process.
9	Monitoring Plan	Summary of the monitoring that will be carried out to verify environmental and social performance.
10	Decommissioning and Abandonment	Description of the approach for decommissioning of the facilities at the end of the field's life.
11	Provisional Environmental Management Plan	Outline of the Environmental Management Plan taking into account identified impacts and planned mitigation measures and monitoring requirements.
12	Summary and Conclusions	Summary of the conclusions from the EIA.
References	References	A list of references and websites cited in the text.
Attachment I	Consultation Report	A summary of the consultations undertaken during the EIA process and fisheries study as well as a list of stakeholder issues log, attendance records and photos. Comments received from the EPA following the technical review of the Draft EIS and the Public Hearings are presented indicating the sections in the Final EIA where each comment has been addressed.

Table 1.4 Volume II - EIS Annexes

Annex	Title	Content
Annex A	Air Emissions Inventory and Modelling Data	Calculation of estimated emissions from the TEN Project activities and results air dispersion modelling study.
Annex B	TEN EBS Report	Report by CSA with results from the 2011 Environmental Baseline Survey.
Annex C	Marine Mammal and Turtle Observation Reports	Reports by Gardline Environmental Ltd evaluating marine mammal and turtle sightings.
Annex D	Discharge Modelling Reports	Reports by RPS-ASA on drill cuttings, produced water and oil spill modelling.
Annex E	Underwater Noise Survey Report	Report by Gardline on underwater noise monitoring results and mapping of propagated sound fields.
Annex F	Drill Cuttings BPEO Study	Report by Aquatera on Best Practicable Environmental Option (BPEO) for drill cuttings treatment and disposal.

2 LEGAL AND POLICY FRAMEWORK

2.1 INTRODUCTION

This chapter outlines the administrative framework for the project. It describes the Ghana laws and regulations as well as the international treaties that Ghana is signatory to. It also describes the industry standards and EHS policies and standards that the project has adopted.

2.2 GOVERNMENT ADMINISTRATION

An overview of Ghanaian government ministries and the key administrative bodies (*ie* authorities, agencies and commissions) with responsibilities related to the project is given below and illustrated in *Figure 2.1*.

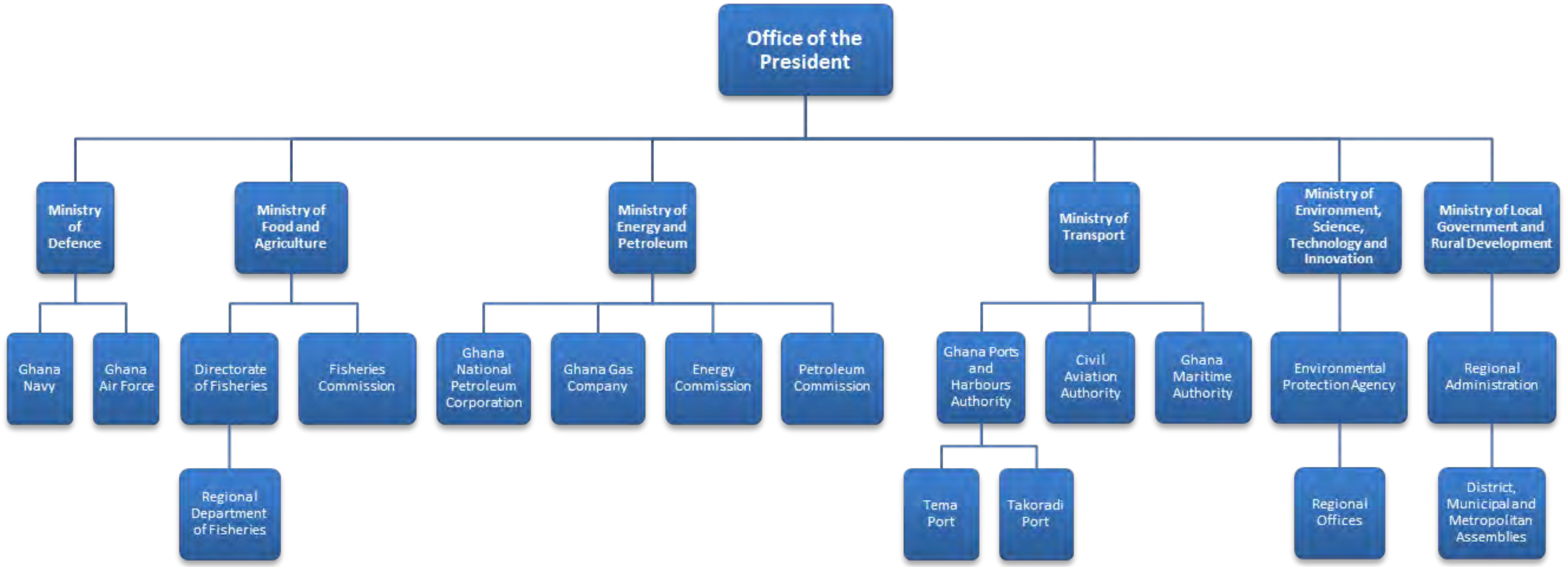
- Ministry of Environment, Science, Technology and Innovation – represented through the Environmental Protection Agency (EPA).
- Ministry of Energy and Petroleum – represented through the Ghana Petroleum Commission and the National Petroleum Corporation (GNPC).
- Ministry of Transport – represented through the Ghana Maritime Authority (GMA), the Ghana Ports and Harbours Authority (GPHA) and the Ghana Civil Aviation Authority (GCAA).
- Ministry of Food and Agriculture – represented through the Directorate of Fisheries the Fisheries Commission and the Regional Departments of Fisheries.
- Ministry of Defence - represented through the Ghana Navy and Ghana Air Force.
- Ministry of Local Government and Rural Development – represented through the ten Regional Coordinating Councils.

The duties and authorities of the relevant administrative bodies within these key Ministries are discussed further below.

2.2.1 *Ministry of Environment, Science, Technology and Innovation*

The Ministry of Environment, Science, Technology and Innovation exists to establish a strong national scientific and technology base for accelerated sustainable development of the country to enhance the quality of life for all. The EPA is part of this Ministry.

Figure 2.1 Relevant Ghanaian Ministries and Administrative Bodies



The Environmental Protection Agency

The EPA was established under the *Environmental Protection Agency Act (Act No. 490 of 1994)* as the leading public body responsible for the protection and improvement of the environment in Ghana. It is responsible for enforcing environmental policy and legislation, prescribing standards and guidelines, inspecting and regulating businesses and responding to emergency incidents.

The EPA is responsible for issuing environmental permits and pollution abatement notices for controlling waste discharges, emissions, deposits or other source of pollutants and issuing directives, procedures or warnings for the purpose of controlling noise. The EPA has the authority to require an EIA, is responsible for ensuring compliance with EIA procedures and is the lead EIA decision-maker.

2.2.2 *Ministry of Energy and Petroleum*

The Ministry of Energy and Petroleum is responsible for developing and implementing energy sector policy in Ghana and for supervising the operations of a number of government institutions, including the Petroleum Commission and GNPC.

Petroleum Commission

The Petroleum Commission was established in 2011 under the *Petroleum Commission Act (Act 821)* for the regulation and management of petroleum resources and to coordinate the policies in relation to these resources. Specifically, the Commission was established to:

- promote petroleum activities for the benefit of Ghana;
- recommend national policies related to petroleum activities;
- monitor compliance with national policies, laws, regulations, agreements on health, safety and environmental standards in petroleum activities;
- monitor and carry out inspections and audits of petroleum facilities;
- promote local content and local participation;
- receive and store petroleum data;
- receive applications and issue permits for specific petroleum activities;
- assess and approve appraisal programmes;
- advise the Ministry of Energy and Petroleum related to activities including development plans and decommissioning plans for petroleum fields;
- issue an annual report on petroleum resources and activities;
- analyse economic information related to petroleum activities and submit forecasts to the Ministry; and
- perform any other function related to the object of the commission.

Ghana National Petroleum Corporation

The GNPC was established in 1983 by the *Ghana National Petroleum Corporation Law (PNDCL No. 64 of 1983)*. The GNPC is a corporate body established under the Ministry of Energy and Petroleum to responsible for the exploration, development, production and disposal of petroleum in Ghana. The GNPC is empowered to conduct petroleum operations and partner with foreign investors to promote the economic development of Ghana. The GNPC is a Partner in the TEN Project.

Ghana National Gas Company (GNGC)

The GNGC's mission is to contribute to Ghana's rapid industrialisation process by building the infrastructure required for gathering, processing and delivery natural gas resources to industry in a safe, cost effective, responsible and reliable manner. The GNGC has been established to manage the Ghana Gas Infrastructure Project which involves future plans to transport gas from offshore oil and gas fields in the WCTP and DWT blocks to shore.

2.2.3 Ministry of Transport

The Ministry of Transport was created to manage infrastructural development and service delivery for the maritime and rail transport subsectors and to complement the other modes of transport for the socio-economic development of the country. The GMA and GPHA fall under the national Ministry of Transport.

With the assistance of the GMA and the GPHA, the Ministry aims to ensure the provision of an efficient, safe, economic and reliable movement of goods and people using the rail and maritime systems and ensure that rail, inland waterways, ports and harbours contribute significantly to the socio-economic development of the country.

The Ghana Maritime Authority

The GMA was established under the *Maritime Authority Act (Act No. 630 of 2002)* and is responsible for monitoring, regulation and coordination of all maritime activities for the Republic of Ghana. The purpose of the GMA is to ensure the provision of safe, secure and efficient shipping operations and protection of the marine environment from pollution from ships.

Ghana Ports and Harbour Authority

The GPHA is responsible for planning, managing, building and operating Ghana's seaports. The GPHA owns Ghana's two main seaports (Takoradi and Tema) and has the following functions with regard to their operation, maintenance and control:

- regulate the use of ports and of the port facilities;
- provide, maintain, extend and enlarge port facilities as required for the efficient and proper operation of the port;
- maintain and deepen the approaches to, and the navigable waters within and outside the limits of any port;
- maintain lighthouses and beacons and other navigational service and aids as necessary;
- provide facilities for the transport, storage, warehousing, loading, unloading and sorting of goods passing through any port, and operate or provide access to road haulage service providers; and
- provide stevedoring and porterage services.

Takoradi is the main sea-port closest to the TEN fields and has been used to support exploration and appraisal drilling and the Jubilee development and will be used for support of the TEN Project's activities.

Ghana Civil Aviation Authority

The GCAA was established in 1930 and the *Civil Aviation Act (Act No. 678 of 2004)* provided for the establishment of a Civil Aviation Authority which focuses on the core functions of airspace management and safety regulations whilst allowing for a different organisation to handle airport development and operations. The Civil Aviation Authority was restructured into the Ghana Civil Aviation Authority (GCAA) and the Ghana Airports Company Limited (GACL) in 2007.

Under the *Civil Aviation Act*, the functions of GCAA include the following:

- licensing and certification of air transport operators;
- licensing and certification of aerodromes and the construction, operation, maintenance and managements of navigation sites;
- provision of air navigation services (air space management) within the Accra Flight Information Region (FIR);
- regulation of air transport services;
- promoting the development of civil air transport industry in Ghana;
- advising Government on all matters concerning civil aviation, among other functions; and
- provision of oversight for all activities related to civil aviation.

2.2.4 *Ministry of Food and Agriculture*

The Ministry of Food and Agriculture is the ministry charged with the development and growth of agriculture, including fisheries. Its primary roles are the formulation of appropriate agricultural policies, planning and coordination, monitoring and evaluation within the overall national economic development. The Directorate of Fisheries and the Fisheries Commission fall under this ministry.

Directorate of Fisheries and Fisheries Commission

The Directorate of Fisheries is responsible for policy formulation and implementation, management and control of the fishing industry under the general guidance and direction of the Fisheries Commission.

The Fisheries Act (Act No. 625 of 2002) established the Fisheries Commission as a body to regulate and manage the utilisation of the fishery resources of Ghana and co-ordinate the related policies. The commission also advises the Minister on all matters pertaining to the fishery industry. The Commission's functions among other things are to ensure the proper conservation of the fishery resources through the prevention of over fishing.

The Directorate's mission is *'…to promote sustainable exploitation and responsible utilisation of fishery resources of Ghana through sound management practices, research, appropriate technological development for both culture and capture fisheries, effective extension and provision of other support services to fish farmers, fishermen, fish processors and traders for improved income and fish food security'*.

The functions of the Directorate are:

- to prepare and keep under continual review, plans for the management and development of marine and freshwater capture fisheries and aquaculture;
- to carry out research for the assessment for fisheries resources; and
- to ensure that monitoring, control and surveillance of the fishery waters of Ghana.

The Directorate has a number of operational divisions for marine fisheries management, namely: inland fisheries management (and aquaculture); marine fisheries research; monitoring; control and surveillance; and finance and administration.

The regional Departments of Fisheries carry out and implement policies of the Directorate of Fisheries particular to the different regions. The regional office for the Western Region is based in Takoradi and this office covers most of the fishing activities in the coastal waters nearest to the offshore TEN Project area.

2.2.5 *Ministry of Defence*

The Ministry of Defence have ultimate authority to police Ghanaian waters and enforce Ghanaian legislation. The Ghana Air Force and Navy will provide additional capacity to the GMA for marine search and rescue operations if required. They would also be available to provide assistance in the event of an emergency such as a major accident offshore, including oil spills. The Ghana Navy is responsible for maritime security at offshore hydrocarbon installations.

2.2.6 *Ministry of Local Government and Rural Development*

The Ministry of Local Government and Rural Development is responsible for the ten Regional Administrations in Ghana. These regions each have a Regional Coordinating Council and are sub-divided into 216 metropolitan, municipal and district areas each with an administrative assembly. Further details of the structure of the administrative assemblies are provided in the Socio-economic baseline in *Chapter 5*. These include the six coastal districts in the Western Region: Jomoro, Nzema East, Ellembelle, Ahanta West, Sekondi-Takoradi Metropolis and Shama.

2.3 *NATIONAL LEGISLATION*

2.3.1 *The Ghanaian Constitution*

Article 41(k) in Chapter 6 of the constitution of Ghana requires that all citizens (employees and employers) protect and safeguard the natural environment of the Republic of Ghana and its territorial waters.

2.3.2 *Environmental Legislation*

The Environmental Protection Act

The Environmental Protection Act (Act No. 490 of 1994) establishes the authority, responsibility, structure and funding of the EPA. Part I of the Act mandates the EPA with the formulation of environmental policy, issuing of environmental permits and pollution abatement notices and prescribing standards and guidelines. The Act defines the requirements and responsibilities of the Environmental Protection Inspectors and empowers the EPA to request that an EIA process be undertaken.

Section 10 of Part 2 of the Act provides for the establishment of a hazardous chemicals committee, comprising representatives from key government organisations with an interest in chemical management, to monitor and advise the EPA on the importation, exportation, manufacture, distribution, use and disposal of hazardous chemicals[1].

To perform its duties under the Act, the EPA has a Division called the Chemicals Control and Management Centre (CCMC), which plays a vital role in the management of chemicals in Ghana. The CCMC's primary objective is to protect human health and the environment from the possible effects of chemicals. The CCMC issues chemical clearance permits to importers of industrial chemicals. It is mandatory for applicants to submit an application form and copies of the Material Safety Data Sheets (MSDS) of every chemical they intend to import into Ghana to the CCMC. These applications are subsequently screened based on the information provided on the MSDS and other sources. In accordance with this procedure, TGL and its contractors will obtain relevant permits for all chemicals to be used for the TEN Project. The CCMC also supervises the disposal of obsolete chemicals. The CCMC collects information on all chemicals (industrial and agrochemicals) imported into Ghana. The EPA has a national database with safety information on chemicals and keeps registers on imports, toxic chemicals and pesticides which are available for public inspection.

Environmental Assessment Regulations

The EIA process is legislated through the *Environmental Assessment Regulations (LI 1652, 1999),* the principal enactment within the *Environmental Protection Act (Act No. 490 of 1994).* The *Environmental Assessment Regulations* require that all activities likely to have an adverse effect on the environment must be subject to environmental assessment and issuance of a permit before commencement of the activity.

The *Environmental Assessment Regulations* set out the requirements for the following:

- Preliminary Environmental Reports;
- Environmental Impact Assessment;
- Environmental Impact Statements;
- Environmental Management Plans;
- Environmental Certificates; and
- Environmental Permitting.

Schedules 1 and 2 of the *Environmental Assessment Regulations* provide lists of activities for which an environmental permit is required and EIA is mandatory, respectively. Schedule 2 includes oil and gas field developments, construction of offshore and onshore pipelines, construction of oil and gas separation, processing, handling and storage facilities and the construction of oil refineries. The *Environmental Assessment Regulations* define what is to be

(1) Certain important terms used in the EPA Act such as chemicals, toxic substances, substances which are hazardous have not been defined.

addressed within the EIA, how the EIA process should involve the public and outlines the steps to be followed within the process. An outline of the EIA process is provided in *Chapter 1*. These requirements, along with references to relevant sections within the EIS, are provided in *Table 2.1.*

Table 2.1 Required Contents of the EIS

Reference	Requirement within the EIA Regulations	EIS Reference
a.	A description of the undertaking.	Chapter 3
b.	An analysis of the need for the undertaking.	Chapter 1
c.	Alternatives to the undertaking including alternative situations where the undertaking is not proceeded with.	Chapter 3
d.	Matters on site selection including a statement of the reasons for the choice of the proposed site and whether any alternative site was considered.	Chapter 3
e.	An identification of existing environmental conditions including social, economic and other.	Chapters 4, 5 and 6
f.	Information on potential, positive and negative impacts of the proposed undertaking from the environmental, social, economic and cultural aspect in relation to the different phases of development of the undertaking.	Chapter 7
g.	The potential impact on the health of people.	Chapter 7
h.	Proposals to mitigate any potential negative socio-economic, cultural and public health impacts on the environment.	Chapter 7 and 8
i.	Proposals to be developed to monitor predictable environmental impact and proposed mitigating measures.	Chapter 9
j.	Contingency plans existing or to be evolved to address any unpredicted negative environmental impact and proposed mitigating measures.	Chapter 8
k.	Consultation with members of the public likely to be affected by the operations of the undertaking.	Attachment I
l.	Maps, plans, tables, graphs, diagrams and other illustrative material that will assist with comprehension of the contents of the environmental impact statement.	Chapters 1-7
m.	A provisional environmental and social management plan.	Chapter 11
n.	Proposals for payment of compensation for possible damage to land or property arising from the operation of the undertaking.	Chapter 11
o.	An indication whether any area outside Ghana is likely to be affected by the activities of the undertaking.	Chapter 7

Fees and Charges

The *Fees and Charges (Amendment) Instrument 2011 (LI 1986)* provides regulation to the *Fees and Charges (Miscellaneous Provision) Act 2009 (Act 793)*. The Act, which became law in 2009, was a comprehensive list of rates, fees and charges collectable by Ministries, Departments and Agencies for goods and services delivered to the public.

2.3.3 Environmental Guidelines

The EPA has issued formal guidance on regulatory requirements and the EIA process. The following documents are relevant to the EIA process and the project.

- Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2011) provide guidance on integrating environment, health, safety and community requirements into the offshore oil and gas operations. The guidelines include effluent limitations for discharges from offshore oil and gas operations.

- Environmental Assessment in Ghana, a Guide (1996) to Environmental Impact Assessment Procedures (1995) is an EPA guidance document which outlines procedures to be adhered to when undertaking an EIA.

- Sector Specific Effluent Quality Guidelines for Discharges into Natural Water Bodies provides maximum permissible effluent discharge concentrations for a number of parameters.

- General Environmental Quality Standards for Industrial or Facility Effluents, Air Quality and Noise Levels. The EPA has published draft standards for industrial or facility effluents, air quality and noise levels. These standards have not been promulgated as of August 2012. Effluent limitations are set out in Schedule 1 while Schedule 2 provides national environmental guidelines for the emission of pollutants from stacks into the atmosphere. Schedule 3 of these draft standards that provides ambient air quality guidelines and ambient noise level standards are outlined in Schedule 4.

2.3.4 Petroleum Legislation

Petroleum Commission Act

The *Petroleum Commission Act 2011 (Act 821)* established the Petroleum Commission for the regulation and management of petroleum resources and to coordinate the policies in relation to these resources.

Ghana National Petroleum Corporation Law

The *Ghana National Petroleum Corporation Law, 1983 (PNDCL No. 64)* established the GNPC as mandated to:

- promote exploration and planned development of the petroleum resources of the Republic of Ghana;
- ensure the greatest possible benefits from the development of its petroleum resources;
- obtain effective technology transfer relating to petroleum operations;
- ensure the training of citizens and the development of national capabilities; and
- prevent adverse effects on the environment, resources and people of Ghana as a result of petroleum operations.

Apart from allowing the GNPC to engage in petroleum operations and associated research, the law empowers the GNPC to advise the Minister of Energy on matters related to petroleum operations.

The Petroleum (Exploration & Production) Law

The *Petroleum (Exploration and Production) Law (Act No. 84 of 1984)* establishes the legal and fiscal framework for petroleum exploration and production activities in Ghana. The Act sets out the rights, duties and responsibilities of contractors; details for petroleum contracts; and compensation payable to those affected by activities in the petroleum sector.

The Act gives regulatory authority to the Ministry of Energy and Petroleum on behalf of the State. All petroleum operations are required to be conducted in such a manner as to prevent adverse effects on the environment, resources and people of Ghana.

The Act requires that a Plan of Development (PoD) for proposed developments be submitted and approved by the GNPC, MoE and the EPA before development of the field. In addition, an EHS Manual, containing details on health, safety, and environmental issues, policies and procedures must be submitted to the GNPC for review before commencement of development activities. The Act further requires that EHS audits of operations be conducted by the EPA and the GNPC.

The Act requires that emergency plans for handling accidents and incidents are discussed and agreed upon with the GNPC and the EPA before the commencement of operations.

National Petroleum Authority Act

The *National Petroleum Authority Act (Act No. 691 of 2005)* establishes the National Petroleum Authority (NPA) of Ghana to regulate, oversee and monitor downstream petroleum activities. The Act mandates the NPA to establish a Unified Petroleum Price Fund and provides for the regulation and licensing of storage and selling of petroleum products.

2.3.5 *Maritime Legislation*

Ghana Shipping (Protection of Offshore Operations and Assets) Regulations

The Ghana Shipping (Protection of Offshore Operations and Assets) Regulations (LI 2010, 2012) stipulate conditions for offshore installation safety zones including the protection of such zones and entry conditions; the establishment of exclusion zones and protection mechanisms; and pipeline protection areas and cable protection areas. The regulations include specific conditions for mobile offshore drilling units (MODUs) requirements for the operation of MODUs (eg requiring a safety operating permit and a design, construction and equipment meeting the requirements of IMO resolutions A.414 and A.649); and requirements for the safety permit. The regulations also set out miscellaneous provisions including offenses and penalties.

Maritime Zones (Delimitation) Law

The Maritime Zones (Delimitation) Law (PNDCL No. 159 of 1986) defines the extent of the territorial sea and Economic Exclusion Zone (EEZ) of Ghana. The territorial sea is defined as those waters within 12 nautical miles (nmi) (approximately 24 km) of the low waterline of the sea. The Act defines the EEZ as the area beyond and adjacent to the territorial sea up to 200 nm (approximately 396 km) from the low waterline of the sea. The Act also grants the rights, to the extent as permitted by international law, to the government of Ghana for the purposes of:

'exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the sea-bed and of the sea-bed and its subsoil, and with regard to any other activities for the economic exploration and exploitation of the zone, such as the production of energy from the water, currents and winds…'

Maritime Security Act

The *Maritime Security Act (Act No. 675 of 2004 as amended)* gives effect to Chapter XI-2 of *the International Convention for the Safety of Life at Sea, 1974 (SOLAS)*. The Act aims to enhance maritime safety and security; to create a legal framework for effective compliance with the International Ship and Port Facility Code (ISPS) which is enshrined in Chapter XI-2 of SOLAS; and to provide for related matters.

Fisheries Act

The *Fisheries Act (Act No. 625 of 2002)* repeals the *Fisheries Commission Act (Act No. 457 of 1993)* to consolidate and amend the law on fisheries. The *Fisheries Act (2002)* provides for the regulation, management and development of fisheries and promotes the sustainable exploitation of fishery resources.

Part 1 of the *Fisheries Act (2002)* deals with the establishment, functioning and responsibilities of the Fisheries Commission, and its mandate to manage national fishery resources. Part 3 regulates the management and development of fishery resources, including conservation measures, while Part 4 relates to jurisdiction and evidence related to non-compliance with the Fisheries Act.

Section 91 allows for the establishment of marine reserves and prohibits fishing, dredging and removal of sand or gravels and the disturbance of natural habitat without permission of the Minister.

Section 92 prohibits the pollution of water such that there is an adverse effect on aquatic resources and provides details of penalties.

Section 93 requires that the Fisheries Commission be informed of any activities likely to have substantial impact on fishery resources before commencement of the activity and allows the Fisheries Commission to require reports and recommendations by the proponent on the likely impact of the activity and possible means of preventing or minimising adverse impacts which shall be taken into account in the planning of the activities.

With reference to fish production and fisheries management, it is important to note that the *Fisheries Act* conforms to the relevant sectors of the United Nations Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries with particular emphasis on gear selectivity and an effective institutional framework. The *Fisheries Act* also gives legislative backing to the recently established Monitoring, Control and Surveillance Division with clearly defined legal powers to regulate fishing operations. The membership of the Division includes the Ghanaian Navy.

Fisheries Regulations

The Directorate of Fisheries under the Ministry of Food and Agriculture has also developed fishery management plans for marine fisheries. *The Fisheries Regulation (LI 1968 of 2010)* further sets up the specific rules and regulations for the implementation of the *Fisheries Act*. The *Fisheries Regulations* address prohibited fishing methods (*eg* lights to attract fish, explosives and poisons, and pair trawling), fishing within oil and gas infrastructure exclusion zones, minimum mesh sizes, the use of Fish Aggregating Devices (FADs), and fishing vessel licensing requirements.

2.3.6 Water Resources Legislation

The Water Resources Commission Act

The Water Resources Commission Act (Act No. 522 of 1996) establishes a commission to regulate and manage the water resources of the Republic of Ghana. The commission is tasked with establishing comprehensive plans for the use, conservation, protection, development and improvement of Ghana's water resources and is able to grant rights for the exploitation of water resources.

No water may be used without the granting of water rights, which may be granted, on application, by the Commission. The Act lays out the requirements and process for the application and subsequent transfer of such rights.

2.3.7 *Pollution Control*

There is currently no single integrated pollution legislation in Ghana. Pollution control exists as part of the environmental and water resource legislation and marine pollution is dealt with by the *Oil in Navigable Waters Act (Act No. 235 of 1964)* (see below). A *Marine Pollution Bill (2010)* is currently in draft stages of the legislative process which, when enacted, will empower the GMA to regulate marine pollution.

Section 2(f) of the *Environmental Protection Act (1994*) enables the EPA to issue pollution abatement notices for:

'*controlling the volume, types, constituents and effects of waste discharges, emissions, deposits or other source of pollutants and of substances which are hazardous or potentially dangerous to the quality of the environment or any segment of the environment…'*

Section 2(h) of the Act allows the EPA to prescribe standards and guidelines relating to air, water, land and other forms of environmental pollution. Section 2(j) requires the EPA to co-operate with District Assemblies and other bodies to control pollution.

The Water Resources Commission Act (see *Section 2.3.6* above) also addresses the control of water pollution. Section 24 of the Act prohibits the interference, altering, pollution or fouling of water resources beyond levels prescribed by the EPA and prescribes penalties for non-compliance.

Oil in Navigable Waters Act

The *Oil in Navigable Waters Act (Act No. 235 of 1964)* is the law which is mostly concerned with the control of water pollution. It was enacted in 1964 to give effect to the *International Convention for the Prevention of Pollution of the Sea by Oil (1954*) and also addresses oil pollution in inland waters.

Section 1 of the Act seeks to regulate the discharge of oil into prohibited areas of the sea. The Act extends the prohibition of pollution to the high seas by ships registered in Ghana and requires that Ghanaian ships be fitted so as to prevent oil fuel leakages or draining of oil into the bilges (unless the oil in the bilges is not discharged).

Section 3 of the Act deals with the discharge of oil into Ghanaian waters, defined by sub-section 2 as:

'*(a) the whole of the sea within the seaward limits of the territorial waters of Ghana, and (b) all other waters (including inland waters) which are within those limits and are navigable by sea-going ships*.'

The Act makes the discharge of any oil or mixture containing oil from any vessel or from land an offence. The owner or master of the ship, or the occupier of the land, or person in charge of the apparatus from where the oil was discharged, may be charged and found guilty of the offense.

Radiation Protection Instrument

The *Radiation Protection Instrument (LI 1559 of 1993)* establishes the Radiation Protection Board, which licenses importers and users of radioactive material and instrumentation. The Board is responsible for ensuring operations relating to devices that use radioactive materials are carried out without risk to the public health and safety and the installations and facilities are designed, installed, calibrated and operated in accordance with prescribed standards.

2.3.8 Protection of Coastal and Marine Areas

Ghana subscribes to a number of international conservation programmes, however, Ghana has at present no nationally legislated coastal or marine protected areas and there are no international protection programmes specifically covering the project area.

Ramsar Sites

The *Wetland Management (Ramsar Sites) Regulations (1999)* are made under the *Wild Animals Preservation Act (Act No. 43 of 1961)* and provide for the establishment of Ramsar sites within Ghana. For designated sites, activities that are not permitted include pollution of water, use of chemicals, hunting wild animals, grazing livestock, fishing using certain gear and in certain seasons and other activities that may have an adverse effect on the environment. Under the *Wetland Management (Ramsar Sites) Regulations (1999)* the Minister of Forestry can designate areas within the Ramsar site where certain activities can be carried out, *eg* sand and soil removal. There are five designated Ramsar wetland sites along the coast of Ghana including: Keta Lagoon Complex; Densu Delta; Muni-Pomadze; Sakumo; and Songor. There is a sixth Ramsar site (Owabi Wildlife Sanctuary) situated inland.

Other Protected Area

Ghana also has one UN Biosphere Reserve and two World Heritage Convention sites. The World Heritage Convention sites include the Asante Traditional Buildings, located near Kumasi, as well as Forts and Castles, most of which are located along the coast in the Central and Western Regions

(UNESCO, 2012). Ghana has more than 1,000 IUCN-management protected areas including 317 Forest Reserves, five Game Production Reserves, seven National Parks, two Resource Reserves, one Strict Nature Reserve, and four Wildlife Sanctuaries (World Resource Institute 2003).

Environmental Strategies, Policies and Plans

A number of government strategies and policies are relevant to the environmental protection of the coastal zone and are outlined below.

The National Energy Policy and Energy Sector Strategy and Development Plan. The Policy, which was approved by Cabinet in March 2010, is intended to guide the development and management of Ghana's energy sector, especially the emerging oil and gas sector. Section 7 provides Policy Direction for energy production and utilisation in an environmentally sound manner. Under the policy, the government of Ghana will, amongst other objectives:

- support and actively participate in international efforts and cooperate with international organisations that seek to ensure sustainable delivery of energy to mitigate negative environmental impacts and climate change;
- ensure effective disposal of all hazardous substances and materials associated with the production, transportation and use of energy; and
- facilitate environmental protection awareness programmes.

The National Biodiversity Strategy. Ghana signed (1992) and ratified (1994) the Convention on Biological Diversity and developed a National Biodiversity Strategy in 2002 for the sustainable use of its biological resources. Forest reserves, national parks and other wildlife reserves including various traditional forms of conservation have been set established to protect biological conservation. These areas occupy approximately 16% of Ghana's land surface. It is recognised that there is a lack of information on biological resources in Ghana and there is a need to address these data gaps. It is further recognised that for sustainable development there is a need to integrate biodiversity issues into national development planning programmes. The strategy recommends the establishment of a National Biodiversity Commission to coordinate policy and the implementation of the strategy among the relevant agencies under the Ministries as well as NGOs, CBOs and local communities.

The National Environment Policy. The National Environment Policy was set out from the National Environmental Action Plan (NEAP). The Plan seeks to redirect national development into more environmentally sustainable programmes and practices through:

- the protection and preservation of the resource base;
- prior assessment of the potential environmental impacts of development projects;
- alternative or multi-purpose uses of land and water resources; and

- the promotion of popular participation in planning, evaluating, and implementing environmental and development strategies.

The latest *National Environment Policy* was launched in 2012, however, the main requirements are still under development.

National Wetlands Policy. The policy promotes the conservation of wetlands included on the Ramsar List and use of wetlands to ensure their 'sustainable utilisation for the benefit of humankind in a way compatible with the maintenance of natural properties of the ecosystem'. The policy recognises wetlands as environmental conservation areas and precludes certain activities within its boundaries (*eg* mining, waste disposal and infrastructure development).

Tourism Development Policy. Ghana's National Tourism Policy focuses on promoting in-bound international tourism, regional tourism and domestic tourism.

Land Management Policy. This policy seeks to promote the judicious use of the nation's land and all its natural resources by all sectors of the Ghanaian society in support of various socioeconomic activities undertaken in accordance with sustainable resource use and maintenance of viable ecosystems. The policy indicates that land for private use must be accessed either through negotiation or compulsory acquisition.

Forest and Wildlife Conservation Policy. This policy is aimed at conservation and sustainable development of the nation's forest and wildlife resources for maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society. The policy provides for additional basis to develop a national forest estate and a timber industry that provides the full range of benefits required by society in a manner that is ecologically sustainable and that conserves the environmental and cultural heritage.

A number of national plans have been formulated to address these areas of coastal management. All the plans and programs are meant to provide for the preservation and sustainable use of fragile ecosystems, such as those that include mangroves or coral reefs. These plans and studies include the following:

- The Coastal Zone Management Indicative Plan (1990);
- The National Environmental Action Plan (1994);
- The Integrated Tourism Development Plan (ITDP) (1996-2010);
- The Draft Integrated Coastal Zone Plan (1998); and
- The National Oil Spill Contingency Plan (2002, Revised Draft 2009).

2.3.9 *Labour Law*

Labour Act

The *Labour Act (Act no 651 of 2003)* consolidates and updates the various pieces of former legislation, and introduces provisions to reflect International Labour Organisation (ILO) Conventions ratified by Ghana (see *Section 2.4.7*). The *Labour Act* covers all employers and employees except those in strategic positions such as the armed forces, police service, prisons service and the security intelligence agencies.

Major provisions of the *Labour Act* include the following:

- establishment of public and private employment centres;
- protection of the employment relationship;
- general conditions of employment;
- employment of persons with disabilities;
- employment of young persons;
- employment of women;
- fair and unfair termination of employment;
- protection of remuneration;
- temporary and casual employees;
- unions, employers' organisations and collective agreements;
- strikes;
- establishment of a National Tripartite Committee;
- forced labour;
- occupational health and safety;
- labour inspection; and
- establishment of the National Labour Commission.

Part XV of the *Labour Act* contains provisions relating specifically to occupational health, safety and environment. These include general health and safety conditions, exposure to imminent hazards, employer occupational accidents and diseases reporting.

Children's Act

The *Children's Act (Act No. 560 of 1998)* defines a child as a person below the age of eighteen years. Sections 12 and 87 prohibit engaging a child in exploitative labour, defined to mean labour depriving the child of its health, education or development.

Commission on Human Rights and Administrative Justice Act

The *Commission on Human Rights and Administrative Justice Act (Act No. 456 of 1993),* establishes a Commission on Human Rights and Administrative Justice to investigate complaints of violations of fundamental human rights and freedoms, injustice and corruption, abuse of power and unfair treatment of persons by public officers in the exercise of their duties, with power to seek remedy in respect of such acts or omissions.

National Vocational Training Act

The *National Vocational Training Act (Act No. 351 of 1970)* and the *National Vocational Training Regulations* (Executive Instrument 15) oblige employers to provide training for their employees for the attainment of the level of competence required for the performance of their jobs and to enhance their career.

Labour Provisions of the Shipping Act

The *Shipping Act (Act No. 645 of 2003 as amended)* regulates the engagement and welfare of seafarers, in particular with respect to crew agreements, wages, occupational safety and health, required provisions and water on board, protection of seafarers from imposition and relief and repatriation. Part VII regulates safety of life at sea. The Act applies to Ghanaian ships wherever they may be and other ships while in a port or place in or within the territorial and other waters of Ghana (section 480).

2.3.10 Land Use

The *Town and Country Planning Act (Cap 84 of 1945) (as amended by Act 30 of 1958 and Act 33 of 1960)* establishes the Town and Country Planning Department (TCPD). The TCPD is responsible for land use in Ghana. The District Assemblies, established under the *Local Government Act (Act No 462 of 1993)* are required to prepare plans, and manage and control development. All decisions on land-use are made in consultation with relevant stakeholders.

2.3.11 Legislation under Preparation

It is recognised that in view of the developing petroleum exploration and production industry, the Ghanaian government is drafting new environmental and marine regulations and guidelines. These include the *Petroleum (Exploration and Production) Act* and new *Health Safety and Environment Regulations* for the oil and gas industry.

2.4 STATE, CONVENTIONS AND CLASSIFICATION REQUIREMENTS

The regulatory requirements for drilling vessels and FPSOs are generally set out by the coastal state or shelf state, the flag state, international conventions and the classification society. The vessel needs to satisfy all of the requirements from these authorities before it is approved fit for purpose. This section provides an overview of the principal relationships between and requirements of these regulators.

2.4.1 *Coastal State Regulations*

All countries have full sovereignty to regulate activities on their continental shelves. As the vessels will be located on Ghana's continental shelf, Ghana regulations, as administered by the GMA, are the governing regulations and take precedence over all flag state and class requirements. However, many jurisdictions, including Ghana, refer to maritime codes, rules and standards related to flag and classification requirements and technical standards for vessel design and operation.

GMA refers to the regulations of the nominated flag state. In the case of the TEN FPSO, the flag state will be the Bahamas Maritime Authority.

2.4.2 *Flag State Regulations*

Ships or offshore facilities trading internationally have to comply with the safety regulations of the maritime authority from the country whose flag the unit is flying. An FPSO does not need a flag unless required by the coastal state (*ie* GMA in Ghana) or when in transit through international waters. Flag states require classification and implementation of the safety regulations such as those of the International Maritime Organisation (IMO).

The relevant maritime authority will require commercial vessels registered in the flag state to be surveyed, certified and undergo verification by a recognised organisation. Flag state legislation will require that the FPSO is to be satisfactorily inspected on an annual basis.

2.4.3 *International Conventions*

The IMO is the marine affairs organisation of the United Nations and develops and maintains conventions that provide safety regulations for ships and mobile offshore units operating internationally.

Of the conventions defined by IMO the following are relevant to FPSOs.

- International Convention for the Safety of Life at Sea.
- International Convention for the Prevention of Pollution from Ships (MARPOL).
- International Convention on Load Lines.
- International Convention on Tonnage Measurement of Ships.

The degree to which these are enforced depends on the flag state. Further details on the international conventions relevant to the EIA (*eg* MARPOL) are provided are provided in *Section 2.5*.

2.4.4 *Classification Societies*

Classification provides assurance that a ship or offshore installation has been designed, constructed and maintained in accordance with sound principles. Major class societies (*eg* Bureau Veritas, Det Norske Veritas and Lloyd's Register) have developed dedicated FPSO rules and standards. Flag states require flagged units to be classed and most coastal states refer to class as the recognised standard for maritime aspects of FPSOs. The TEN FPSO will undergo classification as an FPSO according to established classification society rules. Further details on classification are provided in *Chapter 3, Section 3.4.1*. Drilling vessels to be used will also be classified by one of the major classification societies.

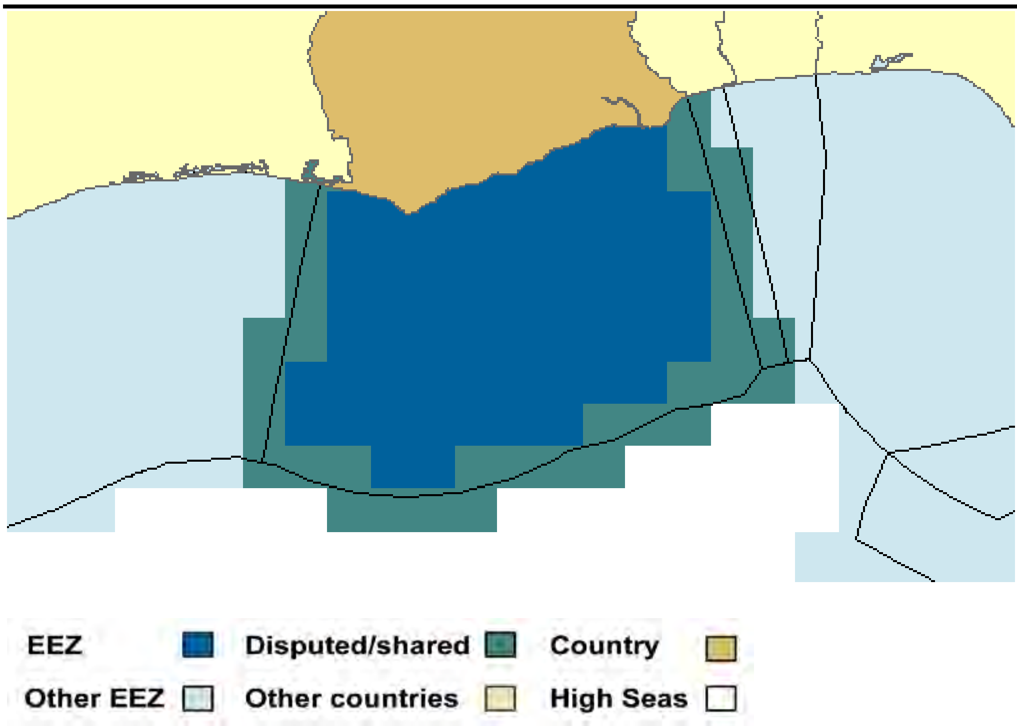
2.5 *RELEVANT INTERNATIONAL AGREEMENTS AND CONVENTIONS*

2.5.1 *United Nations Convention on the Laws of the Sea*

Ghana is signatory to the United Nations Convention on the Laws of the Sea (UNCLOS). Under this convention Ghana claims rights within 12 nmi of territorial water and a 200 nmi Exclusive Economic Zone (EEZ) (*Figure 2.2*). The TEN Project is located approximately 32 nmi offshore and, therefore, outside Ghana's territorial water but inside the 200 nmi EEZ. Clearance for project vessels travelling into the territorial waters (*eg* to and from the onshore base) must be obtained from the GMA and notification should also be made to the Ghanaian Navy. On 28 April 2009, Ghana submitted a proposal to extend its EEZ beyond 200 nmi to 350 nmi to the United Nations Commission on the Limits of the Continental Shelf and is awaiting a decision.

The western boundary of the DWT block is aligned with the maritime border between Ghana and Côte d'Ivoire. In 2010, Côte d'Ivoire appealed to the United Nations to complete the demarcation of the Ivorian maritime boundary with Ghana. The Government of Ghana established a commission with the purpose of undertaking negotiations in order to confirm the country's land and maritime boundaries. The boundary commission have met with Ivorian delegates to negotiate the delimitations according to international law, however, a resolution has not yet been reached.

Figure 2.2 Ghana's Exclusive Economic Zone



Source: Sea Around Us Project 2012

2.5.2 *International Maritime Organisation Conventions*

Ghana is signatory to the following main IMO Conventions.

- *International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Intervention Convention), 1969.*
- *Convention on the International Regulations for Preventing Collisions at Sea (COLREGs), 1972.*
- *International Mobile Satellite Organisation (IMSO) convention, 1976.*
- *Convention on Limitation of Liability for Maritime Claims (LLMC), 1976.*
- *International Convention on Standards of Training, Certification, and Watch keeping for Seafarers (STCW), 1978.*
- *International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).*
- *International Convention for the Safety of Life at Sea (SOLAS), 1974 and the SOLAS Protocol of 1978.*
- *International Convention on Maritime Search and Rescue (SAR), 1979.*

- *International Convention of Oil Preparedness, Response and Co-operation (OPRC), adopted 1990.*

- *IMO Convention 48 and its amendments of 1991 and 1993.*

Further details of the MARPOL Convention and the OPRC Convention are provided below.

The MARPOL Convention

The *International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)* contains a number of the provisions relevant to the project. These include general requirements regarding the control of waste oil, engine oil discharges as well as grey and black waste water discharges.

The MARPOL Convention initially comprised *Regulations for the Prevention of Pollution by Oil (Annex I)* and *Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (Annex II).* Another four annexes have subsequently been added. Ratified parties must accept Annexes I and II, but the other four are voluntary. *Table 2.2* provides a list of MARPOL provisions relevant to oil and gas developments. Annexes I and II were ratified first and in 2010, Ghana ratified the remaining Annexes III to VI which will likely come into force in 2012. A draft Marine Pollution Bill has been prepared to adopt the remaining four annexes of the MARPOL standards into Ghanaian legislation.

It is the intent of the project to comply with all the Annexes. The EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Industry (2010) and International Finance Corporation's (IFC) EHS guidelines for offshore oil and gas development (see *Section 2.5.3*) also require compliance with MARPOL and its annexes. MARPOL Annex I also designates 'special areas' where there are stricter controls on discharge of oily wastes. Waters offshore Ghana are not within a MARPOL special area.

The OPRC Convention

The *International Convention of Oil Preparedness, Response and Co-operation Convention* was adopted in 1990 and came into force in 1995. It requires signatory parties to establish measures for dealing with major incidents or threats to marine pollution, either nationally or in co-operation with other countries. Ships are required to carry a shipboard oil pollution emergency plan and to report incidents of pollution to coastal authorities. Offshore operators are required to have oil pollution emergency plans or similar arrangements which must be co-ordinated with national systems for responding promptly and effectively to oil pollution incidents.

Table 2.2 MARPOL 1973/1978 Provisions Relevant to FPSO Oil and Gas Developments

Environmental Aspect	Provisions of MARPOL 1973/1978	Annex
Drainage water	Ship must be proceeding en route, not within a 'special area' and oil must not exceed 15 ppm (without dilution). Vessel must be equipped with an oil filtering system, automatic cutoff and an oil retention system.	I
Accidental oil discharge	Shipboard oil pollution emergency plan (SOPEP) is required.	I
FPSO hull configuration	Revisions to Annex I issued under IMO Resolution MEPC.139 (53) exclude FPSOs from the definition of an oil tanker. It further stipulates that in the case of a new purpose-built FPSO hulls, the vessel must be configured with double sides, but for an FPSO based on a conversion a single hull may be utilised provided that 'appropriate measures' are taken to mitigate the risk of low energy collisions between the FPSOs and other vessels.	I
Bulked chemicals	Prohibits the discharge of noxious liquid substances, pollution hazard substances and associated tank washings. Vessels require to undergo periodic inspections to ensure compliance. All vessels must carry a Procedures and Arrangements Manual and Cargo Record Book.	II
Sewage discharge	Discharge of sewage is permitted only if the ship has approved sewage treatment facilities, the test result of the facilities are documented, and the effluent will not produce visible floating solids nor cause discoloration of the surrounding water.	IV
Garbage	Disposal of garbage from ships and fixed or floating platforms is prohibited. Ships must carry a garbage management plan and shall be provided with a Garbage Record Book.	V
Food waste	Discharge of food waste ground to pass through a 25-mm mesh is permitted for facilities more than 12 nmi from land.	V
Air pollutant emissions	Sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. Sets limits on emissions of nitrogen oxides from diesel engines. Prohibits the incineration of certain products on board such as contaminated packaging materials and polychlorinated biphenyls.	VI

The convention calls for the establishment of stockpiles of oil spill combating equipment, the holding of oil spill combating exercises and the development of detailed plans for dealing with pollution incidents. Parties to the convention are required to provide assistance to others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided.

2.5.3 *The Abidjan Convention*

The International Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (the Abidjan Convention was signed in March 1981 and came into force in 1984. In compliance with a number of other regional conventions, the Abidjan Convention deals with pollution from ships, via incidental discharges and dumping, by referring the contracting parties to the applicable global conventions.

2.5.4 *International Convention for the Control and Management of Ships' Ballast Water and Sediments*

The International Convention for the Control and Management of Ships' Ballast Water and Sediments aims to prevent, minimise, and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. Ghana is not currently a signatory to this convention.

Under this Convention ports and terminals, where cleaning or repair of ballast tanks occur, should have adequate reception facilities to receive sediments. Ships are required to be surveyed and certified, and may be inspected by Port State Control officers and/or surveyors who can inspect the Ballast Water Record Book and/or sample the ballast water.

The ship can be prevented from discharging its ballast if it is deemed to present a threat to the environment, without the ship thereby being unduly detained or delayed. Ships are required to have onboard and implement a Ballast Water Management Plan approved by the administration. Whenever possible, all ships using ballast water exchange should do so at least 200 nmi from nearest land in water at least 200 m deep, the absolute minimum being 50 nmi from the nearest land.

2.5.5 *Basel Convention*

The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) aims to protect human health and the environment against the adverse effects resulting from the generation, management, movement and disposal of hazardous waste. The Convention regulates the transboundary movement of hazardous waste using the Prior Informed Consent Procedure such that shipments without prior consent are illegal.

The Convention obliges producers of hazardous waste to therefore dispose of their waste in an environmentally responsible manner close to where it is generated. Strong controls on the movement, storage, transport, treatment, reuse, recycling, recovery and final disposal of hazardous waste are imposed.

Transboundary movements would generally be approved, if:

(a) the state of export does not have the capability of managing or disposing of the waste in an environmentally sound manner, such as may be the case in Ghana, or
(b) the receiving state has appropriate, environmentally sound facilities, and agrees to accept the waste.

Ghana gained accession to the Basel Convention on 30 May 2003 (accession has the same legal effect as ratification) which means that it must comply with all the requirements of the Convention. Therefore, certain wastes generated in Ghana, or within its territorial waters, that are exported to another country, will be subject to the provisions of the Basel Convention. Wastes generated from 'normal operations of a ship' are specifically excluded from the Basel Convention, the management of which is covered by MARPOL.

2.5.6 Bamako Convention

Ghana is a signatory to the *Convention on the Ban of the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa (Bamako Convention).* This convention is supplementary to the Basel Convention and covers movement of hazardous waste into or between signatory African countries. The Convention has many provisions virtually identical, or analogous, to the Basel Convention provisions.

2.5.7 International Labour Organisation Conventions Ratified by Ghana

Ghana joined the International Labour Organisation (ILO) in 1957 and has ratified 46 ILO Conventions, including the following core Conventions:

- ILO Convention 29 on Forced Labour;
- ILO Convention 87 on Freedom of Association and Protection of the Right to Organise;
- ILO Convention 98 on the Right to Organize and Collective Bargaining;
- ILO Convention 100 on Equal Remuneration;
- ILO Convention 105 Concerning the Abolition of Forced Labour;
- ILO Convention 111 on Discrimination (Employment and Occupation); and
- ILO Convention 148 on Working Environment (Air Pollution, Noise and Vibration) Convention, 1977.

Other ILO Conventions that were also ratified included Conventions on hours of work in industry, weekly rest, minimum wage fixing, labour inspection, underground work by women, employment service, night work by women, social policy, working environment, child labour, and labour administration.

2.5.8 *Other Conventions and Treaties*

Ghana has also ratified the following international conventions and treaties which may be applicable to the project.

- Africa Convention on the Conservation of Nature and Natural Resources.
- African Charter on Human and Peoples' Rights.
- Convention Concerning the Protection of World Cultural and Natural Heritage.
- Convention on Biological Diversity.
- Convention on the Conservation of Migratory Species of Wild Animals.
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitats.
- Framework Convention on Climate Change.
- International Convention for the Conservation of Atlantic Tunas.
- International Convention on Civil Liability for Oil Pollution Damage.
- International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage.
- International Covenant on Civil and Political Rights.
- International Covenant on Economic, Social and Cultural Rights.
- Montreal Protocol on Substances that Deplete the Ozone Layer.
- Supplementary Convention on the Abolition of Slavery, the Slave Trade, and Institutions and Practices Similar to Slavery.

2.6 *GOOD PRACTICE STANDARDS AND GUIDELINES*

2.6.1 *Introduction*

There are a number of industry good practice standards and guidelines for offshore oil and gas developments.
The TEN Partners have adopted the IFC 2012 Sustainability Framework and associated Performance Standards and EHS guidelines as part of the requirements of the IFC part-funding for the project and on the basis that they

represent good industry practice. This section describes relevant IFC Performance Standards and other relevant best practice guidelines.

2.6.2 *IFC Performance Standards*

All eight of the IFC Performance Standards (2012) need to be applied to funded projects, however, for the TEN Project the following are considered to be the directly relevant Performance Standards:

- PS1: Social and Environmental Assessment and Management Systems;
- PS2: Labour and Working Conditions;
- PS3: Resource Efficiency and Pollution Prevention;
- PS4: Community Health, Safety and Security; and
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.

Additional guidance is contained in the Guidance Notes to the Performance Standards and the following IFC documents:

- Policy on Social and Environmental Sustainability; and
- Policy on Disclosure of Information.

The IFC's set of Guidance Notes corresponds to the Performance Standards and provide guidance on the requirements contained in the Performance Standards, including reference materials and on good sustainability practices to improve project performance.

2.6.3 *IFC EHS Guidelines*

The EHS Guidelines are technical reference documents that address IFC's expectations regarding the industrial pollution management performance of projects. They are designed to provide relevant industry background and technical information. This information supports actions aimed at avoiding, minimising, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project or facility.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a justification for any proposed alternative is needed as part of the site-specific environmental assessment. This justification needs to demonstrate that the choice for any alternate performance level is consistent with the overall requirements of the relevant IFC Performance Standards.

The updated EHS Guidelines serve as a technical reference source to support the implementation of the IFC Performance Standards, particularly in those aspects related to Performance Standard 3: Pollution Prevention & Abatement, as well as certain aspects of occupational and community health and safety.

The general EHS Guidelines contain information on environmental, health, and safety issues potentially applicable to all industry sectors and should be used together with the relevant IFC industry sector guidelines. For the TEN Project, the relevant EHS Guidelines that would apply are:

- EHS General Guidelines (IFC 2007a);
- EHS Guidelines for Offshore Oil and Gas Development (IFC 2007b);
- EHS Guidelines for Shipping (IFC 2007c); and
- EHS Guidelines for Crude Oil and Petroleum Product Terminals (IFC 2007d).

2.6.4 Oil Industry Exploration and Production Forum

The International Association of Oil & Gas Producers (OGP) (former E&P Forum) was formed in 1974 and is the international association of oil companies and petroleum industry organisations. The OGP is concerned with all exploration and production operations and has sought to establish industry positions on environmental protection and personnel safety. The guidance provided in *Table 2.3* is of relevance to the project and has been adopted by the project as industry good practice standards for environmental assessment and management.

2.6.5 International Petroleum Industry Environmental Conservation Association

The International Petroleum Industry Environmental Conservation Association (IPIECA) has produced several volumes of guidance on spill response and contingency planning for the marine environment. As part of this, they have developed the 'Tiered Response' approach, which categorises the appropriate response to a spill incident based on size and proximity to operations. Additional relevant guidance on oil spills is provided by IPIECA within:

- IPIECA, 1991: A Guide to Contingency Planning for Oil Spills on Water; and
- IPIECA, 1991: Guidelines on Biological Impacts of Oil Pollution.

2.7 PROJECT ENVIRONMENTAL STANDARDS

The following water, air and noise standards are based on MARPOL, good industry practice such as the Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and IFC EHS Guidelines. Many of these standards have now been adopted in the EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010).

Table 2.3 Oil Industry Exploration and Production Forum Guidelines

Organisation	Standard	Key Element
E&P Forum	Exploration and Production Waste Management Guidelines	The guidelines were prepared for oil and gas exploration and production companies who require information on the range of waste management options available for wastes generated by their activities. Sections of the document provide a general description of waste management principles, an identification and overview of E&P activities and associated wastes and options for waste reduction, recycling, treatment and responsible disposal.
Exploration and Production (E&P) Forum / United Nations Environment Programme (UNEP)	Environmental Management in Oil and Gas exploration and Production	This document provides an overview of environmental issues and management approaches in oil and gas exploration and production operations. It defines the framework for environmental management against a background of existing information developed by industry, the United Nations Environmental Programme, and a variety of non-governmental organisations. It gives a brief overview of the oil and gas exploration and production process and examines potential environmental effects or impacts and discusses environmental protection measures. Section 6 describes how impacts can be avoided or minimised.
OGP	Principles for Impact Assessment – the Environmental and Social Dimension	This guidance focuses on increasing the coverage of social and community impacts in EIA, together with such factors as public consultation and access to local knowledge.
OGP	Environmental-Social-Health Risk and Impact Management Process	This document provides guidance to operators on delivering oil and gas projects that are integrated with the Environmental, Social and Health (ESH) appraisal process of identifying and mitigating environmental, social and health impacts.
OGP	HSE Management Guidelines for Working Together in a Contract Environment	The overall objective of this guideline is to improve the company and contractor health, safety and environmental performance regarding exploration and production activities. The guidelines are designed to improve workplace safety, health and environmental performance by assisting the company and contractor in administering and effective HSE programme for the contract.
OGP	Offshore Environmental Monitoring for the Oil and Gas Industry	The document, developed by the Committee's Offshore Environmental Monitoring Task Force, provides guidance to exploration and production companies on the design of offshore environmental monitoring studies.

2.7.1 *Water Quality*

Table 2.4 provides industry good practice standards for effluent discharges from offshore oil and gas developments based on MARPOL, IFC and OSPAR standards. These have been adopted in the EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2010).

Table 2.4 Industry Good Practice Standards for Effluent Discharges

Source	**Industry Good Practice Standards**
Drilling fluid	Enhanced cuttings treatment to reduce oil on cuttings to less than 3% as a weighted average. Use of low toxicity (Group III) NADF, no free oil, limits on mercury (max 1 $mgkg^{-1}$) and cadmium (max 3 $mgkg^{-1}$) concentrations. Discharge via a caisson at least 15 m below sea surface.
Completion and Workover Fluids	Discharge to sea if oil and grease do not to exceed 40 mgl^{-1}daily maximum and 29 mgl^{-1} monthly average. Any spent acids to be neutralised (to attain a pH of 6 or more) as per EPA guidelines.
Cooling Water	The effluent should result in a temperature increase of no more than 3°C at the edge of the initial mixing/dilution zone. Where the zone is not defined, use 100 m from point of discharge as per EPA guidelines.
Produced Water	Oil and grease not to exceed 40 mgl^{-1} daily max and 29 mgl^{-1} monthly average as per EPA guidelines.
Produced Sand	No discharge unless residual oil less than 1% by weight on dry sand as per EPA guidelines.
Sewage	Treat with approved marine sanitation unit (achieve no floating solids, no discolouration of surrounding water) as per MARPOL Annex IV requirements. Minimum residual chlorine of 1 mgl^{-1}as per IFC EHS Guidelines.
Food Waste	Macerate to acceptable levels and discharge in compliance with MARPOL 73/78 Annex V requirements.
Bilge Water	Treat to 15 ppm oil concentration as per MARPOL 73/78 Annex I requirements.
Storage Displacement Water (Ballast Water)	Compliance with the International Convention for the Control and Management of Ship's Ballast Water and Sediments
Deck Drainage	Treat to 15 ppm oil concentration as per MARPOL 73/78 Annex I requirements.
Desalination Brine	Mix with other discharge streams if feasible.

Note: MARPOL 1973/1978 = International Convention for the Prevention of Pollution from Ships. PPM = parts per million

2.7.2 *Air Quality*

Key provisions of the IFC EHS guidelines for offshore oil and gas developments relating to air emissions are outlined in *Table 2.5*.

Table 2.5 Key IFC Provisions for Point Source Air Emissions

Source	Guideline
General	All reasonable attempts should be made to maximise energy efficiency and design facilities for lowest energy use. The overall objective should be to reduce air emissions and evaluate cost effective options for reducing emissions that are technically feasible.
Exhaust Gases	Guidance for the management of small combustion sources with a capacity of up to 50 megawatt-hours thermal, including standards for exhaust emissions, is provided in the IFC's General EHS Guidelines. For engines using liquid fuels these are as follows. • Particulate matter: 50 $mgNm^{-3}$ (up to 100 if justified by project-specific conditions) (approximately 24 and 49 ppm respectively). • Sulphur dioxide: 1.5% of sulphur (up to 3% if justified by project-specific conditions). Consideration to using low sulphur fuels or secondary treatment to meet 1.5% sulphur. • Nitrogen oxides: 1,460 $mgNm^{-3}$ if bore size diameter <400 mm (up to 1,600 $mgNm^{-3}$ if justified to maintain high energy efficiency) and 1,850 $mgNm^{-3}$ if bore size diameter >400 mm. These normalised gas concentrations equate to approximately 711, 779 and 901 ppm respectively. • Dry gas, excess oxygen content: 15%. For gas-fired engines these are as follows. • Nitrogen oxides: 200 $mgNm^{-3}$ for spark ignition, 400 $mgNm^{-3}$ for dual fuel and 1,600 $mgNm^{-3}$ for compression ignition. • Dry gas, excess oxygen content: 15%.
Greenhouse Gases	Significant (>100,000 tonnes CO_2 equivalent per year) greenhouse gas (GHG) emissions from all facilities and offshore support activities should be quantified annually as aggregate emissions in accordance with internationally recognised methodologies and reporting procedures.
Venting and Flaring	Measures consistent with the Global Gas Flaring and Venting Reduction Voluntary Standard (part of the World Bank Group's Global Gas Flaring Reduction Public-Private Partnership should be adopted when considering venting and flaring options for offshore activities). The standard provides guidance on how to eliminate or achieve reductions in the flaring and venting of natural gas. Continuous venting of associated gas is not considered current good practice and should be avoided.
Well Testing	During well testing, flaring of produced hydrocarbons should be avoided, especially in environmentally sensitive areas. Feasible alternatives should be evaluated for the recovery of these test fluids, while considering the safety of handling volatile hydrocarbons, for transfer to a processing facility or other alternative disposal options. An evaluation of alternatives for produced hydrocarbons should be adequately documented and recorded.

Source	Guideline
Fugitive Emissions	Methods for controlling and reducing fugitive emissions should be considered and implemented in the design, operation, and maintenance of offshore facilities. The selection of appropriate valves, flanges, fittings, seals, and packings should consider safety and suitability requirements as well as their capacity to reduce gas leaks and fugitive emissions.

The IFC General Environmental EHS guidelines (IFC 2007a) defer to the World Health Organisation (WHO) air quality guidelines standards (WHO 2005). The WHO guideline standards have been followed in this EIA as they are more stringent than the EPA ambient air quality guidelines for Ghana. The WHO (2005) and EPA ambient air quality standards are outlined in *Chapter 7*.

2.7.3 *Noise Levels*

The EPA draft noise standards are summarised in *Table 2.6*.

Table 2.6 ***Ghana Draft Ambient Noise Level Standards***

Zone	Description of Noise Reception	Permissible Noise Level in dB(A)	
		Day (06h00 - 22h00)	Night (22h00 – 06h00)
A	Residential areas with low or infrequent transportation	55	48
B1	Educational (school) and health (hospital, clinic) facilities	55	50
B2	Areas with some commercial or light industry	60	55
C1	Areas with some light industry, places of entertainment or public assembly and places of worship located in this zone	65	60
C2	Predominantly commercial areas	75	65
D	Light industrial areas	70	60
E	Predominantly heavy industrial areas	70	70

Source: EPA (draft)

Permissible adjustment to measures noise levels for intermittent noise as per *Schedule 4* of the draft noise standards is provided in *Table 2.7*.

Table 2.7 ***Permissible Adjustment to Measured Noise Level for Intermittent Noise***

Cumulative period for which intermittent noise is present in any hour	Maximum allowable adjustment above the permissible ambient level (dBA)
More than 15 minutes	± 5
5 minutes - 15 minutes	- 1
1 minute – 5 minutes	- 10
Less than 1 minute	- 15

Note: These duration adjustments are not applicable when noise being assessed includes discrete noise impulses or consists of repetitive noise with an impulsive character *eg* hammering or riveting.

Underwater Noise Levels

The IFC guidelines for minimising underwater noise are applicable to the offshore oil and gas production operations including production activities and offshore and near shore structural installations, *eg* seismic surveys, pile driving, construction activities and marine traffic.

These guidelines recommend the following measures to reduce the risk of noise impact to marine species.

- Identifying and avoiding areas sensitive for marine life such as feeding, breeding, calving, and spawning areas.
- Planning seismic surveys and offshore construction activities around sensitive times of the year (*eg* breeding season).
- Identifying fishing areas and reducing disturbance to these areas by planning for seismic surveys and construction activities to be undertaken at less productive times of the year, where possible.
- Reducing operation time, where possible.
- Monitoring the presence of sensitive species (if expected to be in the project area) before the onset of noise creation activities and throughout the seismic program or construction. Experienced observers should be used where significant impacts to sensitive species are anticipated.

It is noted that a number of these measures are intended for noisy operations such as seismic surveys and pile driving that are not part of the activities being assessed in this EIA.

2.7.4 Ghana Oil and Gas Industry Standards

TGL has adopted the Ghana Standards Board's Oil and Gas Industry Standards as a set of recognised standards for the TEN Project. A full list of the ISO standards adopted by the Ghana Standard's Board for the Oil and Gas Industry can be found here at www.gsb.gov.gh.

2.8 PROJECT EHS POLICIES AND STANDARDS

All facilities will be designed, developed and operated in conformance the Tullow EHS Policy, Tullow Oil Environmental Standards (*toes*), Tullow Safety Rules and the TGL EHS Management System (EHSMS). Although the TEN fields will be developed by the TEN Partners, as Operator of the DWT block, Tullow's EHS policies and standards will be adopted. A copy of Tullow's EHS policy is provided in *Figure 2.3*.

Tullow Oil Environmental Standards

These standards are applicable to all Tullow's operations and revolve round the following four key areas with a set of project tools to support their delivery: biodiversity, greenhouse gases, resource management and social-economic aspects. A diagram summarising ***toes*** is provided in *Figure 2.4*.

Other applicable company standards include Tullow's:

- Safety Rules;
- Community Disturbance Philosophy; and
- Drills Cuttings and Fluids Disposals guidelines.

Tullow's Safety Rules (T-EHS-STD-001)

Tullow's Safety Rules are a set of requirements designed to manage high risk activities that have the potential for negative impacts on their staff, the environment and the surrounding communities. The effective implementation of these rules will lead to reduce the risk to the workers, the environment and the surrounding communities during the operations.

Figure 2.3 Tullow Oil EHS Policy

Think Environment
Think Health
Think Safety
Think Forward

TULLOW OIL plc

Environment, Health and Safety Policy

At Tullow Oil, we expect everyone to *Think* about their role in managing Environmental Health and Safety (EHS) risks that exist in our business and, in particular, within their own area of responsibility and influence.

To help us manage these risks we require everyone connected with our activities to:

- **Respect** our stakeholders and our values
- **Reflect** on lessons learned and their actions
- **Protect** the environment and each other

By following these principles and ***Thinking Forward*** we will ensure that EHS risk management forms an integral part of our day-to-day working practices and alignment with the EHS Vision.

To achieve this, we commit to:

- Proactively manage EHS risks and plan our operations taking those risks into account;
- Comply with the requirements of all applicable EHS laws and regulations, and apply industry best practice where legislation is lacking;
- Invest in building a competent and capable organisation to deliver consistently high levels of operational and EHS performance, supported by strong visible EHS leadership;
- Prevent pollution and minimise other adverse impacts on the environment and the local communities where we operate;
- Maintain a safe working environment by implementing safe systems and taking responsibility for the health and wellbeing of our staff and contractors;
- Ensure those working on our behalf adopt similar high standards of EHS;
- Monitor our progress against strong EHS objectives and targets to continually improve our performance.

In adhering to this Policy, everyone in Tullow or working on our behalf is empowered to stop any activity they regard as irresponsible or unsafe.

Aidan J Heavey

Aidan J Heavey
Chief Executive Officer, Tullow Oil plc
May 2012

T-EHS-POL-0001 Rev9

Figure 2.4 Tullow Oil Environmental Standards

Source: Tullow 2013

Tullow's Community Disturbance Philosophy (T-EHS-PHL-002)

The philosophy is based on a commitment that Tullow will prevent community disturbance through eliminating or reduce disruption to an acceptable level. It is Tullow's intent to ensure minimum community disturbance in order to foster and maintain good relations with local stakeholders. To avoid or reduce the potential for disturbance complaints the following principles apply.

- *Mitigation by design*: focus on planning and minimising the key risks relating to community disturbance through the evaluation of technical solutions and adoption of internationally recognised good practice and standards, and national legislation, in operational design.

- *Intervention*: mitigation actions should be undertaken where a disturbance is observed to exceed established thresholds (as set through the EIA, regulators and regulations or recognised international standards.

This philosophy applies also to all those activities associated with a project being undertaken, such as surveys, vehicle movements, ground works, construction camps and any operational activities which may have a potential to interact and disturb the local communities.

Tullow's Drills Cuttings and Fluids Disposals Guidelines (T-WEL-GUD-0002)

Tullow's Drills Cuttings and Fluids Disposals Guidelines are applicable to the disposal of drill fluids and cuttings for both onshore and offshore drilling programmes where Tullow is the operator. The guidelines set minimum requirements to be considered during the planning stages of well construction, well testing and well intervention activities. Where local legislation dictates more stringent requirements, these shall be followed. This Standard should be used to inform project-specific procedures.

2.8.2 EHS Management System

The TEN Project will be governed by the Tullow EHSMS. From the commencement of operations, the TGL EMS Management Framework (TGL-EHS-PRC-04-0052), certified to the ISO14001:2004 standard, will also be applied to the TEN Project.

Relevant procedures, plans and programs will be implemented during the course of the project to meet the management requirements. These are based on industry best practice and Tullow Oil's EHS policy and standards. Applicable elements expected of subcontractors will be communicated and included in all contracts. The provisional ESMP for the project, along with the key elements of the TGL EHSMS, is presented in *Chapter 11*.

2.8.3 EHS Management Plans

The primary document that describes TGL's proposed strategies and systems for managing EHS issues during execution of the TEN Project is the EHS Management Plan (00002-TLW-ES-PLN-0001). This plan covers the Front-End Engineering Design (FEED), construction, installation and hook-up, commissioning with a handover to operations of the FPSO and subsea systems.

Well engineering activities will be managed through the Tullow Well Operations Management Plan (WOMP). EHS bridging documents (1) will be developed that bridge to TGL's EHSMS. The WOMP is linked with the EHS Management Plan.

The TEN Project ESMP, which covers the FEED, construction, installation and hook-up, commissioning and operations, will be used to manage environmental aspects in particular.

A UK Safety Case approach and risk based design will be employed for the TEN based on the *UK Offshore Installations (Safety Case) Regulations 2005*.

(1) A bridging document is a written document which defines how two or more safety management systems co-exist to allow co-operation and co-ordination on matters of health, safety and environmental protection between different parties (usually the Company and the Contractor). Such a document cross-references the detailed procedures which will be used and defines the responsibilities, accountabilities and work activities of the various parties.

Under the EHSMS, TGL has a number of EHS-related plans, programmes and procedures, details of which are provided in *Chapter 11*, including the following:

- Oil Spill Response Plan;
- Emergency Response Plan;
- Civil Crisis Plan;
- Ghana Incident Management Plan;
- Business Continuity Plan;
- Incident Investigation and Reporting Procedure;
- Waste Management Plan; and
- EHSS Audit Plan and process.

2.8.4 *Community Development and Social Performance Policies*

TGL has developed a Social Performance (SP) policy and strategy that requires all project activities to be undertaken to best industry standards and in a socially responsible manner. As part of the SP strategy, TGL will implement a SP Management Framework and Plan to support community and social responsibility projects and initiatives. Details of the key elements of the SP strategy are provided in *Chapter 11*.

2.9 SUMMARY

A summary of the legislation applicable to the TEN Project is provided in *Table 2.8*.

Table 2.8 Applicability of Legislation to the TEN Project

Law	Application
The Environmental Protection Act (Act No. 490 of 1994)	– TGL and its contractors will obtain relevant permits for all chemicals to be used for the TEN Project (Section 2) – Allows the EPA to prescribe standards and guidelines relating to air, water, land and other forms of environmental pollution (Section 2h)
Environmental Assessment Regulations (LI 1652, 1999)	– An EIA is required for the TEN Project (Schedule 2)
Fees and Charges (Amendment) Instrument 2011 (LI 1986)	– Sets out fees and charges collectable by ministries which may be payable by TGL
Petroleum Commission Act 2011 (Act 821)	– Not directly applicable to the TEN Project
Ghana National Petroleum Corporation Law, 1983 (PNDCL No. 64)	– Not directly applicable to the TEN Project

Law	Application
Petroleum (Exploration and Production) Law (Act No. 84 of 1984)	– Requires that petroleum operations prevent adverse effects on the environment, resources and people of Ghana – Requires that a Plan of Development be submitted and approved by GNPC, MoE and EPA – Requires an EHS manual be submitted and approved by GNPC before commencement of development activities – Requires EHS audits be conducted by EPA and GNPC during operations – Requires TGL to discuss emergency plans with the GNPC and EPA before operations commence
National Petroleum Authority Act (Act No. 691 of 2005)	– Not directly applicable to the TEN Project
Ghana Shipping (Protection of Offshore Operations and Assets) Regulations (LI 2010, 2012)	– Sets conditions for MODUs and operating within protection zones.
Maritime Zones (Delimitation) Law (PNDCL No. 159 of 1986)	– Not directly applicable to the TEN Project
Fisheries Act (Act No. 625 of 2002)	– Establishes penalties for water pollution and adverse effects on aquatic resources (Section 92) – Requires that the Fisheries Commission be informed of any activity which is likely to have a substantial impact on fishery resources (Section 93)
The Fisheries Regulation (LI 1968 of 2010)	– Sets up specific rules for fishing in oil and gas infrastructure exclusion zones
Water Resources Commission Act (Act No. 522 of 1996)	– Sets up a Commission to regulate and grant water rights – Prohibits the interference, altering, pollution or fouling of water resources beyond levels prescribed by the EPA and prescribes penalties for non-compliance (Section 2j)
Oil in Navigable Waters Act (Act No. 235 of 1964)	– Regulates the discharge of oil into prohibited areas of the sea (Section 1) – Act deals with the discharge of oil into Ghanaian waters (section 3)
Radiation Protection Instrument (LI 1559 of 1993)	– Establishes the Radiation Protection Board which prescribes standards for facilities for use of radioactive materials.
Wetland Management (Ramsar Sites) Regulations (1999)	– Establishes and protects Ramsar wetland sites in Ghana.
Labour Act (Act no 651 of 2003)	– Introduces provisions to reflect International Labour Organisation (ILO) Conventions ratified by Ghana – Contains provisions for general health and safety conditions, exposure to imminent hazards, employer occupational accidents and diseases reporting (Part XV).
Children's Act (Act No. 560 of 1998)	– Prohibits engaging a child in exploitative labour (sections 12 and 87)
Commission on Human Rights and Administrative Justice Act (Act No. 456 of 1993)	– Establishes a commission to investigate violations of human rights and freedoms, injustice and corruption, abuse of power and unfair treatment of persons by public officers.
National Vocational Training Act (Act No. 351 of 1970)	– Obliges employers to provide training for to employees to carry out and enhance their careers.
Shipping Act (Act No. 645 of 2003) (as amended)	– Regulates the engagement and welfare of seafarers in Ghanaian waters (section 480).
Ghana Maritime Security Act, 2004 (Act 675) (as amended)	– Aims to enhance marine safety and security and create a legal framework for compliance with the international ship and port facility code (ISPS).

3 PROJECT DESCRIPTION

3.1 INTRODUCTION

TGL and the TEN Partners have discovered three fields in the DWT block, namely Tweneboa, Enyenra and Ntomme, containing oil, condensate and gas. TGL and the TEN Partners propose to develop and produce these reservoirs. This chapter provides a description of the TEN facilities and equipment, main project activities and associated emissions and discharges. Information on project personnel and an overview of the project health and safety provisions are also provided.

The TEN surface facilities and subsea designs are based on estimates of the recoverable volume of oil and gas resources derived from subsurface modelling. The estimate of resources is an indication of the probability of oil and gas volumes that can be produced under current economic conditions. The TEN reserves are categorised as follows.

- **Low case.** Proven resources that can be produced using current technology at current prices with 90% probability of being produced.
- **Mid case** (also known as the Development Plan)**.** Probable resources that can be produced using current or developing technology at current prices with 50% probability of being produced.
- **High case.** Possible resources that could be developed under favourable conditions with 10% probability of being produced.

The description of the TEN Project is based on the Development Plan for the project ie assuming the mid case of recoverable reserves. The mid case development will require 24 wells (11 oil producers, one gas producer, ten water injectors and two gas injectors) and subsea equipment connected to a Floating Production Storage and Offloading (FPSO) vessel where well fluids and associated gas will be processed into crude oil product suitable for storage and export to world markets.

3.2 PROJECT OVERVIEW

3.2.1 Project Location

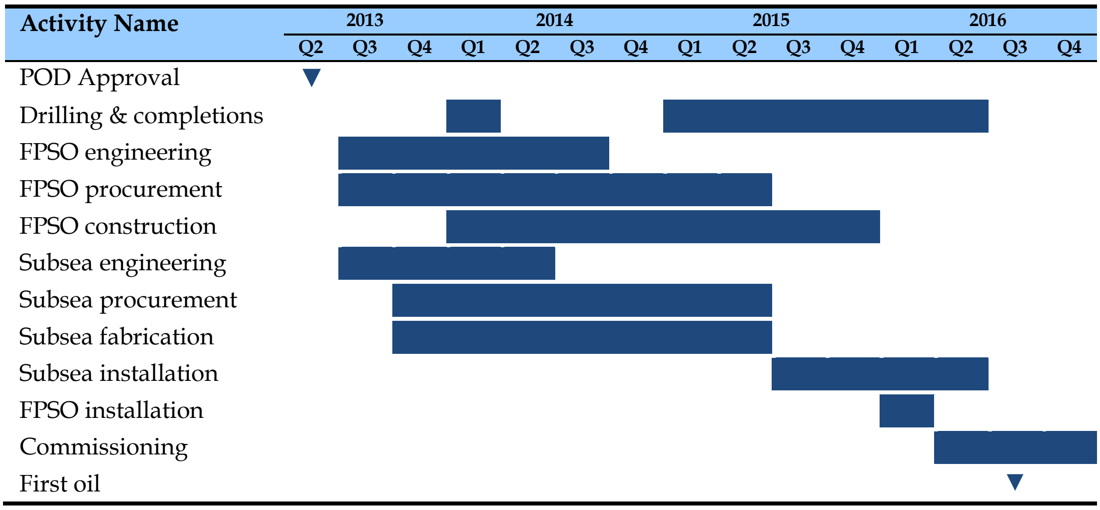
The TEN Project area covers approximately 450 km^2 and is located within the DWT block (see *Chapter 1, Figure 1.1*). The TEN facilities, including the proposed FPSO vessel, would lie approximately 60 km south of the nearest coastline in Ghana, 140 km southwest of the port at Takoradi, 10 km east of the Ghana and Cote d'Ivoire maritime border and 20 km west of the Jubilee field. Water depths at the fields range from about 1,000 to 2,000 m.

The FPSO is planned to be located near to the central part of the Enyenra reservoir (E 484470 m, N 507230 m), at similar latitude to the Jubilee FPSO (E 511990 m, N 508074 m). The position of the FPSO has been selected taking into consideration known geohazards, bathymetry, mooring requirements, oil offloading requirements and metocean data. The water depth at this location is approximately 1,450 m.

3.2.2 *Project Schedule*

A provisional schedule, assuming a target date for first oil in mid 2016, is provided in *Table 3.1*. The programme may change subject to detailed scheduling of fabrication times of various elements and the availability of drilling vessels and specialist construction vessels. The drilling and completion of the wells required for first oil will be undertaken from Q1 2014 to the end of 2015. The remaining wells required for the development will continue to be drilled following first oil until mid-2016. Subsea facilities will be fabricated from Q4 2013 and subsea installation will take place from Q3 2015 to Q2 2016. The FPSO will be installed in early 2016.

Table 3.1 ***Provisional Schedule***

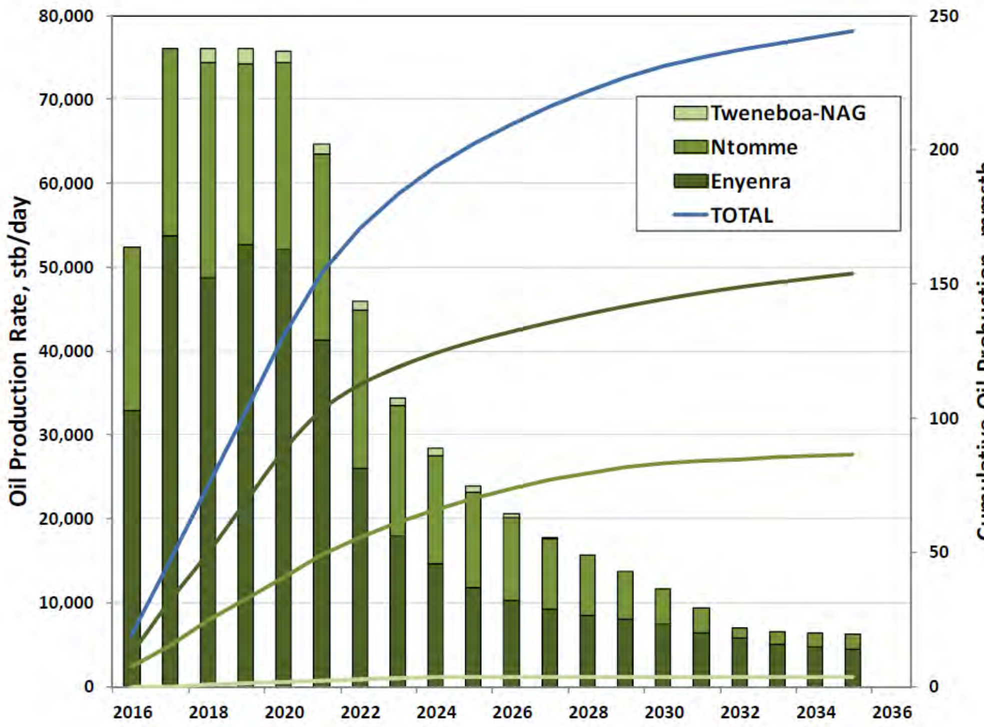


Note: This schedule is provisional and subject to change.

3.2.3 *Production Profiles*

Average oil production in year one is forecast to be up to 52,000 barrels per day (bpd), rising to a plateau rate of approximately 76,000 bpd from 2017 to 2020. A total oil and condensate recovery of 245 million barrels (Mbbl) is expected by the end of the contract term in 2036. The 20 year profile is presented in *Figure 3.1*.

Figure 3.1   ***Estimated Oil Production and Cumulative Oil Recoveries for the Development Plan***



Source: TGL 2013

3.3 *PROJECT ALTERNATIVES*

The *Environmental Assessment Regulations (1999)* require that the EIA describe the alternatives considered. This section describes the work carried out to select the design concept and the process that was followed for assessing design options.

The aim of considering alternatives is to establish whether there are reasonable options which could be pursued which meet the project's objectives with less impact on the environment, and if there are, to explain what other factors determined the choice of proposal.

For the TEN Project the main alternatives considered to date included surface facility alternatives, mooring system alternatives and engineering design alternatives.

In addition, a drill cutting Best Practicable Environmental Option (BPEO) study was undertaken to determine the best cuttings treatment and disposal option for development drilling (included in *Volume II: Annex F*).

3.3.1 *Surface Facility Alternatives*

The TEN surface facility options were assessed during TGL's Concept Select studies. The surface facility option was further refined during subsequent pre-Front End Engineering Design (FEED) development studies. Given that the DWT reservoir appraisal programme was on-going in parallel with the TEN Project planning, the surface facility options needed to be flexible in nature of design to accommodate any changes in TGL's ongoing appraisal and understanding of subsea oil and gas reservoirs up to submission of the Plan of Development (PoD).

TGL evaluated the technical, operational and economic risk factors associated with various surface facility options. Oil industry experience elsewhere in similar fields, including the nearby Jubilee field, was used to define the approach. The evaluation process included a high-level risk assessment of three surface facility options, namely:

- a permanently moored FPSO with oil storage capacity commensurate with the production capacity and optimum offloading requirements;
- a Tension-Leg Platform (TLP) with oil export to the Jubilee FPSO; and
- a Spar platform with moderate oil storage capacity and export to the Jubilee FPSO.

As part of the concept selection process a risk assessment workshop was undertaken by the project team[1] to compare the material Major Accident Hazards (MAHs) and commercial and technical risks for the installation, hook-up and commissioning, and operational phases of the surface facility options. The qualitative assessment assigned rankings to each surface facility alternative based on its overall risk contribution. These rankings were combined with a risk weighting depending on the level of risk and difficulty of mitigation for a range of MAHs.

The risk assessment indicated that overall the FPSO surface facility option had the lowest risk for both installation, hook-up and commissioning (HUC) and production operation risks. The overall outcome of the evaluation is shown in *Table 3.2*. The outcome of the risk assessment was supported by the findings of an economics assessment which showed that the FPSO option will generate the best value and highest rate of return.

Table 3.2 Relative Risk Assessment Summary

Risks	Risk Score			Lowest MAH Risk Concept
	FPSO	SPAR	TLP	
All MAH risks	71	96	118	FPSO
All MAH installation and HUC risk	13	29	24	FPSO
All MAH production operation risk	58	87	94	FPSO

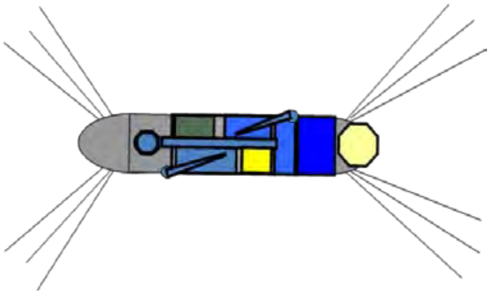
(1) The workshop included 11 attendees representing project management, planning and scheduling, EHS, pipelines/risers and subsea, facilities, structural, marine and drilling and completions.

3.3.2 *Mooring System Alternatives*

Two mooring system alternatives were considered for the TEN FPSO, namely spread mooring and turret mooring.

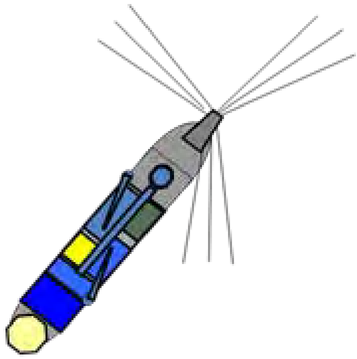
A spread mooring system comprises an array of mooring lines between seabed anchors and fixed chain stoppers on the deck of the FPSO (*Figure 3.2)*. This array would keep the FPSO on location and effectively prevent it from rotating. For a spread moored FPSO, oil offloading is undertaken via an Oil Offloading Line and Oil Offloading Buoy (OOB).

Figure 3.2 Example of FPSO with a Spread Mooring



A turret mooring system is defined as a system where a number of mooring legs are connected to a turret which is essentially part of the moored vessel (*Figure 3.3*). The turret system has a bearing/swivel assembly which allows the vessel unrestricted 360° rotation around the geostationary point, whilst also accommodating the maximum heave, pitch and roll motions of the FPSO with wind, wave and current conditions. All the subsea risers are connected to the turret and the flow directed to and from the FPSO through the multi-product swivel stack. Offloading from a turret moored FPSO is undertaken using a tandem mooring system where the export tanker connects to the FPSO bow to stern using a hawser and oil is transferred via a floating hose.

Figure 3.3 Example FPSO with an External Turret Mooring System



There are three types of turret mooring systems: disconnectable, internal and external (see *Figure 3.4*).

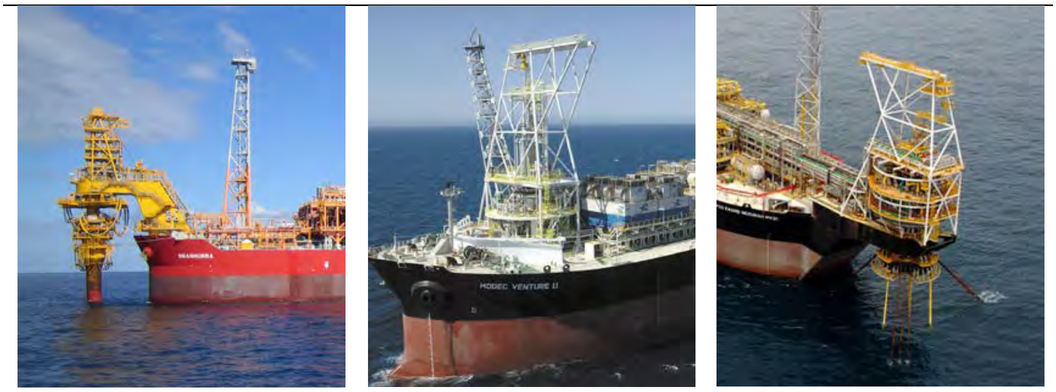
Disconnectable turret mooring systems are sometimes employed in localities with harsh environmental conditions, such as areas prone to hurricanes, typhoons or icebergs. As the conditions offshore West Africa are relatively benign, the need for disconnectable systems has been discounted.

Internal turret mooring systems are built into the hull, usually towards the front of the vessel although they can sometimes be positioned more centrally. Internal turret systems are able to connect a large number of risers and offer good fluid transfer capabilities.

External turret mooring systems largely comprise the same components as internal systems except they are located outside of the vessel's hull and attached to either the bow or stern. External turrets are typically less expensive to install on tanker conversions and have shorter fabrication times, however, they are not able to connect to as many risers as internal turrets.

For the TEN Project a FPSO with an external turret mooring system was selected as it provides the best option that meets the project's needs.

Figure 3.4 *Example of Different Types of Turret Mooring*



Disconnectable (external) | Internal | External

Source: MODEC 2012; Woodside 2012

3.3.3 *Engineering Design Alternatives*

TGL is evaluating a number of design alternatives, based on safety, engineering, technical, financial and environmental considerations. There have been a number of key lessons learnt regarding the installation, hook-up, commissioning and start-up of the Jubilee Field from the Phase 1 development that has been taken onboard in the TEN subsea and FPSO facilities design.

TGL commissioned a design competition for the FEED phase of the development which involved three FPSO contractors developing alternative FPSO designs using a set of common specifications (known as a Basis of Design). A subsequent study was then undertaken to determine the optimum

FPSO design specifications and included the development of Best Available Technology (BAT) assessments.

The BAT assessments considered the following criteria.

- Financial. The cost of installation/operation.
- Technology. The requirement for additional equipment.
- Regulatory. The consistency with applicable laws/regulations.
- Benchmarking. The common practice in region and internationally.

The BAT assessments documented the evaluation of options and the basis for selecting the preferred options. The FPSO design is further refined during the subsequent detailed engineering studies.

The main design options considered during the select and optimisation phases were as follows:

- FPSO Crude Oil Tank (COT) gas blanketing system alternatives;
- alternative turbines for power generation on board the FPSO;
- alternative disposal options of aromatic hydrocarbons from the Vapour Recovery Unit (VRU) on the triethylene glycol (TEG) boilers;
- produced water disposal options; and
- flare gas recovery option for normal operations.

Other design alternatives that were considered in the design process included: riser designs options, commissioning and injection chemical type options, hydraulic fluid type options, alternative offloading options, gas utilisation options, and flaring optimisation options.

In addition a number of lessons learnt from the Jubilee FPSO project have been incorporated into the TEN FPSO design. These included:

- the design of the bilge, slops and produced water treatment and discharge system;
- improved FPSO in-line oil in water analyser;
- improved emissions monitoring systems on gas turbines; and
- increased capacity for on board macerator to deal with the maximum throughput of material associated with the maximum possible personnel on board the FPSO.

Gas Blanketing System Alternatives

The FPSO requires a blanketing medium to maintain a slight positive pressure within the cargo tanks and prevent air (containing oxygen) being drawn in and potentially forming explosive mixtures with the hydrocarbon gas. Alternative gas blanketing mediums considered are an inert gas or hydrocarbon blanketing gas.

An inert gas blanketing system results in higher concentrations, and additional volumes of organics, vented to atmosphere whereas a hydrocarbon blanketing system eliminates venting under normal operating conditions. A fuel gas blanketing with a vapour recovery system was selected for the TEN FPSO.

Alternative Turbines for Power Generation

Main power generation systems on the FPSO will include generators driven by dual fuel (gas/diesel) turbines. Dual fuel turbine driven power generators will be used as the main power supply. The generators will run on diesel until fuel gas becomes available during the FPSO production process. For the base case there will be four generators with two generators operating at any time and two being on standby. In the future there may be a need to have three operating generators and one on standby.

Turbines are available with Standard Annular Combustor (SAC) or Dry Low Emissions (DLE) technology. Emissions have been estimated for both SAC and DLE turbine options for gas fuel and diesel using standard emission factors. Emission estimates, per turbine, are shown in *Table 3.3.*

Table 3.3 ***Summary of Emissions Arising from SAC and DLE Turbine***

Pollutant	**SAC**		**DLE**	
	Gas (Te yr^{-1})	**Diesel (Te yr^{-1})**	**Gas (Te yr^{-1})**	**Diesel (Te yr^{-1})**
NO_x	603	1,564	102	569
CO	11	8	62	58
CO_2	136,205	171,195	134,672	171,195
HC	2	3	21	3
SO_x	0	107	0	107

Note: Figures have been rounded to the nearest decimal place.

The comparison demonstrates that when operating on gas as would be the norm, emissions of:

- nitrogen oxides (NO_x) are approximately six times higher for the SAC turbine, as expected;
- carbon monoxide (CO) are approximately six times higher for the DLE turbine;
- carbon dioxide (CO_2) are similar for both SAC and DLE turbines;
- of hydrocarbons are approximately 10 times higher for the DLE turbine; and
- sulphur oxides (SO_x) are zero, as would be expected with a fuel gas with negligible fuel sulphur content.

When operating on diesel, emissions of NO_x are approximately three times higher with the SAC turbine, and emissions of CO are approximately seven times higher with the DLE turbine. The global warming potential of the emission estimates, as CO_2 equivalent (CO_2e), indicate that the CO_2e emissions are marginally lower with the use of DLE turbines when operating on gas, and no different when operating on diesel.

The recommendation of the BAT assessment was for SAC turbines to be used with the option in the gas turbine design to retrospectively install a DLE upgrade/conversion when the technology has improved and if deemed necessary at a later stage.

Disposal and Recovery Options for Aromatic Hydrocarbons from VRU on TEG Boilers

TEG boilers will provide dehydration facilities to remove water from injection gas to prevent water build-up in injection pipelines. The TEG, containing water removed from the gas, will be thermally regenerated to remove excess water and recover the TEG. The regeneration vapour contains aromatic hydrocarbons, which are considered an atmospheric pollutant, and greenhouse gas. In addition, long term exposure to high concentrations of volatile aromatic hydrocarbon compounds (*eg* BTEX) [1] can present occupational health issues. A VRU will be installed to prevent continuous release of these emissions to the atmosphere.

An assessment was undertaken to consider the best option for disposal of recovered or condensed vapour from the VRU on the TEG dehydration reboiler unit. The disposal options for aromatics in the recovered vapour are outlined below (*Table 3.4*). The preferred option is to return the recovered vapour to the Low Pressure (LP) compressor for reinjection or export.

Table 3.4 Disposal and Recovery Options for Aromatic Hydrocarbons from VRU on TEG Boilers

Disposal Options for Aromatics	Considerations
Low pressure flare	Inconsistent with the project's no routine flaring policy and may result in incomplete combustion as flare burner efficiency would not be adequate.
Returned to Low Pressure separator for reinjection or export	Preferred option from an environmental, health and safety perspective.
Fuel gas system	This is common industry practice but may result in off-specification (off-spec) exhaust gas from the gas turbines and may not be energy efficient.
Contingency venting	Contingency venting is required for safety reasons.
Condensed and sent to cargo tank for off-spec export	Additional equipment will be required for processing the vapour.
Collection and incineration onshore	Frequency of collection and selection of suitable onshore incineration facility. Waste contractor in STM currently developing incineration facilities.

(1) Benzene, Toluene, Ethylbenzene, Xylene

Produced Water Disposal Options

TGL has undertaken a study to assess the feasibility of Produced Water Reinjection (PWRI). PWRI is practiced in the oil and gas industry to reduce the volume of produced water discharged into the sea. It is noted here that produced water is treated to reduce the hydrocarbon concentrations prior to discharge to the sea.

Once the exact composition of the produced water is understood it may be possible to mix the produced water with the seawater being used for water injection back to the TEN reservoir formation. Further details on produced water volumes and treatment facilities are discussed in *Section 3.8.3*.

For the purposes of the EIA the base case taken is that the treated produced water will be discharged to sea from the TEN FPSO.

Flare Gas Recovery System

Traditional flare systems are open to the flare tip and so purge gas and any other gas which enters the flare system during normal operation (such as low pressure (LP) and high pressure (HP) flash gas) is continually burnt at the flare tip. Routine flare volumes can be small, but continuous and therefore represent a significant source of CO_2 and other combustion emissions to atmosphere. Elimination of routine flaring is considered to be BAT. The three flare system options were considered for the TEN FPSO are outlined in *Table 3.5*. The closed flare system (Option 3) is the preferred option for both the LP and HP process streams for the TEN FPSO.

Table 3.5 FPSO Flare Design Options

Flaring Option	Considerations
1. Conventional all-open flare desig	Conventional system does not provide any reduction in routine flaring. This was excluded from the preferred FPSO design contractors bid submission.
2. Sectionalisation valves (XVs) in series (downstream) of pressure control valves (PCVs) that dump-to-HP flare (combined with open flare).	XVs installed downstream of PCVs on the flare system. The XV valves are normally closed and aim to act as an isolation to stop any leakages through the PCV to the flare header thus reducing gas to flare under normal operating conditions. The XVs are 'fail open' and further protection is provided by upstream PSVs should the XV fail to open. This system requires purging with hydrocarbon gas and as such combustion of purge and pilot gas would be required. Compared to a traditional all-open flare design, it has been estimated that this system would reduce flaring emissions by 40% (the HP contribution to flare leakages)
3. High pressure and low pressure closed flare system with Flare Gas Recovery (FGR) unit	In a FGR system the flare is closed during normal operations and a fast opening valve (FOV) in the line to the flare tip is opened when pressure in the flare system is high. A water seal by-passing the FOV provides a free path to the flare should the FOV fail to open on demand. Nominal gas release into either the LP or HP Flares can be recovered into process streams via a recovery system consisting of a crossover line for HP flare and by boosting the LP flare gas to the process tie-in pressure. In closed flare system, the flare is not normally lit and no pilots are operational. The flare line downstream of the FOV can be purged with nitrogen. In a flaring event the flare is ignited by a reliable ignition system. Closed flare systems are considered to be proven technology by the oil and gas industry.

3.3.4 *Drill Cuttings Best Practicable Environmental Option Study*

TGL commissioned a BPEO study of drilling waste (cuttings and drilling fluid) treatment and disposal options for the TEN Project. This approach is aligned with Tullow Oil Environmental Standards (toes) which includes a requirement to carry out a transparent assessment of the available options through a BPEO process. The BPEO is defined as the option that provides the most benefit or least damage to the environment as a whole, at an acceptable cost, in the long term as well as the short term. The aim of the BPEO study was to determine the best management practice for the treatment and disposal of drilling discharges during the TEN drilling campaign.

The BPEO report documents the main options that were considered, the assessment process and reasons for selecting the BPEO. A copy of the BPEO report, which provides a complete list and description of all of the treatment options considered, is included in *Volume II: Annex F*. The key stages of the BPEO process are outlined below and are shown schematically in *Figure 3.5*.

- A wide range of options were identified throughout the drilling process relating to the quality and quantity of drilling waste created and subsequent treatment and disposal.

- Absolute assessment criteria were defined and categorised, including health and safety, technical risk, cost, reputation, ecological, economic, social and regulatory considerations.

- Options were screened against the absolute criteria in consultation with stakeholders to eliminate any unfeasible options.

- The remaining options were assessed in more detail against the absolute assessment criteria.

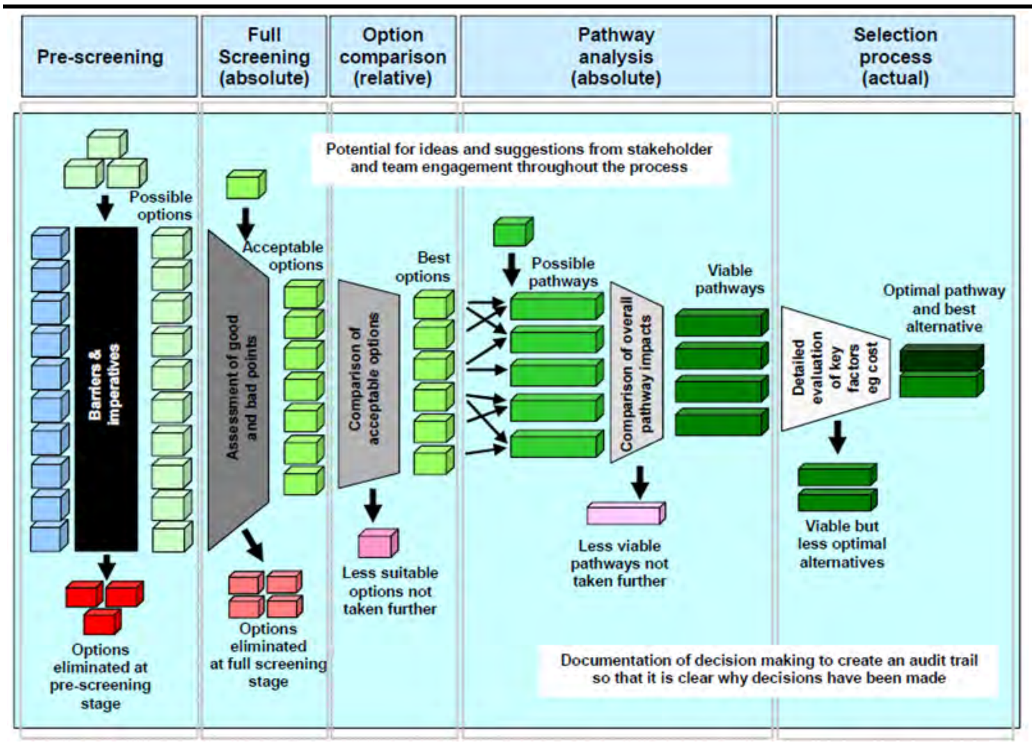
- The remaining options were combined into potential pathways.

- Relative assessment criteria were developed in consultation with stakeholders.

- Options were assessed according to the relative criteria and ranked. The best options were reviewed and a BPEO recommended.

The options taken forward following the pre-screening assessment are presented in *Table 3.6*. Offshore treatment using shakers and cuttings dryers was assumed as the base case for the relative assessment.

Figure 3.5 Schematic Diagram of the Overall BPEO Process



Source: Aquatera 2012

Table 3.6 Options Taken Forward Following Pre-Screening

Drill Cuttings Lifecycle Phase	Option Considered
Bottom hole drilling fluid	Water Based Mud (WBM)
	Non Aqueous Drilling Fluid (NADF)
Onshore treatment	Cuttings driers
	Thermal desorption
Offshore treatment	Disposal at sea onsite – WBM
	Disposal at sea onsite – NADF
Containment and transport to shore	Bulk cuttings transfer using pneumatic or similar system
	Skip transfer
	Hybrid bulk transfer
Onshore transport	Heavy goods vehicle
Onshore treatment and disposal	Thermal desorption onshore
	Land farming
	Cutting pit
Re-use and recycling	Non-structural construction – bricks
	Landfill cover

Source: Aquatera 2012

The study recommended offshore treatment using offshore Thermal Desorption Unit (TDU) technology as the BPEO under specific assumptions. Treatment using offshore TDU technology is considered to have a number of advantages over more conventional treatment technologies. Oil on cuttings can be reduced to less than 1% (by weight) using this technology which will meet regulatory targets, reduce biochemical impact on the seabed and result in better cuttings dispersion with reduced physical seabed impacts. The use of this technology will not significantly increase atmospheric emissions. The use of thermal desorption technology will only be economically feasible for a longer continuous drilling programmes where the associated capital cost of mobilising a MODU capable of accommodating a TDU could be spread across many wells.

3.4 *Offshore Facilities and Equipment*

The wells and subsea equipment (including manifolds, flowlines and umbilicals) will be connected to an FPSO vessel via flexible dynamic risers. On the FPSO the well fluids will be processed into crude oil product suitable for storage and export via tankers. This section provides a description of the FPSO vessel including topside facilities, mooring system and offloading system, and the subsea equipment to be installed as part of the TEN Project.

3.4.1 *Floating Production Storage and Offloading Vessel*

General Considerations

The TEN Project will utilise a permanently moored FPSO as the main process and storage facility. The FPSO will be designed to withstand the worst case, site-specific environmental conditions in the development area and along the transit route from the shipyard. The FPSO hull will be converted from an existing double hulled Very Large Crude Carrier (VLCC). The conversion will take account of the required design life of 20 years and vessel operability and habitability while considering all appropriate transportation, installation, on-site and life of field design conditions.

The donor vessel, the *Centennial J*, is a former trading tanker constructed in 1997 by Mitsubishi Heavy Industries. The tanker is a 300,955 Dead Weight Tonnes (DWT) vessel with a length and beam of 340 m and 56 m, respectively, and a depth of 31.8 m.

Operational Management Arrangements

The TEN FPSO will be designed and operated by a specialist FPSO contractor and TGL will lease it under a long term contract. TGL will have a company representative onboard the FPSO responsible for achieving field operational and Environmental, Health and Safety (EHS) targets and for the operation of the subsea system and wells connected to the FPSO. TGL will set operations and EHS targets with the contractor, administer the contract, provide supporting logistics, manage the integrated operations plan, and schedule production and oil tanker offloading operations. The FPSO at the Jubilee field is a similarly sized turret moored FPSO and is shown in *Figure 3.6*.

Figure 3.6 Typical Floating Production Storage and Offloading Vessel

FPSO Kwame Nkrumah MV21 offshore Ghana

Source: MODEC 2013

Classification

The vessel will be registered in the Bahamas and fly the flag of that country. The classification will include the following areas.

- Vessel including the structure, equipment and marine systems (including helideck and cranes).

- Mooring, including structure, mooring system and riser systems.

- Production and production support systems, including all items supported above the support stools on the main deck of the hull.

The TEN FPSO will use an established classification society, which is a member of the International Association of Classification Societies (IACS). Classification provides assurance that safety and quality requirements set by the classification society are met during the design and construction of the FPSO, and are maintained during its installation and operation. Class approval of the FPSO will be evidenced by issuance of certificates to show that the requirements of the classification society have been complied with.

Capacities

The FPSO will be modified to allow for the storage of 1.7 Mbbl of oil. In addition, there will be slop tanks for oily water from drainage areas and off-spec tanks for out-of-specification crude, and produced water which is required to undergo further treatment to reduce oil content.

The FPSO will have the capability to accommodate the maximum estimated quantities of oil, gas and water in any of the production profiles (*ie* low, mid and high case) with a nominal capacity of 80,000 bpd for oil production, 180 MMscfd for gas treatment/compression (*Table 3.7*). The topside facilities will have the capacity for delivery of 132,000 bpd of filtered, de-aerated seawater for injection.

The nominal capacity is the FPSO's operating capacity or 'nameplate' capacity when the FPSO is receiving fluids from the fields at the conditions set out in the Development Plan profile (*Figure 3.1*) with 100% availability of well fluids and the facility equipment. The FPSO is designed to operate with key spare equipment (*eg* power generation, gas compression and water injection) in standby mode but available for use if required such that facility availability is maximised and the target of 76,000 bopd at 95% availability is achieved.

Table 3.7 FPSO Technical Specifications

Feature	Capacity / Number	Units / Notes
Oil processing	80,000	bpd (nominal)
Liquids (oil and water) processing	100,000	bpd (nominal)
Gas processing	180	MMscfd (nominal)
Produced water treatment	65,000	bpd (nominal)
Gas injection	135	MMscfd (nominal)
Water injection	132,000	bpd (nominal)
Fuel gas	10	MMscfd (nominal)
Power generation capacity	54	MWe (nominal)
Storage capacity	1,700,000	bbl (nominal)
Offloading rate	1,000,000	In 20 hours
Minimum availability	95%	
Weight topsides	18,000	Te (estimated)
Turret capacity	24	-
Turret allocation slots (used/future)	15/9	-
Mooring pattern	3x3	-
Mooring composition	-	Polyester chain
Mooring piles	9	Estimated
Crane capacity	15	Te (at 40 m radius)
	25	Te (at 30 m radius)
Accommodation	120	Personnel on Board

MMscfd = million standard cubic feet per day; bbl = barrels; bpd = barrels per day; MWe = megawatt electrical; te = tonnes.

Accommodation

The accommodation will be converted for a maximum of 120 persons (permanent and temporary personnel). Existing facilities will be refurbished and extended to accommodate the expected level of people. All materials and equipment used will be in accordance with relevant requirements(1). Included in the accommodation are the following facilities:

- cabins and utilities for 120 persons;
- galley, catering, messing and recreation facilities;
- central control room (including Emergency Command Centre);
- radio room;
- offices (including Permit Control);
- uninterrupted power supply or battery room; and
- helicopter waiting room.

Topside Facilities

A description of the main FPSO facilities is presented in *Table 3.8,* a general layout plan of the topside facilities is shown in *Figure 3.7* and a flow diagram is shown in *Figure 3.8*. The following sections provide more information on the main topside facilities and systems. The FPSO topsides equipment, piping systems and vessels will be designed for continuous operation with normal inspection, maintenance and replacement routines.

Communications and Navigation

Electronic communications equipment will allow the FPSO personnel to communicate with other vessels in the vicinity and onshore bases to transmit and receive information and weather forecasts. The communication equipment on the FPSO will meet Safety of Life at Sea (SOLAS) requirements and also have other systems such as data transfer. The communication equipment will include the following.

- VHF marine radio.
- VHF aeronautical radio.
- INMARSAT terminal equipment.
- MF/ HF SSB radio telephone.
- Process UHF hand held radios and trucked radio system.
- PA/GA system.
- Telephone system.
- Data system.
- AIS (Automatic Identification System).
- Muster station intercom.
- Liferaft radios and beacon locating equipment.

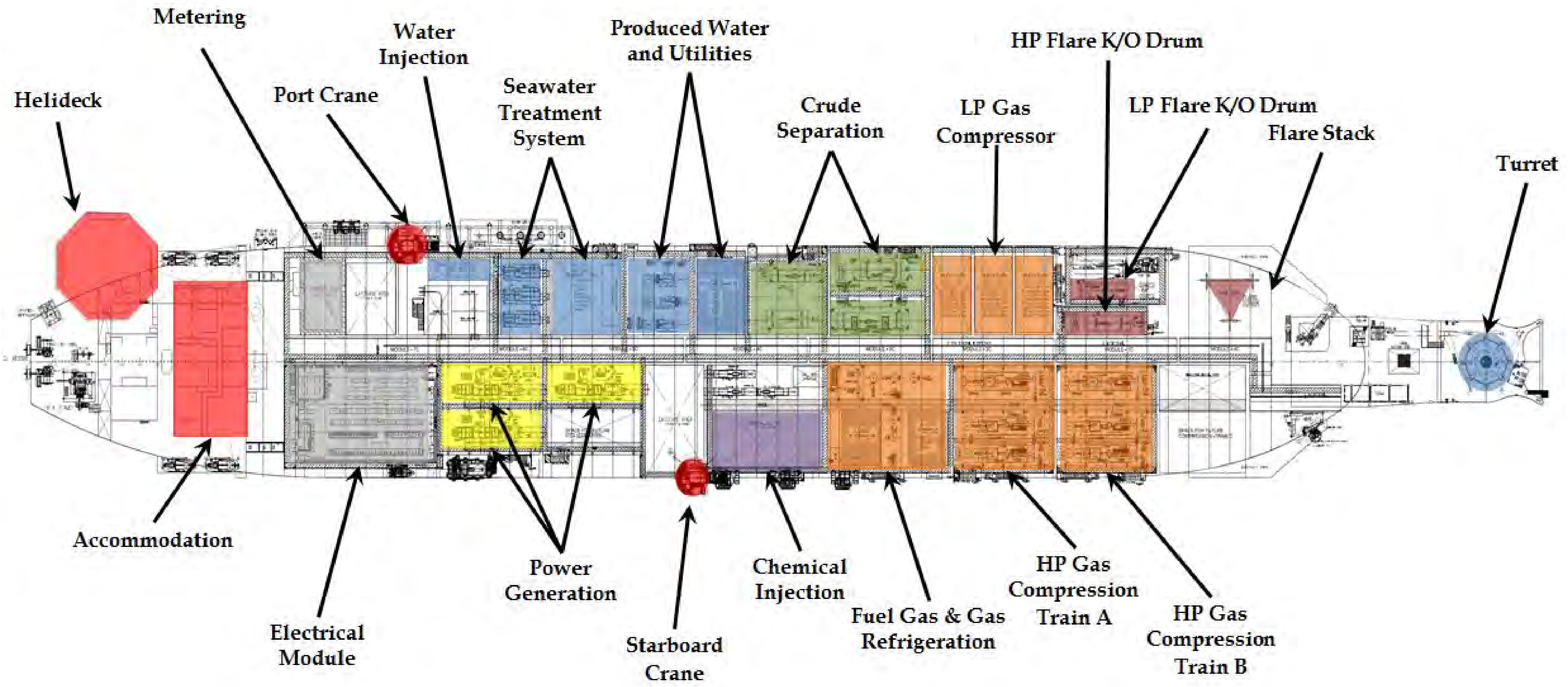
(1) International Labour Organisation (ILO) 92/133, the MODU Code 1989 and relevant Classification Society rules.

Table 3.8 Topside Facilities

Facilities	Description	Function
Oil separation and treatment system	HP oil separator and HP NAG (non-associated gas) gas separator. Two crude/crude exchangers. MP separator. Electrostatic flash vessel and treater. LP separator. Two crude transfer pumps. Two sales oil coolers.	Separation of crude from emulsified water, brine and solids (primarily sand) and removal of dissolved natural gas.
Subsea controls and support systems	Subsea Master Control system including hydraulic and electrical supplies, riser manifolds and associated facilities.	System provides controls and chemicals for the subsea equipment (wells, manifolds *etc*).
Subsea flowline circulation system	Subsea flowline circulation system including three pumps and a flowline circulation fluid heater.	Provides ability to condition flowline fluids to prevent hydrate formation within the subsea production pipelines.
Low Pressure (LP) gas compression	Three-stage LP gas compression upstream of gas cooling and safety gas drum.	Condensed hydrocarbon liquids are separated from the hydrocarbon gas stream.
MGC1 (main gas compressor stage 1)	Two single-stage medium pressure (MP) gas compression trains upstream of dehydration.	
Gas dehydration and regeneration system	Gas dehydration and Tri-Ethylene Glycol (TEG) regeneration system.	To avoid hydrates in the submarine pipelines, all of the gas will be dehydrated (dewatered).
MGC2 (main gas compressor stage 2)	Two single-stage HP gas compression trains downstream of dehydration to achieve gas lift and export pressures.	The gas compression system is required to compress associated gas from the separation system for fuel gas, riser gas lift, gas export and re-injection into the producing reservoirs.
MGC3 (gas injection compression trains)	Two single-stage HP gas compression trains downstream of HP gas compression to achieve gas re-injection pressures.	
Refrigeration system	Closed loop refrigeration system.	The refrigeration system provides enhanced liquids recovery from the gas processing units.
Fuel gas conditioning system	Fuel gas conditioning system.	Conditioning of fuel gas to remove rich heavy hydrocarbons before use in gas turbines.
Three power generation Units	Gas turbine driven electrical generators.	An electrically driven centralised power generation scheme will be employed to drive main rotating equipment and power consumers.

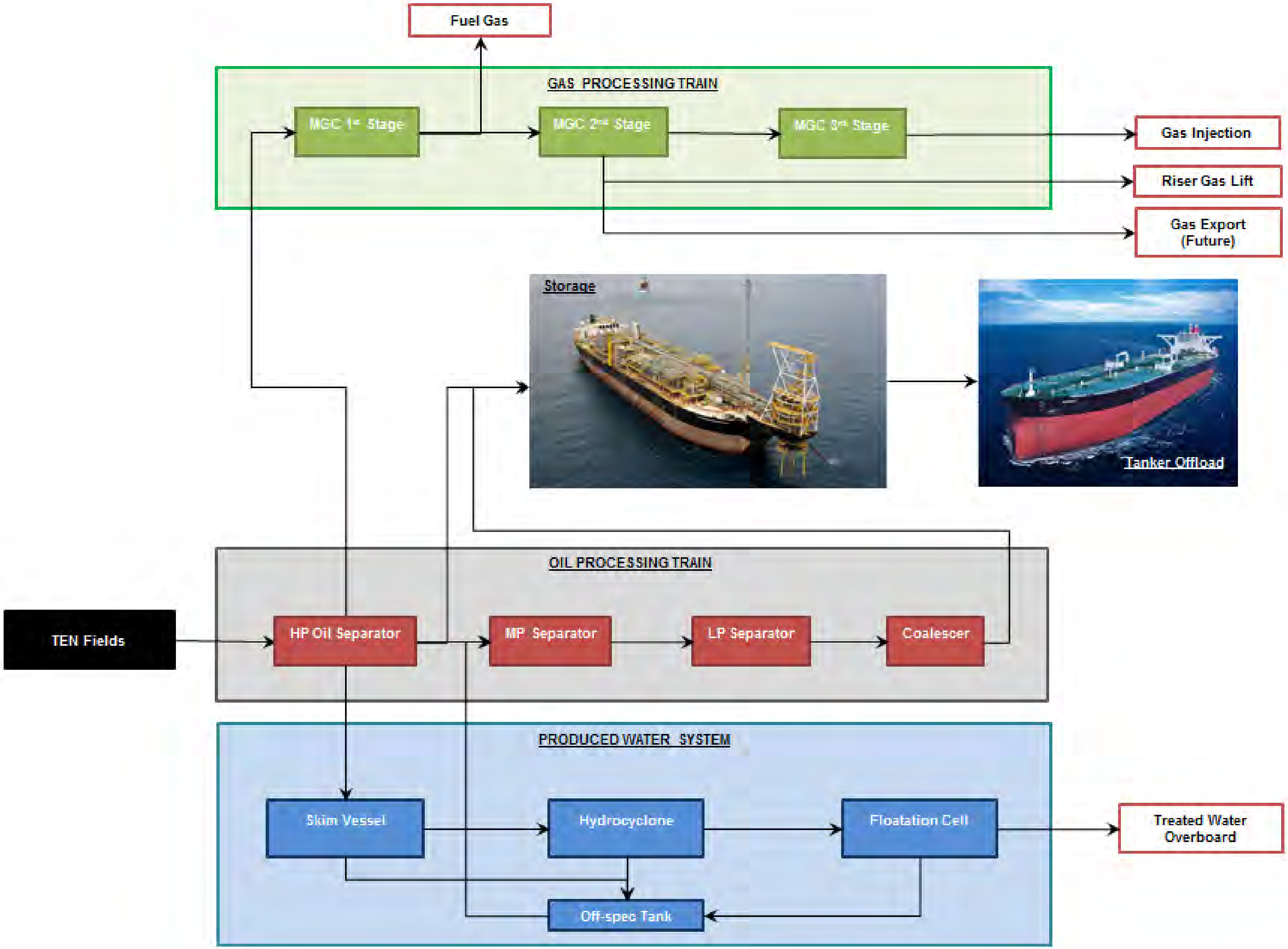
Facilities	Description	Function
Produced water treating system	Produced water treating system including skim vessels, hydro-cyclones and flotation cell.	Produced water is treated to remove particulates, oil and water from the produced water.
Chemical injection system	Chemical injection tanks with pumps.	Facilities for chemical injection are required in order to efficiently treat the hydrocarbons before export, maintain flow assurance, maintain corrosion inhibition and enable treatment of seawater.
Freshwater system	Desalination system for generating freshwater for use in process, utility and accommodation areas.	Produce fresh water for use in process, utility and accommodation areas on the FPSO and for supplying supply/support vessels.
Process cooling medium system	Closed-loop (service water to cooling water) process cooling medium system, with two circulation pumps and one expansion tank.	For cooling the production prior to going to storage.
Seawater injection system	Filters, vacuum de-aerator with associated vacuum pumps and three high pressure injection pumps.	Sea water is filtered and the oxygen removed to minimise corrosion in the downstream water injection facilities.
Flare system	HP and LP closed flare system with flare gas recovery (FGR) unit. Complete with HP and LP knockout drums.	The flare system will collect and safely dispose of high pressure hydrocarbons in the event of an emergency or other shutdown.
Gas blanketing	Hydrocarbon gas (fuel gas) will be used to blanket hull oil storage. Vapours will be recovered via a VRU.	Prevents the formation of potentially explosive mixtures of was forming in oil storage tanks.
Vent system	Closed venting system	Venting of hydrocarbon vapours from hazardous open drain tanks. Also if hull storage hydrocarbon gas blanketing system is unavailable inert gas will be used as a back-up system and vented.
Cooling and heating medium systems	Closed-loop heating medium system, with two circulation pumps and one expansion tank.	Circulation system to allow cooling/heating of the gross production downstream of the HP separators.
Drainage systems	Closed drainage system and oily water treatment.	Drainage system for oily water that does not drain directly to sea but is requited to be contained for treatment and clean up.
Laboratory	Laboratory facilities to perform analysis of process fluids and effluents.	Analysis of process fluids and effluents.

Figure 3.7 Indicative Layout of the TEN FPSO



Source: TGL 2013

Figure 3.8 Simplified Process Flow Diagram



Source: TGL 2013

The following navigation aids will be provided and will meet Safety of Life at Sea (SOLAS) requirements.

- Navigational lights and flashing lights.
- Fog horn.
- Aeronautical beacon for easy location of the FPSO in bad visibility.
- X and S band marine RADAR with more than 20 nautical mile (nmi) range.
- RACON (Radar transponder commonly used to mark navigational hazards) and loading computer.
- Anti-collision RADAR system.

Uninterruptable power supplies (UPS) will be provided for all communication and navigational equipment.

Chemical and Fuel Storage

Chemical and fuel storage tanks will be located on the FPSO. Bulk storage for chemicals will be provided in a multi compartment tank on the FPSO topside. Estimated chemical storage volumes are provided in *Table 3.9*. Diesel will be stored in the FPSO hull and distributed to the topsides. The FPSO will have a diesel storage capacity of approximately 3,800 m^3.

Chemicals and fuel will be delivered by the supply vessel using bunker (direct supply by hose), drums, intermediate bulk containers (1.5 to 2.5 m^3) and tote tanks (4.4 m^3). A specialist production chemicals supply company will be used with experience in chemical selection, storage, use and optimisation.

Approximately 10 MMscf per day of gas will be used as fuel in main generators, deck boiler and for the flare pilot flame on board the FPSO.

Table 3.9 Indicative Fuel and Chemical Storage on FPSO

Substance	Quantity stored on site (m^3)
Lube Oil and Grease	100
Antifoam	15
Biocide (Subsea)	2
Biocide (Oil)	2
Biocide (Water)	8
Corrosion Inhibitor	50
Demulsifier	15
H_2S Scavenger	30
Methanol	200
Oxygen Scavenger	8
Polyelectrolyte	1
Scale Inhibitor	20
Scale Inhibitor #2	8
Wax Inhibitor	15
Triethylene glycol (TEG)	2
Water Injection Antifoam	2

Chemical Injection System

A number of production and water treatment chemicals will be injected into the FPSO topsides facilities, the subsea flowlines and directly into the subsea wells. Injection in the topsides will be through injection lines, while subsea and well chemicals will be deployed down the subsea umbilical lines to their point of injection. Chemical injection is required for the following reasons.

- Maintain flow paths by preventing gas hydrates forming within subsea wells, flowlines and facilities.

- Aid the oil-water hydrocarbon separation process to achieve export specification crude.

- Provide corrosion inhibition for the subsea and surface facilities.

- Prevent scale deposition within the subsea and surface facilities.

- Condition seawater prior to injection into the reservoir.

A series of chemical injection tanks, pumps and associated pipework will be located on the FPSO for injection of chemicals into various operational locations. The purpose, injection points, typical concentrations and frequency of use of the various chemicals to be used are listed in *Table 3.10*. This list is indicative as no suppliers have yet been selected.

Drainage System

There will be three separate drainage systems.

- **Closed drain.** Piping and headers associated with the intermittent collection of hydrocarbon liquids from process vessels depressurised for maintenance, as well as the collection of a few other normally non-flowing process streams. It includes a dedicated closed drain drum and two pumps.

- **Hazardous area open drains.** Piping and headers associated with the collection of spillage, in hazardous hydrocarbon processing areas of the FPSO will go to the slop tanks through a water seal.

- **Non-hazardous area open drains.** Piping and headers associated with the collection of spillage and rainwater in non-hazardous utility areas of the FPSO will go to the slop tanks through a water seal separate from the hazardous area open drains.

Table 3.10 Indicative Production and Water Treatment Chemical Usage

Chemical	Purpose	Injection Point	Concentrations and Frequency of use
Hydrate Inhibitor (Methanol)	To prevent hydrate generation from well fluids during initial production/start-up until a fluid temperature outside the hydrate zone is achieved. To disperse hydrates that may be generated within gas processing facilities.	Subsea wellheads and surface	Long-term unplanned shut downs (>8 hours): batch injection of 7.5 bbls per well and jumper on well closure. Planned shutdowns: 150 to 300 barrels may be injected into the total system for safeguard for an extended period.
Demulsifier	To assist with oil/water separation.	Surface production header	Continuous injection at between 25 and 50 ppm depending upon proportion of water present.
H_2S Scavenger	Contingency service against reservoir souring.	Subsea manifold	Requirement would be contingent on level of H_2S production.
Scale Inhibitors	Calcium carbonate inhibition. Note: location depends on type and location of scale problems and would be upstream of the scaling area.	a) Subsea - downhole or wellhead. Surface – Crude Heat exchanger, heating/cooling medium tanks. b) Water injection system into injection water stream during first months of injection.	Injection rates between 20 to 50 ppm are normal. Injection frequency is continuous. 10 to 100 ppm.
Corrosion Inhibitors	Injection to control corrosion of facilities.	Surface (separation and heating or cooling medium tanks).	Treatment rates would depend upon corrosion conditions, 10 to 20 ppm on total fluids.
Paraffin (Wax) Inhibitors	Contingent service may be injected subsea if the arrival temperatures are persistently below the wax appearance temperature.	Subsea flowlines: Subject to crude waxing properties.	If required continuous injection at between 200 and 750 ppm.
Asphaltene Inhibitor	To prevent asphaltene precipitation on mixing crude oil and condensate streams.	Surface injection upstream of separators.	Continuous when required depends on crude/condensate ratio. Treatment 50 to 100 ppm.

Chemical	Purpose	Injection Point	Concentrations and Frequency of use
Defoamers (Antifoam)	Foaming depressant	Surface – Process separators, foaming depressant.	If required continuous injection at 5 to 15 ppm.
Water Clarifiers (Deoilers)	To demulsify/deoil water to allow for better separation of contaminants.	Surface Injection upstream of separators and on produced water draw off from separators prior to inlet to the Flotation Cell to enhance final clean-up of the produced water.	Continuous injection at 5 to 20 ppm.
Bacteria Treatment/Biocides	To control bacterial growth.	a) Surface process separation equipment and storage tanks where produced water accumulates. b) Water Injection process facilities. c) Diesel storage tanks.	Periodic batch treatments to keep bacteria under control. Injection rates would be 200 to 500 ppm over 2 to 4 hour period. Laboratory samples routinely taken to determine effectiveness of treatment programme.
TEG	Continuous circulation. To provide gas dehydration for downstream plant.	Surface facilities – TEG Contactor. Gas dehydration process to lower water content.	Continuous circulation within TEG process to provide gas dehydration (water dew point control).
Oxygen Scavengers	Water injection. To remove residual oxygen to reduce corrosion.	Surface - Single injection point into Water Injection De-aerator tower.	Injection rates are 10 to 20 ppm for oxygen scavenger
WI Antifoam	Water injection to control foaming in de-aerator column.	Surface upstream of water injection de-aerator column.	Continuous use during periods of planktonic bloom, 2 to 10 ppm.

Note: This is an indicative list only: (a) additional chemicals may be required if process or other problems are encountered; and (b) chemical injection rates will be finalised by chemical supplier/support.

The closed drain system will be designed to receive drainage from process hydrocarbon equipment and pump it back into the process via the off-spec tank in the hull. The open drain system will be designed to collect oily rainwater drainage from drip pans and drain boxes throughout the topsides, rainwater on FPSO decks and deluge water from the modules. The design of the open drain system will comply with MARPOL requirements.

Flare and Vent System

A flare system is a safety pre-requisite for FPSOs and other oil and gas producing facilities so that the pressurised hydrocarbon gas inventory can be safely disposed of in the event of an emergency to reduce risks to personnel and the facility itself. *Figure 3.9* shows the flare stack on a typical FPSO.

Figure 3.9 Typical Flare Stack on FPSO

Source: MODEC 2013

The FPSO is designed to minimise routine flaring. The FPSO will be equipped with a HP and LP closed flare system with Flare Gas Recovery (FGR) unit. Nominal gas release into either the LP or HP Flares will be recovered into process streams via a crossover line (HP gas) and a Vapour Recovery Unit which uses a compressor to boost the LP gas to the process tie-in pressure. In closed flare systems, the flare is not normally lit and no pilots are operational. In the event flaring is required, for relief of high pressure for emergency shutdown or operational purposes (including maintenance, shutdown and start-up), the flare is ignited by a reliable ignition system. The volumes of gas in the flare headers will be continuously metered.

The design of the flaring and venting system and implementation of measures will be consistent with Tullow Oil Environmental Standards and the *Global Gas Flaring and Venting Reduction Voluntary Standard* (see *Chapter 2, Table 2.5*) to achieve a reduction in the flaring and venting of natural gas.

Gas Blanketing System

Following the recommendation of a BAT assessment undertaken as part of the design optimisation phase, TGL have selected hydrocarbon gas (fuel gas) blanketing with a vapour recovery system. Used blanket gas and cargo vapours are directed to the VRU for pressure boosting and return to the LP process stream.

In the event that the cargo tanks hydrocarbon gas blanketing and vapour recovery system is unavailable, an inert gas blanketing system (via the deck boiler) will be used with venting to the atmosphere via dedicated atmospheric vent on the flare tower.

Produced Water System

As discussed in *Section 3.3*, TGL has commissioned a produced water re-injection feasibility study to determine if produced water properties and reservoir conditions allow PWRI. The EIA assumes that produced water discharge will not exceed a maximum oil content of 40 mgl^{-1} daily and 29 mgl^{-1} averaged over 30 days with no visible sheen under normal operating conditions as per the EPA (2010) standards.

The produced water system will be designed for a nominal 65,000 bpd capacity. The FPSO will have a water-treating unit that will receive combined produced water streams from the separators. The system will use a three stage water treatment process with each stage using a different technology thus providing enhanced levels of oil removal with each successive stage (see *Figure 3.10).*

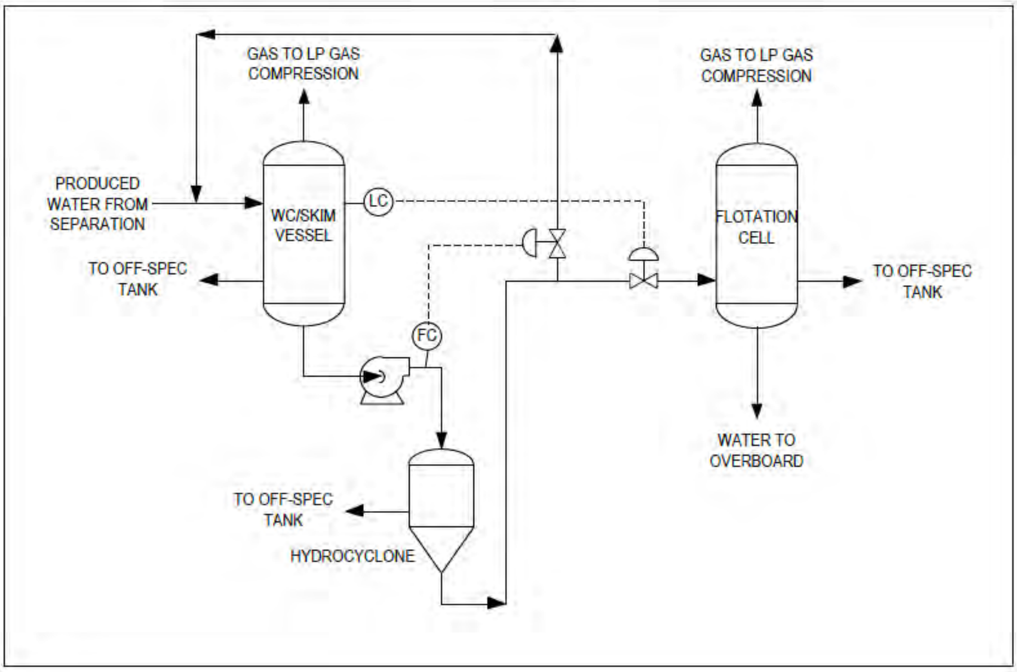
The three treatment stages are as follows.

- **Stage 1:** All of the produced water removed from the FPSO process trains will be collected in the water collection or skim vessel. Skimmed hydrocarbons will be removed and directed to the off-spec tank in the hull.

- **Stage 2:** The separated produced water will then be pumped out of the skim vessel to the de-oiling hydrocyclone units.

- **Stage 3:** The partially treated produced water from the hydrocyclone units will be pumped into gas flotation cells. Gas will be induced into the produced water inlet stream. The hydrocarbon layer formed at the top of the vessel will be periodically skimmed off and directed to the off-spec tank in the hull. The treated water will be pumped out of the flotation cell and directed through the produced water cooler prior to overboard discharge.

Figure 3.10 Produced Water Treating Process



Source: TGL 2012

A small amount of hydrocarbons will remain associated with the produced water. An on-line analyser will continuously measure the oil in water levels and an alarm will sound at 35 mgl^{-1} to alert operations staff and allow for intervention. There will be an automatic trip limit of 40 mgl^{-1} that will divert the produced water to the off-spec tank (with a 24 hour capacity) in the hull for recycling.

Power Generation

The dual fuel (gas/diesel) turbine driven power generators, located on the topsides will be used to supply main power. The generators will run on diesel until fuel gas becomes available. The turbines will be LM2500 + G4 aero-derivative gas turbines each rated at approximately 27 MW (*Figure 3.11*). The turbines will be 'DLE ready' *ie* they will be designed in a manner that will allow a DLE combustion system to be installed as an upgrade at a later date when such technology is deemed suitable for offshore use.

The three existing diesel engine power generators, located in the shipside engine room will, however, be refurbished for use for initial start-up power generation and also for commissioning. A new emergency diesel engine power generator will be installed to supply emergency power to topsides and subsea equipment.

Figure 3.11 Illustrative Gas Turbine Power Generating Facility

Source TGL 2012

Seawater (Distribution, Treatment and Injection) System

The seawater system will provide seawater, with treatment as required, to meet the FPSO cooling systems and reservoir injection demands. The seawater will be lifted from approximately 70 m below the surface. This depth will ensure that the water entering the system is less susceptible to having high levels of suspended particles. Lifted water will undergo electro-chlorination to prevent any marine growth in intake piping and pass through coarse filter strainers (to remove 98% of suspended solids). These filters will be cleaned as required, and any waste will be bagged and transported to shore for treatment and disposal by an EPA approved waste contractor.

Water to be injected into the reservoir will first be de-aerated. This will be achieved by a vacuum de-aerator tower and by injecting oxygen scavenging chemicals. The injection water will then be pumped to meet the required pressure for injection by water injection pumps.

Cooling Systems

The marine and topsides cooling systems will be designed to satisfy the general cooling demands of the FPSO. The marine cooling water system will consist of a once through system. The cooling medium generated by an evaporative water maker in the FPSO hull. The water will be cooled by cross-exchange with the lifted seawater. The topsides cooling system will consist of a closed circulation loop, pumps and surge tank. The system's cooling medium will be filled and topped up with water generated by Reverse Osmosis (RO) unit on the topsides. It is anticipated that the water will return to the cross-exchange at a temperature of 30°C for the marine system and 60°C for the topsides system.

3.4.2 Mooring System

An external turret mooring system has been selected for the FPSO. The system will consist of 9 chain anchor 'legs' of steel and polyester construction in groups of three (*ie* 3x3). Each leg will be anchored to the seabed using suction piles. The FPSO will be able to rotate around the turret (weathervaning) in response to current and wind.

3.4.3 Offloading System

Offloading of crude oil from the FPSO to the export tankers will be undertaken using a tandem offloading system where the export tanker bow moors to the FPSO stern using a hawser and the oil is transferred using a floating hose. A break-away coupling will be fitted in the hose. The hawser system will include a tension meter, recorder and alarm system which will display the mooring system load in the main control room of the FPSO. If the tension limits are reached, the export tanker will be alerted for hose disconnection and unmooring. When not in use, the cargo transfer hose will remain deployed from the stern of the FPSO.

At a nominal processing capacity of 76,000 bpd, the FPSO will have ullage capacity for approximately 21 days. It is planned to offload oil in 1 million barrel loads with each load taking approximately 20 hours to offload and 12 hours for export tanker connection and disconnection. Export tanker visits will be approximately every 10 to 12 days during the peak production period.

3.4.4 Restricted Zones

Restricted access areas, such as advisory and exclusion zones, will be enforced around offshore facilities in the development area for the safety of all sea users. These areas will be mapped on international nautical charts and formally designated by the Ghana Maritime Agency (GMA) and endorsed by the International Maritime Organisation (IMO). TGL proposes to establish the following restricted areas (*Figure 3.12*).

- **Area To Be Avoided (ATBA).** A 5 nmi radius advisory zone geographically centred on the FPSO indicating the presence of an oil production area where non-essential users are recommended to stay outside. Entry will not be excluded but the area will be marked on nautical charts as cautionary advice to all sea-users and specifically to the sea lane to the south.

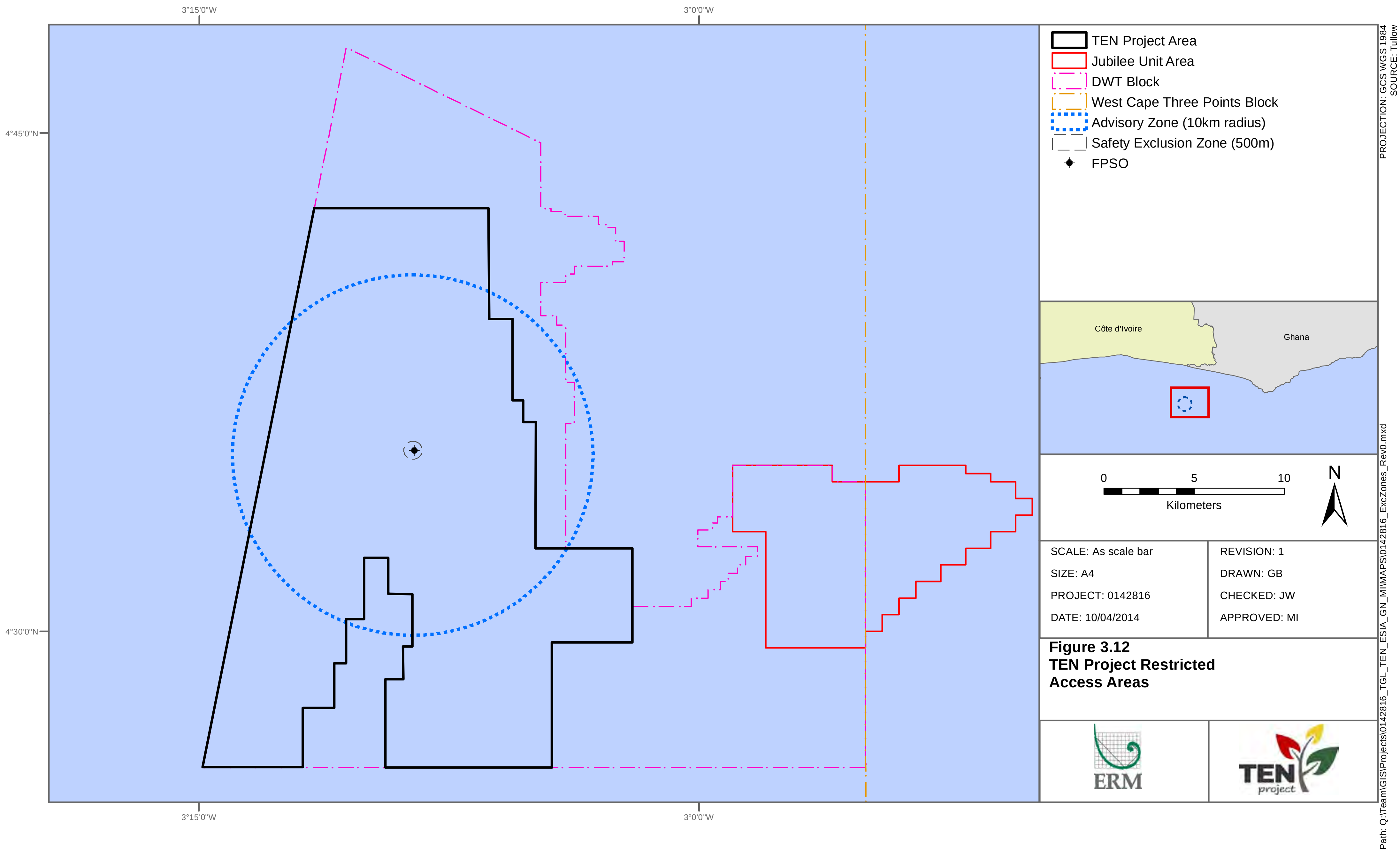


Figure 3.12
TEN Project Restricted Access Areas

- **Export tanker anchorage/pilotage waiting and boarding area.** A 3 nmi radius advisory area in proximity to the ATBA, providing a safe waiting area for export tankers prior to coupling with the FPSO for crude oil offloading.

- **Permanent safety exclusion zone.** A 500 m radius safety zone surrounding the FPSO facility, endorsed by the IMO, will be legally enforced.

- **Temporary safety exclusion zones.** 500 m radius safety zones to be applied at each of the drill centres when a Mobile Offshore Drilling Unit (MODU) or well intervention vessels are present.

Safety exclusion zones are an international standard for oil industry zoning. They will be legally enforced with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (*eg* fishermen) when potentially close to the FPSO or MODU (when present). The enforcement will also be applied by in-field standby and guard vessels.

Measures will be implemented to ensure that all those engaged in maintaining the safety exclusion zones have received adequate training on the correct code of conduct and rules of engagement which will be based on the UN Voluntary Principles of Security and Human Rights.

3.4.5 Subsea Development Plan

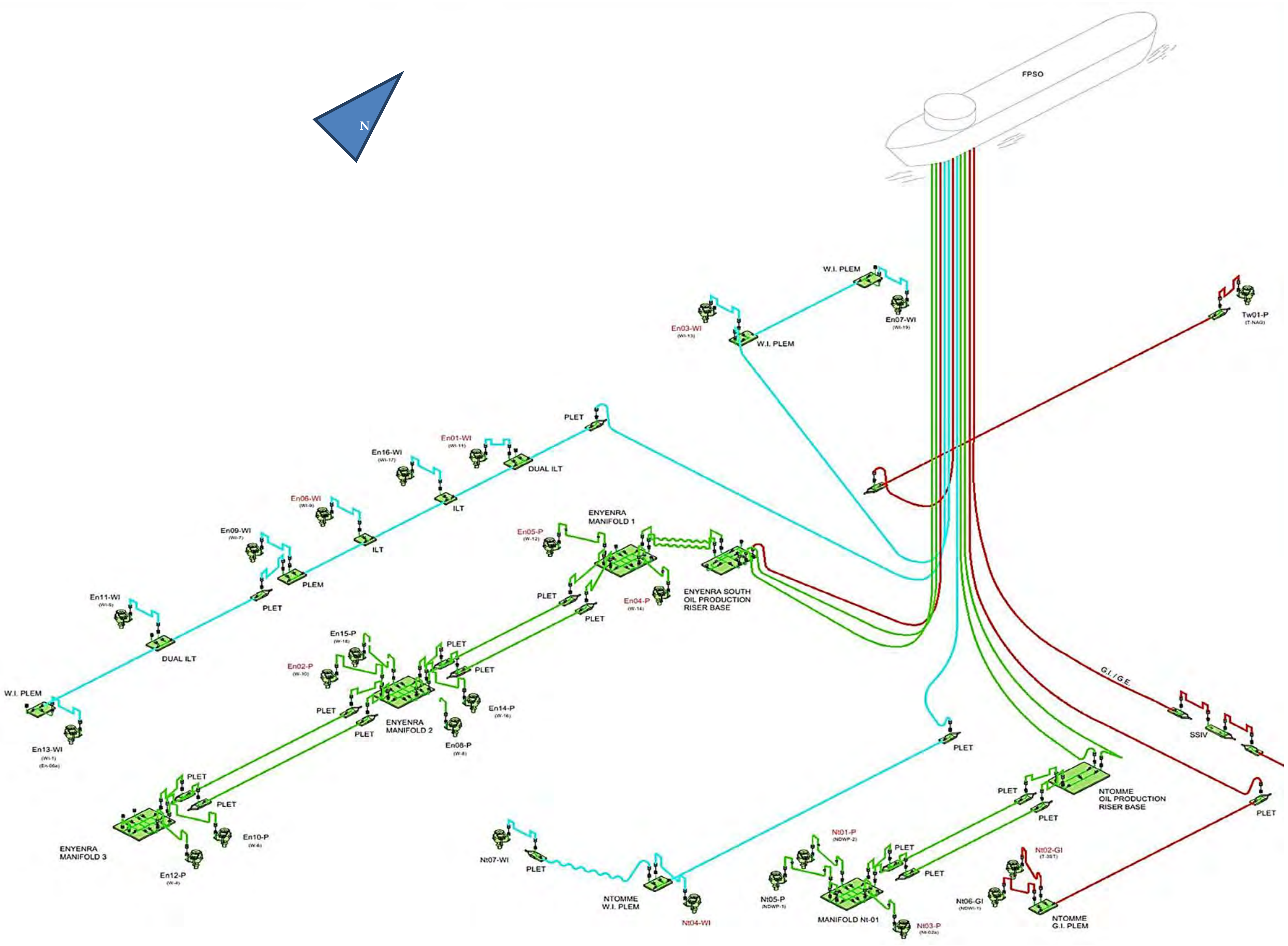
Ten wells, consisting of five oil producers, four water injectors and one gas injector, will be drilled and completed to be ready for first oil. Once production has commenced additional wells will be drilled, completed and subsea infrastructure connected. The development will comprise a total of 24 wells including 11 production wells, ten water injection wells, two gas injection wells and one gas production well. A summary of the development wells is provided in *Table 3.11* and an indicative field schematic is provided in *Figure 3.13*

Table 3.11 First Oil, Mid Case (Development Plan) and High Case Wells

Wells	First Oil	Mid Case	High Case
Well status			
Number of existing wells	5	8	8
Number of wells to be drilled	5	16	22
Well status (total)	**10**	**24**	**30**
Well type			
Oil production wells	5	11	14
Gas production wells	0	1	1
Water injection wells	4	10	13
Gas injection wells	1	2	2
Well type (total)	**10**	**24**	**30**

Source: TGL 2013

Figure 3.13 Field Schematic for Mid Case Development



Source: TGL 2013

A list of well data is provided in *Table 3.12* for the mid case and high production profiles. Water depths at the well locations will range between approximately 1,100 to 2,000 m. It should be noted that final well locations have not been confirmed and may deviate from the proposed locations.

Table 3.12 TEN Well Data for Mid and High Production Cases

Name	Type	Mid Case/High Case	Wellhead Location (UTM) East (m)	Wellhead Location (UTM) North (m)	Water Depth (m)
Enyenra					
En05-P	Oil Producer	MC/HC	481039	508132	1,442
En04-P	Oil Producer	MC/HC	481088	508111	
En08-P	Oil Producer	MC/HC	479745	502972	1,630
En02-P	Oil Producer	MC/HC	479697	502981	1,630
En14-P	Oil Producer	MC/HC	479749	502995	1,630
En15-P	Oil Producer	MC/HC	479702	503005	1,630
En12-P	Oil Producer	MC/HC	475612	495359	1,877
En10-P	Oil Producer	MC/HC	475642	495341	
En17-P	Oil Producer	HC	483283	515662	1,030
En18-P	Oil Producer	HC			
En13-WI	Water Injector	MC/HC	474942	492538	1,990
En20-WI	Water Injector	HC	476330	496087	1,870
En11-WI	Water Injector	MC/HC	476330	496087	1,870
En09-WI	Water Injector	MC/HC	478505	498796	1,770
En06-WI	Water Injector	MC/HC	479260	501122	1,674
En01-WI	Water Injector	MC/HC	480525	506504	1,520
En03-WI	Water Injector	MC/HC	481496	509819	1,355
En16-WI	Water Injector	MC/HC	479778	503772	1,615
En07-WI	Water Injector	MC/HC	481644	510168	1,330
En19-WI	Water Injector	HC	483092	514574	1,103
Ntomme					
Nt03-P	Oil Producer	MC/HC	488227	497494	1,730
Nt05-P	Oil Producer	MC/HC	488193	497500	1,730
Nt01-P	Oil Producer	MC/HC	488186	497521	1,730
Nt02-GI	Gas Injector	MC/HC	489047	501894	1,601
Nt06-GI	Gas Injector	MC/HC	489061	501870	1,610
Nt04-WI	Water Injector	MC/HC	487772	495697	1,773
Nt07-WI	Water Injector	MC/HC	485390	495110	1,750
Tweneboa					
Tw01-P (1)	Gas Producer	MC/HC	484847	513189	1,149
Tw02-P	Oil Producer	HC	487755	508550	1,270
Tw03-WI	Water Injector	HC	487000	507700	1,315

Source: TGL 2013

Subsea Infrastructure

The Enyenra mid-case field layout will consist of eight oil producers and eight water injectors which are spread across the central and southern locations within the Enyenra field. The production wells are planned to lie predominantly in clustered drill centres connected to three manifolds. These manifolds will be connected to a dedicated riser base in series (one after the

(1) Tw-01 is an option. If the option is taken then the well will be included in all three production cases.

other) using dual flowlines. The riser base will be connected to the FPSO by dual risers.

Water injection will be provided by two water injection risers. Injection water will be distributed in both northerly and southerly directions to provide water injection to the Enyenra oil producing reservoirs. The central location will consist of two water injectors one of which will tie-in to an inline tee (ILT) and the other into a water injection Pipeline End Manifold (PLEM). The southern location will consist of six water injectors that will tie back to five ILTs (both single and dual) and a PLEM.

The Ntomme field is planned to be developed by a combination of gas and water injection enabling effective and flexible pressure maintenance, reservoir management and maximising liquid recovery. The field will support three oil producers, two gas injectors and two water injectors located in the easterly section of the TEN Project area. Dual risers will connect the oil producers to the FPSO via an oil production manifold and riser base. The gas and water injection will be provided from the FPSO via dedicated risers to the injection PLEMs which support the two injector wells in both cases.

The Tweneboa TG1 non associated gas pool will be developed through the recompletion of the existing TG1 discovery well (Tw-01P), tied in to its dedicated PLEM to a 3 km gas production flow line connecting via a PLET to its dedicated riser to the FPSO.

Development of the Tweneboa oil pool which is under study for inclusion in the high case scenario may consist of a single oil producer and single water injection well. The Tweneboa oil producer would lie adjacent to the Ntomme production riser base manifold where it would be tied into and commingled with the Ntomme production fluids.

Definitions of subsea equipment terminology are provided in *Box 3.1*. The production and gas injection manifolds, jumpers, PLETs and ILTs, flowlines and risers will be designed to international standards.

Box 3.1 Subsea Equipment: Definition of Terms

Production manifolds
Production manifolds are subsea equipment installed on the seafloor, comprised of valves and pipes, which act as a gathering point for the produced fluids/gas from individual production wells.

Production trees
Production trees are comprised of a set of control valves that are installed on production wellheads to control production fluids/gas.

Jumpers, flowlines and risers
Jumpers are generally rigid insulated pipes that connect wellheads to manifolds. Flowlines are dual insulated pipes that carry production fluids from production manifolds to riser bases or injection water/gas from riser bases to injection manifolds. Risers carry production fluids from the riser base on the seabed to the FPSO or injection water/gas from the FPSO to riser bases.

Water injection manifolds
A water injection manifold is a piece of equipment comprised of valves and pipes that sits on the seafloor and through which water is distributed to individual water injection wells.

Water/gas injection trees
Water/gas injection is controlled by subsea control valves (within the injection trees) connected to the wellhead.

Umbilicals
Umbilicals are used to convey chemicals, data (control system information, pressure and temperature) electrical power and high/low pressure hydraulic fluid supply to allow manipulation of infrastructure valves, tree safety valves and flow chokes.

Pipeline End Manifold (PLEM) / Pipeline End Termination (PLET) and In-Line Tee (ILT)
A PLEM is a subsea component that includes a flange and makes it possible to connect a rigid pipe to another structure such as a manifold or a tree through a jumper. It is also called a PLET, especially when serving a single pipeline valve or having only one vertical connector. An ILT is a pipeline tie-in structure that provides tie-in points along a pipeline.

Production Systems

All production wells will be drilled from clustered well drill centres. Each drill centre will typically have a production manifold with connection hubs that gather production from the surrounding wells. The wells will be tied back to the subsea manifolds using either rigid or flexible jumpers. Insulated 8 inch (20 cm) flowlines will carry production via intermediate production manifolds to riser bases and then to the FPSO via 8 inch risers.

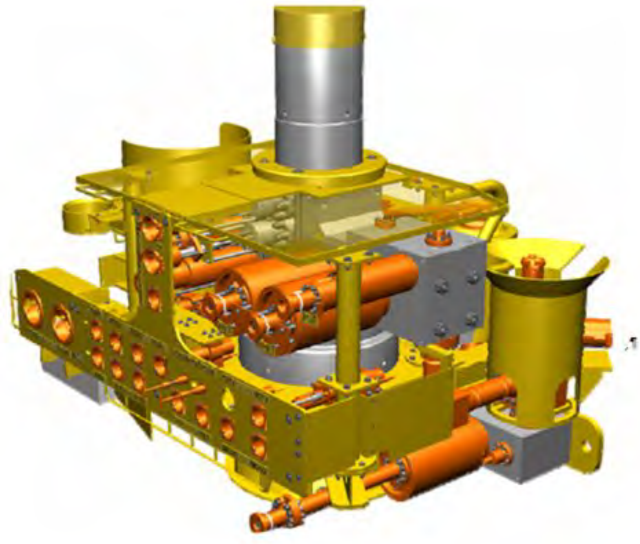
Production Wells

The subsea layout for the mid case will include eight oil production wells to the west of the FPSO in the Enyenra field, three production wells to the east in the Ntomme field and one gas production well from the TG1 non associated gas pool in the Tweneboa field. Well locations will be located close enough to manifolds to enable the use of rigid jumpers to connect each well.

Production Trees

Production from individual wells will be controlled at each subsea wellhead by horizontal type subsea Xmas Trees (*Figure 3.14*). The production trees will be controlled by a retrievable subsea control module (SCM) mounted on the tree. The dimensions of each production tree are 4.5 m by 4.5 m, with an in air weight of 48 tonnes (te).

Figure 3.14 Production Tree Schematic

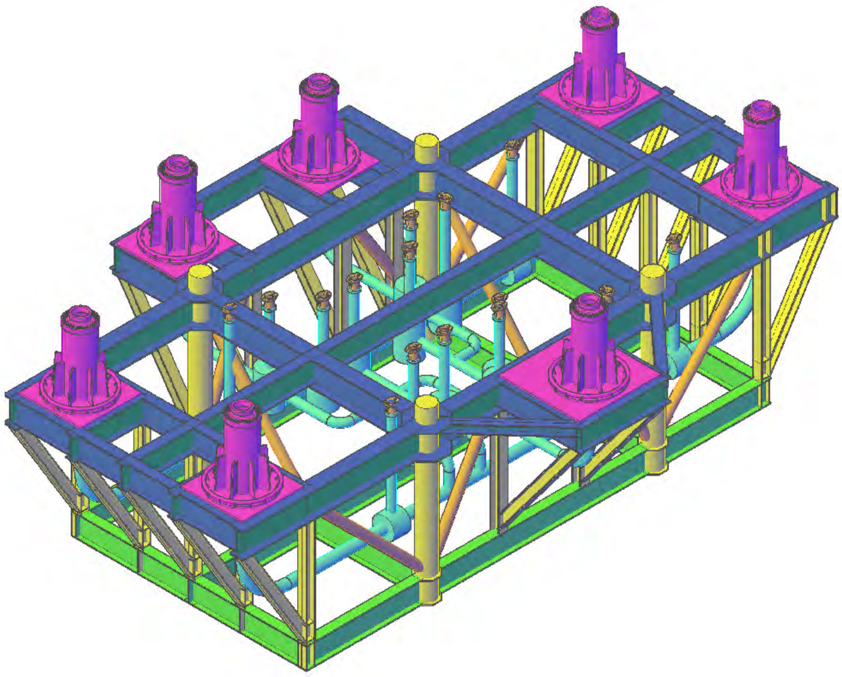


Source: TGL 2012

Production Manifolds

Production manifolds will be installed on the seafloor as a gathering point for produced oil from the individual production wells. The manifolds will be supported by mud mats on the seafloor unless seabed conditions dictate the use of suction piles to provide additional support. A vertical connection system (single bolt clamp) will be used on the rigid jumpers to connect production wells to the manifold. The dimensions of each manifold are approximately 16 m by 10 m, with a weight in air of 150 te. Production manifolds and mud mats, exclusive of production lines, will occupy an area of 160 m^2 each. A typical manifold is shown in *Figure 3.15*.

Figure 3.15 A Typical Manifold



Note: The TEN Project will use 4-slot manifolds which will have the same seafloor footprint as the one shown above.
Source: TGL 2012

Flowlines and Risers

The production flowlines will convey multi-phase and commingled production fluids from the individual wells and manifolds to riser bases located in close proximity to the FPSO. Production flowlines will be insulated carbon steel flowlines. Single un-insulated carbon steel flowlines will convey gas for injection to injection manifolds and to the individual injection wells. Water injection flowlines will be single un-insulated carbon steel flowlines with a polyethylene liner carrying water to injection manifolds. The flowlines for the TEN Project are listed in *Table 3.13*.

Riser bases will be installed to the east and west of the FPSO (*Figure 3.16*). These bases will be supported by suction piles. The same style of connection will be used to interconnect all production and injection flowlines. Flexible risers will be connected to the FPSO.

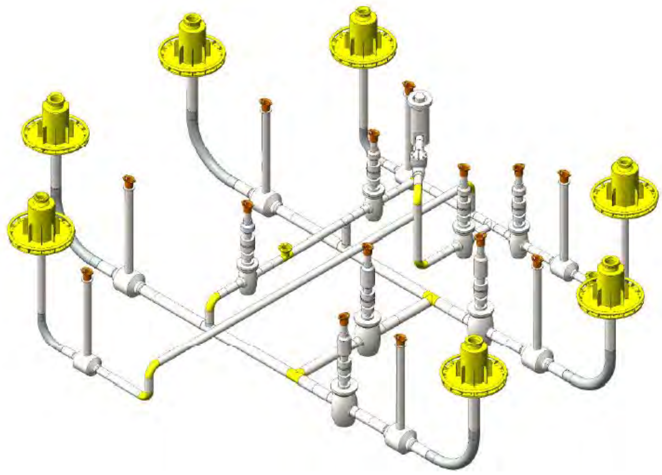
A gas export pipeline will be utilised to transfer TEN export gas to a Jubilee gas export pipeline tie-in point for onward export onshore via the GNPC Jubilee Export pipeline. The carbon steel line pipeline will run approximately 37 km from a riser base, including an SSIV, on the East side of the TEN FPSO to a tie-in structure located at Jubilee FPSO Gas Export Riser Base. The pipeline will be installed prior to first gas export, scheduled to commence twelve months after first oil.

Table 3.13 Proposed Flowlines for the TEN Project

Flowline	Route From	To	Size (inches)	Length (m)
Enyenra oil production (dual flowline)	Manifold 3 (3 wells)	Manifold 2 (3 wells)	8	5,400 (x2)
Enyenra oil production (dual flowline)	Manifold 2 (3 wells)	Manifold 1 (2 wells)	8	5,300 (x2)
Enyenra oil production (dual flowline)	Manifold 1 (2 wells)	Enyenra oil riser base	8	370 (x2)
Enyenra oil production riser (two dedicated risers)	Enyenra oil riser base	FPSO	8	4,550 (x2)
Enyenra oil production gas lift	FPSO	Enyenra oil riser base	6	2325
Enyenra south water injection (single flowline serving 6 wells)	Water injection riser south PLET	Water injection PLET	10 8	12,625 7,570
Enyenra north water injection (single flowline serving 2 wells)	Water injection riser north PLET	Water injection PLEM	8	2,526
Ntomme gas injection riser	FPSO	Gas injection riser PLET	10	4,625
Ntomme gas injection	Gas injection riser PLET	Gas injection PLEM (2 wells)	10	3,630
Ntomme oil production riser (two dedicated risers)	FPSO	Ntomme oil riser base	8	4,550 (x2)
Ntomme oil production (dual flowline)	Ntomme oil riser base	Manifold (3 wells)	8	7,390 (x2)
Ntomme water injection riser	FPSO	Water injection riser PLET	8	4,775
Ntomme water injection	Water injection riser PLET	Water injection PLEM (2 wells)	8	9,200
Tweneboa gas production	FPSO	Gas production PLET	6	4,250
	Gas Production Manifold	Gas production PLET	6	3,330

Notes 1 inch = 2.54 cm.

Figure 3.16 Typical Riser Base



Source: TGL 2012

Water and Gas Injection System

Water Injection Wells

Water injection wells will be drilled from a number of drill centres in each location of the Enyenra field. The subsea layout will include up to eight water injection wells in the Enyenra field and two wells in the Ntomme field. Water will be fed to these injection wells from the FPSO via risers and flowlines. Each water injection drill centre will have ILTs.

Gas Lift and Injection Wells

Gas for artificial gas lift from the Enyenra oil production riser base will be provided via a dedicated riser. The Ntomme reservoir gas injection wells will be supplied with a single flowline from the east side of FPSO which will transport gas to the gas injection PLEM.

Injection Trees

Injection into individual wells will be controlled at the subsea wellheads by horizontal type trees. The injection trees will be controlled by a retrievable SCM mounted on the tree. The injection trees will be of similar dimensions to the production trees (*ie* 4.5 m by 4.5 m).

Injection PLEM and ILTs

The water and gas injection PLEMs and water injection ILTs will be installed on the seafloor as a distribution point for injected gas and water to the individual injection wells. Risers will be installed from the FPSO to each PLET on the east and west sides. Two flowlines will carry water to the outlying water injection ILTs. Both gas and water injectors will connect to their respective ILT or PLEM using jumpers.

Each ILT will measure approximately 12 m by 11 m, including the overall mud mat dimensions, with a in air weight of 80 te. ILTs will occupy an area of 229 m^2 each. Each of the injection PLEMs will measure 18 m by 11 m, with a weight in air of approximately 116 te.

<u>Injection Flowlines and Risers</u>

Water injection flowlines will carry conditioned seawater and/or a conditioned produced water/seawater from the water injection module on the FPSO to the water injection ILTs. Conditioned gas from the gas compression process on the FPSO will be carried via a single dedicated riser and flowline to the gas injection wells in Ntomme.

Subsea Control Systems

All subsea hydraulically-operated valves will be actuated using a multiplexed electro-hydraulic subsea control system. Hydraulic power, electrical power, communication signals and injection chemicals will be supplied and distributed from the FPSO Subsea Control System (SCS) modules via the riser and infield umbilicals to umbilical termination assemblies (UTAs) and subsea distribution units (SDUs). The SDUs will be located on the seafloor in close proximity to the production manifolds. Electric and hydraulic flying leads will connect the SDUs to the subsea trees and manifolds. Umbilicals will be used to convey multiple chemical supply lines, low and high pressure hydraulic supply and communication telemetry and subsea electrical power. Dynamic umbilicals will connect the FPSO and riser bases and static umbilicals will connect the riser bases to the UTAs.

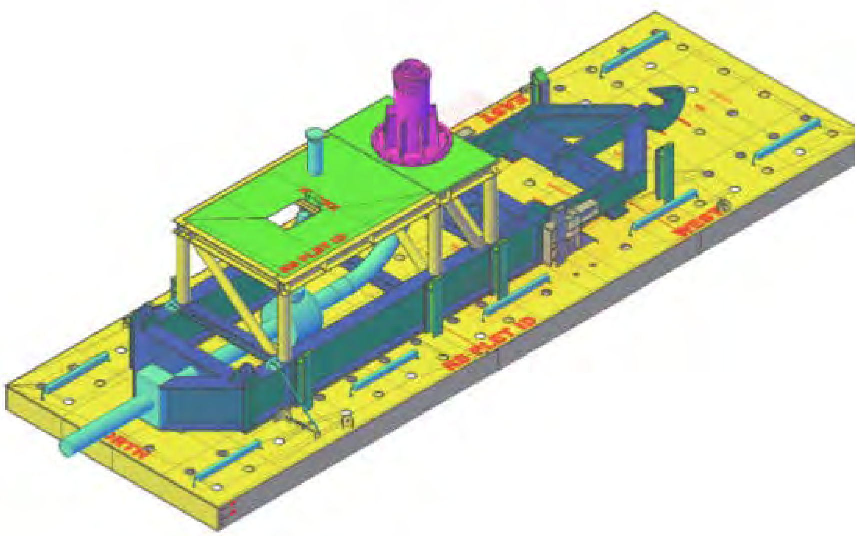
Downhole Safety Devices

The project will install downhole SSSVs at each well, which will be controlled by subsea and FPSO safety control systems. These systems will shut the valve in (stop the flow), in the event of an emergency or operational upset in the well. These devices are typical to the oil industry and isolate the well contents and oil reservoir from the environment in emergency conditions.

Suction Piles and Mud Mats

Production manifolds and riser bases will be secured to the seabed using suction piles. ILTs, PLEMs and PLETs will be mounted on mud mats to distribute the weight of infrastructure and prevent them from sinking. PLETs in close proximity to manifolds and will be mounted on integrated mud mats with typical dimensions of 16 m by 5 m. ILTs and PLEMs will be mounted on independent mud mats of 21 m by 11 m away from other infrastructure. A typical mud mat arrangement is shown in *Figure 3.17*.

Figure 3.17 Typical PLET and Mudmat Arrangement



Source: TGL 2012

Seafloor Footprint

Subsea infrastructure for the TEN Project will be installed over an area of approximately 500 km^2. Seafloor disturbance will be caused by the FPSO moorings and the installation of subsea production facilities, such as manifolds, ILTs, riser bases, PLETs, PLEMs, flowlines and umbilicals. A summary of the development's facilities and its expected footprint on the seafloor is provided in *Table 3.14*. The proposed drilling vessel will be dynamically positioned and therefore not require anchoring and as such will not disturb the seabed. The area of seafloor directly disturbed by the installation of the subsea infrastructure will be approximately 0.52 km^2.

Table 3.14 Seafloor Footprint for the TEN Project

Seabed footprint	Dimensions (m)		Quantity	Length (km)	Footprint (km^2)
FPSO					
Mooring System		**Diameter (m)**			
Piles		6	12	-	0.0003
		Breadth (m)			
Lines		20	12	2	0.4800
Subsea infrastructure					
Subsea Trees	**Length (m)**	**Breadth (m)**			
Oil Production Trees	4	4	11	-	0.0002
Gas Production Trees	4	4	1		0.0000
Water Injection Trees	4	4	10	-	0.0002
Gas Injection Trees	4	4	2		0.0000
Structures					
Production manifolds	16	10	4	-	0.0006
PLEMs	14	6	4	-	0.0003
Water injection ILTs	21	11	5	-	0.0012
Riser base manifolds	18	9	2	-	0.0003
PLETs	11	5	24	-	0.0013
SSV	-	-	1	-	-
Production Flowlines	**Diameter (ins)**	**Diameter (m)**			
Enyenra	8	0.203	2	13.5	0.0027
Ntomme	8	0.203	2	9.9	0.0020
Tweneboa	6	0.152	1	4.9	0.0008
Injection Flowlines					
Water injection	10	0.254	3	12.6	0.0032
	8	0.203	3	24.5	0.0050
Gas injection	10	0.254	1	3.6	0.0094
Gas Lift Line					
Enyenra	6	0.152	1	2.3	0.0004
Gas Export Pipeline	10	0.254	1	37	0.0094
Umbilicals					
Production	10	0.254	-	21.6	0.0055
Water injection	10	0.254	-	24.9	0.0063
Gas injection	10	0.254	-	3.8	0.0010
				Total	**0.5223**

3.4.6 *Radioactive Sources*

There will be limited use of radioactive sources during the drilling, construction and production phases of the project.

Once a well has been drilled, well logging operations are undertaken to provide accurate information on the well. During this process, logging instruments are attached to the bottom of a 'wireline' and lowered to the bottom the well. The wireline containing an array of monitoring instruments is then slowly brought back up, the devices reading different data as they pass each formation and recording it on graphs, which can be interpreted by the geologist, geophysicist and drilling engineer. Some of these instruments, and those used during Logging While Drilling will have radioactive sources.

During the construction phase, X-ray techniques will be used for non-destructive testing of welding seams as part of the quality control process required prior to installation of subsea infrastructure.

During the operational phase, multi-phase flow meters will be installed on each of the production well jumpers to monitor the production rates of the wells. Each flow meter will contain a gamma emitting source (Barium 133), which will be shielded and of low activity. Prior to shipment from Europe, each flow meter will be tested by a certified authority to ensure compliance with Article 3 of the EU Euratom Directive that stipulates maximum exposure levels[(1)].

All radioactive sources will require certification by the Ghana Radiation Protection Institute, including both an Import permit and Utilisation permit. TGL will comply with the requirements of the Ghana Radiation Protection Institute.

3.5 *ONSHORE SUPPORT OPERATIONS AND ONSHORE BASE*

3.5.1 General Considerations

Existing onshore logistics bases located in Sekondi-Takoradi will be used for the TEN Project. These onshore bases are located approximately 140 km to the northeast of the TEN fields. Sekondi-Takoradi will provide warehousing, accommodation, office and supply support to the FPSO as well as provide the centre for community liaison activities. The majority of onshore logistics support infrastructure in Sekondi-Takoradi is already in place following the installation of the Jubilee FPSO.

The main facilities to be used by the TEN project are located at the Takoradi commercial port and Takoradi Air Force Base. A description of the Sekondi-Takoradi facilities is presented below. Tema port will potentially be used for the construction, fabrication and assembly purposes. Tema activities will be undertaken by a third party and will be subject to a separate environmental assessment and permit. Tema is located approximately 360 km to the northeast of the TEN fields.

The TGL head office is located in Accra and currently provides logistics, sub-surface (*ie* reservoir engineering), operations, engineering, administration, legal, procurement, finance and management oversight.

(1) 1 micro Seivert (μSv)/h (100 μRem/h).

Teams will be located in Accra during operations and in Takoradi, with some personnel based offshore. Personnel numbers will peak during the installation and commissioning phases. TGL has constructed a permanent office complex for personnel in Accra. Accommodation for additional personnel will be provided by leasing houses or apartments in both Accra and Takoradi.

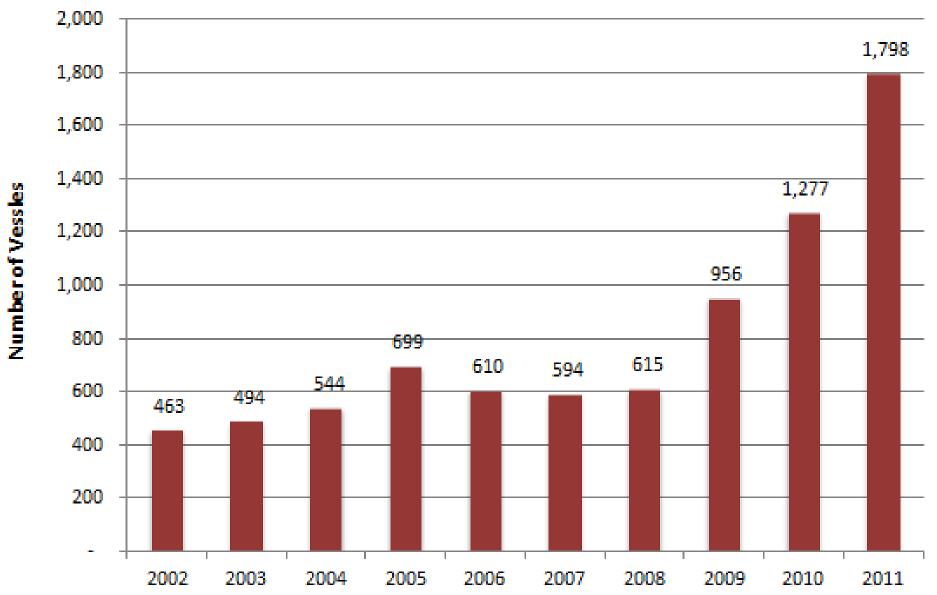
3.5.2 Takoradi Commercial Port

Overview

Takoradi is one of Ghana's main ports and between 2002 and 2011 the port handled an average of 805 vessels per year (*Figure 3.18*). There has been a marked increase in vessel traffic at the port since 2009 which is likely due to additional oil and gas vessel traffic. Berthing facilities at the port include eight berths with lengths ranging between 120 and 225 m (*Figure 3.19*). The maximum draft at the wharf is 10 m.

The GPHA is undertaking a port feasibility and development master plan study for the Port of Takoradi. This plan takes into account the broad context of port infrastructure, estimated traffic flows, the impact of port development on the national economy and covers various concession and franchise arrangements for attracting private sector participation.

Figure 3.18 Total Takoradi Port Traffic (Vessel Calls) 2002 - 2011



Source: Adapted from GPHA 2012

Facilities

- Dedicated Tullow Berth
- Bulk Drilling Fluids Storage
- General & Flotation Hose Storage
- Tullow Marine Offices
- Production Tree Pre-Development

0 100 200 300 400

Metres

N

Figure 3.19
Takoradi Port

SCALE: 1:10,000	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

ERM

TEN project

PROJECTION: GCS WGS 1984

SOURCE: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_TakoradiPort_Rev0.mxd

TGL currently lease a number of areas for offices, storage and berths within the Takoradi port area from GPHA (see *Figure 3.19)*. Any upgrades of the leased areas will require prior approval by the GPHA and the areas will be handed back to GPHA once they are no longer required.

Takoradi's port will be used by the TEN Project for:

- the importation of materials with some dock space to serve as a loading/offloading point for equipment and machinery;
- dispatching equipment and allowing for temporary storage of materials and equipment;
- bulk chemical and materials storage; and
- pre-deployment checks (*eg* hydrotesting) and assembly of equipment (*eg* production trees).

Berths

Dedicated berths have been leased by TGL to service offshore activities. These will be required for the project life. Support vessels for offshore oil exploration activities are serviced at berths 5 and 6. If there is insufficient space at Takoradi port on occasion, support ships may use Sekondi Naval base.

During exploration activities, one support vessel called at the port each day on average, with a maximum of four support vessel calls per day. Once the FPSO has been installed and begins operations, a supply boat will visit the FPSO a number of times per week, depending on the requirements for supplies. Additional calls will be required during the installation and commissioning activities.

Specific activities at the port that occur include bunkering, transfer of waste to waste contractor, loading supplies for the MODU, FPSO and support ships, and during installation and commissioning phases the loading/unloading of seabed infrastructure.

Laydown and Storage Areas

A pre-deployment area will store and carry out pressure-test work for the production trees. This will involve small quantities of potable water being used in an enclosed isolated area for safety reasons given the high pressures that will be used. This work will be undertaken at the port to avoid the need to transport oversize loads (*ie* the production trees) through the city of Takoradi to TGL's Air Base facilities. The area to be used is 300 m^2 and leased directly by TGL.

A 500 m^2 bulk drilling fluids facility has been constructed on the main port quay and is operated MI Swaco and BJ cement. The maximum storage capacity of the largest tank in the plant is 950 bbls. These suppliers also lease two warehouses (3,850 m^2 and 1,350 m^2) from the GPHA for dry bulk goods such as cement and caustic soda. Both warehouses are covered and well ventilated. There are spill containment kits, including chemical retrieval tools, and absorbent material in the warehouse. It should be noted that these are pre-existing facilities that supply exploration and development phase drilling and are included in this project description for completeness and will not be addressed in the impact assessment.

TGL has built a secure chemical store inside the existing commercial perimeter of Takoradi port to supply the operational phase. The store is covered and fully bunded 50 m by 30 m building has been constructed on land leased by TGL from GHPA. This facility is managed and operated by Baker Hughes on behalf of TGL (TGL are the EPA permit holders for this facility). Production chemicals to be stored include oxygen scavengers (*eg* sodium bisulphite), biocides, scale inhibitors (*eg* phosphanates), corrosion inhibitors (*eg* amines), acids and methanol.

Water Supply

TGL has installed a 600 m^3 potable water tank on the main quay near to the drilling fluids storage area. This water will primarily be used for the TEN drilling programme. Some additional water may be required to supply the smaller construction vessels that do not have desalination plants.

The MODU, FPSO and the major construction vessels will produce their own potable water using onboard desalination plants. Pressure testing of pipelines and vessels during construction will use inhibited seawater.

3.5.3 Takoradi Air Force Base

TGL leases part of the Air Force base and currently uses it to support existing Jubilee operations and exploration and production drilling activities. TGL will use these (or similar) facilities for the lifetime of the TEN project. TGL upgraded infrastructure at the Takoradi Air Force base for onshore storage and support facilities for the Phase 1 and Phase 1A Jubilee development and operation (*Figure 3.20*). The same infrastructure will be used for TEN.

A disused aircraft hangar on the base was converted into a warehouse, with adjacent office space and meeting facilities for approximately 30 persons dedicated to the running of TGL's facilities. A canteen and toilet block was also built. A 40,000 m^2 fenced area will be used to store steel pipe/casing and well construction and testing equipment.

To minimise TGL heavy vehicle traffic affecting access to the air base by other vehicles and pedestrians, a small access road to the Takoradi Air Force base was upgraded to segregate pedestrians from traffic.

Roads

- Axim Road
- Cape Coast Road
- New Road Access

Facilities

- Airport Offices and Warehouse
- Bay Court Offices and Warehouse
- TGL Heliport
- Lease Area

0 100 200 300 400
Metres

N

Figure 3.20
Air Force Base

SCALE: 1:10,000	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

PROJECTION: GCS WGS 1984

SOURCE: Tullow

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_AirForce_Rev0.mxd

The base will also be used by TGL to locate its helicopter operations to transport personnel to the FPSO as well as using a fixed wing aircraft to fly to/from Accra. Flights will be on a daily basis and will use the Dauphin AS365N3 helicopter for flights to/from the FPSO/MODU and a Beechcraft B1900D fixed wing for flights to/from Accra. FPSO requirements will be integrated and optimised with MODU requirements.

Aviation fuel is sourced from a fuel farm located at the base and is shared by the Ghana Air Force with oil companies located at the base. NHV Aviation has been contracted to provide service and operation of these machines.

Bay Court

Office and warehouse facilities have been leased by TGL at the Bay Court complex near the airport in Takoradi (*Figure 3.20)*. High quality chrome tubing and other delicate parts (*eg* electronics) will be stored at this location. This also forms the main Takoradi regional office for TGL.

A number of service companies such as Baker Oil Tools, i-Tech-7, Oceaneering and Schlumberger also directly lease sections of the Bay Court complex. These specialists companies provide direct support to the oil industry in general. Operations include assembly of specialist equipment for later installation in the wells, pressure testing, support for subsea remote operated vehicle operations and well logging.

3.6 *MAIN PROJECT ACTIVITIES*

3.6.1 *Drilling and Completions*

Seven existing, and currently suspended, wells will be completed and 17 new wells drilled and completed. The drilling vessel is likely to be West Leo (see *Figure 3.21*). The West Leo is a sixth generation, self-propelled and dynamically positioned MODU. The dynamic positioning system uses thrusters for station keeping to maximise schedule efficiency and flexibility in the field. The West Leo will be backed up by the Stena DrillMax drillship. The Stena DrillMax is a sixth generation, dynamically drillship (DP Class 3), capable of drilling in water depths up to 3,000 m (see *Figure 3.22*).

Figure 3.21 West Leo

Source: maritimt.com

Figure 3.22 Stena DrillMax Drillship

Source: Stena

Drilling Schedule

The provisional drilling schedule is shown in *Figure 3.22*. Drilling is expected to start with two early wells in Q1 2014 followed by the recommencement of the main project drilling schedule in Q4 2014 continuing until the end of 2017. It is assumed that it will take approximately one month to drill and one month to complete each well.

It is proposed that the West Leo MODU will drill two wells in Q4 2013/Q1 2014 prior to the main drilling and completions programme commencing in Q4 2014, when three wells will then be drilled, most likely by the Stena DrillMax, prior to the West Leo commencing completions and continuing the programme. Five of these wells will be the existing appraisal wells Tweneboa-03ST (Nt02-GI), Ntomme-2A (Nt03-P), Nt04-WI, Owo-1R (En-5-P) and Enyenra-2A (En06-WI). At first oil, 10 wells will have been completed (five existing and five drilled in the proposed programme).

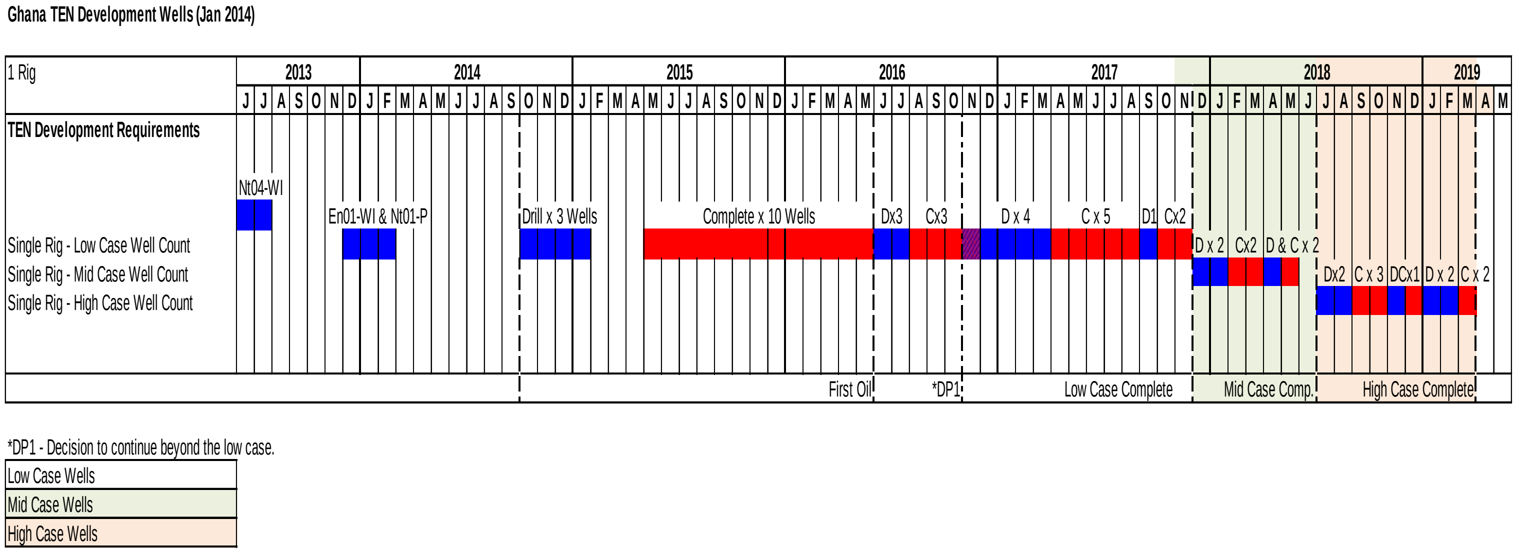
After first oil the MODU will be used to continue to drill and complete 12 new wells and complete two existing wells.

Drilling Process Description

Drilling for oil and gas uses a rotating drill bit attached to the end of a drill pipe (the 'drill string') to bore into the earth to reach oil and gas deposits. For each well to be drilled the MODU will be positioned at the well location. The first stage in drilling (known as 'spudding') is to place a 36 inch (90 cm) diameter conductor into the seabed which will allow the MODU to be connected to the well after drilling the 26 inch (66 cm) section via a blowout preventer and marine riser. Once this is in place drilling continues using a series of two to three (or more) progressively smaller diameter drill casings which are cemented in place. A typical well design for the TEN Project wells is provided in *Table 3.15*.

The BOP for the TEN drilling campaign consists of two annular preventers (one on the lower marine riser package and one on the BOP stack itself), one blind ram, one shear ram and one casing shear ram, three variable bore pipe rams and one set of test rams along with the appropriate outlets and lines.

Figure 3.23 *Drilling Schedule*



Source: TGL 2013

Table 3.15 Indicative TEN Project Well Design

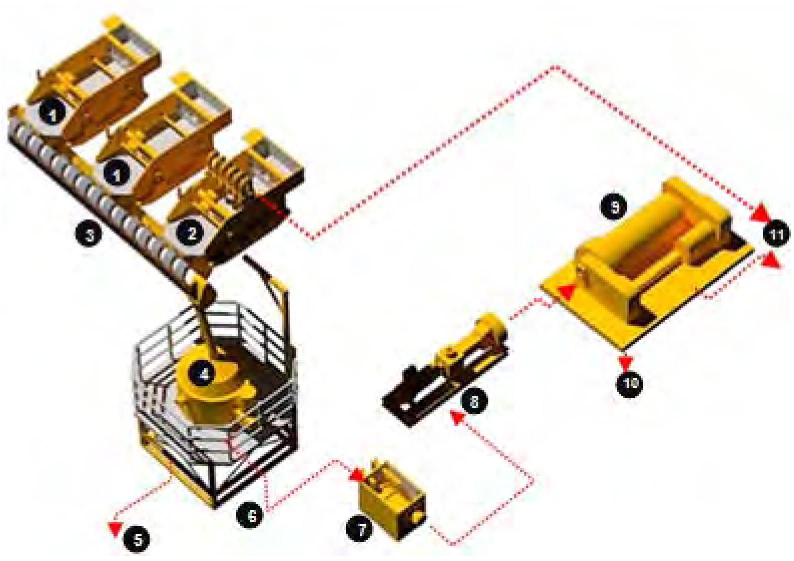
Diameter (inches)	Casing	Indicative depth (m TVD)	Section length (m)	Mud Type
36	36" conductor	1,584	84	Seawater with sweeps
26	20" surface casing	2,300	716	Seawater with sweeps
16	13 ⅜" intermediate casing	3,300	1,000	Low toxicity Non Aqueous Drilling Fluid (NADF)
12 ¼	9 ⅝" production casing	4,200	900	Low toxicity NADF

TVD: Total Vertical Depth

The rotating drill bit breaks off small pieces of rock (called drill cuttings) as it penetrates rock strata. The cuttings typically range in size from clay to coarse gravel and their mineral composition will vary depending on the types of sedimentary rock penetrated by the drill bit.

Drilling fluids (also called muds) are pumped down the drill string during drilling to maintain a positive pressure in the well, cool and lubricate the drill bit, protect and support the exposed formations in the well and lift the cuttings from the bottom of the hole to the surface. Drilling fluids are slurries of various solids and additives (used to control the fluids' functional properties such as density). For the 36 inch conductor and 26 inch surface section the drilling fluids (mainly seawater) and cuttings are discharged onto the seabed but once the surface casing is in place the drilling fluids can be re-circulated between the drilling vessel and the well. Returned drill cuttings and drilling fluid will be separated and cleaned on the drilling vessel using solid control equipment (*Figure 3.24*).

Figure 3.24 Advanced Solid Control System including a Secondary Treatment System



1. VSM300 shale shakers
2. Mud cleaner
3. Conveyor
4. Vertical cuttings dryer
5. Cuttings discharge
6. Recovered mud
7. Catch tank
8. Centrifuge feed pump
9. Centrifuge
10. Solids discharge
11. Clean mud to mud tank

Source: ERM

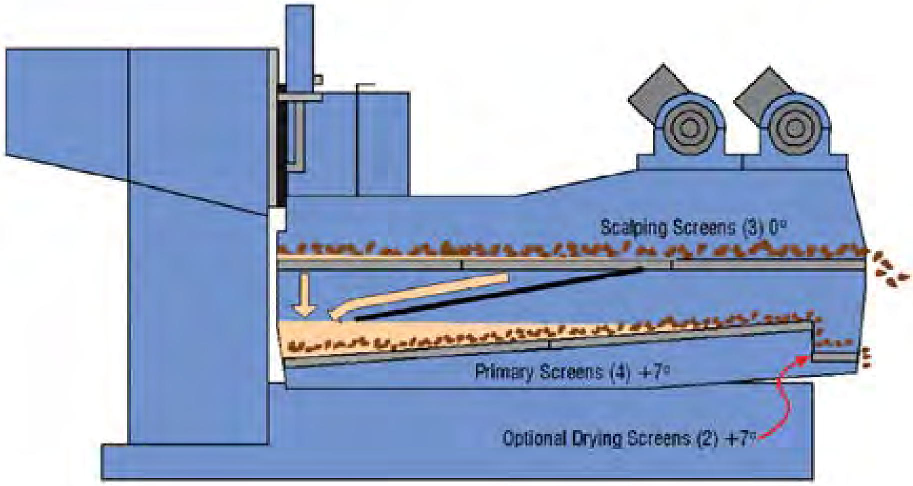
Solid Control Equipment

It is proposed that well drilling prior to first oil will utilise Brandt VSM 300 shale shakers (*Figure 3.25*) and a vertical cuttings dryer for onboard drilling fluid recovery and cuttings treatment. After first oil TDU technology will be used as the secondary cuttings treatment device with the vertical dryer kept as back up.

Shakers are devices that remove drill cuttings from the drilling fluid. They typically consist of large, flat sheets of wire mesh screens of various mesh sizes that shake drill cuttings across and off the screens as the drilling fluid flows through them and back into the drilling fluid system. The VSM 300 will include three scalping screens and four primary screens. In addition, there are two optional drying screens; however, instead of using these cuttings will be conveyed to the Thermal Desorption System.

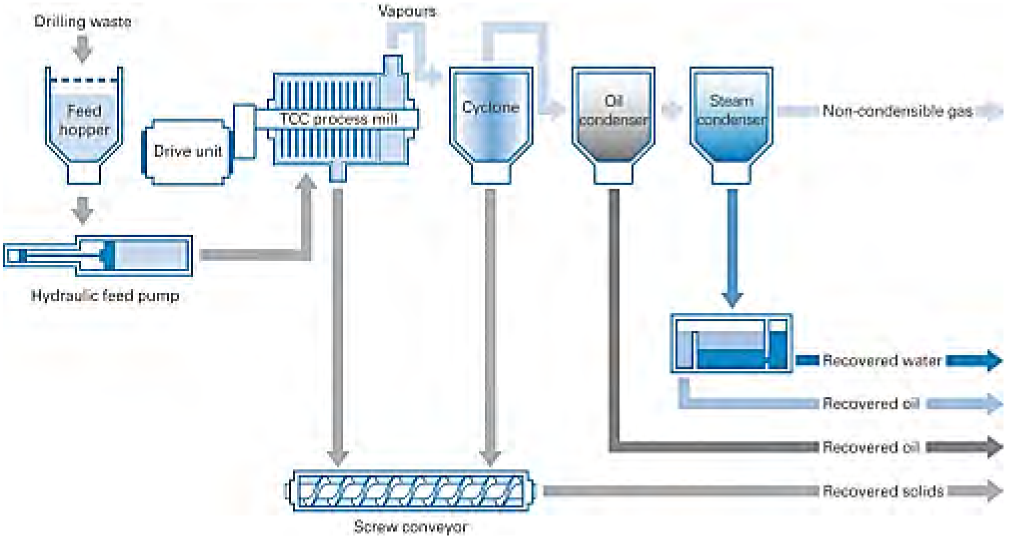
Thermal desorption is a technique (*Figure 3.26*) that utilises mechanical pulverisation of solids generating heat to separate oil, water and solids effectively to different waste streams for recycling and/or discharge. Thermal desorption requires a larger equipment footprint but can minimise residual oil on cuttings below that achievable by a vertical cuttings dryer. The back-up vertical cuttings dryer works by passing cuttings through a high-capacity centrifuge screen. Solids are discharged at the screen bottom and fall by gravity into the water-flushed cuttings trough and are discharged overboard. Liquids pass through the screen and are collected and pumped to a decanting centrifuge for final processing and reuse in the drilling fluid system.

Figure 3.25 VSM 300 Shale Shaker



Source: National Oilwell Vargo 2010

Figure 3.26 Thermal Desorption Process



Source: Thermatech

Types of Drilling Fluid

There are three types of drilling fluid used in offshore exploration and development drilling operations; water-based drilling fluids or muds (WBMs), oil-based drilling muds (OBMs), and synthetic-based drilling muds (SBMs). The latter two drilling muds can be broadly classified as non-aqueous drilling fluids or muds (NADF), which are divided into three groups according to the level of aromatic content (*Table 3.16*).

Table 3.16 NADF Classification Groups and Descriptions

Classification	Base Fluid	Aromatics	Aromatic (%)	PAH (%)
Group I	Diesel and conventional Mineral Oil	high aromatic content	>5	>0.35
Group II	Low toxicity mineral oil	medium aromatic content	0.5 – 5.0	0.001-0.35
Group III	Enhanced mineral oil and synthetics (esters, olefins and paraffin's)	low to negligible aromatic content	<0.5	<0.001

For both types of drilling fluid (OBF and NADF) a variety of chemicals are added to the water or non-aqueous liquid to modify the properties of the fluids. Additives include clays and barite to control density and viscosity and polymers such as starch and cellulose to control filtration. The type of drilling fluid used for a particular well or drilling programme will depend largely on the technical requirements of the well, local availability of the products and the contracted drilling fluid supplier. Often, both WBMs and NADFs are used in drilling the same well. WBMs will be used to drill some sections (particularly the top sections) of the well and then NADFs will be substituted for the deeper sections to the bottom of the well.

NADFs are often required for particular sections of the well as they offer better well stability (particularly when drilling through water-sensitive formations such as shales). They also offer better lubricity and high temperature stability and reduce the formation of gas hydrates (which is a particular issue for deep sea wells). In addition, NADF use results in more efficient drilling, fewer drilling problems and requirement for remedial work, thereby reducing the potential for health and safety risks.

For the TEN drilling programme, seawater and some WBMs (sweeps) will be used to drill in the upper sections (36 and 20 inch) of each well and a Low Toxicity Oil Based Mud (LTOBM) will be used for the mid and lower sections of each well (16 or 13 ½ and 9 ⅝ inch). The LTOBM proposed for the drilling programme is Escaid 120. Escaid 120 is a de-aromaticised hydrocarbon Enhanced Mineral Oil Based Fluid categorised as Group III (enhanced low toxicity mineral oil). The LTOBM will not be discharged to sea but recycled for further use and ultimately returned to the suppliers; however, a portion of the fluids will remain adhered to the drilling cuttings that are discharged to sea.

Well Completions

After wells have been drilled a process known as 'well completion' is undertaken to prepare the well for its operational function (*ie* producing well or injector well) and to install a number of safety and operational controls. For each well, subsurface safety valves will be installed to provide pressure isolation and prevent pollution in the event of damage to the wellhead, surface (mudline) isolation valves and flow control valve (subsea tree). For producing wells, downhole pressure and temperature gauges will be installed to provide continuous data during the life of the wells. In addition, pressure and temperature will be recorded at the subsea tree and throughout the subsea facilities.

Completions will be undertaken from the MODU and for each well this process will take approximately one month.

Flaring

As part of the well completion operations, short-term flaring will be required during well testing and well flowback to the MODU for well clean-up purposes. Well clean up maximises the production rate for the wells by ensuring reservoir fluids enter the wellbore thereby removing previous drilling fluids.

Well Workovers and Interventions

When wells require repair for mechanical reasons or restoration of their production or injection levels due to blockage or other reasons such as severe injection water breakthrough, they will be worked over by bringing a MODU or well intervention vessel into the field for a workover operation of approximately 30 days. Discharges from workover activities are discussed in *Section 3.8.3*.

3.6.2 ***Installation***

FPSO

The turret moored system will consist of three clusters of three mooring lines. Each mooring line will consist of an upper polyester section, a mid-section of chain and a lower section of polyester which is attached to a suction pile. The FPSO suction piles will be spaced approximately 2 km from the FPSO location.

After installation each mooring leg will be load tested before being laid on the seabed for later recovery when the FPSO arrives on site. The FPSO will sail to the TEN location using its main engine which will be decommissioned once on station and the mooring system attached. On arrival, the sailing time within Ghanaian waters will be one or two days. Hook up of the mooring system will be performed by a dynamically positioned construction vessel (*Figure 3.27*).

Figure 3.27 Typical Subsea Installation Vessel

Source: TGL 2012

Subsea Manifolds

Each of the four subsea manifolds and the two riser bases will be installed on the seabed at various locations in the development area. The equipment will be installed using a DP construction vessel; possibly an anchor handling vessel (AHV) or anchor handling tug supply (AHTS) outfitted with a crane or an 'A' frame. Manifolds and riser bases will be mounted on suction piles and may be equipped with short steel skirts that will penetrate the seabed sediments and provide resistance to horizontal movement and additional stability.

Flowlines, Pipeline and Umbilicals

Installation of the flowlines and the export pipeline will be performed by a DP lay vessel. Each flowline and PLET will likely be lowered to the seabed and then laid towards the riser base. The jumper section of flowline between the wellhead and PLET will be installed after the PLET has been installed. The riser section between the riser base and the FPSO will be installed once the FPSO is on location. The DP lay vessel will be re-supplied with flowlines, pipeline sections, PLETs and manifolds by a supply vessel or cargo barges towed by tugs.

Installation of the control umbilicals will proceed in much the same manner as the flowlines. Installation will be by DP cable or umbilical vessel, or possibly the same vessel that laid the flowlines. Installation will likely begin by lowering the umbilical to the seabed close to the PLET then away towards the manifold. Terminations will be completed by ROV.

Risers

Installation of the production risers, water and gas injection risers and gas lift riser, will all be installed after installation of the FPSO. The riser installation will be carried out by a DP lay vessel. The installation will start at each riser base and laid towards the FPSO. Once the end of the riser is received, a winch on the FPSO will pull the riser in and then riser will be secured. With flexible risers, it is possible to pre-install these and leave them on the seabed for later recovery and installation once the FPSO is on location. This option is presently under review.

3.6.3 Commissioning and Start-up

Commissioning of all FPSO systems will occur to ensure compliance with classification, flag state and statutory requirements, engineering completions, testing, and commissioning of fire and gas, safety and process control systems amongst others. Commissioning will occur in three phases:

- onshore phase of commissioning;
- anchorage and voyage phase of commissioning; and
- offshore phase of commissioning.

It is intended that the maximum amount of commissioning will be undertaken onshore at the FPSO conversion shipyard outside Ghana. The onshore activities will as a minimum, include commissioning of all systems to meet classification society and statutory requirements, including but not limited to, accommodation facilities, utilities, power generation, fire water, communication, navigational, voyage and cargo and ballast systems. In addition, the onshore commissioning activities will ensure the mooring system components are ready for service and the oil processing, produced water, heating and cooling systems have been satisfactorily function tested.

After departure from the shipyard the FPSO will be anchored at a deep water location to test systems that cannot be tested at the shipyard, this includes function testing the topside water systems, running of the water injection and sea trials.

Once the FPSO reaches the TEN fields the mooring system will be installed. The riser and umbilicals will then be hooked up to the turret. Other commissioning activities during the offshore phase will include the testing of facility safety shutdown procedures, establishing communication links and re-testing the integrity of critical systems. Decommissioning of the redundant voyage systems will be undertaken after mooring.

Commissioning of the subsea system will encompass pipelines, jumpers or spools, umbilicals, manifolds and riser base structures on the oil production, water injection and gas injection/production flowlines.

Commissioning activities will involve the following.

- Cleaning to remove any construction waste, loose scale and debris prior to hydrotesting.

- Internal gauging to confirm that there are no unintended intrusions (dents, gouges *etc*) into flowlines.

- Pressure test using inhibited seawater (*ie* hydrotest).

- Leak testing of jumpers and spools including seal testing (internal and external) after installation.

- Dewatering and drying of gas flowlines after hydrostatic testing to remove water from flowlines.

- Testing of the SCS to verify functionality prior to connection with the subsea equipment for commissioning.

3.6.4 Processing and Production

Oil Processing and Production

The oil separation system will consist of a single train designed for an oil/condensate flow of 80,000 bpd. Within this train, a HP oil separator will receive production fluids (oil/condensate) from the oil manifold while a HP gas separator will receive produced gas/condensate from the gas production manifold. The oil separator will perform three-phase separation (into oil, water and gas) and the gas separator a two-phase separation (gas and water). The crude oil and condensate from the separators will be comingled and heated by two crude/crude exchangers and by two crude heaters before arriving at a medium pressure (MP) separator for further phase separation. The now dehydrated crude will enter the final stage of stabilisation in the LP separator. At each stage gas and water will be removed and routed to the gas treatment module and produced water treatment module, respectively.

The stabilised crude is then desalted in a single- electrostatic treatment stage and stored on board for subsequent export via tankers. Produced gas will be processed and used for fuel on board the FPSO. Surplus gas will be sent into the gas injection flowline and re-injected into the Ntomme reservoir to provide pressure support or exported to shore via the Jubilee field (see below). Produced water will be treated to international specifications and discharged overboard and, if feasible, may be commingled with treated seawater for reinjection into Enyenra and Ntomme oil reservoirs. The process flow diagram for the FPSO topside facilities is shown in *Figure 3.8*.

Gas Processing

Gas separated from the production fluids in the oil separator and produced gas from the gas separator will be routed to the gas treatment module. The gas treatment module will comprise dehydration and compressor units. An external refrigeration unit is also included for enhanced liquids recovery. From the gas treatment module gas will be routed to the fuel gas module where it will be cleaned and compressed as required to be used in the gas turbines for power generation. All treated associated gas from the Ntomme and Enyenra fields can either be fully or partially re-injected into the Ntomme gas cap to support oil production, in conjunction with water injection along the flank of the field.

Tweneboa non associated gas (T-NAG) will be produced from the Tweneboa reservoir gas cap as a gas export stream. Once processed, this gas together with any Ntomme or Enyenra field associated gas not re-injected into the reservoir will be exported to shore via a dedicated export line from the TEN FPSO tying in to the planned GNPC Jubilee Export pipeline.

Water Injection

The water injection system will use treated seawater to maintain reservoir pressure. The seawater will be lifted, filtered and deoxygenated to meet the required specification before being injected. Suitable scale inhibitors will be utilised to mitigate the formation of barium sulphate and calcium carbonate formation scale resulting from pressure and temperature changes downhole. The injection water will be pumped at high pressure to the water injection wells in the field.

Gas Utilisation

Primary gas treatment equipment (compression, filtration, and dehydration equipment) will be located on the FPSO in support of gas export, gas injection, riser gas-lift and fuel gas. The TEN Project will utilise high-pressure gas from the FPSO as injection gas to enhance ultimate recovery of oil. Gas for riser gas-lift will be accommodated either by using a separate, low pressure gas-lift riser that feeds lift gas into the riser base, or by taking a side-stream from the high pressure gas injection riser in the riser base.

Gas utilisation will be undertaken in the four phases described below. The forecast gas export from the TEN Project is presented in *Figure 3.27*.

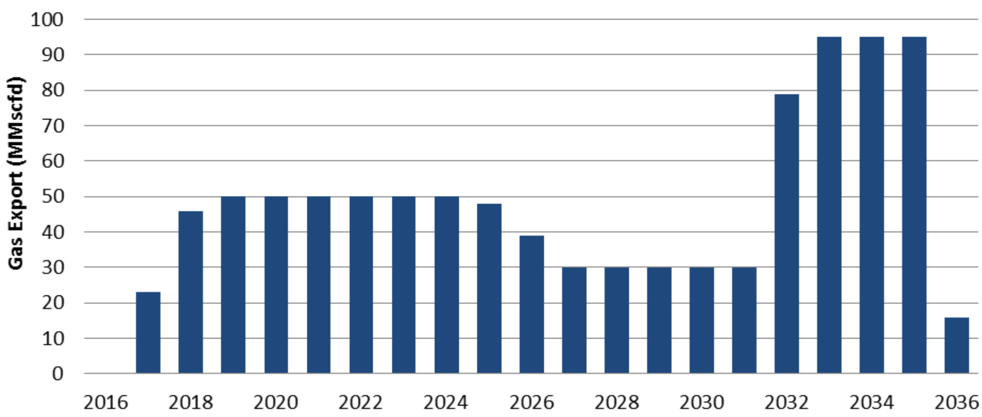
- *Gas Re-Injection.* Associated gas from the Enyenra and Ntomme fields will be re-injected into the Ntomme primary gas cap for pressure maintenance to support Ntomme oil extraction. An estimated 10 MMscfd of gas will be used for power generation onboard the FPSO.

- *Commercialisation of Associated Gas.* An estimated 30 MMscfd of gas will be exported within 12 months of first oil ('First Gas'). Commercialisation of the associated gas is expected to begin in 2017.

- *Commercialisation of Non-Associated Gas.* An estimated 20 MMscfd of non-associated gas will be exported from the Tweneboa field within 24 months of first oil. Commercialisation of NAG is expected to begin in 2018.

- *Ntomme Gas Blow Down.* Blow down (final phase of extraction of reservoir gas cap) of the Ntomme gas is scheduled to begin in 2032. It is expected to supply 95 MMscfd through to the contract expiry.

Figure 3.28 Forecast Gas Export from the TEN Project



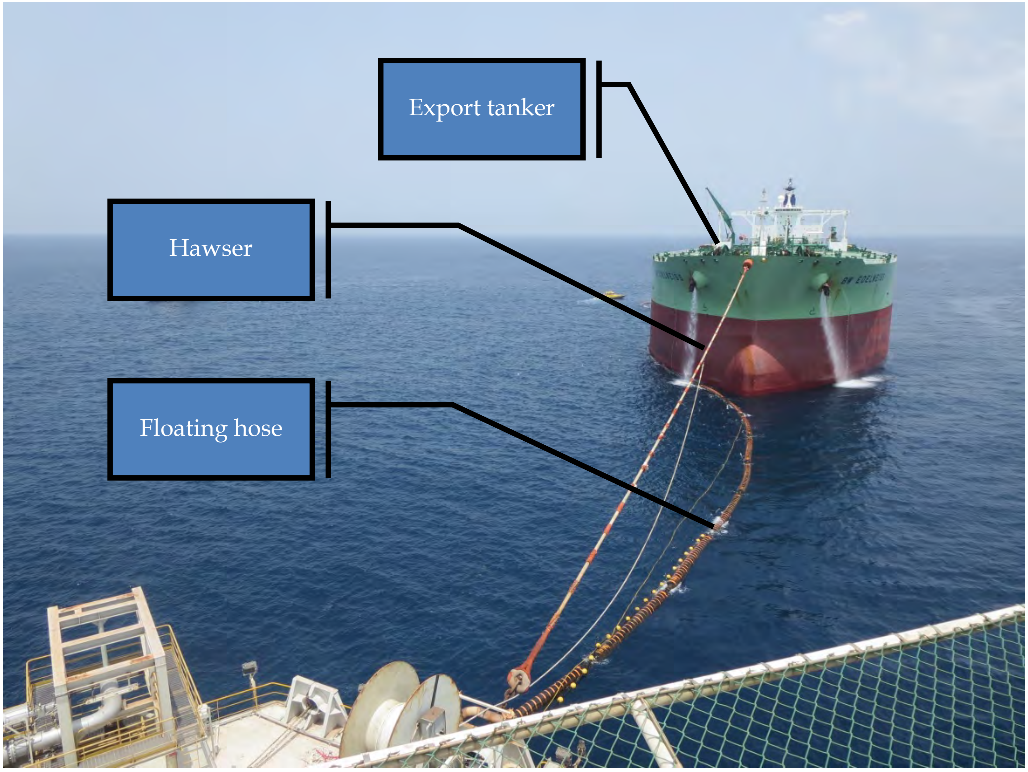
Export Tanker Operations

During the period of peak production, crude oil stored on the FPSO will be transferred to an export tanker via a floating hose approximately every 13 days, with offloading volumes typically being approximately one million barrels of oil. Offloading will typically take 20 hours with an additional 12 hours to connect and disconnect the export tanker.

All crude oil transfers and vessel movements in the TEN Project will be controlled by operational procedures according to applicable standards and legal requirements.

Upon arrival at the TEN fields, the export tanker will be boarded by a TGL Mooring Master before proceeding to the loading position with the FPSO. The export tanker will be moored to the stern of the FPSO using a hawser, with fluid transfer through a floating hose (*Figure 3.29*).

Figure 3.29 Illustrative Offloading Operations



Source: TGL

The FPSO will not be equipped to receive ballast water from incoming tankers. Export tankers in the TEN fields for cargo transfers may only discharge clean ballast water meeting international guidelines. The FPSO will have permanent, separate ballast tanks and there will be routine discharge of clean ballast water from the FPSO to maintain the proper draft during production and cargo loading cycles.

TGL will provide one large Anchor Handling Vessel to manage and restrain the approach of the export tanker and function as the hold back tug during offloading and general field support activities. A hose handling vessel located on the FPSO will also be provided to assist in offloading hose and hawser operations.

Electrical Power Generation

The electrical power generation system aboard the FPSO will consist of dual fuel turbine generator sets that can provide sufficient electrical power to serve the entire facility. In addition, shipside diesel engine power generators will be installed as an essential alternative power source for shutdown and start-up of all the processing and subsea systems. Emergency power generation capacity will also be provided.

Ballast Water Management

Export tankers in the TEN Project area for cargo transfers may only discharge clean ballast water meeting MARPOL standards. This will form part of the tanker vetting procedure. The TEN FPSO and visiting export tankers will undertake ballast water management measures in accordance with the International Convention for the Control and Management of Ships Ballast Water and Sediments. This includes ballast exchange at sea, to minimise the transfer of organisms. The FPSO will have permanent, separate ballast tanks and there will be routine discharge of clean ballast water from the FPSO to maintain the proper draft during production and cargo loading cycles.

Flaring

No continuous flaring of excess hydrocarbon gases during normal operations is planned. Flaring will be avoided other than to maintain safe conditions such as flaring purge gas, facility depressurisation, operational upset conditions or during limited duration activities such as process start-up, re-start and maintenance activities.

Short-term flaring is likely at the TEN FPSO during the initial commissioning period of three to six months when the gas compression will be brought to a steady state. Pre-commissioning of gas handling and compression systems in the dockyard prior to vessel sailing to Ghana will reduce the offshore time required to complete later commissioning and will therefore reduce the volumes of gas that may have to be flared in the development area.

Venting

All FPSO cargo tanks are maintained in a pressurised state and the vapour space created in the storage tanks of the FPSO will be filled with a hydrocarbon gas (fuel gas) as the gas blanket. The purpose of maintaining the inert condition of the void spaces in the storage tanks is to avoid the potential for oxygen ingress and thus a fire or explosion. All excess blanket gas will be recovered via a VRU during cargo tank filling operations and returned to the hydrocarbon compression process.

An additional VRU will be installed to collect the vapours from the gas treatment system's TEG dehydration reboiler unit to mitigate the venting of aromatic hydrocarbon compounds that can be released by these units.

3.6.5 ***Support Operations***

Marine Vessel and Helicopter Support

Support vessels, including crew and supply boats, will be required to support the TEN drilling, completion, installation and production operations. Vessels will primarily operate out of the Sekondi-Takoradi support base. Helicopter support will also be necessary during installation and production operations.

Helicopters will operate out of the Takoradi Air Force base. Typical vessel and helicopter requirements are detailed in *Table 3.17.*

Table 3.17 Summary of Vessel and Helicopter Support Requirements for TEN

Phase	Number Required	Candidate Vessel or Aircraft Characteristics	Frequency (round trip per day)
Drilling and Completions			
AHV/AHTS	1	60 to 75 m length, 10,000 hp	N/A
Support vessels	2	Two 60 m workboats	2
Helicopter	1 or 2	Sikorsky S76, S-61 or S-92; Eurocopter AS332, EC 155, AS365; Bell 212, 412	4
FPSO and infrastructure installation			
Pipelay vessel	2	*Seven Borealis*, *Deep Energy*; 20,000 hp	N/A
HLV	6	60 to 75 m length, 10,000 hp	N/A
Support vessel	2	*SIMAR Esperanca*, *Deep Pioneer*; 100-150 m workboats; 8,500 hp	N/A
Barges	4	80 m	N/A
AHTS	1	20,000 hp	N/A
Helicopter	1	Sikorsky S76, S-61 or S-92; Eurocopter AS332, EC 155, AS365; Bell 212, 412	1
Production			
Support vessel*	1	85 m workboat; 8,500 hp	1
AHV	2	4,200 hp; used as needed during mooring	N/A
Helicopter	1	Sikorsky S76, S-61 or S-92; Eurocopter AS332, EC 155, AS365; Bell 212, 412	2

* Shared with Jubilee operations.

Construction and Operation Support Vessels

All construction and support vessels used by the project will operate in compliance with their classification standards, including SOLAS Convention requirements. All the vessels that are to be used for the project will be 'class certified' and will have been inspected and accepted for their intended service. Specialist vessels with experienced crews will be provided for the installation of the infrastructure.

3.7 PERSONNEL REQUIREMENTS

TGL's head office in Accra will provide the overall business management for the project. As of August 2013, there were 294 TGL permanent employees based in Accra and/or at the logistics and operations support base in Takoradi (90% national and 10% expatriates). Staff numbers in both areas are expected to fluctuate during the different phases of the project.

During drilling and well completion operations, which are scheduled to begin in 2014 and continue until 2017, engineers, technical and support personnel will be required by the MODU contractors and the support services companies. The main project installation activities will occur in 2015/16 with a fleet of installation vessels offshore, followed by the start of production at the FPSO. During installation and production, the FPSO and support vessels will be manned by trained operators, technicians, engineers and vessel crew. The estimated manning levels across the various phases of the project are indicated in *Table 3.18*. This includes drilling activity, installation and operation of the FPSO and export tanker and support vessel operations. It should be noted that these figures are estimates and will vary with activity levels. Some TGL personnel will have wider roles than the TEN Project; therefore manning levels indicated in *Table 3.18* do not all represent new job opportunities.

The projected number of job opportunities for Ghanaians at the start of the project is also noted and this will increase over the project life. TGL and its contractors are committed to the development of national staff and capacity for the oil industry in Ghana.

Table 3.18 Summary of Personnel Requirements by Stage

Stage of Activity	Duration	Total Manning Level	Approximate Local Content
FPSO and Project Construction and Installation Phase			
TGL Accra Headquarters	To first oil 2015	80 growing to 120	80 growing to 110
TGL Takoradi shore base	To first oil 2015	35 growing to 50	20 growing to 45
FPSO field installation, commissioning and start-up	9 months	200	40
Port Support – marine	9 months	60	35
Aviation Support – helicopter and fixed wing	9 months	40	20
Onshore construction	9-18 months	30 - 150	25 – 140
Drilling			
MODU	4.5 years	120	30 – 40
Supply vessels (x2 assumed)	4.5 years	20	10
Total Drilling, Construction and Installation		**585 - 760**	**260 – 440**
FPSO Operation (Production, Oil Transfer)			
TGL Accra Headquarters	20 years	120	110
TGL Takoradi shore base	20 years	50	45
FPSO Production phase	20 years	90	10 later 70
FPSO Hold Back Vessel	20 years	10	4 later 10
FPSO Multi Service Vessel	20 years	17	5 later 15
FPSO Supply Vessel	20 years	10	4 later 10
FPSO Maintenance Services	20 years	30	25
Onshore Support			
Aviation Support	20 years	20	16
Total Operations and Support		**347**	**219 later 299**

Notes: Duration denotes the need for designated manning levels for the entire stage of the project. Local content target – indicates a target level for local employment; actual levels will be dependent on available personnel and training results.

3.8 *EMISSIONS, DISCHARGES AND WASTES*

3.8.1 *Introduction*

This section presents a listing, discussion and estimation of the magnitude of the main sources of emission to air, discharges to water and waste generated for shore disposal that will result from the proposed project and operations. The data have been obtained from engineering estimates and by bench-marking to other FPSO projects, as well as from the project design team.

3.8.2 *Emissions to Atmosphere*

Development activities including well completion operations, the subsea equipment and FPSO facility installation, commissioning and operation, export tanker operation, flowline and umbilical installation and support vessel and helicopter operations will emit greenhouse gases and varying amounts of other pollutants such as carbon monoxide (CO), oxides of nitrogen (NOx) and sulphur (SOx), volatile organic compounds (VOCs) and particulate matter (PM).

Table 3.19 outlines projected emissions of these pollutants from the main project activities. Estimated Greenhouse Gas (GHG) emissions are provided in *Table 3.20*. Detailed calculations, assumptions and emissions factors used are included in *Volume II: Annex A.*

Table 3.19 Estimated Air Pollutant Emissions for the TEN Project (Mid Case)

Project Stage	Estimated Annual Emissions (te)				
	PM_{10}	SOx*	NOx	VOC	CO
Pre-First Oil. Drilling and completion of 10 wells and installation	602	15,104	21,631	645	4,140
Drilling and completion of 14 wells, installation, commissioning and start-up (40 weeks from First Oil)	843	21,181	30,817	4,410	8,175
Annual Steady State Production (41 weeks from First Oil)	0	3	2,157	823	572

*Assumes 2% Sulphur in fuel

Table 3.20 Estimated Emissions for the TEN Project (Mid Case)

Project Stage	Estimated Annual Emissions (te)		
	CO_2	CH_2	CO_2e
Pre-First Oil. Drilling and completion of 10 wells and installation	1,151,705	76	1,153,459
Drilling and completion of 12 wells, installation, commissioning and start-up (40 weeks from First Oil)	2,599,860	3,610	2,682,886
Annual Steady State Production (41 weeks from First Oil)	384,809	657	399,912

Flaring Emissions

For the purposes of the air emissions modelling a worst case estimate of 48 MMScfd flared over 280 days (40 weeks) during initial commissioning and start-up was assumed until the gas compression system is brought to steady state.

During operation, routine flaring will be avoided, however, there will be non-routine flaring to maintain safe conditions or during short-duration activities such as upset conditions, re-start and maintenance activities. Based on industry performance it is not expected that greater than 5% of produced gas will be flared per month for non-routine reasons. For example an estimated 282 MMscf of produced gas will be flared per month at a peak gas production of 5,649 MMScf per month (based on an early production profile from previous reservoir appraisals).

Well Flowback

During well flow back and drill stem testing, reservoir and wellbore fluids will be flared as they are produced from the well. Typical well completion fluids include control fluid, dielectric fluid, diesel, base oil, methanol, defoamer and demulsifier. Estimated emissions volumes are reported in *Table 3.25* at the end of this section.

3.8.3 Operational Discharges

Discharges from the TEN Project will result from the following activities.

- **Drilling.** MODU and support vessel operations during well drilling will result in routine discharges to sea (*ie* sewage, grey water, food waste, bilge water, ballast water and deck drainage). In addition, process discharges will include drill cuttings and fluid. WBM will be used for the two top sections and drilling fluid and cuttings will be discharged to the seabed. The middle and bottom sections will be drilled with NADF and the drilling vessel will use solid control equipment to treat cuttings prior to disposal. Prior to first oil treatment will be by shale shakers and a vertical cuttings dryer; subsequent to first oil treatment will be by shale shakers and TDU. The testing or operation of the subsea BOP would also result in small volumes of hydraulic fluid being discharged.

- **Completions**. MODU and support vessels operations during well completions will result in routine discharges (*ie* sewage, grey water, food waste, bilge water, ballast water and deck drainage). In addition, operational discharges will include returned completion fluids. Completion fluids can typically include weighted brines, acids, methanol and glycols and other chemical systems, and seawater used as a displacement and circulation fluid.

- **Installation and Commissioning.** Installation and pipelay vessels will make routine discharges during operations (*ie* sewage, grey water, food waste, bilge water, ballast water and deck drainage). In addition, equipment hydrotest water will be discharged.

- **Operations**. Routine discharges from the TEN Project include the following: produced water, black water (sewage), grey water, food waste, deck drainage, bilge water, ballast water, brine and cooling water. Non-routine discharges from the TEN Project include the following: hydraulic fluid, workover fluid and hydrate inhibitor.

The discharges and treatment systems are discussed below and summarised in *Table 3.25* at the end of this section. Discharges will comply with Ghanaian legislative limits (see *Chapter 2: Section 2.7*) or industry standards in the absence of appropriate Ghanaian standards.

Produced Water

Produced water is a by-product of the processing of hydrocarbons from underground reservoirs. Water is naturally present in these reservoirs is produced as a liquid with the oil or as a vapour with the gas.

Produced water will be discharged to the sea following treatment to reduce the concentration of dissolved oil to at or below 40 mgl^{-1} maximum monthly average and 29 mgl^{-1} maximum daily average oil content and no visible sheen on the sea surface following discharge under normal operating conditions. These limits are in accordance with the Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2010). The limits exceed the requirements specified in the IFC's guidance for offshore oil and gas development(1) and comply with recommended practice from OSPAR(2) and the USEPA(3). The produced water treatment process is described in *Section 3.4.1*.

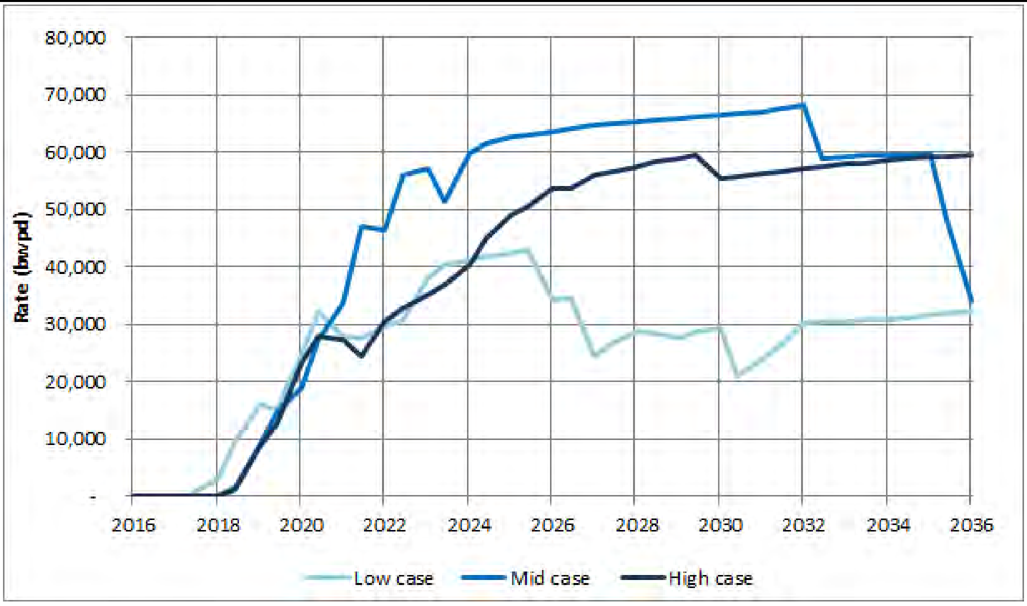
Volumes of discharged produced water are expected to vary over the field lifetime. Low volumes of produced water are expected in the early stages of production. The graph in *Figure 3.30* shows forecasted low, mid and high case produced water discharge rates.

The average expected produced water discharge rate over 20 years for the low case production profile is 18,171 bpd with a maximum rate of 42,943 bpd in 2025. For the mid case profile the average expected rate over 20 years is 31,751 bpd with a maximum rate of 68,238 bpd in 2032. Finally, for the high

(1) World Bank IFC "Offshore EHS Guidelines for Offshore Oil and Gas Development": 29 ppm monthly average; 42 ppm daily average oil content and no visible sheen.
(2) Oslo-Paris Commission (OSPAR): 30 ppm maximum oil content.
(3) US Environmental Protection Agency (EPA) Gulf of Mexico NPDES general permit (permit #GMG290000): 29 ppm monthly average; 42 ppm daily maximum oil content and no visible sheen.

case profile the average expected rate over 20 years is 27,471 bpd with a maximum rate of 59,571 bpd in 2036.

Figure 3.30 ***Produced Water Profiles (Low, Mid and High) (Sept 2012)***



Source: Adapted from TGL 2012

Black and Grey Water

Black water (*ie* sewage or sanitary effluent), consisting of human body wastes from toilets and urinals, will be treated using a marine sanitation device that treats the waste and produces an effluent with a maximum residual chlorine concentration of 1 mg l^{-1} and no visible floating solids or oil and grease. Grey water (*ie* domestic waste) includes water from showers, sinks, laundries, galleys, safety showers and eye-wash stations. According to MARPOL, grey water does not require treatment before discharge.

The FPSO has a designed throughput capacity of 30,000 bpd grey water and 2,400 bpd black water. Estimated effluent volumes based on monitoring data from the Jubilee FPSO are provided in *Table 3.25*.

Cooling Water

The main demand for, and discharge of, cooling water during the life of the development will be from the FPSO topsides and marine systems. Topsides cooling water is utilised for general cooling demands for all utility and anticipated service loads. Marine cooling water is utilised for general cooling demands such as HVAC refrigeration, diesel generators (when in use) and cargo pump turbine cooling.

Seawater will be pumped through the cooling system heat exchangers on a once-through basis, cooling gas, oil and produced water. Discharge of cooling waters will be continuous during the operation of the FPSO. The discharge rate of cooling water for the topsides and marine systems is 221,090 bpd (max 560,000 bpd) and 210,000 bpd, respectively. Discharged cooling water from the topsides system will have a temperature of approximately 55°C compared to approximately 30ºC for the marine system. The cooling water will be dosed with biocide and corrosion inhibitor to prevent fouling and corrosion of the FPSO cooling system.

Deck Drainage

Deck drainage consists of rainfall runoff, deck washings, and runoff from curbs and gutters, including drip pans and work areas. The FPSO has been designed to contain runoff and prevent oily drainage from being discharged directly to sea. Deck drainage that may contain oil is diverted to separation systems depending on the area collected. There will be no discharge of free oil in deck drainage that would cause a film, sheen or discoloration of the surface of the water or a sludge or emulsion to be deposited beneath the surface of the water.

Oily water will be treated using a three-stage oil-water separation (or alternative water de-oiling technology), to meet MARPOL standards. Only non-oily water (*ie* less than 15 ppm oil and grease, maximum instantaneous oil discharge monitor reading) will be discharged overboard. If the deck becomes contaminated, oily deck drainage will be contained by absorbents or collected by a pollution pan for recycling and/or disposal. Assuming a surface area of 20,000 m^2 for the FPSO and a maximum monthly rainfall amount of 170 mm, the monthly average deck drainage would be 3,400 m^3 (1 mm = 1 litre per m^2). Deck washes may account for an additional 200 m^3 (approximately) per month.

Bilge Water

Support vessels will occasionally discharge treated bilge water. These vessels will comply with the requirements of Annex I of MARPOL 73/78. Under these regulations, water must be retained onboard until it could be discharged to an approved reception facility, unless it is treated by approved oily water separators and monitoring equipment before being discharged to the sea.

Ballast Water

Ballast water that is discharged will be subject to MARPOL 73/78 requirements. MARPOL 73/78, Annex I, requires that discharges into seawater outside of special areas contain no more than 15 mgl^{-1} oil and grease. In addition, requirements of the *International Convention for the Control and Management of Ships' Ballast Water and Sediments* will be adhered to. Ships are required to have onboard and implement a Ballast Water Management Plan. All ships using ballast water exchange will do so at least 200 nmi from nearest land in water at least 200 m deep. All vessels that operate in the field will comply with MARPOL 73/78 with respect to any ballast water discharge impacts and their potential oil-in-water levels.

On the FPSO the primary means of maintaining an even keel, stability and trim will be through management of the distribution of crude oil within the storage tanks, therefore the requirement for ballast water intake and discharge will be minimal. In the event that ballasting is required the ballast pump is capable of pumping at a rate of 4,000 m^3per hr (604,800 bpd). Ballast water will be segregated into dedicated ballast tanks.

Brine Discharge

Brine generated from reverse osmosis during freshwater generation will be discharged overboard. Brine discharges are estimated at 40 m^3 per hour (6,000 bpd).

Drill Cuttings and Fluid

Typical volumes of drilling fluid and cuttings generated for each well are provided in *Table 3.21*. The total volume of cuttings to be generated from each well is expected to amount to approximately 484 m^3.

Approximately 300 m^3 of cuttings drilled with WBM will be generated from the top two sections of each well. All the WBM (1,390 m^3) from the top sections will be discharged to sea. Approximately 184 m^3 of drill cuttings and an associated 5.5 m^3 of residual NADF on cuttings will be discharged to sea from the bottom sections of each well (assuming 3% retention). The TDU would reduce levels of oil on cuttings to less than 1%.

Table 3.21 Estimated Cuttings and NADF Volumes (Per Well)

Hole Size in	36″	26″	16″	12 ¼″
Drilling Fluid System	WBM	WBM	NADF	NADF
Estimated Discharges				
• WBM	190 m^3	1,200 m^3	0	0
• WBM Cuttings	55 m^3	245 m^3	0	0
• NADF (assume 3% retention as worst case)	0	0	2.9 m^3	2.6 m^3
• NADF Cuttings	0	0	97 m^3	87 m^3
Discharge Location	Seafloor	Seafloor	15 m Below Surface	15 m Below Surface

Note: Volumes are indicative and may be different depending on the final well design.

Completion Fluids

During well completions, various chemicals will be used on the MODU. Completion fluids can typically include weighted brines or acids, methanol and glycols and other chemical systems. Once used these fluids may contain contaminants including solid material, oil and chemical additives. Most of the chemicals used during completions will remain downhole or will be injected into the formation. Some completion chemicals such as upper completion chemicals and flowback fluid chemical will be flared off after use. Returned fluids, such as wellbore clean-up fluids, will be discharged overboard (*Table*

3.22). This will include completion brine (*eg* calcium chloride), diatomaceaous earth filter aid, surfactant and surfactant booster.

Table 3.22 Typical Well Completion Fluids to be Discharged

Typical Chemical	Function	Potential usage (estimated per well)	Disposal	Typical CHARM Rating	Typical OCNS Category
$CaCl_2$	Completion brine	845 T	Re-use as much as possible or overboard discharge	N/A	E (PLONOR)
CELITE 545	Diatomaceous Earth Filter Aid	5.3 T	Overboard discharge once tested	N/A	E (PLONOR)
Tetraclean-105	Surfactant	5.9 T	Overboard discharge once tested	Gold	N/A
Tetraclean-106	Surfactant Booster	3.3 T	Overboard discharge once tested	N/A	E (PLONOR)

Three of these typical chemicals are essentially non-toxic and are rated as 'pose little or no risk' (PLONOR) according to the OSPAR Offshore Chemical Notification Scheme (OCNS) (Category E)(1). The OCNS provides hazard assessments on chemical products that are used offshore using a dispersion model (known as the CHARM model(2)) to calculate the ratio of Predicted Effect Concentration against No Effect Concentration (PEC: NEC) and is expressed as a hazard quotient (HQ), which is then used to rank the product in the form of a colour banding. Data used in the OCNS assessment include chemical toxicity, biodegradation and bioaccumulation as well as volumes used. According to the CHARM model the surfactant is categorised as Gold (*Table 3.23*).

(1) OCNS – developed by the Oslo/Paris Commission, groups chemicals according to their environmental effect. Groupings are from A to E and indicate the potential environmental effect of chemical discharge to the marine environment with grouping E being those with least potential for adverse environmental effect.
(2) CHARM - requires offshore chemicals to be ranked according to their calculated Hazard Quotients (HQ). Chemicals on the OSPAR List of Substances / Preparations Used and Discharged Offshore which are Considered to Pose Little or No Risk to the Environment (PLONOR) do not need to undergo CHARM. The ratio of the Predicted Environmental Concentration (PEC) (*ie* concentration of chemical to which environment is exposed) to the predicted No Effect Concentration (NEC) *(ie* estimate of concentration level that no adverse effects are to be expected) is calculated and is called the Risk Quotient (RQ). If the RQ is >1 then there is predicted to be an effect on the environment; if the RQ is 1 then predicted effects/no effects are the same; if the RQ is <1 then there is no predicted effect upon the environment. If the RQ value exceeds 1 then the operator must either substitute another chemical OR justify the discharge.

Table 3.23 ***Key to Hazard Quotient and Colour Bands***

Minimum Value	Maximum Value	Category
> 0	< 1	Gold
>= 1	< 30	Silver
>= 30	< 100	White
>= 100	< 300	Blue
>= 300	< 1,000	Orange
>= 1,000		Purple

The *Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development* (EPA, 2010) define four categories of chemical as shown in *Table 3.24*. Permitting conditions for the Jubilee Phase 1 development stipulate that chemicals in the red and black categories shall only be chosen if they are necessary for technical and safety reasons. Of the chemicals listed in *Table 3.22* three are in the green category as PLONOR list chemicals and one in the yellow category for having an LC50 at 202 mg l^{-1}.

Table 3.24 ***EPA Categorisation of Chemicals***

Category	Description
Black	Black category consists of chemicals on the following lists: a) OSPAR List of Chemicals for Priority Action b) In addition, substances with the following ecotoxicological properties: • Substances that have both a low biodegrability (BOD28 <20%) and a high bioaccumulation potential (log Pow 5) • Substances that have both a low biodegradability (BOD28 <20%) and a high acute toxicity (EC50 or LC50 at 10 mgl^{-1})
Red	Red category consists of substances with the following ecotoxicological properties: a) Inorganic substances which are acutely toxic (EC50 or LC50 at 1 mg l^{-1}) b) Organic substances with a low biodegradability (BOD28 <20%) c) Substances that meet two of the three criteria: • Biodegradability equivalent to BOD28 <60%; • Bioaccumulation potential equivalent to Log Pow 3 and molecular weight <700; or • Acute toxicity of EC50 or LC50 at 10 mg l^{-1}.
Yellow	Yellow category consists of substances that from the ecotoxicological properties of the substances shall not be categorised as red or black, and that are not defined as OSPAR PLONOR substances.
Green	Green category consists of substances on the PLONOR list.

Before any completion fluids are discharged overboard they will be tested for total oil and grease (TOG) content and if the TOG content is below the specification then the fluids will be discharged to sea. If the TOG content is greater than the specification then the returned fluids will be retained on the vessel in closed systems (such as tote tanks), where this is practical, and shipped for onshore disposal.

Table 3.25 Summary of Discharges and Treatment

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Black Water	Sewage treatment. Treat with approved sanitation unit. Maceration and Chlorination	Single; holding tank storage; discharge overboard (above sea surface)	Variable depending on number of personnel. Estimated 174 l per person per day. Drilling: MODU (120 personnel), 20,900 l d^{-1}; Support vessels (20 personnel), 3,483 l d^{-1} FPSO & Project Installation: FPSO and installation vessels (200 personnel), 34,833 l d^{-1} FPSO Operation: FPSO (90 personnel), 15,675 l d^{-1}; support vessels (26 personnel), 6,444 l d^{-1}; maintenance (30 personnel), 5,225 l d^{-1}	Intermittent	• Achieves no visible floating solid • No discolouration of surrounding water • < 1.0 mgl^{-1} chlorine concentration	EPA (2010) Annex IV MARPOL
Grey Water	None	Single; holding tank storage; discharge overboard (above sea surface)	Variable depending on number of personnel. Estimated 405 l per person per day. Drilling: MODU (120 personnel), 48,538 l d^{-1}; Support vessels (20 personnel), 8,090 l d^{-1} FPSO & Project Installation: FPSO and installation vessels (200 personnel), 80,897 l d^{-1} FPSO Operation: FPSO (90 personnel), 36,404 l d^{-1}; support vessels (26 personnel), 14,966 l d^{-1}; maintenance (30 personnel), 12,135 l d^{-1}	Continuous	• No visible floating solids or discoloration of surrounding water	EPA (2010) Annex IV MARPOL
Produced Water	Oil-water separation. Three stage process: skim vessel, hydro-cyclone and induced gas flotation (IGF) tank	Single; holding tank storage; discharge 3 m below the sea surface	FPSO: Low levels during initial production; average discharge rate of 31,751 bpd is expected over project lifetime with a peak discharge rate of 68,238 bpd (mid case profile).	Intermittent	Oil and grease not to exceed 40 mgl^{-1}daily maximum or 29 mgl^{-1} monthly average.	EPA (2010) IFC and USEPA (2007); Also complies with OSPAR (2001) (OSPAR 01/18/1, Annex 5) 30 ppm monthly average oil content and North Sea UK 30 ppm monthly average and 100 ppm daily average oil content

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Deck Drainage	Oil-water separation	Single, discharge overboard	Deck drainage water generation variable, depending upon facility and vessel characteristics, rainfall amounts; discharge volumes variable. FPSO: 113,000 l d^{-1} (3.4 x 10^6 l per month)	Intermittent	• No free oil; • 15 mgl^{-1}instantaneous reading oil water threshold • 20 mgl^{-1} (monthly weighted average) oil water threshold.	EPA (2010) Annex 1 MARPOL
Bilge Water	Bilge water separator	Single, discharge overboard (above sea surface)	Bilge water generation variable, depending upon facility and vessel characteristics; discharge volumes variable FPSO: 110 bpd (est.) Support vessels: 110 bpd (est.)	Intermittent	• No free oil; • 15 mgl^{-1} instantaneous reading oil water threshold • 20 mgl^{-1} (monthly weighted average) oil water threshold.	EPA (2010) Annex I MARPOL
Ballast Water	None	Single; Discharge overboard (above sea surface)	FPSO: 604,800 bbl per day maximum designed discharge rate	Intermittent	• No free oil; • 15 mgl^{-1}instantaneous reading oil water threshold • 20 mgl^{-1} (monthly weighted average) oil water threshold. • Ballast water exchange at least 200 nmi from nearest land in water at least 200 metres deep. The absolute minimum being 50 nmi.	Annex I MARPOL International Convention for the Control and Management of Ships' Ballast Water and Sediments
Cooling Water (filtered seawater)	Filtered initially. No further treatment	Topsides: 16" – 24" line approx 7m ABL (Above Keel). Marine: 16" line approx 7m ABL (Above Keel) 30m from Aft	FPSO Topsides: 9,708 to 221,090 bpd (Max = 560,000 bpd) FPSO Marine: Max – 1,391 m^3 per hour (equal to 208,850 bpd)	Continuous	The effluent should result in a temperature increase of no more than 3°C at the edge of the mixing zone or 100 m from point of discharge.	EPA (2010)

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Completion and Well Workover Fluids	• Oil-water separation • Any acids used will be neutralised to pH 6 or more by addition of soda ash prior to any discharge	Single, discharge overboard	Estimated volumes per well: • Completion brine ($CaCl_2$) 845 te • Diatomaceous Earth Filter Aid 5.3 te • Surfactant 5.9 te • Surfactant Booster 3.3 te	Intermittent	• Maximum one day oil and grease discharge should not exceed 40 mgl^{-1}; 30 day average should not exceed 29 mgl^{-1}. • Any spent acids will be neutralised (to attain a pH of 6 or more) before testing and disposal.	EPA 2010 IFC (2007) and USEPA (2007)
Riser, Umbilical and Pipeline Commissioning	None	Primarily subsea discharge with some near surface discharge	• Pre-commissioning fluid: 10,000 m^3 • Deoxygenated seawater : 35,000 m^3 • Monoethylene glycol (MEG): 50-100 m^3 • Umbilical storage fluid (MEG): 15 m^3 • MeOH : 4 m^3	Intermittent	• Treatment chemicals: maximum manufacturers recommended dose or 500 mgl^{-1} • No free oil	USEPA (2007)
Hydrate Inhibitor	None	Single, discharge overboard	Discharge in batch mode only during unplanned and planned system shutdowns. Volumes of up to 200 to 400 bpd.	Intermittent	-	
Hydraulic Fluids	None	Multiple subsurface discharge	<u>Subsea trees</u>: 0.28 m^3 per yr assuming normal valve operations. Annual shutdown tests may result in release of an additional 1 to 2 m^3.	Intermittent	-	-
Brine	None	Single, discharged overboard	Brine generated during freshwater generation; volumes variable. <u>FPSO</u>: 6,000 bbl per day <u>Support Vessels</u>: NA; <u>Export Tanker:</u> 30 to100 bpd	Continuous	• No free oil • Mix with other effluent streams	USEPA (2007) EPA (2010)
Drill Cuttings and Fluid	• Shale shakers and vertical dryer before first oil • shale shakers and TDU after first oil	• WBM and cuttings to the seabed • Treated NADF cuttings discharged via caisson	Estimated volumes per well: • WBM: 1,390 m^3 • WBM cuttings: 300 m^3 • NADF (3% retention): 5.5 m^3 • NADF cuttings: 184 m^3	Continuous (when drilling), batch when using TDU	• <3% as a weighted average • Use of Group III NADF • No free oil • Limits on mercury (max 1 mg kg^{-1}) and cadmium (max 3 mg kg^{-1}) • Discharge via a caisson	EPA (2010)

If any acid is used during well completions or workovers for breakdown of the rock formations, the spent acid will be injected into the rock formation. In the unlikely event that acidic completion/workover fluids are returned back to the MODU, they will be neutralised to attain a pH of 6 or more using soda ash or similar prior to discharge, as per EPA (2010).

Pre-Commissioning, Testing and Line Flushing Fluids

Liquid discharges will result from flowlines, umbilicals and the water treatment facilities during testing and pre-commissioning activities at the offshore location.

Pre-commissioning fluids for subsea infrastructure, production flowlines and gas export pipeline will use a seawater soluble additive, containing dye, oxygen scavenger, corrosion inhibitor and biocide in up to 10,000 m^3 of raw seawater.

The discharge will be subsea, except for the production flowline volumes which will be produced back to the FPSO and discharged from surface. This is a conservative estimate for all flowlines and subsea lines that will be installed. In addition, deoxygenated and filtered sea water will be pumped through the subsea flowlines and manifolds to flush the subsea system. Four line flushes are planned with an additional overall volume of 5,000 m^3 of deoxygenated and filtered sea water.

Gas injection, production and export flowlines and pipelines will be dewatered (*ie* water is pumped out), flushed with MEG to remove any remaining water and then filled with nitrogen and left *in situ* under pressure. Typically a total volume of 50 to 100 m^3 of MEG will be discharged to sea.

Prior to injecting into the water injection wells the water treatment facilities will be commissioned. During this process approximately 30,000 m^3 of deoxygenated sea water will be discharged overboard.

Production risers will be left *in situ* with inhibited seawater. During commissioning, the flowline circulation tank on the FPSO will be filled with diesel which will be used to displace the seawater. Residual diesel will be contained on board the FPSO.

For the long term storage of the umbilical tubing including transportation, installation and post installation testing, an umbilical storage fluid (40% MEG) will be used. The volume (approximately 15 m^3) within the umbilicals will be discharged at the seafloor once the umbilicals are commissioned. Approximately 4 m^3 of methanol will also be displaced in this umbilical flushing process.

Workover Fluids

In general, workover fluids are similar to completion fluids (listed in *Table 3.22* above) and will be re-used, re-injected into the formation or remain downhole. Some chemicals will be returned to the surface for disposal to sea after testing, or taken to shore and returned to the supplier for disposal.

Hydrate Inhibitor

Gas hydrates form at low temperature and elevated pressure at certain conditions with natural gas and water present. Hydrates are a form of 'hard ice' which is difficult to remove if it forms subsea. Methanol is used worldwide in the oil and gas industry as the hydrate control chemical of choice for production systems. Alternative chemicals may be used in the future, however, they are generally limited in their application and specific field testing would be required before these can be used.

Methanol will be used for the following purposes:

- intermittent use for hydrate inhibition during well start-up;
- displacement of subsea trees, well jumpers/flowlines and wellbores across sub-surface safety valves for hydrate inhibition during shutdowns; and
- to equalise the differential pressure across subsea valves prior to opening them where cooling due to pressure drop upon opening could otherwise cause hydrate formation.

Hydrate control chemicals will be selected from PLONOR substances, *ie* EPA yellow and green category substances (see *Table 3.23* and *Table 3.24*). Methanol will be injected in batches of approximately 5 bbls per well during long term (*ie* more than 4 hrs) systems shutdowns (either planned or unplanned) to prevent hydrate formation. Following shutdown the methanol will be discharged to sea. Methanol will also be used when water is produced or present in the wells, for example in the early commissioning phase of the subsea system and wells. With increasing produced water later in the TEN field life, larger volumes of methanol will be used during extended system shutdowns and following well start up the methanol will be discharged to sea in volumes of up to 200 to 400 bbls in one day.

Hydraulic Fluid

Subsea hydraulically operated manifold and tree valves will be actuated using an electro-hydraulic subsea control system. The subsea control system will use a water based glycol (non-CHARM) with an OCNS Group D rating. Small volumes of hydraulic fluid will be vented from the control system equipment when given a command to close. This will result in the discharge of approximately 0.28 m^3 of hydraulic fluid per year (based on 88 valves releases every three months each discharging an average of 0.8 l per valve), although the exact quantities discharged will depend on the frequency of operation of the subsea valves. Valves on water and gas injection manifolds will be ROV actuated, so they will not release any fluid. In addition there may be a requirement for the release of the hydraulic fluid system during emergency shutdown or during annual tests. The volume of the complete system to be discharged would be between 1 and 2 m^3.

Naturally-Occurring Radioactive Material

Produced water, having been in contact with various rock strata at elevated pressure and temperature, contains many soluble components including barium and the radioactive intermediates of the uranium and thorium decay series. Typically as the water is produced from the wells, the temperature and pressure decreases creating conditions in which the barium and radionuclides can co-precipitate inside separators, valves and pipework, forming an insoluble NORM scale.

Some of the soluble radionuclides and particles of NORM scale can pass through the system and be discharged with the produced water. Similarly, some particulate scale and soluble radionuclides can be entrained with the exported oil. No NORM scales or sludges are expected for the TEN Project. From recent well Pressure Volume Temperature (PVT) samples, only very low traces of barium (max 25 ppm) were detected. Therefore, no significant barium sulphate scale is expected. To prevent scale formation, there will also be capability to inject scale inhibitor into the well and process facilities

3.8.4 Noise

The MODU, FPSO, installation vessels, export tankers and support vessels will introduce sound into the marine environment during their operation. Vessel noise is primarily attributed to propeller cavitation and propulsion engines (*ie* noise transmitted through the vessel hull). Noise will also be produced from drilling activities and during operational equipment such as flowlines and valves. The main sources of underwater noise associated with the Project can be categorised into the following.

- **Drilling Activities.** The majority of sound produced by drilling activities on the seabed are continuous and of low frequency.
- **Propeller and Thrusters (on the MODU)**. Noise from propellers and thrusters is predominantly caused by cavitation around the blades whilst moving at speed or operating thrusters under load in order to maintain a vessel's position (*ie* dynamic positioning). The noise produced is typically broadband noise, with some low tonal peaks.
- **Machinery Noise.** Machinery sound is often of low frequency, and often becomes dominant for vessels when stationary or moving at low speeds. The source of this type of sound is from large machinery, such as large

power generation units (diesel engines or gas turbines), compressors and fluid pumps. Sound is transmitted through different paths, *ie* structural (machine to hull to water) and airborne (machine to air to hull to water), or a mixture of both. The nature of sound is dependent on a number of variables, *eg* number and size of machinery operating, coupling between machinery and deck. Sound is typically tonal in nature.

- **Equipment in Water.** Sound is produced from equipment such as flowlines, valves and risers. Noise produced will tend to be relatively low for drill casing, but possibly more significant for sub-sea valves.

Indicative sound levels that may be produced by project activities are included in *Table 3.26*.

Table 3.26 Indication of Sounds That May be Produced by Project Activities

Project Activity	Approximate Highest Sound Levels (dB re 1 µPa @ 1m)*	Peak Frequency Band – Indicative Ranges (Hz)**
Tug	170 dB	50 - 1,000
Pipelay vessel	180 dB	1,000 - 100,000
Supply vessel	180 dB	10 -1,000
Export tanker	190 dB	10 - 100
Subsea choke valve	120 dB	1,000 - 100,000
FPSO	160 dB	1,000 - 100,000
MODU	174 to 185 dB	10 - 10,000

*Sound pressure is expressed on a decibel scale (dB) and referenced to 1 micro Pascal at 1 m from source.

** Sound frequency is expressed in Hertz. Only the approximate range of peak frequencies is presented, frequencies outside this range are likely to exist but be lower in sound level.

Underwater sound monitoring has been carried out for the Jubilee FPSO. The measured sound output during normal operation was primarily within the 25 Hz to 2 kHz frequency range. Peak sound output occurs between around 100 to 250 Hz and likely results from machinery noise radiating through the hull of the FPSO. Lower frequency sound of around 13.5 kHz also radiated from the FPSO which likely originates from high-speed rotating equipment. The measured sound during off-loading was primarily within the 400 Hz to 16 kHz frequency range. The broader frequency range was thought to be due to propeller noise of the tanker handling tug vessel used during the off-loading operations.

3.8.5 Solid Waste

Project generated wastes will be managed and disposed of in a manner to prevent potential impacts on the environment and risks to human health. Wastes will be generated from offshore activities and associated onshore logistical support bases.

The majority of solid wastes generated offshore will be transferred from the FPSO, MODU and support vessels and appropriately managed onshore. Selected low risk wastes such as food from the galleys will be discharged offshore in line with MARPOL requirements and industry standard practice. During initial drilling, installation and commissioning phases, the nature and quantities of the wastes generated will vary. This section describes the mainly solid wastes that will be required to be transferred for treatment, recycling, and/or disposal at appropriate facilities in Ghana in accordance with TGL's Waste Management Plan (WMP). TGL will use an EPA licenced waste contractor to manage wastes from the TEN Project with disposal to EPA regulated facilities.

Categorisation of Wastes

Wastes generated from project activities will be categorised as non-hazardous or hazardous according to their types and associated risks. The definitions of waste categories are as follows.

- Non-hazardous wastes are those that do not exhibit any hazardous properties and are relatively low risk to human health and the environment. This category would include a range of materials that may be recycled or can safely be disposed of in a landfill.

- Hazardous wastes exhibit one or more characteristics which mean that the wastes are potentially harmful to human health and/or cause damage to the environment (air, land, and/or water) or natural ecosystems. For example, the waste may be corrosive, reactive, toxic, mutagenic[(1)], teratogenic[(2)], infectious, carcinogenic[(3)], ecotoxic, flammable, or explosive.

Waste Types Generated

Specific types of non-hazardous waste (generally solid waste) will be separated and sorted on the FPSO, MODU and supply vessels and shipped to shore for treatment, recycling, or disposal. The types of non-hazardous solid waste that would be expected to be generated from the project include the following.

Non-Hazardous Wastes:
- general domestic waste - from the galley and living quarters;
- food waste;
- plastic - including drinks bottles;
- scrap metal - empty drums and cables; and
- wood – pallets and crates.

Hazardous Wastes:
- batteries - including large lead-acid type;
- chemical residues;

(1) An agent, such as a chemical, ultraviolet light, or a radioactive element, that can induce or increase the frequency of mutation in an organism.
(2) A substances or agent that can interfere with normal embryonic development.
(3) A substance or agent that tends to produce a cancer.

- clinical/medical wastes;
- oil filters;
- oily rags and absorbents;
- used oil - from engine maintenance; and
- oily water – slops and contaminated water.

The general estimated quantities of non-hazardous and hazardous waste that will be produced by the offshore and onshore commissioning and operational activities of the TEN Project are presented in *Table 3.27*.

Waste volume estimates are based on actual monthly waste data gathered by TGL during 2011 for their current operations.

Offshore Wastes

The types of hazardous waste that would be expected to be generated from the FPSO include the following.

- Hydrocarbon residues from vessel maintenance activities and sludge from oil processing and production equipment, crude oil storage and other storage tanks, and from bilge/machinery space that cannot be returned to the production stream.
- Various hazardous waste such as filters cartridges, fluorescent lighting tubes, batteries, oil filters and oily rags.
- Used oil, chemical and/or paint residues.
- Clinical/medical waste such as syringes, medicine bottles and dressings.

In addition, quantities of non-hazardous waste, mainly general domestic wastes, will be generated on the FPSO from the daily operations of the catering facilities and living quarters.

The MODU and supply vessels will produce mostly general domestic wastes, scrap metal, used oils and relatively small amounts of other hazardous wastes. However, the scale and nature of waste will vary as the duties change from drilling to well development throughout the phases of development.

The majority of wastes generated offshore will be shipped to shore for management. All other non-hazardous and hazardous wastes will be segregated offshore prior to transfer to the onshore base at Takoradi for onward management via specific waste contractors to approved treatment and disposal facilities.

Selected wastes on the FPSO, such as used oils from machinery maintenance and servicing will be recycled into the closed drain system of the production crude stream. Where this is not possible then any used oil will be transported ashore in secure containers for disposal with other used oils as detailed in TGL's WMP.

Table 3.27 Example Waste Types and Estimated Generation Rates during Operations

Category	Waste Type	Units	Estimated Quantity Range			
			FPSO	MODU	Vessels (various)	Onshore Bases
Non-hazardous	General domestic waste	m^3/month	40 - 70	60 – 160	40 - 80	10 - 30
	Wood	m^3/month	0 - 30	10 – 45	0 - 5	0 - 2.5
	Plastic	m^3/month	0	0 – 2	0	0 - 0.25
	Scrap metal	m^3/month	0 - 0.5	5 – 19	0	0 - 0.5
Hazardous	Oily rags and oil filters	m^3/month	0 - 5	0.3 - 8	0.5 - 2.5	0 - 0.25
	Used oil	m^3/month	0	5 - 8	20 - 55	0 - 20
	Batteries	Te/month	0 - 1	0 - 1.3	0 - 0.2	0 - 0.2
	Clinical waste	kg/month	0 - 10	0 – 5	0 - 10	0 - 10
	Oily water (slops)	m^3/month	0	30 - 300	0 - 100	0
	Filter cartridges	No. units	0	0 – 10	0	0
	Drums (with residues)	No. drums	0 - 25	50 – 125	0 - 25	0 - 20
	Other various wastes	m^3/month	0 - 5	0 – 3	0 - 0.5	0

Source: TGL 2012

Food waste from the galleys of the FPSO, MODU and supply vessels will be discharged to sea. Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged with no floating solids or foam in conformance with MARPOL requirements.

Onshore Wastes: Shore Base

The onshore base in Takoradi will produce small quantities of non-hazardous wastes such as general domestic waste from workers, scrap metal wastes and relatively small amounts of hazardous wastes. However, the scale and nature of waste will vary as the duties of such bases change from support of drilling and installation and construction to operation of the FPSO. Office and accommodation areas have waste facilities for general office waste such as paper and plastic.

Wastes generated will be consolidated with those brought to shore from the offshore activities and will be treated, recycled or disposed of at appropriate facilities in-country or stored at appropriate facilities, as defined in TGL's WMP.

Waste Management Plans and Procedures

TEN specific waste management procedures will be incorporated and used to update the TGL WMP (TGL-EHS-PLN-04-0008). The WMP will be implemented for all stages of the TEN Project in accordance with TGL's requirements and procedures and will follow current good practice within the oil and gas industry (OGP 2009). The WMP will include a description of the non-hazardous and hazardous waste streams expected from the various project activities. The WMP adopts the principles of the 'waste hierarchy' to ensure that waste generation is reduced and reuse and recycling is maximised. Waste such as scrap metal will be recycled at approved facilities, where possible.

Information on the procedures for handling, storage and treatment and disposal of all project wastes will be included in the WMP. As part of the development of the WMP, TGL will identify suitable local companies and facilities to receive both non-hazardous and hazardous wastes. All companies receiving TEN Project wastes will be approved by the Ghana EPA and will be audited by project staff prior to receiving any wastes to ensure good practices are in place and companies operate to wholly acceptable standards.

Where suitable facilities do not exist for the onward management of hazardous wastes in-country TGL will store the wastes as an interim measure until suitable companies have been identified. Where necessary the export of hazardous wastes will be considered as an option to allow the sound management of specific waste streams. Where this is necessary all international conventions shall be followed.

TGL recognises that waste traceability is a key issue and that it has a duty to ensure that any waste generated is handled safely and in accordance with legal requirements and good international practice. The WMP will implement a waste tracking system to ensure the management of wastes produced from all operational activities from generation to final disposal. Waste Transfer Notes will be used to ensure that wastes are transferred from the producer, through the transportation chain to the final disposal point and will provide a record of due diligence across the system.

3.9 PERSONNEL HEALTH AND SAFETY

3.9.1 Introduction

The basis of good maritime safety is compliance with all applicable conventions and codes that cover the type of operations being conducted. These cover all aspects of the project, from FPSO design and construction through to operation and training of personnel. The FPSO and support vessels must comply with the following IMO conventions that are concerned with safety at sea.

- *International Convention for Safety of Life at Sea (SOLAS) 1974* and associated Protocols and Amendments.
- *International Convention on Load Lines (LL) 1966.*
- *Convention on the International Regulations for the Prevention of Collisions at Sea (COLREG) 1972.*
- *International Standards of Training, Certification and Watchkeeping Convention (STCW) 1978 and 1995 Amendments.*
- *International Convention for Safe Containers (CSC) 1972.*
- *International Convention on Maritime Search and Rescue (SAR) 1979.*
- *Convention on the International Maritime Satellite Organisation (INMARSAT) 1976.*

The project will also comply with safety requirements outlined in Ghanaian legislation and regulations that cover shore based operations. These include the following.

- *Labour Act (Act No. 651 of 2003)*;
- *Explosives Regulations (LI 666 of 1970)*;
- *Road Traffic Act (Act No. 683 of 2004)*;
- *Electricity Corporation of Ghana (Electrical Power) Regulations (LI 1366 of 1988)*; and
- *Radiation Protection Instrument (LI 1559 of 1993).*

3.9.2 FPSO Design

The FPSO design will satisfy requirements set out by the IMO (see above) and the rules of an established ship classification society. The purpose of a classification society is to evaluate floating vessels, including FPSOs, against the structural and mechanical standards developed for the particular class of vessel. An independent technical authority will constantly review construction of the TEN FPSO to verify compliance with the certified design. The final stage in the process to attain classification is a survey of the FPSO by the classification society once construction is completed.

In addition to the requirements of the classification society and IMO listed above, various industry standards (*eg* RP 2SK Recommended Practice for Design and Analysis of Station Keeping Systems for Floating Structures) will apply to the FPSO.

To maintain its classification, the FPSO will undergo regular inspections throughout its operational life by an authorised certifying body. Loss of classification will result in a stand down of the FPSO.

It should be noted that whilst the discussion above has focused on the FPSO, class specific standards also apply to other ships involved in the project. Regular maintenance will be undertaken to verify on-going compliance with stipulated IMO standards and class requirements.

Safety Case

In addition to the requirements of the classification society, the TEN partners are undertaking a Safety Case on the project design based on UK *Safety Case Regulations (2005)*. The Safety Case will be used to help develop the safety management system for the FPSO as well as to make sure that the design is modified accordingly; *eg* provisions for evacuation and rescue, safe refuge for personnel in the event of an emergency and fire systems fit for purpose.

The safety case will identify both safety critical elements (SCE), and in line with recent guidelines from the Energy Institute, environmentally critical elements (ECE). ECE are any part of the facility, plant or computer programmes whose failure will either cause or contribute to an environmental event, or the purpose of which is to prevent or limit the effect of an environmental event (Energy Institute, 2012). An environmental event is defined in the guidelines as a major environmental hazard where specific controls are required in order to manage the associated risks; or in other words, hazards that could lead to incidents with significant impacts on the environment, such as the spillage of large volume of oil for example due to the failure of a riser.

The Safety Case will identify all the SCEs and ECEs such as fire and gas detectors, fire pumps, emergency shutdown valves, which comprise the major safety detecting and mitigating equipment on the FPSO. Performance standards will be developed for all these SCEs and ECEs and will be integrated into the FPSO Maintenance Management System to ensure that they continue to meet the required performance over time. Topside process equipment certification will be carried out annually.

The TEN Safety Case will be issued in two stages, firstly the Design Safety Case which will be used to demonstrate that the facility design meets the TGL risk tolerability criteria and demonstrate that all risks have been identified and reduced to as low as reasonably practicable (ALARP) levels and the second, the Operational Safety Case will be used to demonstrate that the facility will be operated and maintained in a safe manner in order to protect both the environment and all the personnel on board.

Hierarchy of Control

TGL will apply the following hierarchy of control principles to reduce risks identified in the design and operation of the FPSO (and other operations) to as low as practicably possible.

- **Elimination:** remove the hazardous substance, machine or task completely from the work place.

- **Substitution:** replace the hazardous substance, machine or task with a safe one.

- **Engineering:** modify tools or equipment, enclose equipment, or put guards in place.

- **Administration:** develop and implement safe procedures for hazardous jobs.

- **Personal Protective Equipment:** equipment such as safety glasses, footwear and hearing protection can be important, but are a last resort.

Design Environmental Conditions

The FPSO will have adequate structural strength and remaining fatigue life to cover transit, installation and operation in the field. The TEN FPSO has an expected minimum remaining fatigue life of 20 years and has been designed for the site specific environmental operating conditions at the TEN fields in Ghana, without the need to access dry docking facilities.

The FPSO has also been designed to withstand the 'design environmental conditions', which are the extreme ambient weather and oceanic conditions of winds, waves and currents.

Fire and Gas Protection Systems

The fire and gas protection system will be monitored from the central control room on the FPSO and is designed to provide early detection of any hazards, initiate appropriate mitigations (operational shutdowns and active fire suppression and protection) and to facilitate the safe evacuation of personnel. The system is also designed to provide rapid automatic emergency shutdown and blow-down of gas inventories. The active fire protection system and equipment will be designed in accordance with class requirements to contain local fires to prevent escalation, to protect escape and evacuation routes and provide cooling for equipment and structure. The active fire protection system and equipment will include the following:

- firewater system;
- foam system;
- gaseous (CO_2) fire extinguishing system;
- water mist system; and
- portable fire extinguishers.

Emergency Evacuation

Shutdown procedures in case of emergency will be developed as per the requirements of the classification society, in which a general alarm will sound and the emergency lights, public address system and radio communication will be functional.

Emergency evacuation will be by helicopter from a helideck situated directly above the accommodation block and/or totally enclosed motor propelled survival craft and life rafts.

Sufficient survival craft/life rafts will be installed to accommodate twice the total maximum number of people on board the vessel. These will be located both fore and aft of the work deck in safe zones that are designed to provide safe access to lifeboats under a range of emergency situations (see *Figure 3.7*).

There will be at least one SOLAS life jacket per person in readily accessible locations adjacent to each lifeboat station. The FPSO also has a safe refuge for personnel in the event of an emergency.

Other Safety Design Features

Other design features of the FPSO that have a safety function also include the following.

- Crude oil stage tanks will be blanketed with fuel gas (or an inert gas if this system is unavailable) to maintain a safe environment for loading and discharging crude oil.

- The accommodation block will be mechanically ventilated and pressurised, taking fresh air from a safe location remote from the process equipment.

- Oil and gas processing will be controlled and monitored remotely.

- Shutdown systems will close off the flow and contain hydrocarbons under pressure in an emergency and allow depressurisation via the flare stack.

- Suitable ventilation will be built into the vessel to prevent gases building up in a confined space.

- The flare tower design will be compliant with class provisions. Allowance will be made in the design for prevailing winds to limit the exposure of personnel, equipment, and helicopter traffic to vented gas, flare exhaust or flame radiation.

Offshore Safety

TGL will implement a Safety Case for the facility which will demonstrate its case for safety and environmental risk mitigation and on-going operation of the facilities in a safe manner. This is a live process built into the total operation for both facility and personnel, and will be independently verified by an experienced third party body. The Safety Case for offshore oil and gas installations is the standard means for safety management in the UK and Norway North Sea facilities and also in other countries such as Australia, Vietnam and Malaysia. Ghana does not currently have a statutory requirement for implementation of a Safety Case but the TEN partners have adopted this approach as good industry practice.

Procedures for the FPSO are under development by TGL and the FPSO contractor. These will be completed during 2014 and will be used to train personnel before commissioning.

TGL will ensure that the MODU contractor has procedures in place covering offshore work on the MODU. All external work areas require boots/hard hat/eye protection and fire retardant long sleeved overalls. Hearing protection is required as per noise zone requirements. Hand protection is required as per task requirements. Other Personal Protective equipment (PPE) is required as per task requirements *eg* fall arrest equipment for working at height.

3.9.3 Flight Safety

Aviation support operations for TEN will be managed by the aviation team based in Accra and Takoradi according to the Takoradi Supply base operating guidelines manual.

Aircraft will be operated and managed in accordance with the standards laid down in the OGP *Aircraft Management Guidelines Report No. 390 (July 2008), as updated 2013.* Flight operations will be conducted under the aircraft manufacturer's flight manual and regular maintenance will be conducted.

Only passengers who have completed the offshore survival training course will be allowed offshore to work unless in possession of a dispensation. All passengers will receive a briefing before departure which will include safety information and actions to be taken in case of emergency. Hearing protection will be provided in the helicopters.

The helideck on the FPSO will be designed to standards provided in the International Civil Aviation Organisation Annex 14 Vol. 2/Heliports and UK Civil Aviation Authority Publication CAP 437 which includes standards for fire fighting and crash rescue.

3.9.4 ***Shore Safety***

Safety for onshore activities will follow Ghanaian laws and international practices for similar operations. The key areas are described below.

Vehicle Safety

All TEN project vehicles and drivers will comply with the *Road Traffic Act, 2004 (Act 683)*. Procedures will be put in place to cover the following.

- To ensure all vehicles are roadworthy and in good condition, vehicles will be maintained on a regular basis, with safety checks of essential parts completed. In addition, heavy vehicles will have a pre-shift check by the operators to ensure the vehicle is in good running order.
- Drivers will not be allowed to drive under the influence of alcohol or drugs.
- Hazardous goods transported by road will be in accordance with Dangerous Goods transportation guidelines, including methods of packaging, quantity of goods, labelling, and the training and certification of drivers. Dangerous Goods training covers land, sea and air aspects of the project.
- Load weights and dimensions on heavy vehicles will comply with national requirements and local conditions. Vehicles with loads are checked prior to leaving the site.

It should be noted that the need to transport oversize loads through the city of Takoradi has been eliminated by the lease of facilities at the Takoradi commercial port where the oversize loads will be temporarily stored prior to shipment to the field. Heavy vehicles used for transporting pipes, casing or materials will follow the main Axim Road from the Shore Base facilities (*ie* Air Force base and Bay Court) to the port, which is the approved route for heavy vehicles.

Materials Storage and Handling

A number of regulations are in place to manage the safe handling and storage of materials. These include the following.

- *Explosives Regulations 1970 (LI 666)* regulate the transport, use, handling and storage of explosives. A small amount of explosives will be intermittently used on the MODU and full compliance with safety requirements will be enforced whenever they are used.

- *Radiation Protection Instrument 1993 (LI 1559)* for the use of radioactive devices will be followed. It should be noted that the majority of devices are to be installed on the subsea infrastructure with no exposure during operations. However non-destructive testing equipment will be used during construction and radiation officers will supervise its use.

- The *Labour Act (Act No. 651 of 2003)* requires the safety and absence of risks to health in connection with use, handling, storage and transport of articles and substances.

TGL will design chemical storage areas to comply with the HAZCHEM system of storing and segregating dangerous goods. Segregation means keeping incompatible goods apart from one another, using either a physical barrier or intervening space, depending on requirements. Chemicals must be segregated when either stored or shipped to ensure they do not mix in case of spillage. The HAZCHEM system also allows emergency responders to quickly recognise dangerous goods, their properties and dangers, thereby enabling them to respond in the most appropriate manner. HAZCHEM signs will be placed wherever chemicals are stored.

The risks posed by the usage of chemicals will be addressed through engineering solutions to reduce exposure and through training of personnel (*ie* awareness and standard work procedures). On-going access to information on chemical handling and storage will be facilitated through the distribution of Material Safety Data Sheets and standard procedures at appropriate locations. Appropriate spill clean-up equipment will be located at each site where chemicals are stored.

Working with chemicals demands a culture of cleanliness. Workers will be required to wash their hands before eating, drinking or smoking. Safety shower/eye wash stations will also be located strategically, which will be readily available in the immediate work area of all areas where exposure is a risk. Appropriate PPE will also be used by all personnel.

Buildings

Buildings used by TGL will be fit for purpose and comply with Ghana regulations.

3.9.5 *Procedures and Training*

To prevent occupational illness or injury, TGL will develop a strong safety culture through on-going employee training and education. A Safety Management System will be developed that identifies the hazards, assigns risks and develops controls to effectively manage safety in all operations.

Controls for onshore and offshore will cover such matters as:

- duty of care, responsibilities of TGL towards employees and responsibility of employees at work;
- PPE;
- working over water;
- hot work permits for welding near fuel or other hazardous areas, onshore and offshore;
- fire prevention and response, including training for initial response and evacuation, onshore and offshore;
- working at height, onshore and offshore;
- accident/incident investigation;
- emergency shutdown of the FPSO;
- evacuation procedures and drills, onshore and offshore;
- training and certification of crews, onshore and offshore;
- fatigue management;
- chemical storage handling;
- confined space entry, onshore and offshore;
- diving;
- boat operations;
- bunkering;
- cargo transfer; and
- cranes and lifting, onshore and offshore.

TGL will provide the necessary information, instructions and training having regard to the age, literacy level and other circumstances of the worker to safeguard, so far as is reasonably practicable, the health and safety at work of those other workers engaged on the particular work. This process will start with structured inductions during the first days of employment and continue throughout the term of employment.

3.9.6 *Emergency Response*

TGL has developed an Emergency Response Plan to address potential emergencies, designate roles and responsibilities of personnel and identify the requirement to interface with Government and external parties.
The crisis management and emergency response plans are communicated to the workforce through regular drills and training exercises carried out and recorded in the Emergency Response Training Record. Significant findings

from drills are communicated to the workforce and used to further develop the crisis management and emergency response plans.
Personnel receive initial and refresher training to ensure they are competent to carry out their designated roles and responsibilities in a crisis or emergency.
Equipment, facilities and trained personnel for crisis management and emergency response are identified and readily available. An assessment of emergency equipment needs will take place every six months and/or post exercise.

TGL has a Well Control Emergency Response Plan (WCERP) in place for the TEN Project and has also completed a relief well feasibility study. The WCERP and relief well plans will be continually updated as more detailed information on the TEN fields become available.

Resources

For offshore emergency response a helicopter will always be within 1 hour's flight time of the FPSO and a vessel will be no more than six hours cruise time from the FPSO. Search and rescue operations will be conducted in partnership with Ghana Navy, GMA and Air Force assets.

4 ENVIRONMENTAL BASELINE

4.1 INTRODUCTION

This chapter provides a description of the current environmental baseline against which the potential impacts of the TEN Project can be assessed. The chapter presents an overview of the aspects of the environment within the TEN Project and marine and coastal areas that may be directly or indirectly affected as a result of the proposed project.

The TEN Project and its regional setting are shown in *Figure 4.1*. The development is located approximately 140 km southwest of the port of Takoradi, 60 km from shore, 10 km east of the Ghana and Cote d'Ivoire maritime border and 20 km west of the Jubilee field.

This chapter is structured as follows:

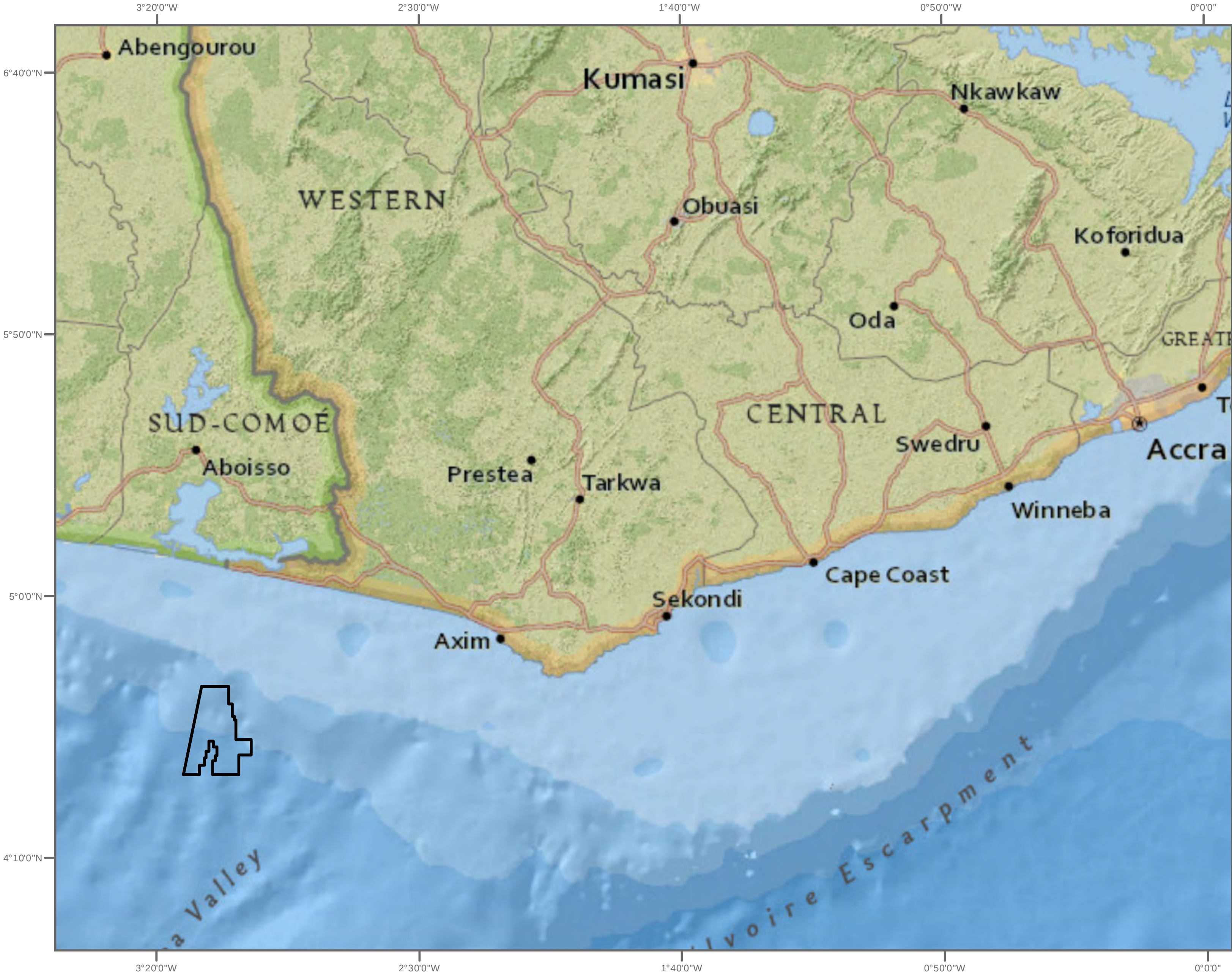
- Data Sources;
- Climate and Meteorology;
- Air Quality;
- Hydrography and Oceanography;
- Bathymetry and Seabed Topography;
- Water and Sediment Quality;
- Marine Habitats and Species; and
- Protected Areas for Nature Conservation.

Fish and fisheries baseline information is provided in *Chapter 5*.

4.2 DATA SOURCES

The baseline description draws on a number of primary and secondary data sources. The primary data sources include the following.

- *Geotechnical and Geophysical Surveys.* TGL appointed Gardline Geosurvey Ltd to undertake a site survey in the TEN Project area and along a linear transect towards shore (Gardline 2011a). The survey was undertaken in July and August 2011 and involved bathymetry surveys, sub-bottom profiling and geotechnical sampling. The geotechnical survey comprised Cone Penetration Tests, vibrocores, piston cores and two box cores. The study provided information on seabed bathymetry, features and sub-bottom conditions and profile. An additional survey was undertaken by Fugro Survey Ltd in 2013 for the TEN Project area and export pipeline route to the Jubilee field (Fugro 2013).



TEN Project Area

0 20 40 60 80 100

Kilometers

N

SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

Figure 4.1
Project Location and Regional Setting

ERM

TEN project

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_TEN_Regional_Rev0.mxd

- *Environmental Baseline Study (EBS)* (CSA 2011a). TGL contracted CSA to conduct the EBS of the TEN Project area and along a transect towards shore. The EBS was undertaken in March 2011 and included daily water column profiling and water collection, seafloor sediment sampling at 15 sampling stations and seafloor plan-view imagery. The study provides site specific physico-chemical, water and sediment quality and biological data. A copy of the EBS report is included in *Volume II: Annex C.*

- *Marine Mammal and Turtle Observation Report* (Gardline 2011b; Gardline 2012). TGL appointed Gardline Environmental Ltd to evaluate marine mammal and turtle sightings data from the areas where TGL operate offshore Ghana. Sightings were recorded from the two security vessels along their support routes. Data recorded over about 26 months were analysed for the periods 17 November 2009 to 30 January 2011 and 8 March to 31 December 2011. The sightings data provide additional information on marine mammal and turtle occurrence offshore Ghana. Copies of these observation reports are included in *Volume II Annex D*. Additional sightings data recorded onboard a seismic survey vessel within the Jubilee field during April and May 2013 is also reported in this chapter.

It is noted that information on the offshore distribution of marine mammals, turtles and offshore pelagic fish is limited due to the lack of historic research in offshore areas.

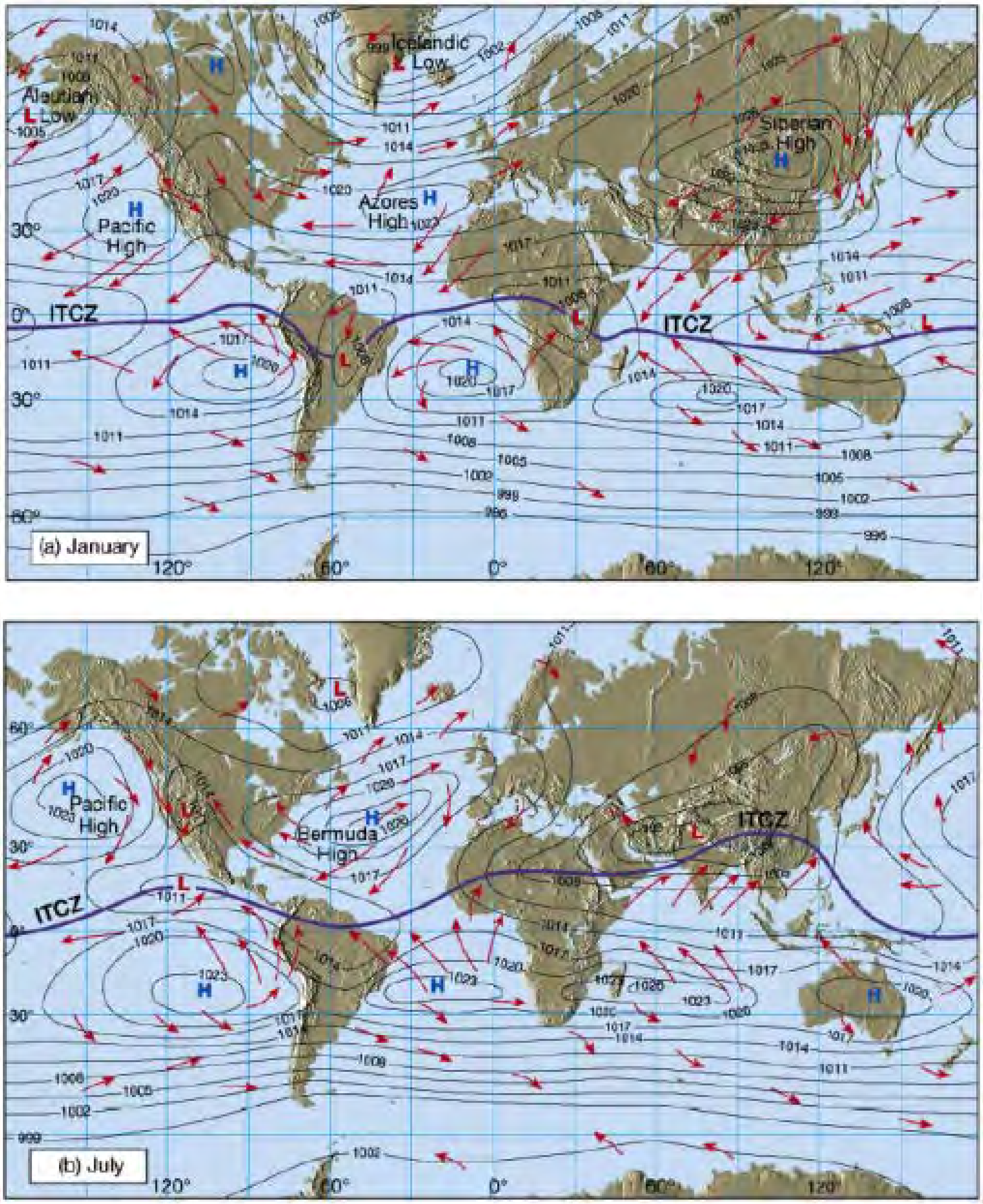
Secondary data sources include various research studies and published literature that are referenced throughout this chapter.

4.3 *CLIMATE AND METEOROLOGY*

The regional climate in the Gulf of Guinea is influenced by two air masses, one over the Sahara desert (tropical continental) and the other over the Atlantic Ocean (maritime). These two air masses meet at the Intertropical Convergence Zone (ITCZ) and the characteristics of weather and climate in the region are influenced by the seasonal migration of the ITCZ (*Figure 4.2*).

During the boreal winter months, the tropical continental air from the northern anticyclone over the Sahara brings in north-easterly trade winds which are dry and have a high dust load (on occasion these penetrate over the Atlantic as far south as 2°N in January). These winds bring a period of dry weather over the region. The northward migration of the ITCZ (during boreal summer) results in warm humid maritime air reaching further inland over the region. In March, the ITCZ is located between 9°N and 12°N and by May to June, it is located approximately between 15°N and 16°N. During these periods, the region generally experiences the rainy seasons. The most northerly limit of the ITCZ is approximately 18 to 24°N and occurs between July and August.

Figure 4.2 Location of the Intertropical Convergence Zone during January and July



Source: Noble Denton 2008

In general, two seasons are characteristic of the climate in the region, namely the dry and wet seasons. The occurrence of these seasons corresponds with periods when the tropical continental and maritime air masses, and their associated winds, influence the region. The peak of the rainy season occurs from May to July and again between September and November. The maximum northern location of the ITCZ between July and August creates an irregular dry season over the region, whereby rainfall and temperatures decline. Mesoscale disturbances which also influence weather patterns in the region include thermal convections, resulting in showery weather over large areas and line squalls (storms) which usually move from east to west or northeast to southwest.

Annual rainfall in the Western Region of Ghana ranges from 730 mm to 3,500 mm with rainfall figures decreasing from the coast inland. The Western Region is the wettest part of Ghana. The annual percentage of rainy days is generally greater than 60%. The diurnal temperature range in the region is between 26°C and 33°C while the annual variation in temperature ranges is relatively small, ranging between 2°C and 4°C. Mean values of relative humidity for the region are high, generally more than 60% throughout the year but may be greater than 80% in the mornings.

Five years of modelled temperature, humidity and rainfall data for the TEN Project area were obtained for the period 2007 to 2011. Data were sourced from Lakes Environmental for an offshore meteorological reference point located at 4.536389 N, 3.101111 W. The location of the reference point is shown in *Figure 4.3*.

Temperature and Relative Humidity

Temperatures at the offshore reference point typically range between 23°C and 30°C (*Figure 4.4*). Temperatures are generally high from February until May and from November to December, with peak temperatures recorded in April. Lower temperatures were recorded between June and October with the coolest month usually being August. Humidity showed an inverse relationship with temperature whereby an increase in temperature results in decreased humidity (*Figure 4.4*). Humidity for the offshore station ranged between 77% and 87% throughout the year, peaking in September

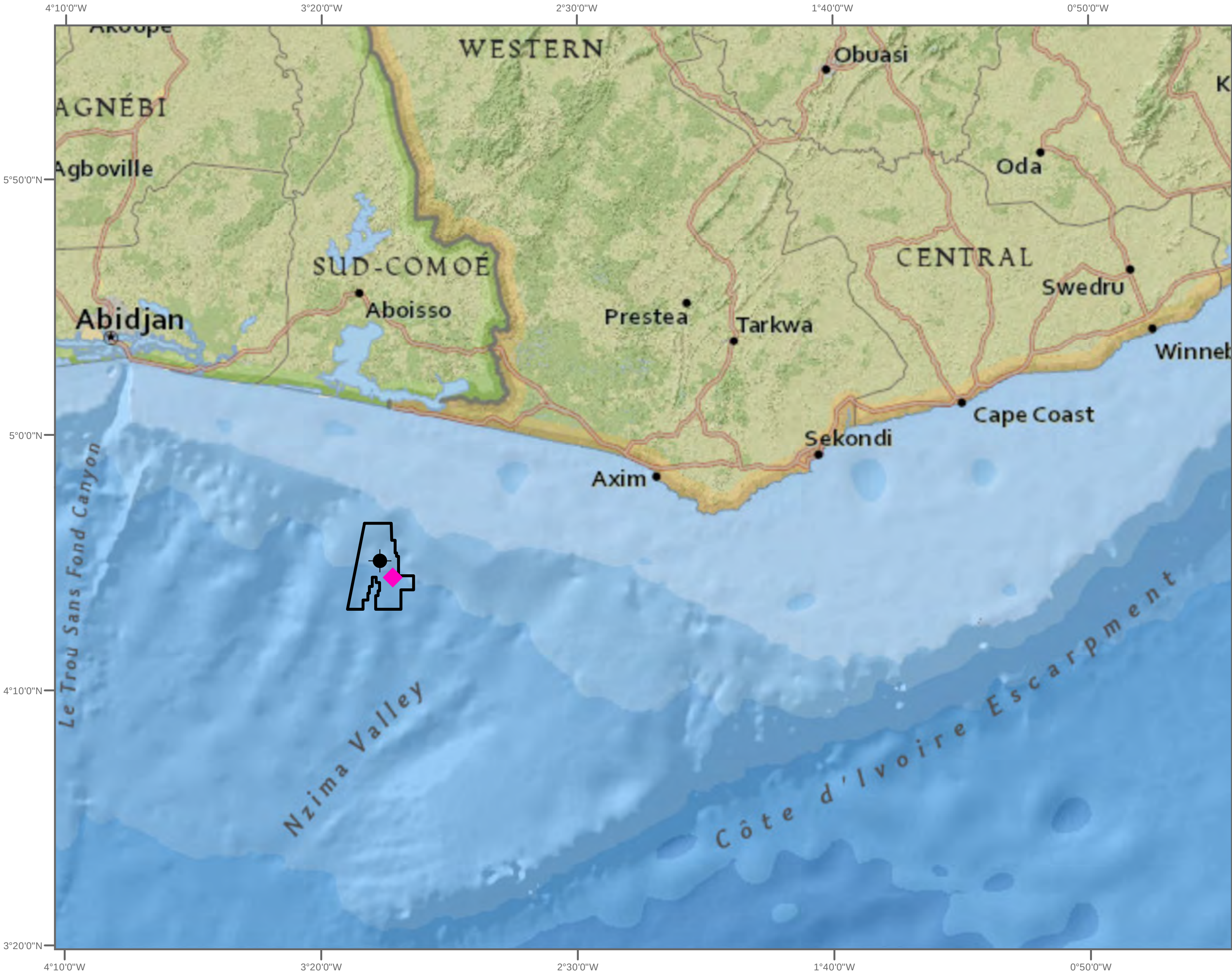
Rainfall

Annual rainfall for the past five years at the offshore station ranged between 975 mm to 1,570 mm. A bi-modal pattern is observed with peaks in May to July and October to December (*Figure 4.5*). The highest rainfall is during June with an average of 359 mm over the five year period. The offshore station experiences the lowest rainfall in March with an average of 13 mm over the five year period.

Wind

Surface atmospheric circulation in the region is influenced by north and south trade winds and the position of the ITCZ. The dry season is generally defined as a period with cool, dry winds from the Sahara which are commonly referred to as the Harmattan (Noble Denton 2008). Trade winds tend to be stronger during the wet season. Extreme winds are caused by squalls (storms), associated with the leading edge of multi-cell thunderstorms.

.



TEN Project Area

TEN FPSO

Meteorological Reference Station

0 20 40 60 80 100

Kilometers

N

SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

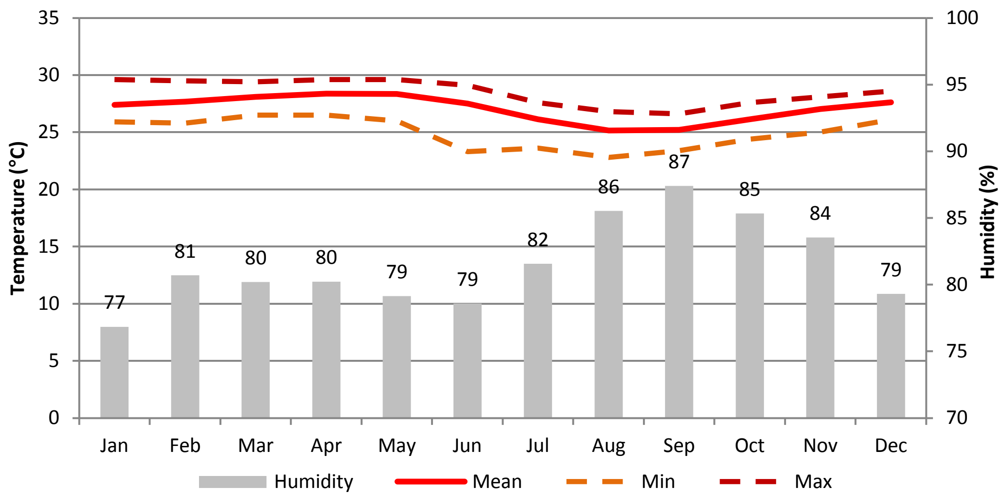
Figure 4.3
Meteorological Reference Location

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

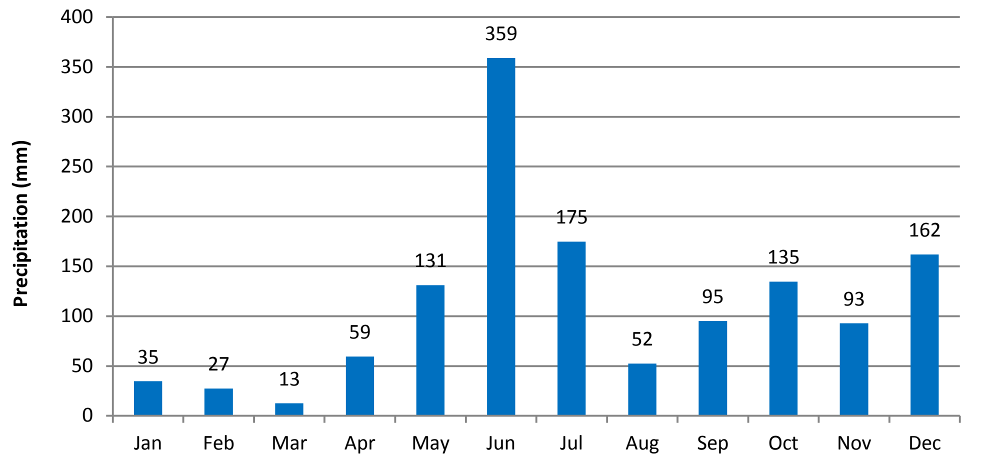
Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_MetStationOverview_Rev0.mxd

Figure 4.4 Temperature and Humidity for Offshore Station at 4.54 N, 3.10 E (2007 - 2011)



Source: Lakes AERMET-Ready data for station 4.536389 N, 3.101111 W

Figure 4.5 Precipitation Data for Offshore Station at 4.54 N, 3.10 E (2007 - 2011)



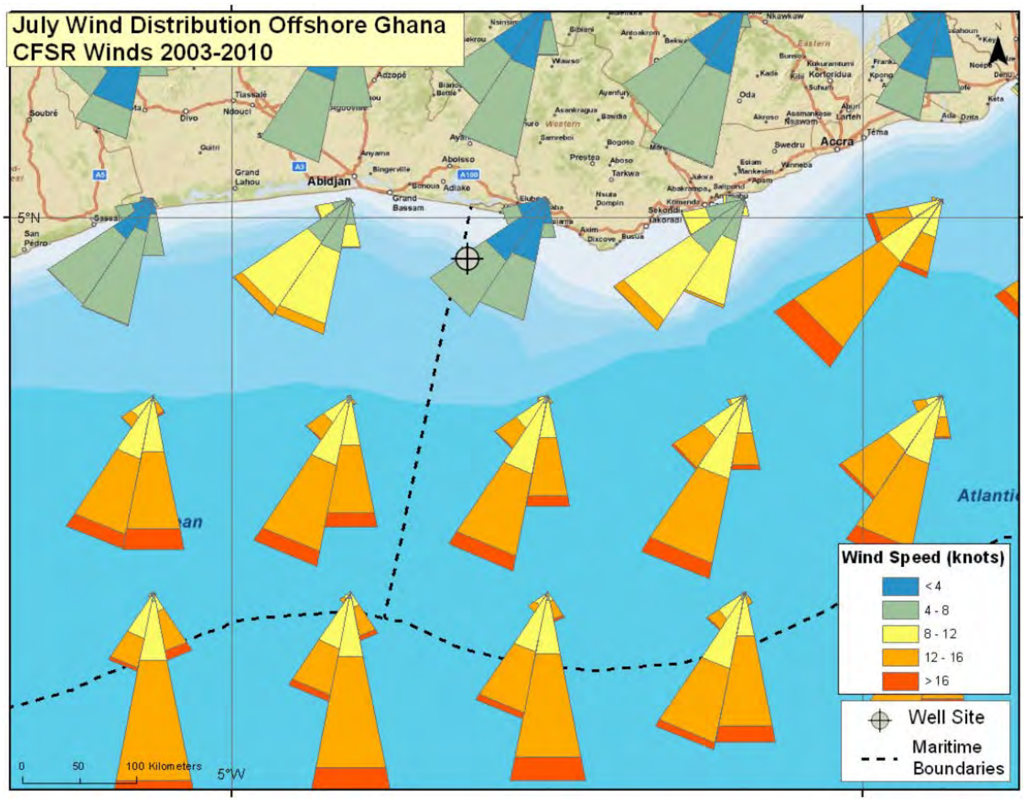
Source: Lakes AERMET-Ready data for station 4.536389 N, 3.101111 W

Data from the Navy Operational Global Atmospheric Prediction System (NOGAPS)(1) show that the predominant wind direction offshore Ghana is the south-southwest. There is only a small difference in wind speeds and directions over the course of the year. From month to month there is some slight variability in the directional trend with more persistent south-westerly winds in the spring and summer and slightly more variability in the winter months. Wind roses for July and November are provided in *Figure 4.6*.

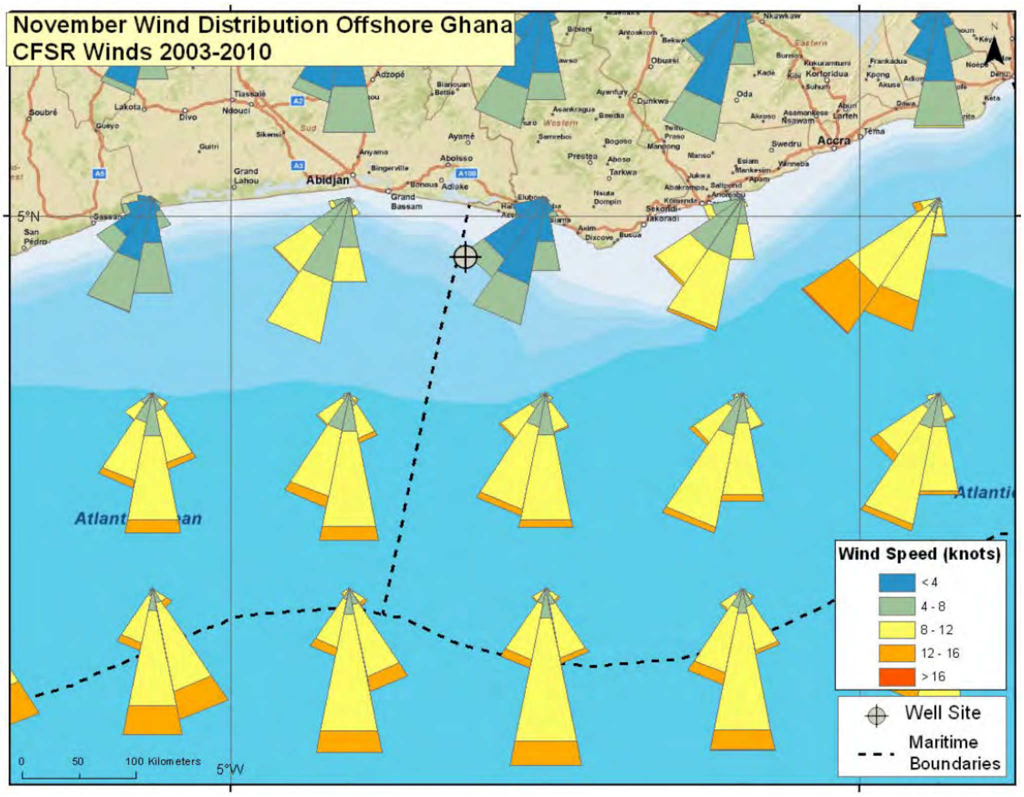
(1) The version of the NOGAPS dataset used is originally derived from the publically available version hosted by the U.S. Global Ocean Data Assimilation Experiment (GODAE) and subsequently has a QuickSCAT correction applied by the HYCOM Consortium.

Figure 4.6 ***Wind Distribution Offshore Ghana from NCEP data for Offshore Station (2003-2010)***

(a) July



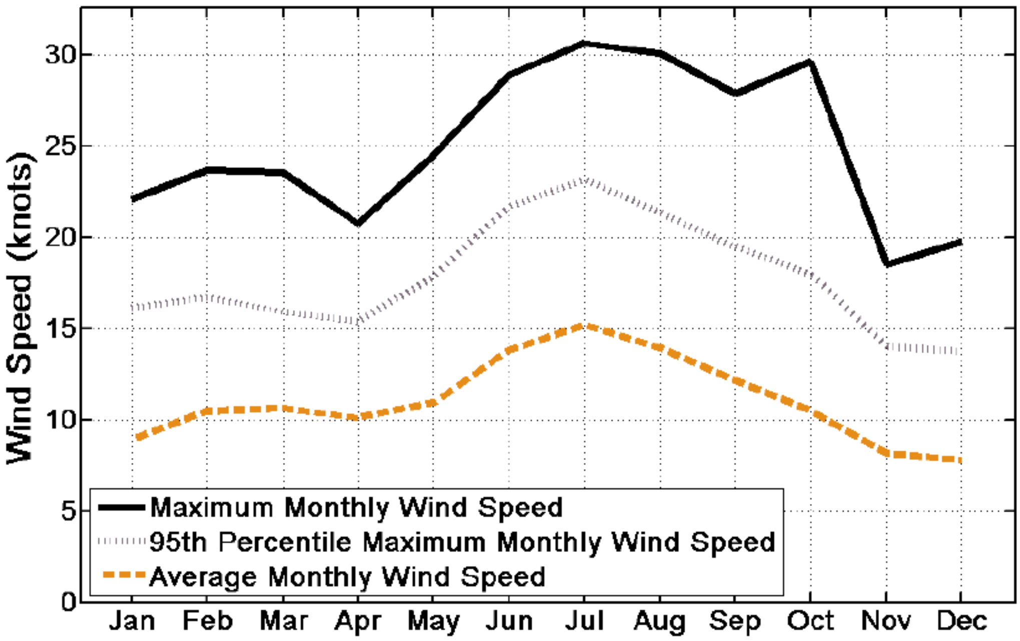
(b) November



Source: RPS-ASA 2012

Average wind speeds are between 5 ms^{-1} (9.7 knots) and 6 ms^{-1} (11.7 knots) and maximum wind speeds are about 16 ms^{-1} (31 knots), occurring in July (*Figure* 4.7). Peak velocities vary throughout the year, with elevated wind speeds during June to September. The highest average velocities occur during July, while the weakest winds are typically in December.

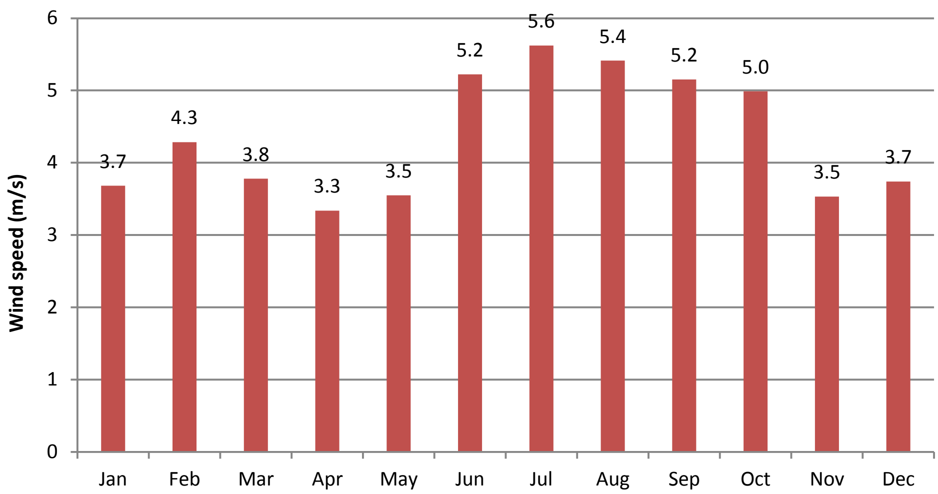
Figure 4.7 ***Monthly Wind Speeds from NCEP Data (Maximum, 95th percentile and Average) for Offshore Station (2003 – 2010)***



Source: RPS-ASA 2012

Average wind speeds for the FPSO location are shown in *Figure 4.8*. Wind speed is highest between June and October with July showing the highest average wind speed of 5.6 ms^{-1} (10.8 knots) and a smaller peak during February. This corresponds with the NCEP data (see *Figure 4.7*). Lowest wind speeds for the offshore station are during April and November (monthly average of 3.3 ms^{-1} (6.4 knots) and 3.5 ms^{-1} (6.8 knots), respectively).

Figure 4.8 *Wind Speed for Reference Station at 4.54 N, 3.10 E (2007 - 2012)*



Source: Lakes AERMET-Ready data for station 4.536389 N, 3.101111 W

4.4 *AIR QUALITY*

The TEN Project is located approximately 60 km offshore and therefore away from any industries, urban areas or other onshore sources of air pollution. The only offshore source of air pollution would be vessels travelling along shipping lanes approximately eight nautical miles to the south as well as vessels involved in oil and gas operations in the DWT block including process emissions from the Jubilee FPSO and combustion emissions from exploration and appraisal well drilling in the vicinity. The airshed in the DWT and WCTP blocks are considered undegraded.

Onshore air quality in the Western Region is expected to be good. Elevated concentrations of pollutants will, however, occur in more densely populated areas such as Axim, Bonyere, Esiama, Half Assini, and STMA, due to combustion sources used for cooking and space heating, road traffic, local and industry. The principal source of atmospheric pollution across central Africa is biomass burning (*eg* firewood for cooking and heating, and controlled burning in savannah areas for agriculture). It has been estimated that Africa accounts for almost one half of the total biomass burnt worldwide (Andrae, 1993). The result of this biomass combustion is the emission of carbon monoxide (CO), oxides of nitrogen (NOx), nitrous oxide (N_2O), methane (CH_4), non-methane hydrocarbons and particulate matter.

TGL conducted ambient air quality monitoring at five locations during 2013 (1), namely the Jubilee FPSO (indoors and outdoors), Accra TGL offices and the Takoradi pipeyard and staff house. The study used passive diffusion tubes to measure concentrations of NO_2, SO_2 and Ozone (O_3). *Table 4.1* presents the minimum, maximum and average measurements for the three

(1) Approximate period June to December 2013.

pollutants of interest. *Table 4.2* presents the World Health Organisation (WHO), US and Ghana Environmental Protection Agency (EPA) air quality standards. All the measured concentrations were within the more stringent WHO air quality standards.

NO_2 concentrations measured for Accra were higher than other locations which is likely to be related to the proximity of a busy six-lane motorway (N1) approximately 80 m from the survey site.

Table 4.1 ***Summary of Ambient Air Quality Monitoring (2013)***

Location	NO_2 (µg m^{-3})			SO_2 (µg m^{-3})			O_3 (µg m^{-3})		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
FPSO indoor	2.9	10.0	4.7	0.4	15.9	3.0	9.5	25.8	19.3
FPSO outdoor	2.0	14.8	4.7	0.3	5.5	1.5	8.5	97.4	65.2
Accra TGL Offices	19.7	60.1	32.3	2.1	12.4	6.3	38.7	95.7	59.9
Takoradi pipeyard	4.7	23.4	9.4	0.7	13.8	3.3	39.9	97.1	64.9
Takoradi staff house	3.0	30.1	9.7	0.8	8.2	3.2	29.6	103.9	53.9

Table 4.2 ***Air Quality Standards (24-hour Mean)***

Standards	NO_2 (µg m^{-3})	SO_2 (µg m^{-3})	O_3 (µg m^{-3})
Ghana EPA (industrial)	150	150	-
Ghana EPA (residential)	60	100	-
WHO	37.6	20	100
US EPA	-	366.8	159

4.5 OCEANOGRAPHY AND HYDROGRAPHY

The oceanography of the Gulf of Guinea comprises the principal water types of the South Atlantic, but is largely influenced by the meteorological and oceanographic processes of the South and North Atlantic Oceans, principally their oceanic gyral currents (Fontaine *et al* 1999; Merle and Arnault 1985). Surface waters are warm (24 to 29 °C) with the daily sea surface temperature cycle showing annual variability. Hydrographic data collected in the Gulf of Guinea indicate that a thermal cycle occurs only in the upper two elements of the water column which together comprise the tropical surface water mass. The oceanic gyral currents of the North and South Atlantic Oceans produce a counter current, the Equatorial Counter Current which flows in an eastward direction. This becomes known as the Guinea Current as it runs from Senegal to Nigeria.

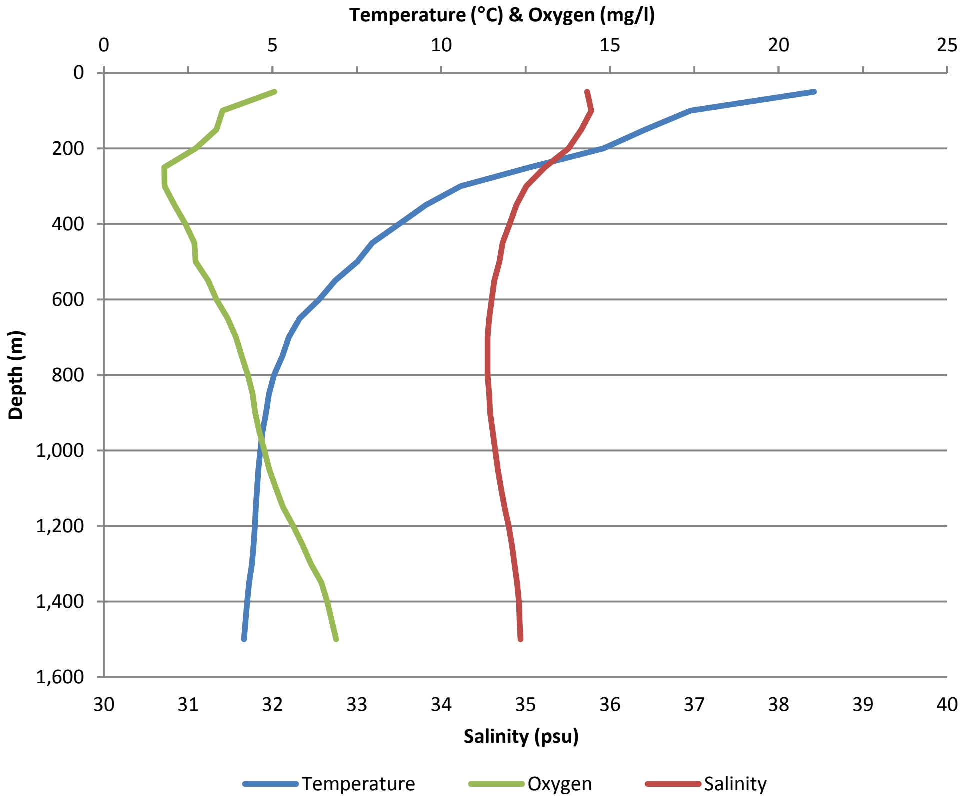
4.5.1 *Temperature and Salinity*

Conductivity, Temperature and Depth (CTD) profiles of the water column and water samples were acquired during the EBS (CSA 2011a) using a SeaBird SBE-19 SeaCat. CTD profiles were taken from near the surface to close to the seabed. Salinity was derived from the conductivity and temperature measurements. In addition, the CTD unit measured dissolved oxygen along depth profiles. Water column samples were taken at two depths, namely at near-surface and at 100 m depth.

A CTD profile for sampling station 4 is shown in *Figure 4.9* and is characteristic of all profiles. Water temperature decreased rapidly in shallow water from 21°C at the near surface to 9°C at 400 m depth. There is an abrupt change in temperature between the surface and 600 m depth, thereafter the decrease in temperature is more gradual to 4°C at 1,500 m. The results show salinity decreasing slightly with depth, with the most significant change occurring between 200 and 400 m depth.

Dissolved oxygen levels reflect the water column processes of primary productivity and respiration/mineralisation. Dissolved oxygen values were 6 to 6.5 mg l^{-1} in the near surface or surface-mixed layer where sunlight allows the highest rates of primary production.

Figure 4.9 ***Temperature, Salinity and Oxygen Profile (Station 4)***



Source: CSA 2011a

Below the surface-mixed layer, decreasing light availability depresses primary productivity and mineralisation of organic matter results in a decrease in dissolved oxygen to under 4 mg l^{-1} below 50 m, then a more gradual decrease down to the oxygen minimum (circa 1.8 mg l^{-1}) between 200 and 300 m depth. Dissolved oxygen levels then shows an increase with depth thereafter to a maximum of 6.9 mg l^{-1} at 1,500 m. This is likely due to the cold, oxygen-rich

Antarctic Deep Water and other water masses present in Gulf of Guinea (see *Section 4.5.2*).

4.5.2 Water Masses

Water masses offshore the Ghanaian coast consist of five principal layers (Longhurst 1962). The topmost layer is the Tropical Surface Water, warm and of variable salinity which extends down to a maximum of about 45 m depending on the seasonal position of the thermocline. Below the thermocline (which varies from 10 to 40 m) occurs the South Atlantic Central Water (cool and high salinity) down to a depth of about 700 m. Below this are consecutively, three cold layers, namely the Antarctic Deep Water (700 to 1,500 m), the North Atlantic Deep Water (1,500 to 3,500 m) and the Antarctic Bottom Water (3,500 to 3,800 m).

4.5.3 Upwelling

Upwelling is the term used when cold, nutrient-rich, water moves from depth up to the surface, resulting in increased plankton productivity in the surface waters. The major upwelling season along the Ghana coast occurs from July through to September/October, while a minor upwelling occurs between December and January/February. The rest of the year is characterised by a strong thermocline.

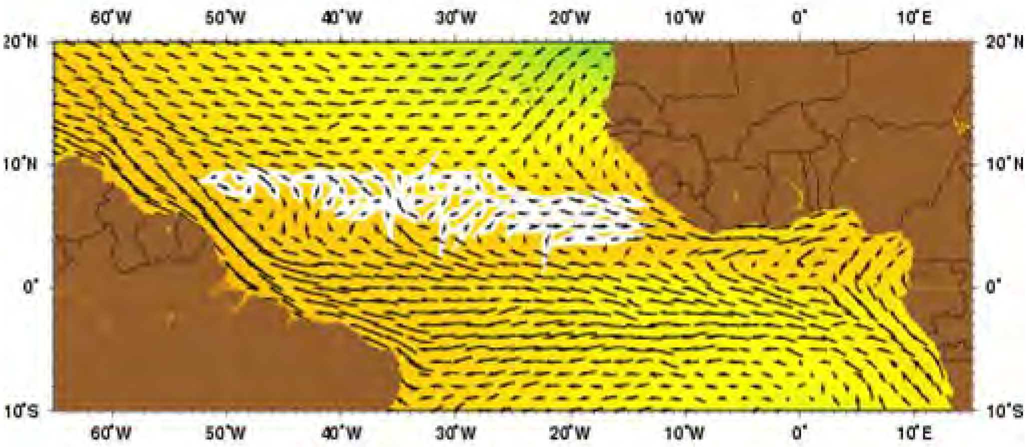
An upwelling index has been developed which is a product of the upwelling duration (change in time) and intensity (change in temperature) which shows a strong positive correlation with fish catches in the region. Regular beach temperature monitoring has revealed that the upwelling intensity is greater within the vicinity of Takoradi where sea surface temperatures are usually lower than elsewhere in Ghanaian waters.

4.5.4 Currents

The offshore waters of Ghana are dominated by the Guinea Current, which is an offshoot of the Equatorial Counter Current shown in *Figure 4.10*. Average currents are oriented to the east and are parallel to the coast. In general, currents within the Guinea Current typically follow the same trends throughout the year with predominantly easterly transport, however, it has been noted that the Guinea Current exhibits minimum velocities during the dry season and maximum velocities during the wet season (RPS-ASA 2012). Additionally, current reversals have been observed particularly during the dry season. These reversals are not well understood but are typically attributed to the changes in flow of the North Equatorial Counter Current, the Canary Current and the Benguela Current (RPS-ASA 2012).

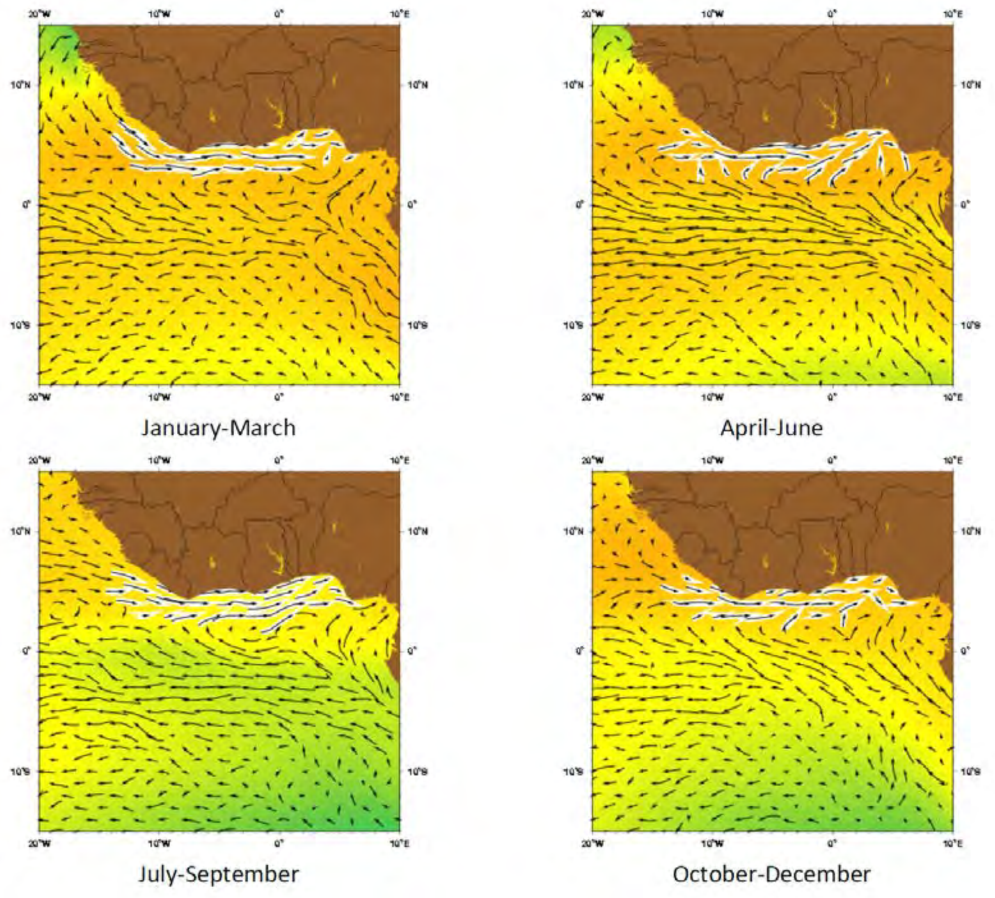
The Guinea Current (*Figure 4.11*) reaches a maximum strength between May and July when it peaks at 1 to 2 knots (approximately 1 ms^{-1}). For the rest and greater part of the year, the current is weaker. The current is less persistent near-shore than farther offshore.

Figure 4.10 *Equatorial Counter Current*



Source: Noble-Denton 2008.

Figure 4.11 *The Guinea Current*



Source: RPS-ASA 2014

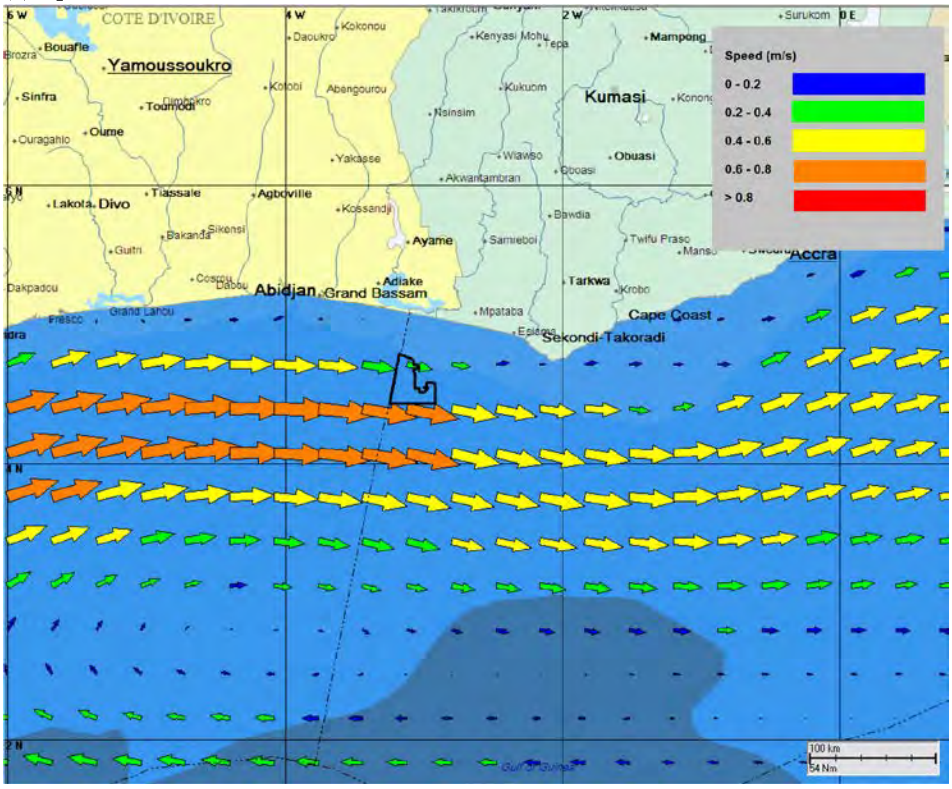
Figure 4.12 presents the monthly average surface HYCOM(1) current field off the coast of Ghana in April and December. The modelling suggests that the

(1) HYCOM is sponsored by the US National Ocean Partnership Program to develop a data-assimilative hybrid isopycnal-sigma- pressure (generalised) coordinate ocean model (HYbrid Coordinate Ocean Model). See http://hycom.org/.

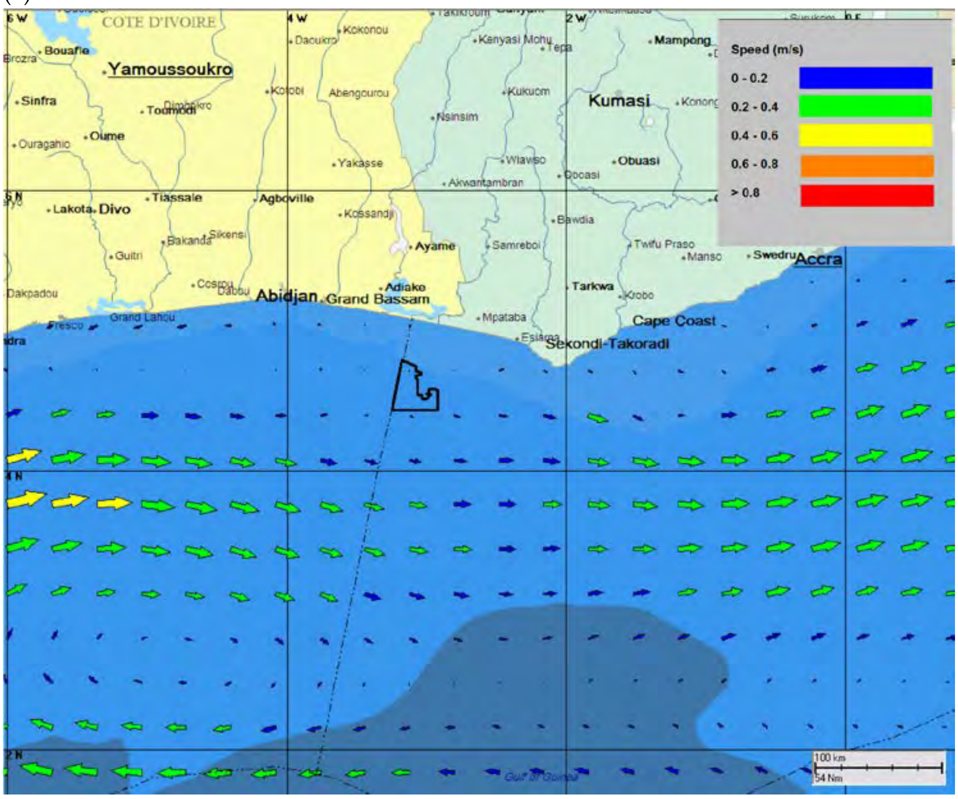
surface currents are stronger in April, with the highest current speed (between 0.6 and 0.8 ms^{-1}) occurring approximately 100 to 200 km offshore Abidjan. At the same location current speed is between 0 and 0.4 ms^{-1} during December.

Figure 4.12 Current Data for the TEN fields

(a) April



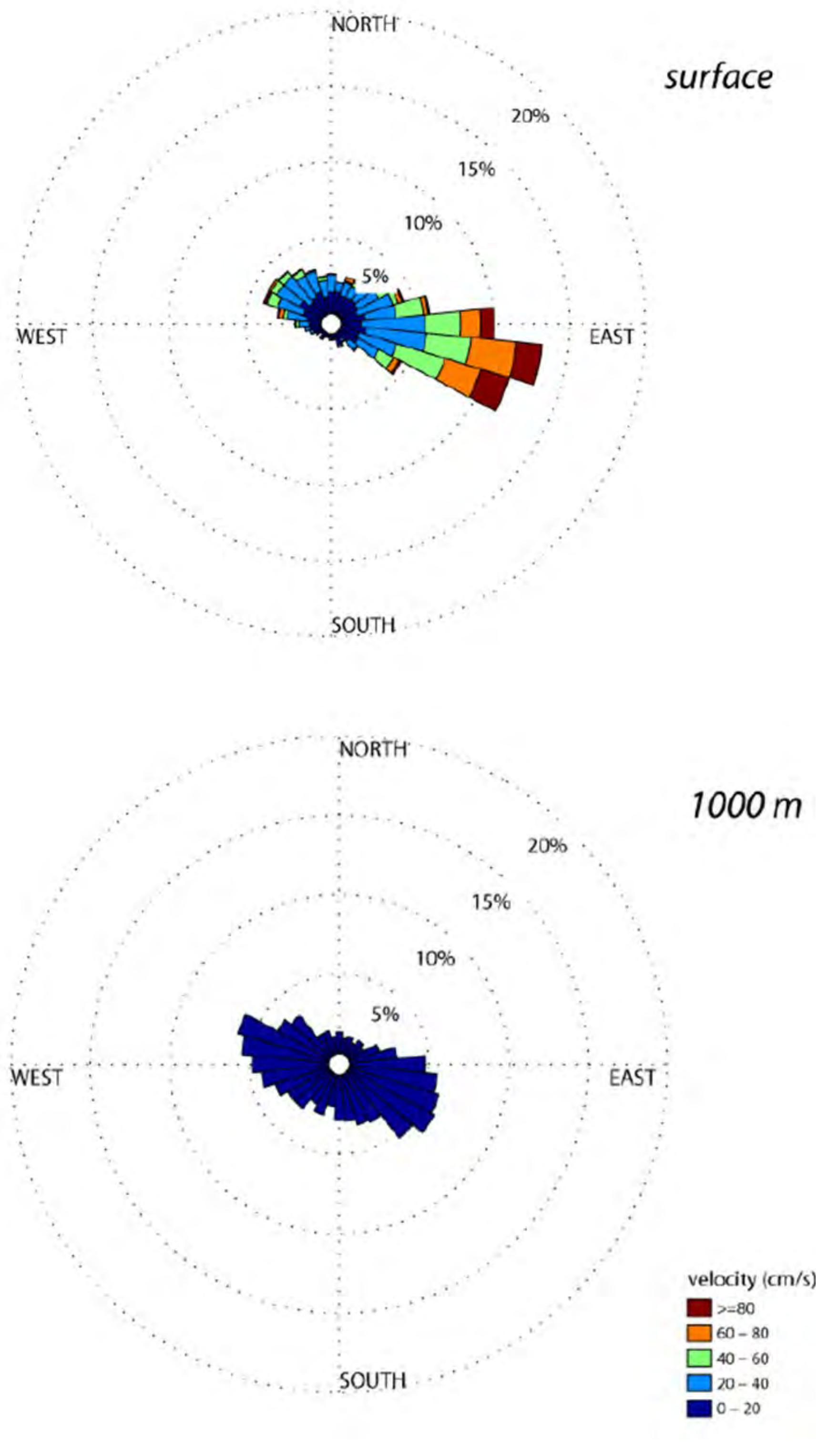
(b) December



Source: RPS-ASA 2013

Figure 4.13 shows the statistical distribution of currents for 2008 to 2013. The near surface currents are persistent towards the east, whereas the currents at 1,000 m depth are more evenly split towards the west and east.

Figure 4.13 HYCOM Current Roses at the Surface and 1,000 m Depth in April (2008-2013)

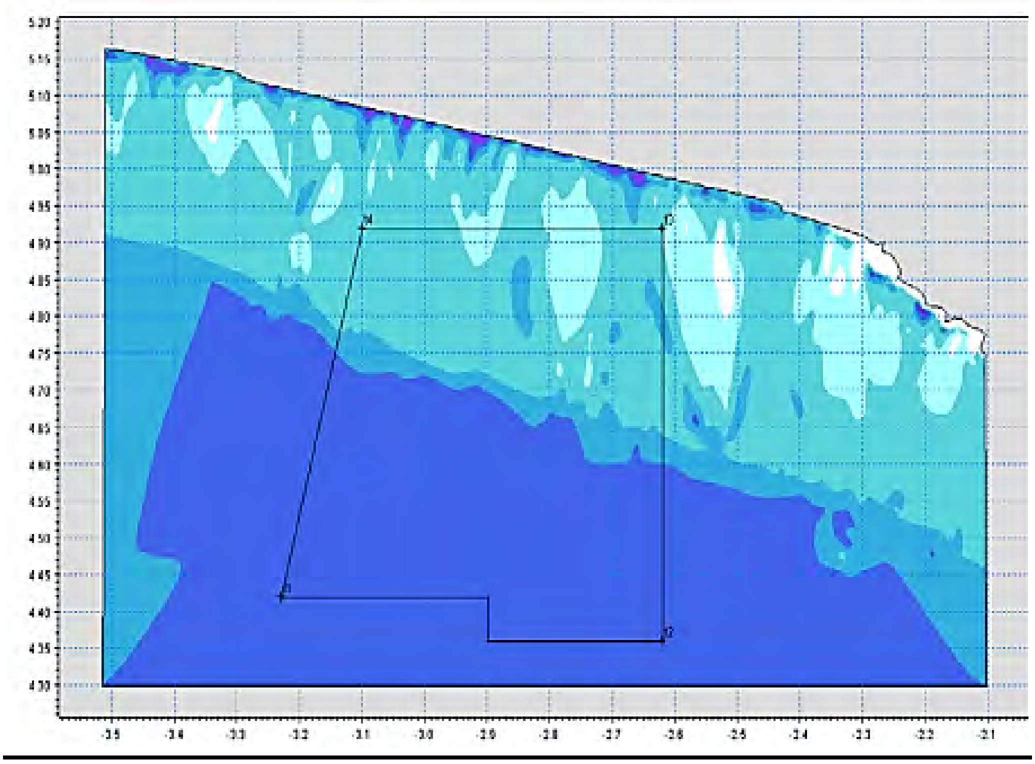


Source: RPS-ASA 2014

4.5.5 Waves

Waves reaching the shores of Ghana consist of swells originating from the oceanic area around the Antarctica Continent and seas generated by locally occurring winds (Noble-Denton 2008). The significant height (*Figure 4.14*) of the waves generally lies between 0.9 m and 1.4 m and rarely attains 2.5 m or more. The most common amplitude of waves in the region is 1.0 m but annual significant swells could reach 3.3 m in some instances. Swells attaining heights of approximately five to six meters occur infrequently with a 10 to 20 year periodicity. The peak wave period for the swells generally falls in the range of seven to fourteen. The swell wave direction is almost always from the south or south-west. Other observations on the wave climate include a long swell of distant origin with wavelengths varying between 160 and 220 m. This swell has a primary period of 12 seconds and a relatively regular averaged height between 1 to 2 m. The swells generally travel from southwest to northeast.

Figure 4.14 Significant Wave Height Offshore Ghana

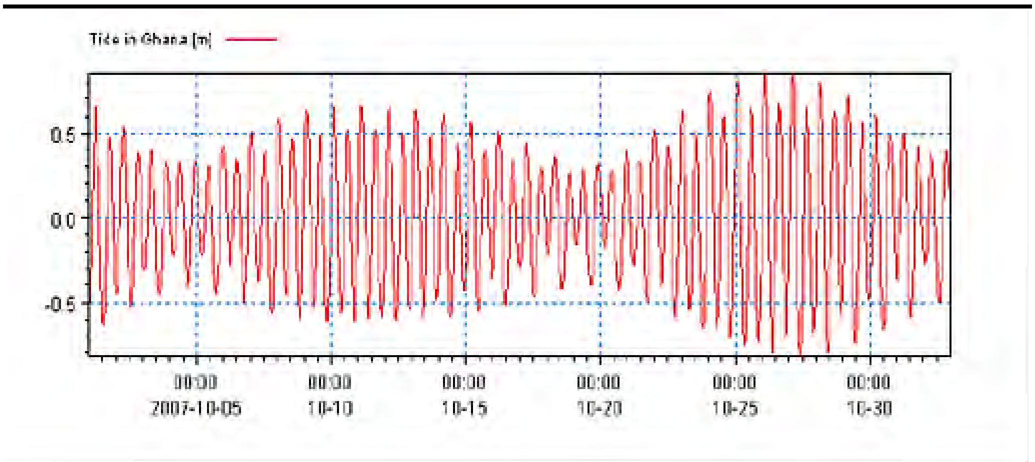


Note: Outline of Cape Three Points and Deepwater Tano concession blocks are shown.
Source: Noble-Denton 2008.

4.5.6 Tides

The tide on the coast of Ghana is regular and semi-diurnal (*Figure 4.15*). The average range varies along the coast, as shown in *Table 4.3* for the main cities. As can be seen, the tidal wave has virtually the same phase across the coast of the country. The average range of Neap and Spring tides increases from west to east. Tidal currents are low and have an insignificant influence on coastal processes except within tidal inlets. Other possible sources of intermittent increases of local water levels include line squalls and the transfer of energy from internal to surface tides. These processes could result in additional increases of about 0.30 m.

Figure 4.15 *Astronomical Tide in 4°N 2.5°W in October 2007*



Source: Noble-Denton 2008.

Table 4.3 *Tidal Range for the Coast of Ghana*

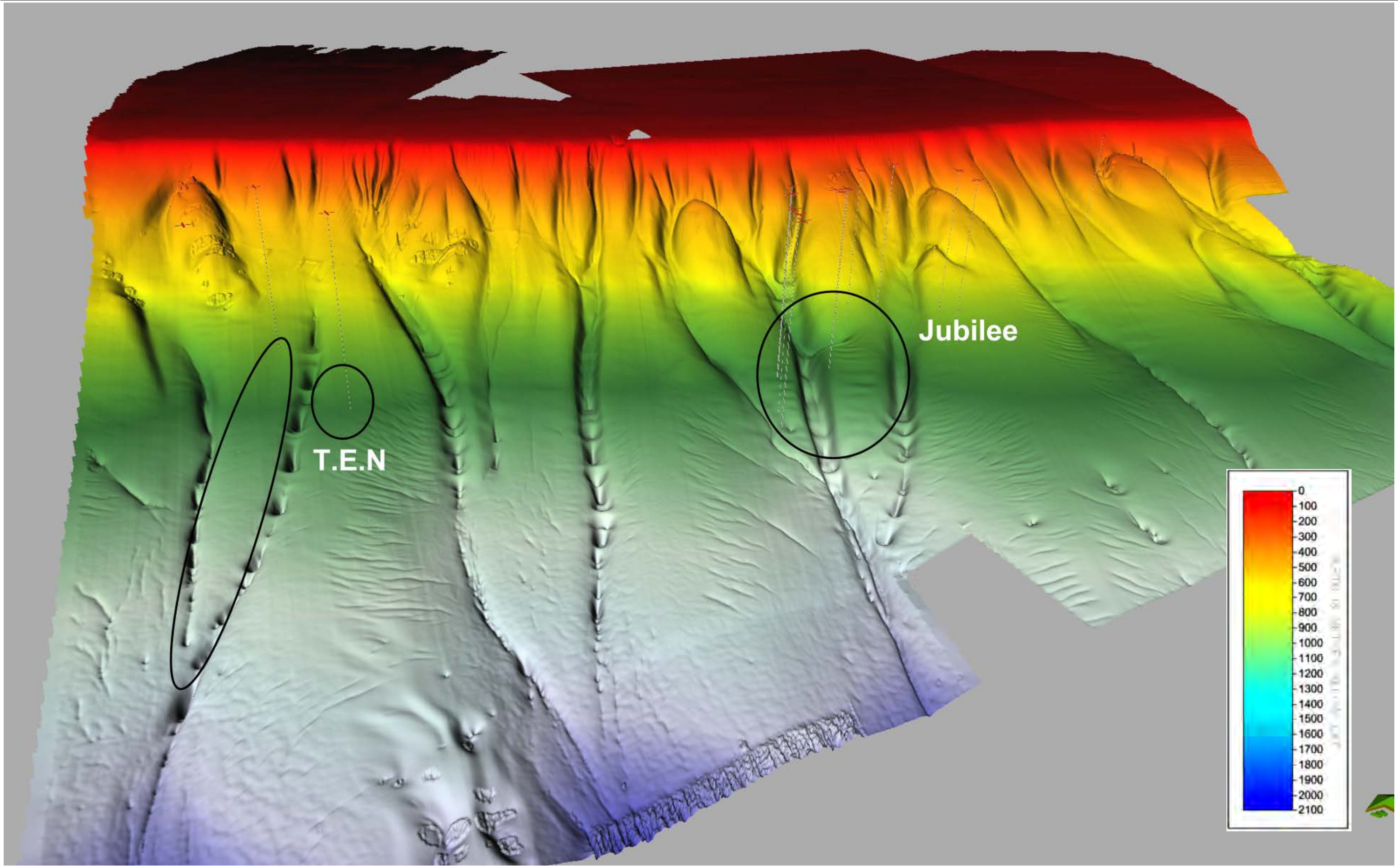
Location	Tidal Range (m) Neap	Mean	Spring	Phase
Takoradi	0.58	0.90	1.22	107°
Accra	0.62	0.94	1.26	107°
Tema	0.64	0.96	1.28	107°
Aflao	0.68	1.00	1.32	108°

Source: Noble-Denton 2008.

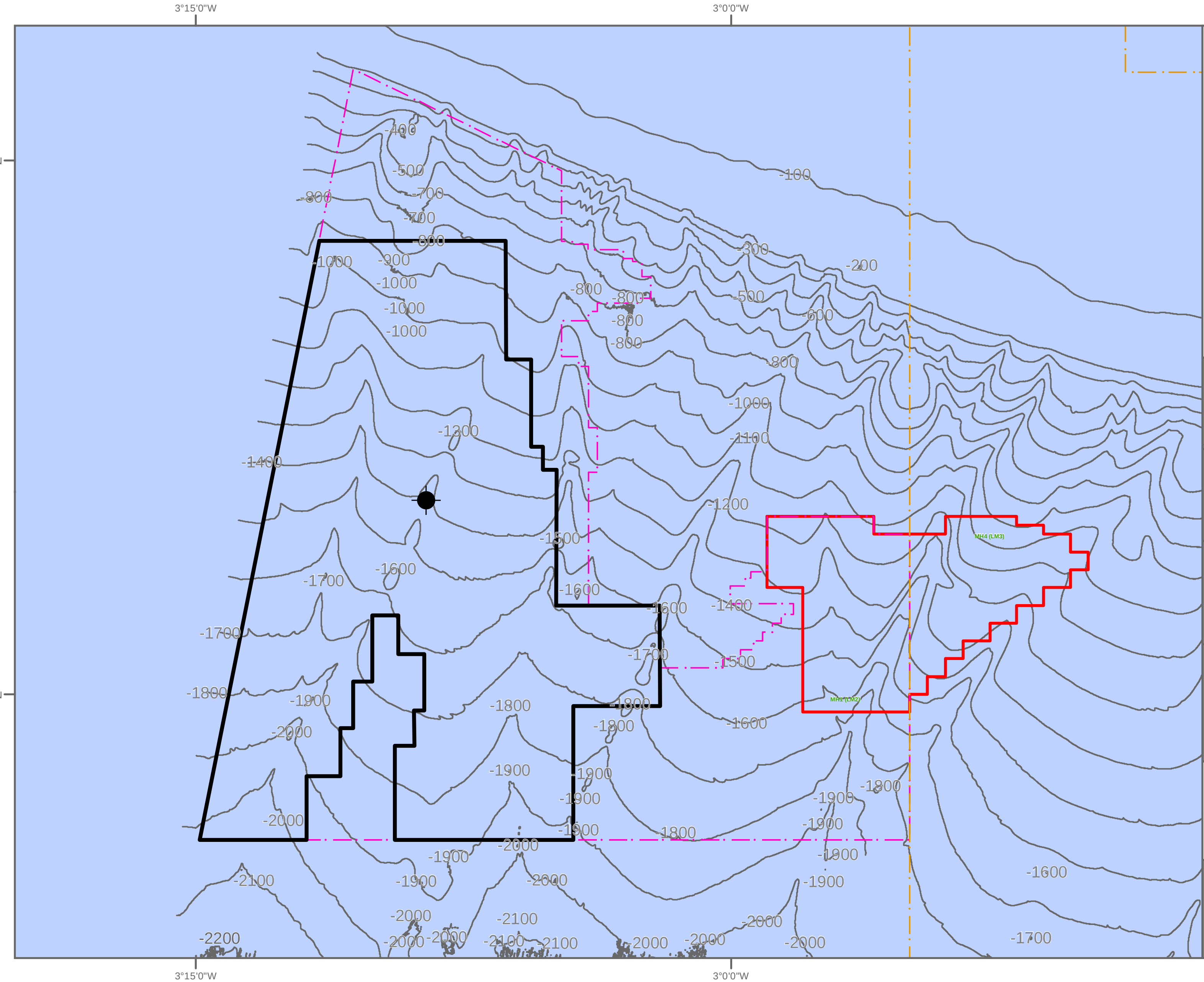
4.6 BATHYMETRY AND SEABED TOPOGRAPHY

The TEN Project is located on the continental slope offshore Ghana in water depths of 1,000 to 2,000 m. The continental shelf has a generally regular bathymetry with isobaths running parallel to the coast. The shelf drops off sharply at about the 140 m depth contour where the slope gradient increases to nearly 10° before reducing to around 5-6°. Immediately following the shelf break, distinctive submarine canyons become apparent on the continental slope. These canyons measure up to 1,400 m across and are 140 m deep, with gradients along the flanks in excess of 40° (Gardline 2011a). The TEN Project area lies in between two of these distinctive seabed canyons (see *Figure 4.16* and *Figure 4.17*).

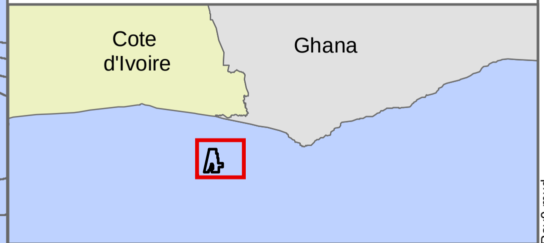
Figure 4.16 Bathymetric Schematic



Source: Gardline 2011a.



TEN Project Area
Jubilee Unit Area
West Cape Three Points Block
DWT Block
TEN FPSO



0 2.5 5 7.5 10
Kilometers
N

SCALE: As scale bar
SIZE: A4
PROJECT: 0142816
DATE: 10/04/2014

REVISION: 1
DRAWN: GB
CHECKED: JW
APPROVED: MI

Figure 4.17
Seabed Bathymetry

ERM
TEN project

PROJECTION: WGS 1984 UTM Zone 30N
SOURCE: Client

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Bathy_Rev0.mxd

The seabed on and over the continental shelf is generally smooth, with low relief sinuous ridge-like features which may be corals, outcropping bedding planes and/or areas of cemented sediments. Sediments initially comprise a gently dipping sequence of well layered sediments which are expected to comprise predominantly claystone. Small channels are apparent immediately below the seabed, the infill of which may differ from surrounding sediments (Gardline 2011a).

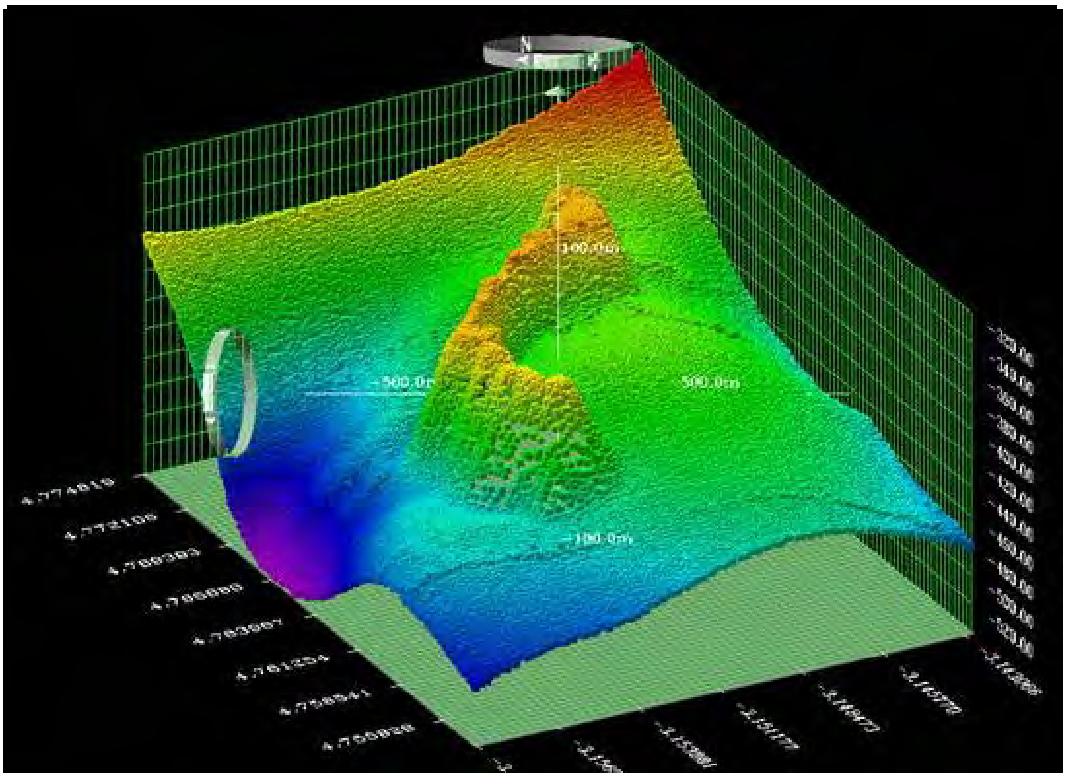
Aside from the submarine canyons, the generally smooth seabed continues beyond the shelf break and down the continental slope. However, a series of slightly oblique down slope sediment ridges/furrows are observed in water depths between 1,260 and 1,640 m. Throughout the deepwater, sediments predominantly comprise very soft clay that is expected to be in excess of 10 m thick overlaying claystone. There is evidence of faulting within the canyon infill sediments and along the flanks of canyons (Gardline 2011a).

Data from a recent geophysical survey of the TEN Project area (Fugro 2013) was largely in agreement with the earlier survey work. The predominant lithology throughout the area is expected to comprise very soft clay with occasional laminations of sandy to silty clay. This interpretation of lithology also extends along the export pipeline route from TEN to Jubilee.

Seabed sediment grain size is further described in *Section 4.7.2*.

An area of coral reef has been identified in the DWT block, north-west of the TEN Project area (10.6 km from the nearest TEN well). *Figure 4.18* presents an enlarged section of the bathymetric map showing the reef and a photograph of the reef taken during the R/V Dr Fridtjof Nansen survey in 2013.

Figure 4.18 Reef Structure Identified in DWT Block



Enlarged bathymetric map from Figure 4.16

Picture by R/V Dr Fridtjor Nansen

4.7 *WATER AND SEDIMENT QUALITY*

The principal source of information on water and sediment quality for the development area is the TEN EBS (CSA 2011a). The survey was conducted by CSA off the R/V JW Powel in March 2011. Sampling stations coordinates and water depths are provided in *Table 4.4* and a map of the sampling locations in relation to the TEN Project is presented in *Figure 4.19*.

The TEN EBS involved the following activities:

- daily water column profiling and water collection;
- seafloor sediment sampling at 15 sampling stations; and
- reconnaissance seafloor plan-view imagery.

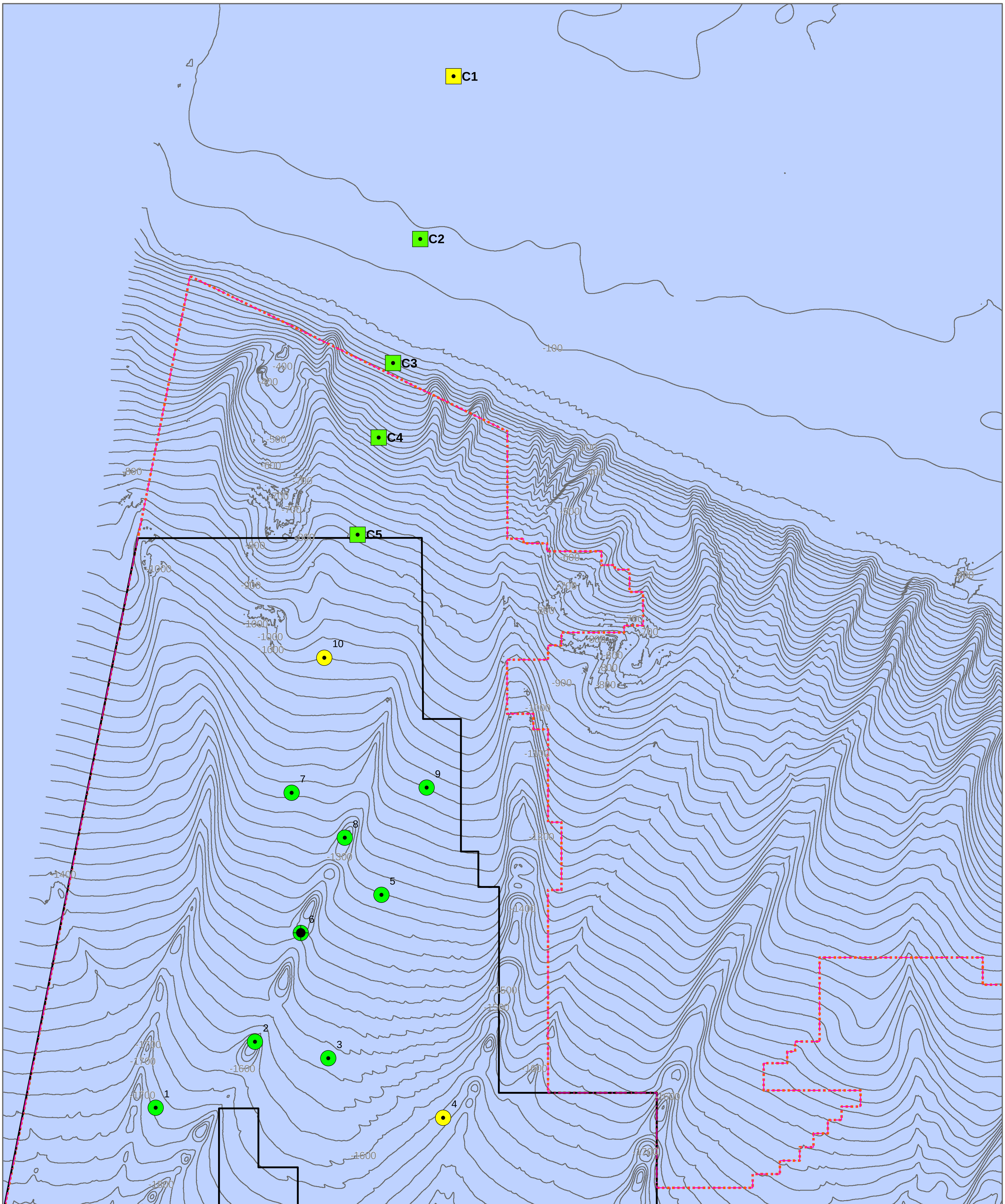
Water depths for the ten sampling stations within the TEN Project area ranged between 997 m and 1,659 m, and for the five sampling stations along a linear transect towards shore (over the continental shelf) between 77 m and 807 m.

EBSs that were previously conducted offshore Ghana provide additional regional information on sediment and water quality. These include the EBS for the Jubilee Phase 1 development that was undertaken by TDI Brooks in 2008 (TDI Brooks 2008) and the marine environmental surveys of bottom sediment undertaken by the Norwegian Institute of Marine Research (IMR) in 2009 (IMR 2009) and in 2011 (IMR 2012). The IMR (2012) report concluded that the results of the metal analysis showed values with the lower part of what is defined as good conditions with no risks of ecological effects and compared to European and Norwegian standards mostly well below what is regarded as background levels. Data from other more recent surveys have not been formally reported but will provide additional background data for future projects.

Table 4.4 TEN EBS Sampling Station Coordinates and Water Depth

Station	Latitude (north)	Longitude (west)	Water Depth (m)
TEN Project area			
1	4°32′13.823"	3°11′12.898"	1,659
2	4°33′26.895"	3°09′23.441"	1,463
3	4°33′08.818"	3°08′02.302"	1,091
4	4°32′02.649"	3°05′55.510"	1,631
5	4°36′09.763"	3°07′03.734"	1,272
6	4°35′27.277"	3°08′32.930"	1,409
7	4°38′02.828"	3°08′42.929"	1,181
8	4°37′13.082"	3°07′44.316"	1,302
9	4°38′08.625"	3°06′13.887"	1,094
10	4°40′32.403"	3°08′06.851"	997
Transect towards shore			
C1	4°51′16.552"	3°05′44.158"	77
C2	4°48′16.448"	3°06′21.104"	91
C3	4°45′58.755"	3°06′51.019"	341
C4	4°44′36.261"	3°07′06.766"	496
C5	4°42′48.703"	3°07′28.978"	807

Source: CSA 2011a.
Note: Coordinates in DMS (WGS 84)



TEN FPSO

Environmental Baseline Survey Sampling Stations

- Sediment
- CTD/Water Quality/Sediment
- Sediment
- CTD/Water Quality/Sediment

West Cape Three Points Block

DWT Block

TEN Project Area

Seabed Contours (25m)

0 1 2 3 4 5
Kilometers

N

Figure 4.19
Environmental Baseline Survey Locations

SCALE: As scale bar	REVISION: 1
SIZE: A3	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 14/04/2014	APPROVED:MI

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_SurveysCSA_Rev0.mxd

4.7.1 *Water Quality*

Water samples were collected using five litre Niskin and GO-Flo water samplers mounted on a Rosette sampler. Results from the water column sampling are shown in *Table 4.5*. Total nitrogen and phosphorus were present in all samples with minor differences among samples at the same water depth. There was a much higher concentration of nitrogen and phosphorus in deeper samples for all stations. There were no apparent differences in chlorophyll and phaeophytin[(1)] between stations 4 and 10. The differences between near surface and at depth can be attributed to differences in primary productivity and organic mineralisation. In surface waters photosynthesis will be active resulting in an uptake of nutrients, reducing concentrations of nitrogen and phosphorus whereas at 100 m depth organic mineralisation will be greater resulting in higher concentrations.

Table 4.5 Total Nitrogen, Total Phosphorus, Chlorophyll (Total and Active) and Phaeophytin in Water Samples

Station	Depth	Total Nitrogen (mgl^{-1})	Total Phosphorus (mgl^{-1})	Total Chlorophyll (μgl^{-1})	Active Chlorophyll (μgl^{-1})	Phaeophytin (μgl^{-1})
4	Near surface	0.15	0.0141	-	-	-
	100 m	0.40	0.0525	-	-	-
10	Near surface	0.22	0.0144	0.68*	0.56*	0.29*
	100 m	0.40	0.0545	0.68*	0.56*	0.29*
C1	Near surface	0.15	0.0161	0.68	0.56*	0.30
	100 m	0.24	0.0335	0.68*	0.48	0.29*

Note: * Detection limit
Source: CSA 2011a.

No data on hydrocarbons were available due to sample contamination. Hydrocarbon data from an EBS for the Jubilee Field in January 2010 showed Total Petroleum Hydrocarbon (TPH) values in seawater at the near surface ranged from 22 to 30 μgl^{-1} and 18 to 33 μgl^{-1} at a depth of 100 m. Total Polycyclic Aromatic Hydrocarbons (PAHs) ranged from 40.8 to 58.2 μgl^{-1} in near surface samples and from 32.4 to 38.1 μgl^{-1} in samples from 150 m depth. These results are comparable to other deep-water surveys conducted worldwide and indicate good water quality at the TEN Project area.

4.7.2 *Sediment Quality*

Sediment samples were collected during the CSA (2011a) environmental baseline survey using two sizes of box core. Samples from all stations in the TEN Project area and the deeper stations along the transect towards shore (>400 m) were collected with a 50 cm by 50 cm (0.25 m^2) box core. Sediment samples from stations along the shallower sections of the transect route were collected with a 30 cm by 30 cm (0.09 m^2) box core. Sediments were sampled and analysed for both biological and physicochemical parameters.

(1) A bluish-black waxy pigment that can be formed from chlorophyll by treatment with a weak acid.

Grain Size and Total Organic Carbon

Results from the sediment grain size analysis are presented in *Table 4.6*. Sediments collected from the development area and the most seaward and deepest stations along the transect route are primarily clayey silt (comprising >75% silt) while the sediment from the shallower sampling stations are silty sand (CSA 2011a).

The highest Total Organic Carbon (TOC) values were recorded in the offshore stations where the finer grained sediments were found. Lower and more variable TOC concentrations were associated with sandier sediments collected at the shallower stations along the transect to the shore, ranging from 0.82% to 2.55% with an average 1.51%. TOC concentrations in samples from the deeper water offshore stations ranged from 2.33 to 2.79% with an average of 2.55% (CSA 2011a). The differences in TOC between offshore area stations and the stations along the transect to the shore is likely to be related to the differences in grain size between the locations (CSA 2011a).

Analysis of samples from the Jubilee field identified three main sediment types, namely sand, silt and clay. Most of the Jubilee survey stations were dominated by clays and silts with exception of one where sand fractions dominated (TDI Brooks 2008). TOC values were low and ranged from 1.2% to 3.0%; generally agreeing with those recorded in the TEN fields.

Table 4.6 Total Organic Carbon (TOC) and Grain Size Distribution

Station	TOC (%)	Sand (%)	Silt (%)	Clay (%)	Classification
TEN Project Area					
1	2.431	1	78	21	Clayey silt
2	2.546	1.4	75.2	23.4	Clayey silt
3	2.789	1.6	75.7	22.7	Clayey silt
4	2.326	0.7	74.3	25	Clayey silt
5	2.689	1.3	77.6	21	Clayey silt
6	2.565	1.5	78.4	20.2	Clayey silt
7	2.457	1.9	75.4	22.7	Clayey silt
8	2.523	3.6	68.3	28.1	Clayey silt
9	2.612	2.3	77.5	20.3	Clayey silt
10	2.546	3.5	76.3	20.2	Clayey silt
Transect towards shore					
C1	0.988	53.5	36.9	9.6	Silty sand
C2	0.82	58	32.2	9.8	Silty sand
C3	1.178	49.8	34.3	15.9	Silty sand
C4	2.016	26.9	57.1	16	Silty sand
C5	2.553	4.6	77.1	18.3	Clayey silt

Source: CSA 2011a

Hydrocarbons

Concentrations of TPHs and PAHs are shown in *Table 4.7*. Concentrations of TPHs were generally higher in the offshore stations compared to the transect route stations (average 42 and 36 μg g^{-1}, respectively). This is likely to be related to the sediment composition with higher levels being found in the lower energy finer sediment areas where organics accumulate.

The distribution of TPH concentrations generally indicates that proximity to previous wellsites may be associated with higher hydrocarbon concentrations, however, there is no defined concentration gradient with proximity to these well sites. Therefore the spatial variability is more likely to be related to local hydrographic and topographic conditions affecting sediment and discharge transport (CSA 2011a).

Concentrations of PAHs reflected concentrations of TPH levels and were generally higher in the offshore area compared to the transect route to shore (average 504 ng g^{-1} and 346 ng g^{-1}, respectively) (CSA 2011a).

The concentrations of TPH and PAHs were higher than those recorded in the Jubilee field which varied between the sampling stations and ranged from 81 ng g^{-1} to 176 ng g^{-1} (dry weight) (TDI Brooks 2008).

There are no defined standards for hydrocarbons as they vary depending on location, anthropogenic activities, natural seeps and, where applicable, their nature and composition.

The Dutch quality standards for mineral oil in soil sediments have an action level of 5,000 µg g^{-1} for the reuse of sediment material. Based on these standards the concentrations recorded during the surveys are considered to be very low.

For PAHs, a concentration of 100,000 ng g^{-1} is used as a screening criteria for disposal of marine sediments in the UK. Based on this figure then concentrations from the CSA 2011 survey would be considered to be very low.

Table 4.7 Concentrations of Hydrocarbons in Sediments

Station	TPH (µg g^{-1})	PAH (ng g^{-1})	Station	TPH (µg g^{-1})	PAH (ng g^{-1})
TEN Project Area			**Transect towards shore**		
1	65	2,111	C1	24	49.6
2	53	1,211	C2	23	113
3	42	161	C3	34	65.8
4	30	239	C4	43	227
5	38	225	C5	54	346
6	37	207			
7	36	169			
8	40	274			
9	35	230			
10	49	213			

Source: CSA 2011a

Metals

Metal concentrations recorded in sediments are summarised in *Table 4.8*. At the offshore development area sediments consisting primarily of silt generally exhibited higher metal concentrations than at shallower transect stations where sediments were predominantly sand.

Seabed sediment quality in the TEN fields is generally good. *Figure 4.20* shows the concentrations of metals in the sampled sediments. The guideline standards for the protection of aquatic life derived from available eco-toxicological studies from the Canadian Council of Ministers for the Environment (CCME) (1), the Dutch Quality standards (2) and the UK CEFAS Action Levels (3) are presented for comparison. The CCME guideline standards are the most stringent and the concentrations of metals in relation to these standards are discussed below.

Concentrations of chromium, copper, nickel, lead, tin and zinc were generally higher in the development area than along the transect route although there was no defined concentration gradient. Approximately half the stations showed exceedances of CCME Threshold Effect Level (TEL) for chromium and copper but no exceedances of the Probable Effect Level (PEL). There were no exceedances of either the PEL or TEL for lead and zinc. There are currently no guideline thresholds for nickel, tin and cobalt.

Concentrations of arsenic were generally similar for both the transect route and the development area (range from 5.8 to 14.7 $mgkg^{-1}$) with the highest concentrations on the transect route and away from the drill site. Approximately half of the stations showed a small exceedance of the TEL (7.24 $mgkg^{-1}$), however, there were no exeedances of the PEL (41.6 $mgkg^{-1}$). Exposure to the TEL is considered to have a likely effect on some sensitive benthic species (ie lower abundances of individuals) whereas exposure to the PEL is likely to cause adverse effects to a wider range of organisms, depending on the sensitivity of the species present (CCME 1999). Arsenic is widely found in natural sediments predominantly in its inorganic form which has limited bioavailability. The recorded concentrations of arsenic in the sediment samples form part of the existing baseline conditions and occur across the survey.

The UK standard for dredged material disposal defines 20 $mg\ kg^{-1}$ as the level below which arsenic concentrations are not considered a concern; similarly the Dutch target concentration for dredge material disposal is 29 $mg\ kg^{-1}$.

(1) The guidelines are derived from available toxicological information according to the formal protocol established by the CCME.
(2) The Dutch quality standards are internationally recognised for assessing the chemical quality of dredged material.
(3) CEFAS Action Levels are defined for assessing dredged material and its suitability for disposal at sea. In general, contaminant levels below AL1 are of no concern and are unlikely to influence a licensing decision. However, material with contaminant levels above AL2 is generally considered unsuitable for sea disposal.

Slightly elevated concentrations of barium were also found. Although naturally occurring, barium is also a primary component of barite-based drilling fluids employed in the oil and gas industry. Barium concentrations in the development area were relatively high (average of 631.9 mg kg^{-1}), which may be considered to be typical of sediments found near previous wellsites where barium-related discharges have occurred (CSA 2011a). There were four wells existing in the TEN development area at the time of the EBS sediment sampling. The concentration of barium in seabed sediments will also be related to the sediment particle size composition with higher levels expected in finer sediments in the deeper offshore areas. The previous EBS undertaken for the Jubilee field also showed that all the offshore stations sampled within and close to the Jubilee field had elevated concentrations of barium (144 ppb to 291 ppb) compared to the stations closer to shore (range 23 to 42 ppb) (TDI Brooks 2008).

Cadmium and mercury are heavy metals that are a concern because of their potential environmental impacts. Concentrations of cadmium in the development area were generally high (average 0.23 mg kg^{-1}) while concentrations along the transect route were comparable with levels normally found in marine sediments (CSA 2011a). Despite being higher than average, there were no exceedances of the TEL for cadmium. Concentrations of mercury were low for both the development area and the transect route (average 0.072 and 0.043 mg kg^{-1}, respectively) and are within the typical range for marine sediments (CSA 2011a). There were no exceedances of the TEL for mercury. Mercury was not detected in any of the samples taken from within the Jubilee field (TDI Brooks 2008). Cadmium concentrations were also not detected in the samples (method detection limit = 0.1 ppb) except at stations J-2, J-4 and J-7 where a concentration of 0.2 ppb was recorded for each station.

Concentrations measured during the environmental baseline survey were either within the same range or higher than those measured at the Jubilee field (TDI Brooks 2008). Concentrations of lead in particular were higher than those at Jubilee which ranged between 4.7 and 5.3 mg kg^{-1}. With the exception of sampling station 4, the majority of measurements fell within the Jubilee field ranges for copper (16.5 to 18.8 mg kg^{-1}), chromium (39.6 to 48.2 mg kg^{-1}) and zinc (46.1 to 49.3 mg kg^{-1}) (IMR 2009).

Table 4.8 *Total Metal Concentrations in Sediment Samples (mg kg^{-1})*

Station	Water depth (m)	Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Cobalt (Co)	Chromium (Cr)	Copper (Cu)	Mercury (Hg)	Nickel (Ni)	Lead (Pb)	Tin (Sn)	Zinc (Zn)
1	1,649	7.2	753	0.19	9.18	54.1	25.5	0.07	42.5	13.2	1.29	61.2
2	1,463	7.9	550	0.23	8.61	53.2	23.6	0.06	38.5	12.4	1.02	57.7
3	1,091	5.8	594	0.21	5.98	45.4	16.5	0.06	28.7	8.11	0.715	45
4	1,631	7.1	887	0.44	13.6	114	40.5	0.08	65.1	15.4	1.63	96.9
5	1,272	8.4	599	0.22	8.42	55.4	22	0.07	36.5	16.6	0.983	57.6
6	1,409	8.3	695	0.22	8.72	54.9	23.3	0.1	38.8	12.2	1.04	57.9
7	1,181	8.5	658	0.22	8.58	60	22.7	0.07	38.7	12	1.08	61.3
8	1,302	5.8	444	0.14	6.2	40.6	14.5	0.07	25.7	7.56	0.736	41.2
9	1,094	7.9	670	0.24	7.8	55.9	20.4	0.07	34.8	10.7	0.964	56.2
10	997	13.1	469	0.22	7.82	55.9	19.8	0.07	36.3	10.7	0.946	55.1
C1	77	8.6	67	0.1	3.18	34	3.7	ND	12.2	4.12	0.257	23.3
C2	91	7.1	53.1	0.17	2.6	29.6	3.5	ND	11.5	2.9	0.229	19.6
C3	341	14.7	105	0.14	5.25	69.5	5.2	0.02	17	4.44	0.505	43
C4	496	6.5	202	0.17	5	49.3	8.4	0.04	20.5	5.1	0.512	38.3
C5	807	5.8	384	0.27	5.34	49.1	15.6	0.07	30.3	7.7	0.4376	45.7
Average marine sediments		7.7	460	0.17	3-6	72.0	33	0.19	52	19.0	ND	95
Continental crust		1.7	584	0.1	24	126.0	25	0.04	56	14.8	2.3	65
CCME *	TEL	7.24	-	0.7	-	52.3	18.7	0.13	-	30.2	-	124
	PEL	41.6	-	4.2	-	160	108	0.7	-	112	-	271
Dutch quality	Target	29	-	0.8	-	100	35	-	35	85	-	140
standards*	Reference	55	-	7.5	-	380	90	-	45	530	-	720
CEFAS	AL1	20	-	0.4	-	50	30	0.25	30	50	-	130
(revised)**	AL2	70	-	4	-	370	300	1.5	150	400	-	600

Source: CSA 2011a. ND=No Data.

Note: Values for average marine sediments (Salomons and Förstner 1985) and continental crust (Wedepohl 1995)

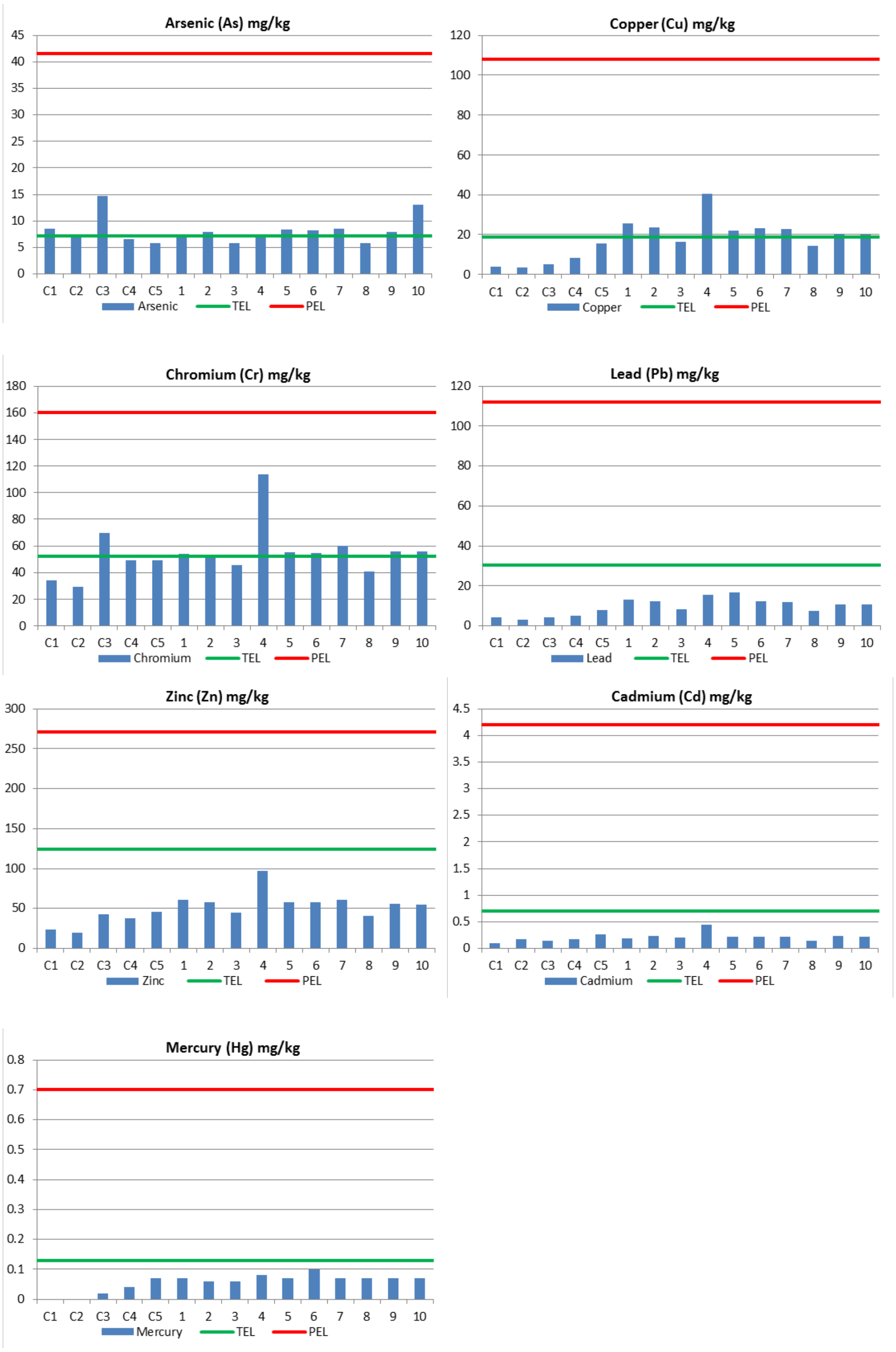
*: Canadian Environmental Quality Guidelines - The lower assessment value, the threshold effect level (TEL), represents the concentration below which adverse biological effects are expected to occur rarely. The upper assessment value, the probable effect level (PEL), defines the level above which adverse effects are expected to occur frequently.

**: The Dutch quality standards are internationally recognised for assessing the chemical quality of dredged material.

***: CEFAS Action Levels are defined for assessing dredged material and its suitability for disposal at sea. In general, contaminant levels below AL1 are of no concern and are unlikely to influence a licensing decision. However, material with contaminant levels above AL2 is generally considered unsuitable for sea disposal.

.

Figure 4.20 Metal Concentrations against CCME Threshold Values



Source: CSA 2011a.

4.8 *MARINE HABITATS AND SPECIES*

4.8.1 *Plankton*

Information on plankton (phytoplankton and zooplankton) was sourced from previously documented surveys in the Gulf of Guinea including EIAs for the West Africa Gas Pipeline Project (WAPC 2004) and other research programmes (*eg* Guinea Current Large Marine Ecosystem project Fisheries Resource Surveys, 2006-2007) and available published sources (*eg* Wiafe 2002). Phytoplankton and zooplankton form a fundamental link in the food chain. Plankton community composition and abundance is variable and depends upon water circulation into and around the Gulf of Guinea, the time of year, nutrient availability, depth and temperature stratification.

Phytoplankton

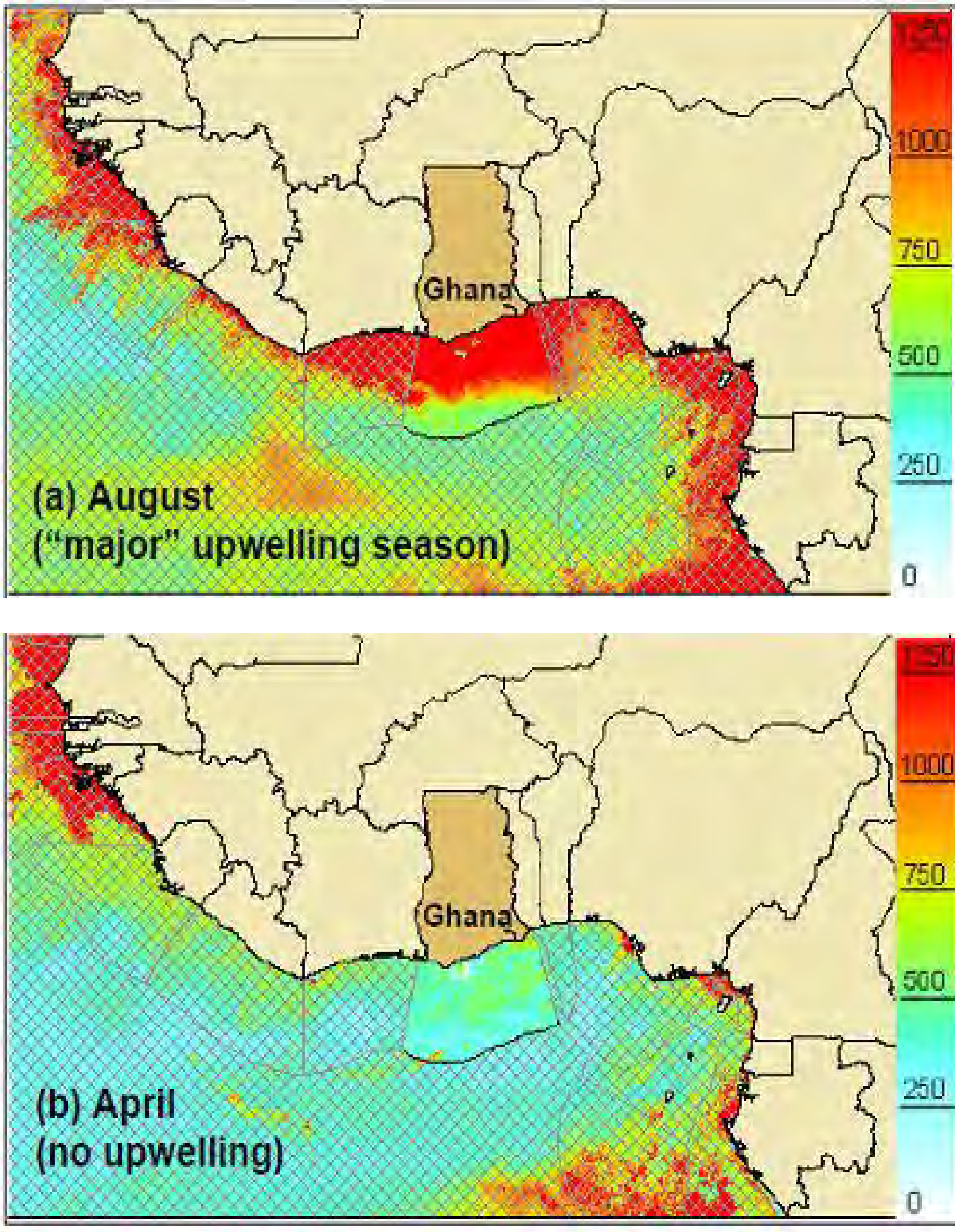
Phytoplankton, grouped as diatoms, dinoflagellates and coccolithophores, are microscopic and range between 30 mm and 60 mm in size. Primary production is linked to the amount of inorganic carbon assimilated by phytoplankton via the process of photosynthesis. Primary production determined for the Gulf of Guinea is about 4,305 to 5,956 mg Cm^{-3} per day (see *Figure 4.21*). Typically, productivity in the offshore ecosystems (100 to 200 m water depth) range from 10 to 100 mg Cm^{-3} per day. Thus, the values obtained within the nearshore areas indicate a system of relatively high productivity. This is not unexpected since the coastal ecosystem of the area undergoes seasonal upwelling that commences in July, which coincided with the WAPC survey period.

The phytoplankton biomass concentrations in the eastern tropical Atlantic are low compared to some other coastal upwelling systems, however, the spatial extent and temporal stability of the enrichment processes allows the development of large phytoplankton cells, consequently there is high zooplankton concentration and this is conducive to high fish production (Jones and Henderson 1987).

The environmental baseline study for the West African Gas Pipeline project (WAPC 2004) was carried out within the nearshore area (15 to 65 m depth) of the Gulf, between Nigeria and Ghana, and identified 69 species of phytoplankton. The phytoplankton community was dominated by *Chaetoceros* spp, possibly a result of planktonic responses to seasonality of the hydrographic regime (Wiafe 2002). Other planktonic species included *Dinophysis acuta*, which is a harmful microalgae with the potential to cause diarrhetic shellfish poisoning in bloom condition at high concentrations (Anderson *et al* 2001).

Distribution of the species indicated that *Penilia avirostris*, a cladoceran, dominated the community in terms of number of individuals. However, a dinoflagellate species, *Chaetoceros* spp, occurred in high numbers at all locations sampled. The diversity of phytoplankton species for the WAGP study ranked highest off the shelf of Ghana compared to the other locations studied (*ie* Togo, Benin and Nigeria).

Figure 4.21 ***Primary Productivity (mg Cm^{-3} per day) Offshore Ghana during August and April***



Source: Sea Around Us Project 2008.

Studies within the nearshore areas of the Western Region of Ghana (*ie* Saltpond, Elmina, Takoradi and Half Assini) show that the dominant phytoplankton species were *Ceratium, Cheatoceros, Rhizosolinia*, and *Peridinium* with the *Ceritium* spp being the dominant taxa.

Zooplankton

Offshore zooplankton assemblages are dominated by copepods, followed by Ostracods(1), Appendicularians(2) and Chaetognaths(3). Maximum abundance is during the primary upwelling although they are also abundant during the secondary upwelling(4).

WAGP (2004) surveys identified 52 zooplankton species. *Penilia avirostris*, *Temora stylifera* and *Para-Clausocalanus* spp dominated the zooplankton community. Species of zooplankton recorded in the nearshore environment in the Western Region of Ghana included *Cyclopoids: Oncaea, Corycaeus, Farranula; Calanoids: Acartia, Clausocalanus, Calanoides, Temora, Centropages, cirripid nauplius, Podon, Evadne, Penilia, Lucifer protozoa, Appendicularia/Oikopleuara, Pontellia nauplius* and *Sagitta*.

Benthic decapod larvae and large crustacean numbers are at their highest between February to June and October to December. Carnivorous species dominate the plankton during the warm season and diversity is high but abundance low. Herbivorous zooplankton, dominated by *Calanoides carinatus* is highly abundant in upwelling conditions. These are later replaced by omnivorous species (*eg Temora turbinate* and *Centropages chierchise*).

4.8.2 Benthic Invertebrates

Benthic fauna forms an important part of the marine ecosystem, providing a food source for other invertebrates and fish as well as cycling nutrients and materials between the water column and underlying sediments. The benthos is made up of diverse species, many of which are relatively long-lived and/or sedentary. Different species of benthic fauna exhibit different tolerances to stress, making them useful indicators of environmental conditions. The Ghana marine environment has not been extensively studied for its marine benthic communities, particularly in deeper waters.

This section is principally based on information obtained on marine macrobenthic faunal assemblages from the TEN fields and transect towards shore during the EBS (CSA 2011a). The survey assessed macrobenthic fauna from ten sediment sample grabs from stations within the TEN Project area and five sediment grab samples from stations from the transect route (*Figure 4.19*).

(1) Ostracoda is a class of the Crustacea, sometimes known as the seed shrimp because of their appearance.
(2) Larvaceans (Class Appendicularia) are solitary, free-swimming underwater saclike filter feeders found throughout the world's oceans.
(3) Chaetognatha is a phylum of predatory marine worms that are a major component of plankton worldwide.
(4) The major upwelling begins between late June or early July when sea surface temperatures fall below 25°C and ends between late September or early October. The minor upwelling occurs either in December, January or February.

Data gathered during the Jubilee EBS (TDI Brooks 2008) have been used to further inform this section providing context to the results of the TEN EBS. The Jubilee EBS was conducted in September 2008 and consisted of 15 sediment sample grabs: nine from the Jubilee field and six in shallower water closer to shore.

The IMR marine environmental survey (IMR 2009) was conducted offshore the Western Region of Ghana and covered a wide area, including the Jubilee field. At the Jubilee field, sampling was carried out prior to drilling at the wellsite J7. The stations were located at a distance of 250 m to the northwest and 250 m and 1,000 m southeast of wellsite J7. A further 18 grab sites on three transects off the western coast of Ghana were sampled. The results of this survey are discussed in the following section to provide context to the results of the TEN EBS.

Figure 4.22 shows the benthic sampling stations from the TEN EBS, the Jubilee EBS and the IMR (2009) survey.

Macroinfauna Methodology

Deepwater sediment samples were collected with a 0.5 m x 0.5 m box core (0.25 m^2). The sample from the 0.25 m^2 box core was partitioned with a 0.35 m x 0.35 m stainless steel insert (*Figure 4.23*). A sub-sample was taken from the top 15 cm of the 0.125 m^2 surface area of the insert for chemical and sediment particle size analysis.

Sediment samples from stations along the transect route on the continental shelf (stations C1, C2 and C3) were collected with a 0.3 m x 0.3 m (0.09 m^2) box core. The full content of these box cores was used for the macroinfaunal analysis. Replicate samples were taken from the shallower transect stations.

Sediment collected for macroinfaunal analyses was wet-sieved on board over a 0.5 mm mesh sieve. The sieved samples were then transferred to a sample container and preserved using a 10% borax-buffered formalin solution stained with Rose Bengal dye. The samples were stored in either 500 ml or 1 litre plastic jars, depending on the sample volume, labelled, taped and stored aboard the vessel.

Epifauna Methodology

High quality colour digital still imagery of the seabed was acquired at each station using a plan-view underwater camera (Ocean Imaging Model DSC6000). The plan-view underwater camera (PUC) system was fitted with two Ocean Imaging Model 400-37 Deep Sea Scaling lasers and to aid in field survey efficiency, a Benthos Model 2216 Deep Sea Pinger was also attached to the camera frame to indicate when successful image acquisition was achieved. The PUC imagery was used to generally characterise the soft bottom substrates and associated biota.

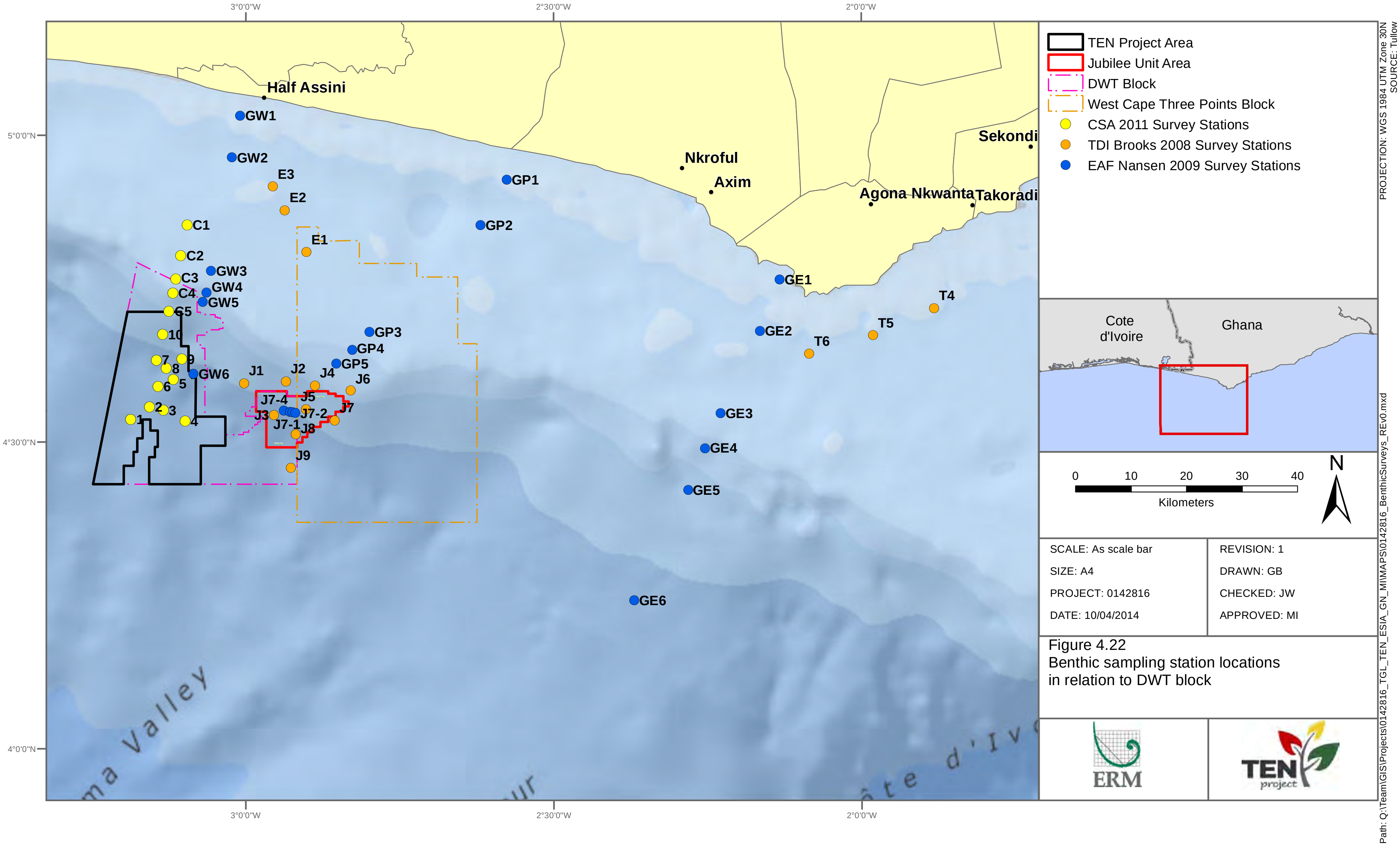


Figure 4.22
Benthic sampling station locations in relation to DWT block

Figure 4.23 Collection of Macroinfaunal Samples from an Insert within the Box Core Sample

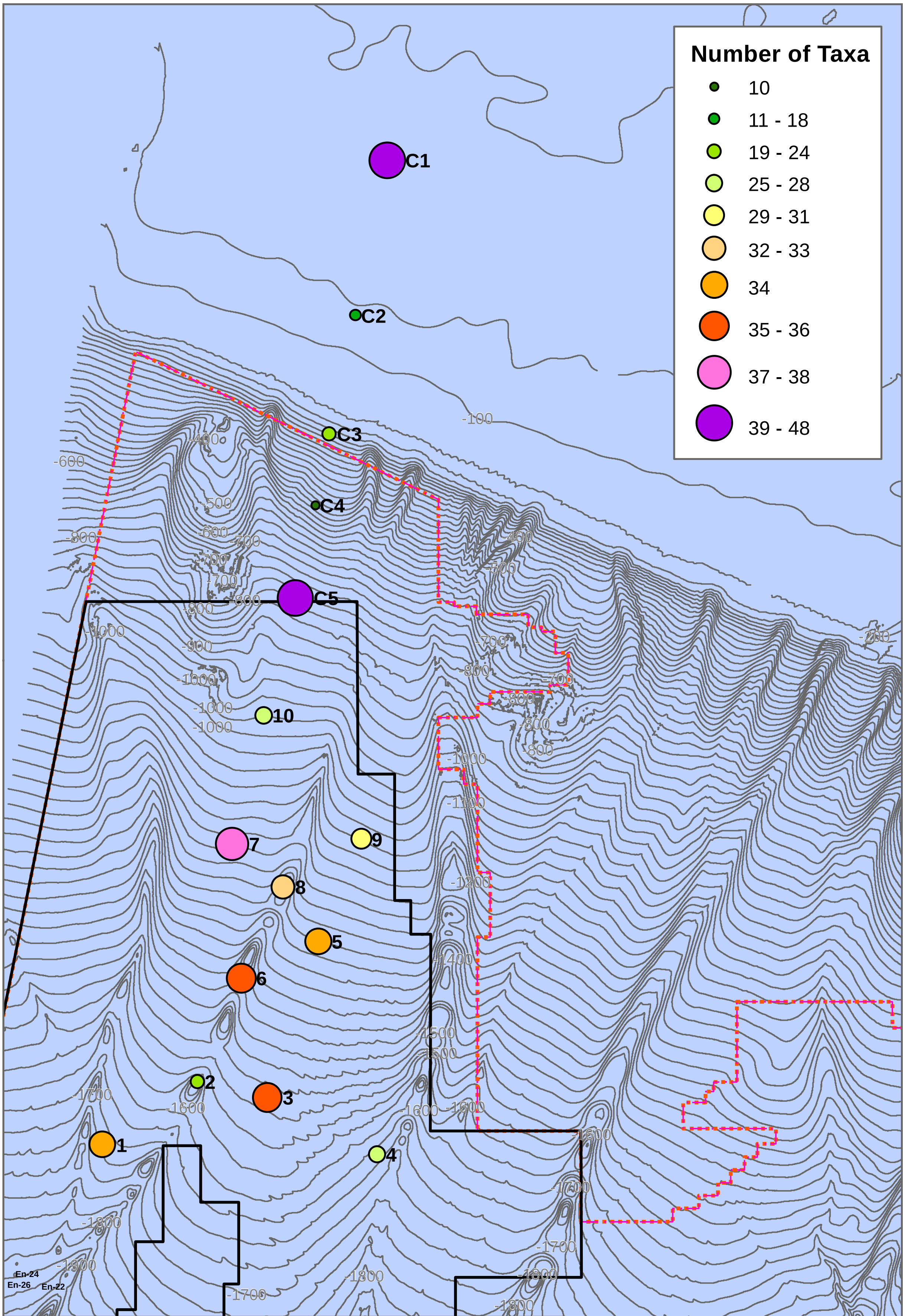
Source: CSA 2011a.

Macroinfauna

Abundance and Richness

The abundance of macroinfauna in the area of the TEN EBS ranged from 449 to 808 individuals m^{-2} with an average of 634 individuals m^{-2}. The abundance at the transect stations varied from 189 to 978 individuals m^{-2} with an average of 508 individuals m^{-2}. Abundances recorded from stations from both the development area and transect were much greater than those recorded for the Jubilee EBS (TDI Brooks 2008) which reported a range of 25 to 385 individuals m^{-2} and an average of 195 individuals m^{-2}. Abundances recorded during the IMR survey (IMR 2009) were more varied (117 to 2,244 individuals m^{-2}). The lowest number of individuals in the IMR survey was recorded at the deep stations near the Jubilee field and the highest number was recorded along transects in shallower waters (stations GP1-GP5 on *Figure 4.22*).

Macroinfaunal abundance was greatest at transect station C1 and decreased progressively with increased water depth to the development area stations (*Figure 4.24)* (CSA 2011a). There was no observed relationship between the proximity of the wellsite locations and the number of macroinfauna.



TEN Project Area

DWT Block

Seabed Contours (25m)

0 1 2 3 4 5

Kilometres

N

Figure 4.24
Grab Sample Locations and Abundance (Density of Individuals)

SCALE: 1:200,000	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

ERM

TEN project

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Benthic_Portrait_Rev0.mxd

Polychaetes and crustaceans were numerically dominant in both the TEN Project area and the transect route (*Table 4.9*). Polychaetes were also the dominant group in both the Jubilee EBS and the IMR survey.

Table 4.9 **_Proportional Abundance of Taxonomic Groups in the TEN EBS_**

	Polychaeta	Bivalvia	Gastropoda	Crustacea	Echinodermata	Other Taxa
Development Area	46%	7%	3%	31%	2%	11%
Transect	64%	2%	0%	14%	4%	16%
All Stations	**54%**	**5%**	**2%**	**24%**	**3%**	**13%**

Source: CSA 2011a.

The number of taxa recorded at stations within the TEN Project area varied from 24 to 38 taxa with an average of 32 taxa. Stations along the transect route were more variable with a range of 10 to 48 taxa and an average of 27 taxa. Both the Jubilee EBS and the IMR survey recorded a more variable number of taxa. The number of taxa recorded per station from the Jubilee EBS ranged from 20 to 78 with a mean of 39. The IMR survey recorded a range of 49 to 227 taxa, which followed the same trend as species abundance with greater numbers recorded from stations along the transects to shore and small numbers of taxa from stations in the deeper Jubilee field area.

Polychaetes and crustaceans were also the dominant taxonomic group (taxonomic richness) in the TEN Project area and the transect route (*Table 4.10*).

Table 4.10 **_Taxonomic Richness by Taxonomic Group in the TEN EBS_**

	Polychaeta	Bivalvia	Gastropoda	Crustacea	Echinodermata	Other Taxa
Development Area	46%	8%	3%	30%	5%	8%
Transect	65%	3%	1%	15%	5%	11%
All Stations	**55%**	**6%**	**2%**	**23%**	**5%**	**10%**

Source: CSA 2011.

Table 4.11 provides the Pielou index and Shannon-Wiener index for each survey station. Evenness, which is determined using the Pielou index, appears to be less diverse, indicated by a higher index value, at transect stations compared to development area sites. Shannon-Wiener gives an indication of the species diversity at each station. These values were very similar between development area stations and more variable between the transect stations.

Table 4.11 Community Indices for Macroinfauna Samples

Station	Pielou Index J'	Shannon-Wiener H'(loge)
1	0.9435	3.177
2	0.9103	2.814
3	0.8885	2.992
4	0.9211	2.888
5	0.8924	3.065
6	0.9075	3.024
7	0.9044	3.045
8	0.9617	3.096
9	0.8793	2.865
10	0.837	2.587
C1a	0.9376	3.435
C1b	0.9377	3.307
C2a	1.0000	2.565
C2c	0.9916	3.151
C3b	0.9335	2.749
C3c	0.8892	2.209
C4a	0.9866	1.768
C4b	0.8831	2.552
C5a	0.9366	3.246
C5b	0.9163	2.197

Benthic Community Structure

The results of the multivariate statistical analysis including cluster analysis and Multi-Dimensional Scaling (MDS) ordination are presented in *Figure 4.25* and *Figure 4.26*.

The deepwater samples in the development area were distinct from the samples collected on the continental shelf along the transect route. Of the deepwater development area sites, station 8 was distinct from the other nine stations, which all had similar taxonomic composition (similarity >38%).

The taxonomic composition of transect sites was more variable. For stations C1 and C3, the macroinfaunal composition from the two replicate box cores (a and b) was similar (similarity >31%). In contrast, the macroinfaunal community at stations C2, C4, and C5 was not as similar (similarity <25%), based on comparison of two replicates from each station.

Figure 4.25 Dendogram Showing the Similarity of Benthic Communities at Each Station

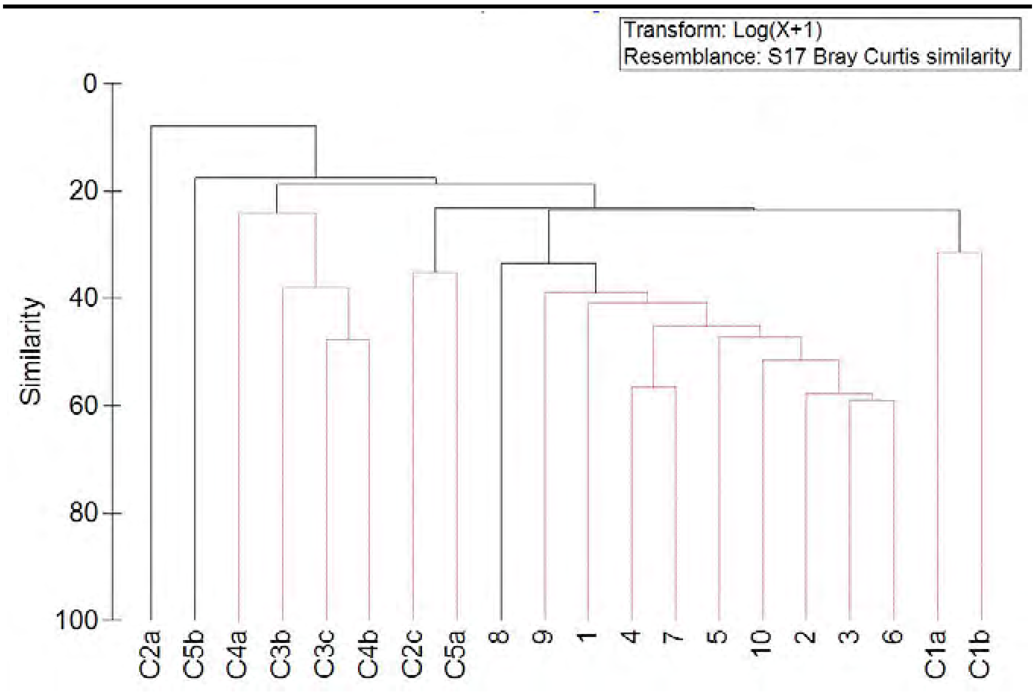
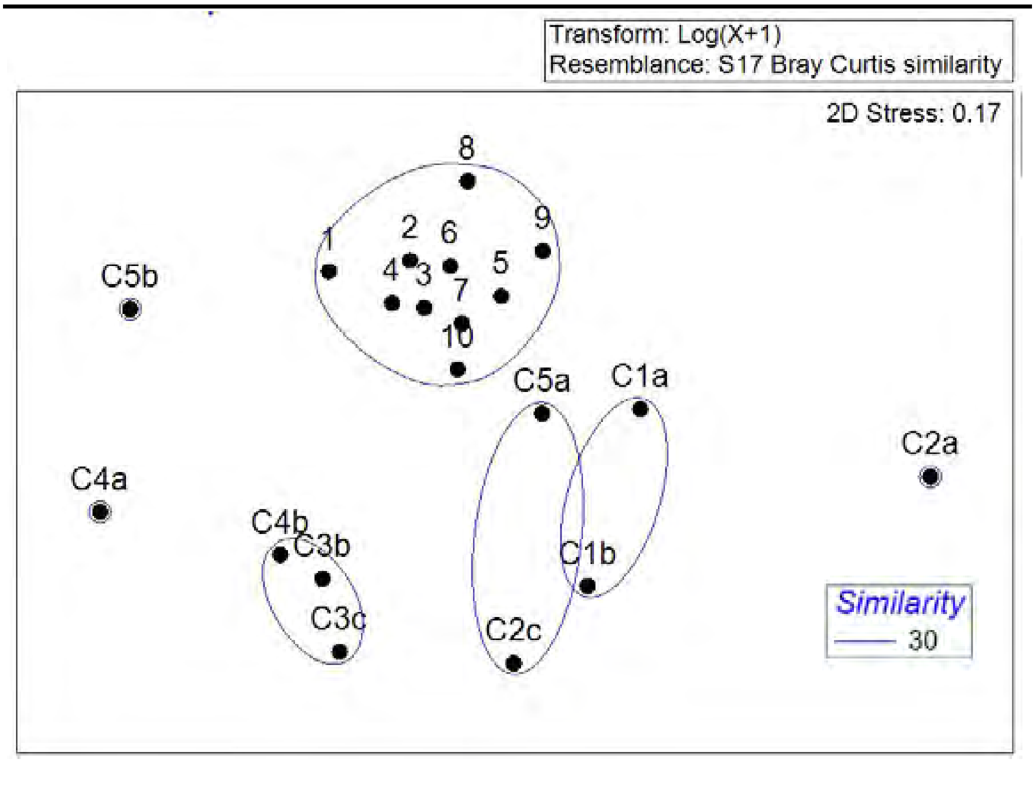


Figure 4.26 Cluster Analysis of Benthic Communities (MDS Plot)



Source: CSA 2011a.

Stations with a similarity of 30% or greater were grouped as shown in *Figure 4.26*. PRIMER(1) was used to identify which species primarily accounted for observed differences in macroinfaunal communities between sample groups. *Table 4.12* presents the predominant species identified in the analysis for each sample group.

Table 4.12 Predominant Species Identified in the SIMPER Analysis

Sample Grouping	Taxa*	
C2a	*Chloeia cf. inermis* (P) *Eunice vittata* (P) *Marphysa* sp B (P) *Diopatra neapolitana capensis* (P) *Harmothoe* sp A (P) *cf. Plesionika heterocarpus* (C) *Amphipholis* sp A (E)	*Tharyx dorsobranchialis* (P) *Marphysa* sp A (P) *Glycera longipinnis* (P) *Scoloplos* sp A (P) *Chaetoderma* sp (G) *Amphioplus archeri* (E)
C5b	*Aricidea longobranchiata* (P) *Spiophanes* sp (P)	*Prionospio cf. steenstrupi* (P)
C3b, C3c, C4a, C4b	*Paraonis gracilis oculata* (P) *Aricidea (Acmira) simplex* (P)	*Prionospio sexoculata* (P) *Magelona cincta* (P)
2c 5a	*Isolda cf. pulchella* (P) *Tharyx* sp A (P) *Aglaophamus (Nephthys) lyrochaeta* (P)	*Capitella capitata* (P) *Eunice vittata* (P) *Paraonides* sp A (P)
C1a C1b	*Paralacydonia paradoxa* (P) *Polyophthalmus pictus* (P) *Caulleriella cf. acicula* (P)	*Tharyx dorsobranchialis* (P) *Amphioplus archeri* (E)
8	*Harpinia* sp (C) *Nephthys* sp A (P) *Aricidea (Acmira) cerrutii* (P) *Nucula* sp (B)	*Aricidea (Acmira) lopezi* (P) *Tharyx dorsobranchialis* (P) *Paraonides lyra lyra* (P) *Tellina* sp C (B)
1, 2, 3, 4, 5, 6, 7, 9, 10	*Harpinia* sp (C) *Joeropsis* sp (C) *Chaetoderma* sp (G) *Aedicira* sp A (P)	*Polyophthalmus pictus* (P) *Paraonis gracilis oculata* (P) *Prionospio cirrifera* (P)

* Major taxonomic level identified in parentheses after taxon name.
B = Bivalvia; C = Crustacea; E = Echinodermata; G = Gastropoda; P = Polychaeta.

All the development area stations, with the exception of station 8, were characterised by the presence of the microcrustacean species *Harpinia* sp and *Joeropsis* sp, polychaetes *Aedicira* sp A, *Polyophthalmus pictus*, *Paraonis gracilis oculata*, and *Prionospio cirrifera*, and the gastropod *Chaetoderma* sp. While *Harpinia* sp was also present, the predominant species at station 8 included

(1) PRIMER is a statistical software package for conducting multivariate analysis on abiotic and biotic datasets (Clarke and Gorley, 2001). This software package is used by benthic ecologists worldwide to investigate the similarities and patterns of biological communities and environmental variables.

several different polychaete and bivalve species not encountered at any of the other development area stations.

Results of the analysis also revealed four separate groupings among the transect stations. Very few species co-occurred among the groups (*Table 4.12*). While each station grouping contained species unique to that grouping, several species such as the brittlestar *Amphioplus archeri* and the polychaete *Tharyx dorsobranchialis* were present in multiple transect station groupings. A limited amount of faunal overlap was evident between development area and transect route taxonomic groupings (*eg Tharyx dorsobranchialis*, *Paraonis gracilis oculata*).

Environmental Parameters

Multivariate analysis was conducted to determine whether benthic macroinfaunal assemblages correlate with one or more environmental parameter. The macroinfaunal samples considered in the analysis included development area stations 1 to 10 and transect stations C1a, C2a, C3b, C4a and C5a. The set of environmental parameters consisted of the following:

- metals concentrations (Al, Ar, Ba, Cd, Cr, Co, Cu, Fe, Pb, Hg, Ni, Sn, V and Zn);
- organic material concentrations (TPH, PAHs, TOC and Extractable Organic Matter);
- sediment particle size classifications (sand, silt and clay);
- sediment nutrient concentrations (nitrogen and phosphorus); and
- water depth.

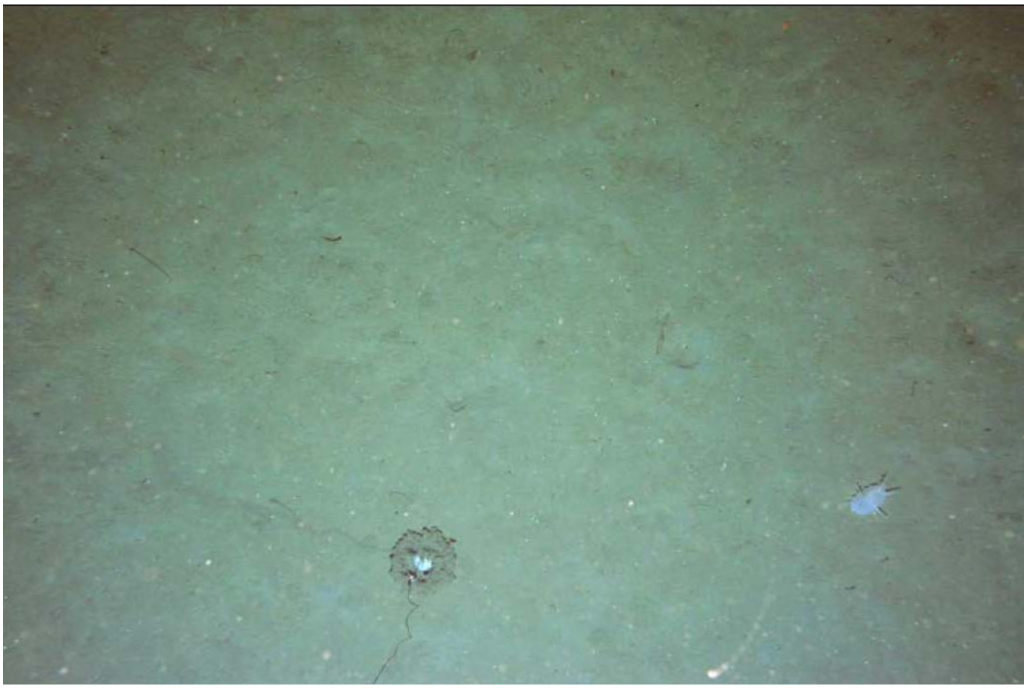
Results of this analysis indicate that several parameters are correlated with macroinfaunal assemblages. Environmental parameters that influence macroinfaunal community composition and faunal distribution include sediment TOC concentrations, sediment particle size and water depth. Sediment chemical and nutrient levels did not have a detectable correlation with similarities or differences in macroinfaunal samples.

Epifauna

A review of the images taken from the plan view underwater camera showed a soft bottom substrate with a mixture of fine and coarse sediments. Stations 1 to 10 and C4 were observed to have predominantly fine sediment whereas stations C1 to C3 and C5 had predominantly coarse sediments. The majority of these stations showed evidence of biological activity (*ie* bioturbation) on the substrate including small burrows, depressions and tracks which indicates a relatively productive and active macrobenthic community throughout the TEN EBS study area. Plan view photographs at Station C2 and Station 3 are shown in *Figure 4.27*.

Figure 4.27 Plan View Seabed Photographs at Station C2 and Station 3

Soft bottom substrate characterised by coarse sediments at Station C2 along the transect route. A prominent burrow formation and a couple of burrowing anemones (Ceriantharia) are visible in image.



Soft bottom substrate characterised by various bioturbation including small depressions and tracks at Station 3 in the TEN Project area. A translucent holothuroid is visible in the lower right of the image.

Source CSA 2011a. Mark in the lower part of the photograph is the camera trigger.

Biota observed at these stations included epifaunal species (*ie* on the substrate) and also within the near bottom water column.

Epifaunal species included:

- translucent holothuroids;
- crustaceans;
- solitary hard coral;
- fireworm (*Hermodice* sp);
- burrowing anemones (Ceriantharia);
- long-spined sea urchins (Echinoidea);
- decapod shrimp; and
- brittlestars (Ophiuroidea).

Species observed within the near bottom water column included various unidentified fishes, pteropod molluscs and jellyfishes.

Threatened and Endangered Species

No sensitive habitats or threatened or endangered species were identified during the course of the TEN EBS.

Summary

The results of the multivariate statistical analysis, including cluster analysis and multidimensional scaling, indicated that deepwater samples were distinct from the samples collected along the transect towards shore (on the continental shelf). All the deepwater development area stations had similar taxonomic composition with the exception of one station. The taxonomic composition at the stations along the transect route was more variable.

Results of the multivariate analysis indicated total organic carbon, sediment particle size and water depth were correlated with the similarities and differences among the macroinfaunal samples. The seabed imagery showed bioturbation and biota at the majority of stations, indicating the presence of active macrobenthic communities.

4.8.3 Marine Mammals

A number of marine mammal species have been recorded off the west coast of Africa, however, the distribution of marine mammals in Ghana is poorly understood due to the limited level of scientific studies undertaken. The conditions created by the seasonal upwelling in the northern Gulf of Guinea provide favourable conditions for fish, however, which will in turn attract predators such as marine mammals.

The majority of information on cetaceans in Ghana is the result of land-based field research, mainly monitoring of fishing ports for landings of small cetacean by-catches as well as the study of stranded animals. Capture locations and thus habitat (neritic, slope, pelagic) are unknown, as fishermen may operate both shorewards and offshore of Ghana's continental shelf and operate at considerable distances to the east or west of the ports where they landed catches. Specimens derived from by-catches and strandings show that the cetacean fauna of Ghana is moderately diverse, essentially tropical and predominantly pelagic. It comprises 18 species belonging to 5 families: 14 species of Delphinidae (dolphins) and one species each of families Ziphiidae (beaked whales), Physeteridae (sperm whales), Kogiidae (pygmy sperm whales) and Balaenopteridae (rorquals). The species identified in Ghana waters and the IUCN Conservation Status are provided in *Table 4.13* (Van Waerebeek *et al* 2009).

In addition, the West African population of the Clymene dolphin (*Stenella clymene*), which is Ghana's principal dolphin species, was included in Appendix II in the 2008 Conference of the Parties of the Convention for the Conservation of Migratory Species (CMS/UNEP), recognising its vulnerable status.

Table 4.13 Whales and Dolphins of Ghana, IUCN Conservation Status

#	Species	IUCN Status
	Delphinidae	
1	Common bottlenose dolphin (*Tursiops truncatus*)	LC
2	Clymene dolphin (*Stenella clymene)*	DD
3	Spinner dolphin (*Stenella longirostris*)	DD
4	Pantropical spotted dolphin (*Stenella attenuate)*	LC
5	Atlantic spotted dolphin (*Stenella frontalis*) (G. Cuvier, 1829)	DD
6	Long-beaked common dolphin (*Delphinus capensis*)	DD
7	Fraser's dolphin *(Lagenodelphis hosei*)	LC
8	Rough-toothed dolphin (*Steno bredanensis*)	LC
9	Risso's dolphin (*Grampus griseus*)	LC
10	Melon-headed whale (*Peponocephala electra*)	LC
11	Pygmy killer whale (*Feresa attenuata*)	DD
12	Short-finned pilot whale (*Globicephala macrorhynchus*	DD
13	Killer whale (*Orcinus orca*)	DD
14	False killer whale (*Pseudorca crassidens*)	DD
	Ziphiidae (beaked whales)	
15	Cuvier's beaked whale (*Ziphius cavirostris*)	LC
	Kogiidae (pygmy sperm whales)	
16	Dwarf sperm whale (*Kogia sima*)	DD
	Physeteridae (sperm whales)	
17	Sperm whale (*Physeter macrocephalus* or *Physeter catodon*)	VU
	Balaenopteridae (rorquals)	
18	Humpback whale (*Megaptera novaeangliae)*	LC

VU = Vulnerable; LC = Least Concern; DD = Data Deficient

Regular landings in several Ghana ports of Clymene dolphin, pantropical spotted dolphin (*Stenella attenuata*), common bottlenose dolphin and, to a lesser degree, short-finned pilot whale (*Globicephala macrorhynchus*), Risso's dolphin (*Grampus griseus*), Atlantic spotted dolphin (*Stenella frontalis*), rough-toothed dolphin (*Steno bredanensis*) and melon-headed whale (*Peponocephala electra*) suggest that these species are not rare in the northern Gulf of Guinea, although any estimate of population abundance is lacking. Rarely captured species may be characterised by a lower abundance in the areas that are near the continental shelf and slope.

Incidental marine mammal sightings have been recorded from security vessels by trained and untrained TGL personnel during operations at, and on route to the Jubilee field and DWT block. Sightings data were subsequently analysed by marine mammal biologists (Gardline 2011b; Gardline 2012). However, these observations can only confirm the presence of a species and do not provide information on their distribution. Examples of marine mammal sightings are shown in *Figure 4.28* and *Figure 4.29*.

Table 4.14 presents species of cetacean recorded from November 2009 to December 2011, and more recently in April and May 2013. Fourteen species were identified, with three species only being 'possible sightings'. The majority of the species are the same as those identified from by-catches and stranding, however, there are species such as sei whale (*Balaenoptera borealis*) and possibly striped dolphin (*Stenella coeruleoalba*) which have not previously been recorded offshore Ghana.

Table 4.14 Marine Mammals Sightings

Common Name	Nov 09 – Jan 2011	Mar - Dec 2011	Apr – May 2013*
Clymene dolphin	Possibly	Confirmed	-
Common dolphin	Confirmed	Confirmed	Confirmed
Fraser's dolphin	-	Confirmed	Confirmed
Humpback whale	Possibly	Confirmed	-
Melon-headed whale	-	Confirmed	Confirmed
Pantropical spotted dolphin	Confirmed	Confirmed	Confirmed
Short-finned pilot whale	Confirmed	Confirmed	Confirmed
Rough-toothed dolphin	Possibly	Confirmed	-
Spinner dolphin	Possibly	Confirmed	-
Atlantic spotted dolphin	-	Confirmed	-
Sei whale	Confirmed	-	-
Brydes whale	Possibly	-	-
Striped dolphin	Possibly	-	-
Bottlenose dolphin	Possibly	-	Confirmed

Source: Gardline 2011b; Gardline 2012.. * Recorded by TGL within the Jubilee field.

Other species that may be present although have not been confirmed include Atlantic humpback dolphin (*Sousa teuszii*), beaked whales and rorquals. No Atlantic humpback dolphins have so far been confirmed in Côte d'Ivoire, Ghana, Togo, Benin or Nigeria (Debrah 2000; Ofori-Danson *et al* 2003; Van Waerebeek *et al* 2004, 2009; Perrin and Van Waerebeek 2007), despite suitable coastal habitat. There are unconfirmed fishermen's reports that humpback dolphins may occasionally be seen between the Voltra River delta and Lomé, Togo. In recent years, Atlantic humpback dolphins have been encountered with some regularity in Gabon (Schepers and Marteijn 1993; Collins *et al* 2004; Van Waerebeek *et al* 2004). In 2008, the species was listed on Appendix I of CMS reflecting mounting international concern about its population status.

Figure 4.28 Sighting of Pantropical Spotted Dolphin – 29 April 2010

Source: Gardline 2011b.

Figure 4.29 Sighting of Melon-headed Whale – 19 October 2011

Source: Gardline 2011b.

Among beaked whales, the Gervais' beaked whale (*Mesoplodon europaeus*) has been documented from Ascension and Guinea-Bissau (Rice 1998), so may also be present offshore, as well as Blainville's beaked whale (*Mesoplodon densirostris*) which is a pantropical cetacean. Another widely distributed sub-tropical cetacean that may be present within the survey area is the pygmy sperm whale (*Kogia breviceps*). All these species have a pelagic distribution in common and may be present in the Gulf of Guinea. The presence of long-snouted common dolphin in Ghana, Côte d'Ivoire (Cadenat 1959) and Gabon (Van Waerebeek 1997) points to a wide distribution in the Gulf of Guinea, perhaps partly related to the seasonal upwelling over the continental shelf (Adamec and O'Brien 1978).

Other rorquals such as minke whales (*Balaenoptera acutorostrata*), blue whales (*Balaenoptera musculus*) and fin whales (*Balaenoptera physalus*) have very wide distributions globally. Of these, the blue, fin and sei whales are classified as Endangered on the IUCN's Red Data List. The primary and secondary ranges of blue whales and the secondary ranges of fin whales potentially extend into the Gulf of Guinea, although there are no records of blue whales in Ghanaian waters.

Beaching of dead marine mammals or stranding of live marine mammals on beaches that subsequently die is a global phenomenon. There are a number of reasons why marine mammals may be washed ashore including injury from predators, fishing nets and gear, collision with maritime vessels, disease and old age. It is also possible that marine mammals washed up on the coast of Ghana may have died or been injured outside Ghanaian waters.

In recent years it has been reported that 16 humpback whales have been washed up on Ghana's beaches and there is stakeholder concern that this may be linked to the offshore oil and gas industry activities. The Van Waerebeek *et al* study (2009) demonstrates whale and dolphin strandings have occurred in the area over many years prior to the start of the oil and gas industry. It is noted that many other parts of the world have much larger and well-established offshore oil industries within areas were marine mammals frequent and there is no observed relationship between the level of offshore oil industry activities and the incidence of marine mammal strandings.

Ghana's coast forms part of the distribution range of a Gulf of Guinea humpback whale breeding stock (with current estimates putting this population at over 10,000 individuals). The reported increase in strandings of these species may be related to population pressures within the breeding stock or related to the level of reporting of strandings (WDC website 2013).

4.8.4 *Marine Turtles*

The Gulf of Guinea serves as an important migration route, feeding ground, and nesting site for sea turtles. Five species of sea turtles have been confirmed in Ghana waters, namely the loggerhead (*Caretta caretta*), the hawksbill

(*Erectmochelys imbricata*), the olive ridley (*Lepidochelys olivacea*), the green turtle (Chelonia mydas) and the leatherback (*Dermochelys coriacea*) with the latter three species known to next in Ghana (Armah *et al* 1997; Fretey 2001).

All species except the hawksbill are captured with some regularity in fishing nets set off Ghana. Although fully protected by national and international legislation, sea turtles that are landed are sold locally for human consumption. The EEZ waters of Ghana constitute a known feeding area for at least the green turtle. However, there is no published information on the spatial and temporal distribution of turtles in both nearshore and offshore waters. Recent sea turtle telemetry tagging undertaken by a team from the Department of Oceanography and Fisheries, University of Ghana and Galathea II team from Denmark indicated that sea turtles from Ghana migrate as far west as the inshore areas of Liberia.

Marine turtles spend most of their life at sea, but during the breeding season they go ashore and lay their eggs on sandy beaches. The beaches of Ghana from Keta to Half-Assini are important nesting areas for sea turtle species. Approximately 70% of Ghana's coastline is found suitable as nesting habitat for sea turtles, and three species; the green turtle, olive ridley and leatherback turtles are actually known to nest (Armah *et al* 1997; Amiteye 2002). The olive ridley is the most abundant turtle species in Ghana. Population estimates from four previous surveys of these turtle species are provided in *Table 4.15*. The nesting period stretches from July to December, with a peak in November (Armah *et al* 1997). In Ghana, the majority nests observed (86.3%) are those of the olive ridley.

Table 4.15 ***Population of the Three Sea Turtle Species That Nest on the Beaches of Ghana***

Author, year	Leatherback	Olive ridley	Green Turtle
Amiteye, 2002	46	412	32
Agyemang, 2005	30	190	10
Allman, 2007	418	134	0
Agyekumhene, 2009	74	103	0
Average	**142**	**210**	**21**

In the Western region, the beaches at Kengen, Metika Lagoon, Elonyi, Anochi, Atuabo and Benyin are important nesting sites for sea turtles. The locations of these turtle nesting beaches are shown in *Figure 4.30*. The figure also shows the locations where crocodiles occur. The prime nesting sites have been identified as the coastline from Prampram (about 10 to 15 km east of Tema) to Ada and the areas beyond the Volta estuary to Denu, in the Volta region. It is also evident that moderate nesting occurs from Winneba through Bortianor and on some beaches around Accra such as Gbegbeyise and Sakumono (Amiteye 2002). These nesting sites are located along the eastern coast of Ghana away from the TEN Project.

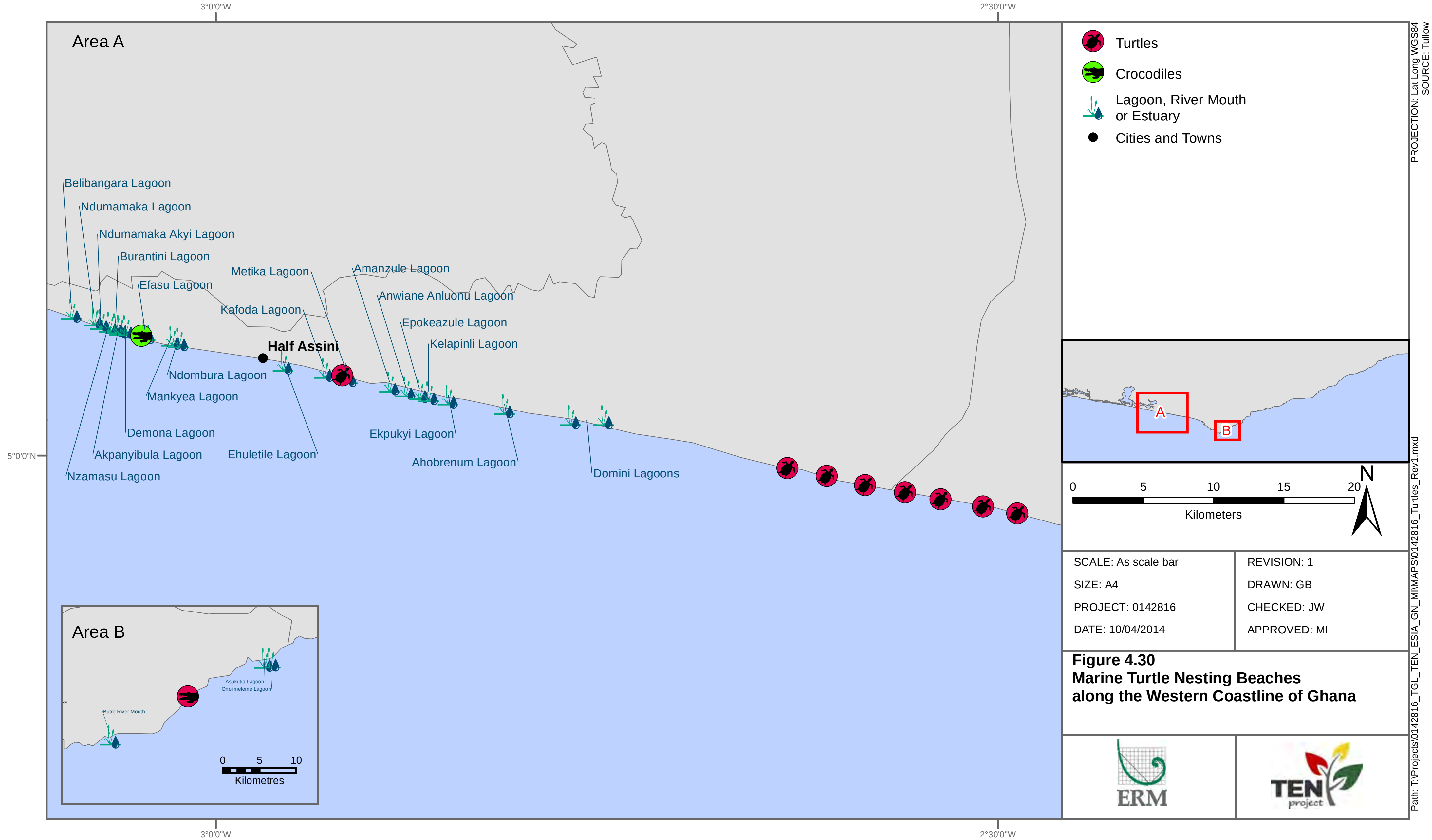


Figure 4.30
Marine Turtle Nesting Beaches along the Western Coastline of Ghana

Despite their protected status, marine turtles continue to face various forms of threat on Ghanaian beaches. The major threat to marine turtle population in Ghana is predation on eggs and juveniles by domestic animals especially pigs and dogs (Billes *et al* 2003). Human exploitation also contributes significantly to the decline in turtle population in Ghana. Female turtles which come to the beaches to lay eggs are normally ambushed and killed as soon as they start laying because they become weak and hence easy to capture. Where the female succeeds to complete laying the eggs, the local people walk the beaches at dawn to look for the tracks and dig up the eggs. Special fishing nets are used by local fishermen for capturing the turtles. The turtle meat and eggs obtained by the above methods are eaten or traded for cash income. The Ghana Wildlife Society has been carrying out sea turtle research and monitoring activities, conservation education and enforcement of legislation since 1995. The Marine Turtle Conservation Project aims to promote the socio-economic development of coastal communities through marine turtle conservation.

There were 30 turtle sightings in the Jubilee field between November 2009 and January 2011, and a further 15 sightings in the Jubilee and DWT fields between March and December 2011 (Gardline 2011b; Gardline 2012). The only confirmed species during the earlier study was green turtle, whereas the later study had confirmed sightings of green, olive ridley and leatherback turtles (*Figure 4.31*).

Figure 4.31 Sighting of an Olive Ridley Turtle (6 May 2011)

Source: Gardline 2011b.

A single green turtle, two olive ridley turtles and a single leatherback turtle were identified during the 2013 seismic survey within the Jubilee field. A further 16 turtles were observed, however, they could not be identified.

4.8.5 Birds

The west coast of Africa forms an important section of the East Atlantic Flyway, an internationally important migration route for a range of bird species, especially shore birds and seabirds (Boere *et al* 2006; Flegg 2004). A number of species that breed in higher northern latitudes winter along the West African coast and many fly along the coast on migration. Seabirds known to follow this migration route include a number of tern species (*Sterna* sp), skuas (*Stercorarius* and *Catharacta* spp) and petrels (Hydrobatidae).

The distance of the migration routes of these species from the shore depends on prey distribution and availability (*eg* the abundance and distribution of shoals of anchovies or sardines) (Flegg 2004). The highest concentrations of seabirds are experienced during the spring and autumn migrations, around March and April, and September and October. The marine birds of Ghana include storm petrels (*Oceanodroma castro*) and Ascension frigate birds (*Fregata aquila*). Records dating back to the 1960s reveal only limited sightings of a few species (Elgood *et al* 1994). The rarity of oceanic birds may be attributable to the absence of suitable breeding sites (*eg* remote islands and rocky cliffs) off the Ghana coast and in the Gulf of Guinea. Waders are present during the winter months between October and March. Species of waders known to migrate along the flyway include sanderling (*Calidris alba*) and knott (*Calidris canuta*).

During the environmental baseline studies for the West African Gas Pipeline (WAGP 2004) in 2002/2003, the survey crew recorded several sightings of black tern (*Chlidonias niger*), white winged black tern (*Chlidonias leucopterus*), royal tern (*Sterna maxima*), common tern (*Sterna hirundo*), Sandwich tern (*Sterna sandvicensis*), great black-back gull (*Larus marinus*), lesser black-back gull (*Larus fuscus*), pomarine skua (*Stercorarius pomarinus*) and great skua (*Catharacta skua*). The two species of skua are predominant in the Western Region offshore environment. Black terns were mainly recorded at nearshore locations close to estuaries and/or lagoons. These species leave the onshore areas to feed at sea during the afternoon. The general low diversity of marine birds may be attributed to lack of suitable habitats and availability of food resources in the offshore area.

There are 40 Important Bird Areas (IBAs) identified by Birdlife International within Ghana (Birdlife International 2009). The coastal IBAs are described in *Section 4.9*. In addition to IBAs, there are a number of estuaries, lagoons and wetlands along the western coastline that provide important habitats for shore birds, gulls and terns, waders and waterfowl. These locations are shown in *Figure* 4.32.

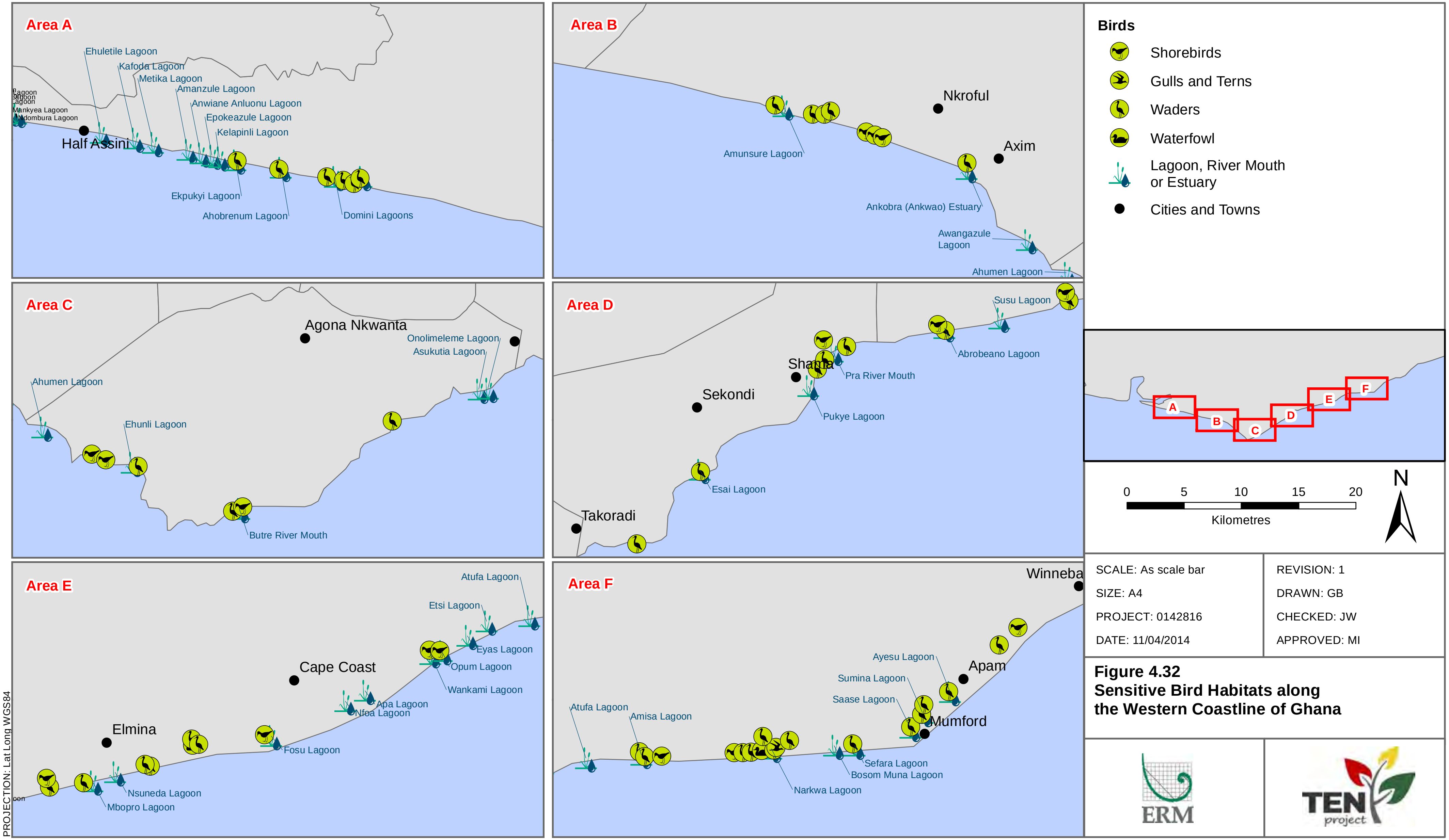


Figure 4.32
Sensitive Bird Habitats along the Western Coastline of Ghana

SOURCE: Tullow

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Birds_Rev0.mxd

4.9 PROTECTED AREAS FOR NATURE CONSERVATION

4.9.1 *Coastal Protected Areas*

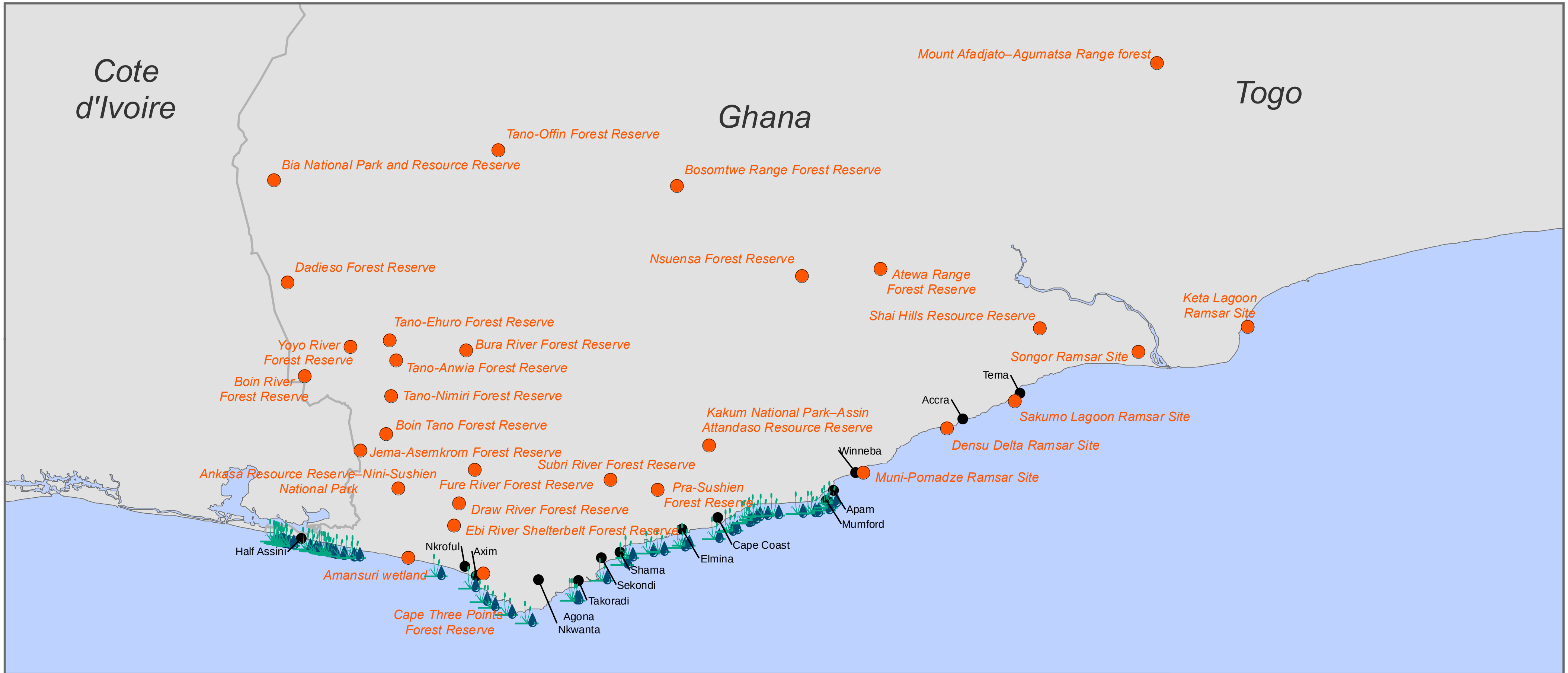
Several coastal habitats are important for their biodiversity as well as for rare and endangered species. However, only five coastal protected areas currently exist within the country. These areas are all located onshore and are protected under the Ramsar convention. They are the Muni-Pomadze, Densu Delta, Sakumo Lagoon, Songor Lagoon and the Anglo-Keta Lagoon complex Ramsar sites (*Table 4.16*). None of these protected areas occur along the western coast. The locations of these Ramsar sites are shown in *Figure 4.33*.

Table 4.16 Coastal Ramsar Sites in Ghana

Name and Site Number	Location	Area (km^2)	Comments
Muni-Pomadze (563)	5°23'N, 0°40'E	94.6	Sand dunes, open lagoon, degraded forest and scrubland. Lagoon opens into the sea during the rainy season.
Densu Delta (564)	5°30'N, 0°15'E	58.9	Sand dunes, lagoons, salt pans, marsh, and scrub. Scattered stands of mangrove with extensive areas of open water.
Sakumo (565)	5°30'N, 0°08'E	13.6	Brackish lagoon with narrow connection to the sea. Main habitats are the open lagoon, surrounding flood plains, freshwater marsh, and coastal savannah grasslands.
Songor (566)	5°45'N– 6°00N, 0°20'E–0°35'E	511.33	Closed lagoon with high salinity, and a large mudflat with scattered mangroves.
Keta Lagoon Complex (567)	5°55'N, 0°50'E	1,010.22	Open lagoon with brackish water influx from Volta River. Coastal savannah grasses with patches of trees and shrubs. Largest seabird populations of all coastal wetlands of Ghana.

Ghana has not declared any marine protected areas with the exception of the intertidal elements of the Ramsar sites. Currently, coastal lagoons and mangrove stands are identified as breeding and nursery areas for a wide variety of marine species. However, none of these are under any protection by state legislation, with the exception of the Ramsar designated areas.

Traditional methods of conservation exist for a number of lagoons and wetlands within the country. The methods include days, periods and seasons of closed fishing, and restrictions on fishing methods, gear and fishers.



IBAs

Lagoon, River Mouth or Estuary

Cities and Towns

0 20 40 60 80 100

Kilometres

N

Figure 4.33
Nature Conservation and Protected Areas

SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 11/04/2014	APPROVED: MI

PROJECTION: GCS WGS 1984

SOURCE: Data obtained from www.birdlife.org 15/06/09

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_IBAs_Rev0.mxd

4.9.2 *Important Bird Areas*

Six Important Bird Areas (IBAs) are located along the coastline of Ghana, namely:

- Amansuri wetland;
- Densu Delta Ramsar Site;
- Keta Lagoon Complex Ramsar Site;
- Muni-Pomadze Ramsar Site;
- Sakumo Ramsar Site; and
- Songor Ramsar Site.

A map showing the locations of these IBAs is provided in *Figure 4.33*. Five of these are designated Ramsar sites, however, only one, the Amansuri wetland (*Figure 4.34*), is located along the western coastline within the project sphere of influence. Further information on this IBA is provided in *Box 4.1*.

Figure 4.34 Amansuri Wetland

Source: ERM 2011.

Box 4.1 Amansuri Wetland Important Bird Area

Location: 4° 55.00' N, 2° 15.00' W **Area:** 38,050 ha

Site description: The site lies c.360 km west of Accra, near the town of Axim. It includes the freshwater Amansuri lagoon (including the village of Nzulenso which is built on stilts in the lagoon), the flood-plains of the Amansuri River, the coastal Amansuri lagoon and estuary, and the sandy Esiama beach, between the Amansuri and Ankobra Rivers. The site covers c.40% of the total catchment of the Amansuri River. The wetland is a blackwater system. The vegetation in the catchment is Wet Evergreen Forest, with swamp-forest in wetter parts. The most common tree in the swamps is the Raffia Palm *Raphia vinifera*, which grows in almost pure stands. The large spiny aroid *Cyrtosperma senegalense* grows along the edge of the raffia while the drier patches support mainly sedges and grasses. The area is subject to seasonal flooding and the nature of the terrain is such that access is very difficult and, as a consequence, large areas remain untouched.

Birds: Key bird species include the Sanderling (*Calidris alba*) and Royal Tern (*Sterna maxima*). The coastal areas of the Amansuri catchment, including the coastal lagoon, estuary and Esiama beach, support appreciable numbers of waterbirds. Other common species occurring at the site include *Pluvialis squatarola*, *Charadrius hiaticula*, *Tringa hypoleucos* and *Arenaria interpres*. Up to 30 *Haematopus ostralegus* are regularly seen on the beach, the only site along the Ghana coast where the species is seen with any degree of frequency. In addition to *Sterna maxima*, small flocks of *S. sandvicensis*, *S. hirundo* and *Chlidonias niger* also regularly roost on sandbanks in the estuary. Species occurring in the inland freshwater lagoon and swamp areas include gallinules, crakes and jacanas. The avifauna of the rest of the catchment has not been studied.

Conservation issues: Amansuri wetland is the largest stand of intact swamp-forest in Ghana and its value is further enhanced by the fact that large areas are still in a relatively pristine condition. The fauna of the site, as with most blackwater areas, is species-poor; however, the communities present are distinctive. With current rates of population growth and development, unless action is taken now to safeguard this unique area, it is likely to suffer the fate of numerous other coastal wetlands, which have become completely degraded. The area is being considered as a Community Nature Reserve, with the possibility of Ramsar designation, under a project being implemented by the Ghana Wildlife Society, with funding from the Netherlands Government. Because of the large size of the catchment and the high population density in some parts, a zonation system will be necessary to focus conservation action on the most biologically important and intact areas. The freshwater lagoon is fished by the Nzulenso community; the fishing is regulated by a wide range of well-enforced taboos, aimed at ensuring sustainability and preventing pollution of the lagoon waters.

Source: BirdLife International 2012.

5 *FISH AND FISHERIES BASELINE*

5.1 *INTRODUCTION*

This chapter provides a baseline description of fish and fisheries in Ghana, forming the basis of the fisheries impact assessment provided in *Chapter 7*. It describes the fish species present in Ghanaian waters, provides information on fishing fleets and supporting infrastructure (*eg* fishing ports), and presents fish landing data for the past 20 years. It also describes the status of the Ghanaian fishing industry and its role in the national economy and people's livelihoods.

The information in this chapter is derived from published sources and through primary research undertaken by ERM and ESL in 2011 to obtain information on fish distribution and fisheries activities in TGL's areas of operation offshore the Western Region of Ghana, including the TEN Project area. The main sources of information reviewed were published data on fish and fisheries, including historic landing records statistics. This was supplemented with information gathered with direct consultations with a range of fisheries regulators, fishers and other directly affected stakeholders to obtain information on fish resources, commercial fishing activities and the key issues and concerns facing the industry (see *Section 5.3* and *Attachment I*). These consultations were undertaken in April 2011 and comprised a series of meetings and interviews in Accra, Tema and in various locations in the Western Region. Details of consultation meetings held in 2011 and supporting information is included in *Attachment I*.

It is recognised that there is limited information available for fish resources and fisheries activities offshore Ghana, in particular in the deepwater areas where the main oil and gas activities are being undertaken.

5.2 *OVERVIEW*

Ghana has a coastline of 550 km and relatively narrow continental shelf to a depth of 75 to 120 m with a total area of approximately 24,300 km^2. The fishing industry in Ghana is based on resources from both marine and inland (freshwater) waters and from coastal lagoons and aquaculture. Within the marine sector, target species include pelagic, demersal and shellfish resources (Quaatey 1997; NAFAG 2007).

There is a long tradition of both artisanal and distant-water fishing fleets in Ghana (Alder and Sumaila 2004) although most commercial marine fishing undertaken by Ghanaian vessels takes place within the Ghanaian 200 miles EEZ. The traditional artisanal inshore fishery in Ghana is well developed and provides about 70% of the total marine fisheries production in the country. Fishing occurs year round but shows some seasonality, with periods of higher landings and periods of reduced catches through the year. The fish landings from the beach, coastal lagoons or estuaries, although comparatively small, provide reasonable quantities of fish products for subsistence purposes. Fishing in lagoons and estuaries involves substantial number of fishers using small scale gear such as gill nets, throw nets and weirs.

Marine fishing activity in Ghana is strongly linked with the seasonal upwellings(1) that occur in coastal waters. Two upwelling seasons (major and minor) occur annually in Ghanaian coastal waters. The major upwelling begins between late June or early July when sea surface temperatures fall below 25°C and ends between late September or early October. The minor upwelling occurs either in December, January or February and rarely lasts for more than three weeks. During the upwelling periods, biological activity is increased due to greater concentrations of nutrients in the water column that have been drawn up from deeper waters. Most fish spawn during this period and stocks are more readily available to the fishers. For the rest of the year, catches are lower and more sporadic.

Fish and fish products provide the greatest proportion of animal protein in Ghana and contribute approximately 60% of the total animal protein intake. About 75% of the total domestic production of fish is consumed locally and the per capita consumption is estimated to be about 25 kg annually (FCWC 2012).

5.3 *FISHERIES CONSULTATIONS*

Consultation meetings were held with fisheries stakeholders in April 2011 to inform the fisheries baseline study. The consultations focussed on the artisanal fisheries sector. Details of these consultations are included in *Attachment I*. Key issues raised by stakeholders in the artisanal sector are provided below (in no particular order of importance).

- Stakeholders were concerned about conflict between fishermen and industrial vessels entering the IEZ illegally and damaging artisanal gear.
- Stakeholders were concerned about illegal fishing including the use of explosives and chemicals.
- Some fishermen were concerned about the lack of compliance of fishermen with the Regulations that prohibit light fishing, while others were concerned that climate change will make legal fishing methods ineffective.
- Fishermen were concerned about high operational costs such as the cost of purchasing and repairing outboard motors.

(1) An upwelling involves wind-driven motion of dense, cooler, and usually nutrient-rich water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water.

- Fishermen were concerned about the increase in seaweed in Ghana which obstructed fishing gear and had to be cleared from landing sites regularly. Some fishermen perceived the sudden abundance of seaweed to be linked to offshore oil and gas operations.

- Fishermen were concerned about perceived loss of access to fishing grounds and not being able to fish around the Jubilee FPSO. Some concerns were also raised regarding clear delineation of the 500 m safety zone to prevent unintentional drifting into the zone and subsequent prosecution.

- Stakeholders were concerned about the general declining fish stocks.

Issues relating to the safety zones, increasing seaweed and declining fish stocks were also raised during subsequent EIA consultations in October 2011, and March and June 2012.

5.4 *FISH SPECIES IN GHANAIAN MARINE WATERS*

The composition and distribution of fish species found in Ghanaian waters, and the wider Gulf of Guinea, is influenced by the seasonal upwelling. The transport of colder, dense and nutrient-rich deep waters to the warmer, usually nutrient-depleted surface water during periods of upwelling stimulates high levels of primary production in phytoplankton. This primary productivity in turn increases production zooplankton and fish. The fish species found in Ghanaian waters can be divided into four main groups, namely:

- small pelagic species;
- large pelagic species (tuna and billfish);
- demersal (bottom dwelling) species;
- Molluscs and Crustaceans; and
- deep sea species.

5.4.1 *Small Pelagic Species*

There are a wide range of small pelagic species in the Gulf of Guinea and they are the most abundant marine resources exploited by fishing fleets operating in Ghanaian waters, targeted by both the artisanal and, to a lesser extent, semi-industrial fleets. They are also a bycatch product of some of the industrial fleet.

Historically, the bulk of small pelagic species have been most abundant during the major upwelling period between July and September and local fishermen in the Western Region also reported these months as generally being the most productive. Seasonal increases in the abundance of small pelagic fish species are influenced by low sea-surface temperatures (less than 23^{o} C), high salinities (less than 35 parts per thousand), and the movement of cold water, rich in nutrients, into surface layers of the water column. The cold, deep, nutrient rich water replaces the warm layers on the surface due to a break in the thermocline caused by wind forces acting on the sea surface.

The key small pelagic fish species found in the Ghanaian waters (mainly in shallow water) are round sardinella (*Sardinella aurita*), Madeira/flat sardinella (*S. maderensis*), European anchovy (*Engraulis encrasicolus*) and chub mackerel (*Scomber japonicus*) (MoFA 2004). These species are commercially important as they represent approximately 80% of the total catch landed in the country (approximately 200,000 tonnes per annum) (MoFA 2004). Further details of these key species are provided below, principally from the online Food and Agriculture Organisation of the United Nations (FAO) Marine Resource Fact Sheets on each species (FAO 2011) unless listed otherwise.

Both sardinella species are found throughout Ghanaian inshore waters and the local population is part of the Central Upwelling Zone stock which is one of three stocks along the West African coast (Whitehead 1985). The breeding patterns of these species are complex, but spawning periods are linked with upwelling regimes and therefore eggs and larvae tend to be most abundant around July and August off Ghana, corresponding with the major upwelling period in this area. The eggs are planktonic and found in the upper mixed layer and upon hatching the larvae feed on plankton in the upper layers. For round sardinella the adult population winters at depths ranging from 50 to 80 m between the longitudes of Cape Three Points and Accra. At the beginning of the major upwelling (normally July), the population moves closer to land and the surface, and thus becomes more readily accessible to fishermen. Spawning is then at its maximum and as the upwelling season progresses; the stock spreads out, off the eastern half of Cote d'Ivoire and toward the east as far as Togo. At the end of the upwelling season (normally around October), the area of distribution of this stock begins to contract and in December the population returns to deep-waters for wintering. Similar displacements toward the coast and the surface are also produced with the minor upwelling (Brainerd 1991). Adults in both species exhibit such seasonal migration towards and from the shore while juveniles remain in shallow water until maturation when they migrate into deeper shelf waters to join the adult stock. This migration with age is not so defined in flat sardinella as round sardinella (Brainerd 1991; Whitehead 1985).

European anchovy are mainly a coastal marine species but they can tolerate a wide range of salinities and may be found in lagoons, estuaries and lakes, especially during spawning. This species shows a tendency to move into more northern waters of it range (up to southern Norway) and generally surface water layers in June to August and retreat to the more southern waters (down to Angola) and descend to deeper water (up to 400 m in West Africa) during December to January. This species forms large schools and feeds on planktonic organisms. Spawning takes place over an extended period from April to November with peaks usually in the warmest months.

Chub mackerel is primarily an inshore pelagic species and are found from the surface down to depths of about 250 m to 300 m. Spawning most often occurs at water temperatures of 15° to 20°C, which results in different spawning seasons by regions and in Ghanaian waters spawning, in common with most pelagic species, coincides with the seasonal upwellings.

Other notable species that are caught include horse mackerel (*Trachurus* sp), little tunny (*Euthynnus alletteratus*), bonga shad (*Ethmalosa fimbriata*), African moonfish (*Selene dorsalis*), West African ilisha (*Ilisha africana*) and very similar looking long-finned herring (*Opisthopterus tardoore*), crevalle jack (*Caranx hippos*), Atlantic bumper (*Chloroscombrus chrysurus*), barracuda (*Sphyraena* spp), kingfish / West African Spanish mackerel (*Scomberomorus tritor*) and frigate mackerel (*Auxis thazard*).

5.4.2 Large Pelagic Species

The large pelagic fish species include the tuna, billfish and some sharks. Key tuna species are skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*) (MoFA 2004). These species are highly migratory and occupy the surface waters of the entire tropical and sub-tropical Atlantic Ocean. They are important species in the ecosystem as both predators and prey, as well as providing an important commercial resource for industrial fisheries.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) carries out regular population assessments of exploited populations within their convention area and assesses the status of the Atlantic populations of each species. The most recent population assessments indicate that resources of yellowfin tuna and bigeye tuna in the Atlantic, key economic large pelagic species, are being fully exploited and any increase in catches would be detrimental to the fish populations. The status of skipjack tuna populations is difficult to assess with traditional stock assessment models due to their particular biological and fishery characteristics, but currently the stock is not thought to be being overexploited (ICCAT 2010).

Billfish species are also commercially exploited in much lower but notable numbers and include swordfish (*Xiphias gladius*), Atlantic blue marlin (*Makaira nigricans*) and Atlantic sailfish (*Istiophorus albicans*). In addition there is a smaller but significant shark fishery in Ghana, with the main species caught being blue shark (*Prionace glauca*) and hammerhead shark (*Sphyrna* spp).

Juveniles and small adults of skipjack, yellowfin and bigeye tuna school at the surface either in mono-species groups or together and these schools are often associated with floating objects such as floating seaweed, pieces of wood and stationary, anchored or drifting vessels (Røstal *et al* 2006). The attraction is likely to be linked to predator avoidance and a focus of aggregation behaviour (1).

Skipjack tuna generally inhabit open waters with aggregations associated with convergences, boundaries between cold and warm water masses, upwelling and other hydrographic discontinuities. Depth distribution ranges from the surface to about 260 m during the day, however, they remain close to the surface during the night. This species spawns in batches throughout the year over a wide area on either side of the equator, with the spawning season becoming shorter as the distance from the equator increases (Collette and Nauen 1983). One of the characteristics of this species is that from the age of one year it spawns opportunistically throughout the year and in large sectors of the ocean (ICCAT 2010) but the Gabon-Ghana waters are one of the important spawning areas(2). This tuna species is also less migratory that either yellowfin tuna or bigeye tuna, keeping to approximately a 5 km radius of their spawning area (3).

Yellowfin tuna are generally confined to the upper 100 m of the water column with their vertical distribution being influenced by the thermal structure of the water column. In Ghana they form part of an Atlantic population whose main spawning ground is the equatorial zone of the Gulf of Guinea, with spawning primarily occurring from January to April (ICCAT 2010) or April to June (4). In addition, spawning occurs in the Gulf of Mexico, in the southeastern Caribbean Sea, and off Cape Verde, although the relative importance of these spawning grounds is unknown (ICCAT 2010). The Gulf of Guinea is one of the most important areas for yellowfin tuna in the Atlantic population and large aggregations are found in near-surface waters, often associated with floating debris (FAO 2011).

Bigeye tuna generally occur from the surface to about 250 m in depth and their vertical distribution is influenced by water temperature and thermocline depth, although their range differs from yellowfin tuna which tend to have a narrower temperature range. Spawning takes place throughout the year in a vast zone in the vicinity of the equator with temperatures above 24°C and the Gulf of Guinea is one of the most important spawning areas for this species (FAO 2011) where it tends to spawn between April and June(5).

Atlantic blue marlin is found in wide open waters, mostly in waters warmer than 17°C, with adults spending over 80% of their time in the surface water; however, they undergo frequent, short duration dives to depths of between 100 m and 200 m and have been known to reach 800 m. Blue marlin display extensive migratory patterns, and important concentrations of them are found

(1) Aggregation behaviour in fish as well as serving an anti-predator role (through for example predator confusion, increased alertness of prey and diminished risk of individual attack), may also serve a reproductive function (since it provides increased access to potential mates), an enhanced foraging role and increased locomotion efficiency.
(2) Personal communication with P. Bannerman, Director of MFRD and Ghana's ICCAT representative, in April 2011
(3) Personal communication with P. Bannerman, Director of MFRD and Ghana's ICCAT representative, in April 2011
(4) Personal communication with P. Bannerman, Director of MFRD and Ghana's ICCAT representative, in April 2011
(5) Personal communication with P. Bannerman, Director of MFRD and Ghana's ICCAT representative, in April 2011

within the Gulf of Guinea (Nakamura 1985). The central and northern Caribbean Sea and northern Bahamas have historically been known as the primary spawning area for this species in the western North Atlantic. Recent reports show that blue marlin spawning can also occur north of the Bahamas. Ovaries of female blue marlin caught by artisanal vessel in Côte d'Ivoire show evidence of pre-spawning and post-spawning, but not of spawning, although in this area females are more abundant than males (4:1 female/male ratio) (ICCAT 2010).

Swordfish are mainly found in open oceanic waters but may occasionally be found in shelf waters, generally above the thermocline. Migrations consist of movements toward temperate or cold waters for feeding in summer, and back to warm waters in autumn for spawning and overwintering. The Gulf of Guinea is not an important swordfish spawning ground (Nakamura 1985).

Sailfish are found in shelf waters and open ocean, often above the thermocline, although they are known to frequently make short dives to depths of up to 250 m. Sailfish spawning has been observed in West African shelf waters throughout the year (Nakamura 1985).

5.4.3 *Demersal Species*

The demersal fish fauna of the western Gulf of Guinea have been studied by many authors since the 1960s and have shown that their composition and abundance change with depth (Fanger and Longhurst 1968; Martos *et al;* Troadec *et al* 1980; Williams 1968). This is partly due to substrate and food preference, and partly due to temperature preferences. In general, two distinct groups or demersal assemblages are noted, those that inhabit soft to muddy bottoms and are usually above the base of the thermocline and those found on hard bottoms, above the base of the thermocline at approximately 50 m, while below the thermocline they inhabit a much wider variety of habitats. In addition, environmental factors such as total organic matter content, temperature, salinity and dissolved oxygen have been shown to determine the distribution of the different demersal fish species within the Gulf of Guinea (Koranteng 2002a; Longhurst and Pauly 1987).

Results of resource surveys conducted in the region over the years indicate that the fish communities represented over similar bottom types and water depths are the same throughout the entire Gulf of Guinea (Koranteng 2002b). A survey undertaken as part of the West African Gas Pipeline Ghana EIA reported a total of 115 marine species from 62 families along the Ghanaian coast at depths between 10 m to 70 m on the east and central parts of Ghana (WAGP 2004). The results indicate the species recorded were comprised of 16 species of crustaceans, 4 species of molluscs, 4 species of invertebrates and 84 species of fish of potential relevance to fisheries in the area. The depth and nature of the seabed were considered to be the most important factors in the differences in catch composition and weight. Catch rates increased with depth with the most productive fishing found at 45 m (WAGP 2004).

In general, demersal fish are widespread on the continental shelf along the entire length of the Ghanaian coastline and species include the following (Koranteng 2002a; MoFA 2004).

- Triggerfish (*eg* grey triggerfish *Balistes capriscus*).
- Grunts (Haemulidae) (*eg* bigeye grunt *Brachydeuterus auritus* and to a lesser degree sompat grunt *Pomadasys jubelini* and bastard grunt (*Pomadasys incisus*).
- Croakers or Drums (Sciaenidae) (*eg* red pandora *Pellagus bellottii*, cassava croaker *Pseudotolithus senegalensis*).
- Seabreams (Sparidae) or Porgies (*eg* bluespotted seabream *Pagrus caeruleostictus*, Angola dentex *Dentex angolensis*, Congo dentex *Dentex congoensis*, canary dentex *Dentex canariensis* and pink dentex *Dentex gibbosus*.
- Goatfishes (Mullidae) (*eg* West African goatfish/red mullet *Pseudupeneus prayensis*).
- Snappers (Lutjanidae) (golden African snapper *Lutjanus fulgens*, Gorean snapper *Lutjanus goreensis*).
- Groupers (Serranidae) (*eg* white grouper *Epinephelus aeneus*).
- Threadfins (Polynemidae) (*eg* lesser African threadfin *Galeoides decadactylus*).
- Emperors (Lethrinidae) (*eg* Atlantic emperor *Lethrinus atlanticus*).

The demersal species that are most important commercially (in terms of catch volumes) are cassava croaker (*Pseudotolithus senegalensis*), bigeye grunt (*Brachydeuterus auritus*), red pandora (*Pellagus bellottii*), Angola dentex (*Dentex angolensis*), Congo dentex (*Dentex congoensis*) and West African Goatfish (*Pseudupeneus prayensis*).

The seasonal upwelling of cold and saline waters over the Ghanaian shelf provokes changes in the geographical distribution of many of the demersal fish species in this area and analysis of trawl surveys data conducted in continental shelf waters of Ghana between 1963 and 1990 shows the relative importance of major species changed in every trawl (Koranteng 2002b). For nearly 20 years between 1970s and 1990s, the triggerfish (*eg Balistes capriscus*) was the most abundant species in the area, a position otherwise claimed by the bigeye grunt. However, it is notable that croakers, seabreams and goatfish, notably red pandora, bluespotted seabream and West African goatfish have maintained their relative importance consistently over time (Koranteng 2002b). In addition, catch landing data from Ghana suggest largehead hairtail /cutlassfish /ribbonfish (*Trichiurus lepturus*) is also an important dermersal fish species in the area.

Further details of these key species are provided below, principally from the online Food and Agriculture Organisation (FAO) of the United Nations resource of Marine Resource Fact Sheets on each species (FAO 2011).

Triggerfish species inhabit bays, harbours, lagoons, and seaward reefs at depths of up to 100 m, but most commonly between 0 m to 55 m. They are semi-pelagic but display predominantly demersal behaviour. They are usually solitary or in small groups and feed on benthic invertebrates like molluscs and crustaceans. At the onset of proliferation in the Ghanaian waters around the 1970s, the species did not have any commercial value and consequently it was discarded and no records were kept of catches, meaning the importance of the species is not truly reflected in the catch statistics (Koranteng 2002b).

Big eye grunt inhabit inshore waters with sandy and/or muddy bottoms in Ghana, at depths of between 10 m and 100 m, but are mostly found between 30 m and 50 m. This species remains near the bottom during the day and migrates vertically at night, feeding on invertebrates and small fishes.

Red pandora inhabit inshore waters, with hard or sandy bottoms, to a depth of 250 m, with their preferred depth being greater than 120 m. Once fish are mature (at 1 to 4 years) they migrate to the coast and intermittent spawning occurs between May and November.

Bluespotted seabream occupies both marine and brackish water down to a depth of 200 m, but usually between 30 and 50 m. They are generally found in hard bottoms (rocks and rubble), the older individuals in the deeper part of the range, the young in inshore areas. They feed mainly on bivalves and also on crustaceans and fish. Spawning migration occurs parallel to the coast with intermittent spawning between spring and autumn over soft bottoms in shallow waters.

West African goatfish/red mullet is found in marine waters between 10 and 300 m, and usually between 20 to 75 m. They inhabit the inshore waters of the continental shelf, over sandy and muddy bottoms and feed on benthic invertebrates.

Largehead hairtail is generally found over muddy bottoms of shallow inshore waters, often enter estuaries. It can occupy marine and brackish waters at depths of near 600 m but is usually between 100 to 350 m. Adults and juveniles have opposing complementary vertical diurnal feeding migration. Large adults usually feed near the surface during the daytime and migrate to the bottom at night while juveniles and small adults form schools 100 m above the bottom during the daytime and form loose feeding aggregations at night near the surface. Adults feed mainly on fish and occasionally on squid and crustaceans while juveniles feed mostly on krill.

The composition of species found in the West African Gas Pipeline trawl surveys along east and central Ghana in 2004, varied from each station. The Channel flounder (*Syacium micrurum*), Guinea flathead (*Grammoplites gruveli*), African wide-eyed flounder (*Bothus podas*), common cuttlefish (*Sepia officinalis*), West African goatfish, and piper gurnard (*Trigla Iyra*) were recorded in the catches taken from the majority of the survey stations within Ghanaian waters. Other species included streaked gurnard (*Chelidonichthys lastoviza*) and Ghanaian comber (*Serranus accraensis*).

5.4.4 *Molluscs and Crustaceans*

A variety of molluscs and crustaceans are known to be present within the DWT and WCTP blocks (ERM 2009). These include the common cuttlefish, pink cuttlefish (*Sepia orbignyana*), common squid (*Loligo vulgaris*), common octopus (*Octopus vulgaris*) and the royal spiny lobster (*Panulirus regius*), deep-sea rose shrimp (*Parapenaeus longirostris*) and other shrimps (mainly southern pink shrimp *Penaeus notialis*, caramote prawn *Penaeus kerathurus* and Guinea shrimp *Parapenaeopsis atlantica*). Of these species the highest catches are of the cuttlefish species, followed by the crustaceans, particularly royal spiny lobster. Further details of these key species are provided below, principally from the online FAO Marine Resource Fact Sheets on each species (FAO 2011) unless listed otherwise.

The cuttlefish species, including the common cuttlefish and the pink cuttlefish, are both caught in Ghanaian waters and are both eastern Atlantic species. However, the latter is restricted to a distribution from 17 °S to 55 °N within the Eastern Atlantic, whereas the distribution of common cuttlefish is more widespread; from the Baltic Sea and the North Sea to South Africa. Prey items consist of small molluscs, crabs, shrimps, other cuttlefish and juvenile demersal fishes. Predators of common cuttlefish include sharks, seabreams (Sparidae) and other demersal fish and cuttlefish.

The common cuttlefish is a demersal, shallow coast waters species occurring predominantly on sandy to muddy bottoms from the coastline to about 200 m depth, but most abundant in the upper 100 m. Larger individuals are encountered in the deeper part of the range. Seasonal migrations (mainly vertical) have been shown to occur in all stocks. Spawning occurs in shallow waters, throughout the year, with peaks at water temperatures from 13 to 15°C off Senegal and on the Sahara Banks in the eastern Atlantic off Morocco, between January and April (primarily large adults); there is a second minor spawning peak of medium and small-sized individuals in late summer and early autumn. Eggs are attached in grape-like clusters to seaweeds, debris, shells and other substrates and hatch after 30 to 90 days depending on temperature. Larvae hatched in early summer from the spring brood usually participate in the autumn spawning of the following year, while those from the autumn brood spawn in spring in their second year of life. Thus, the two cycles alternate.

The pink cuttlefish is a free swimming species occurring over muddy and detritus-rich continental shelf and slope areas between 50 and 450 m depth, but is most abundant between 80 and 150 m. No onshore spawning migrations have been reported. Spawning occurs from early June to November. Females lay eggs in clusters of 30 to 40 attached to sponges on muddy bottoms.

The common squid lives between depths of approximately 0 to 500 m but is most abundant between the 20 to 250 m depth. It is known to migrate vertically and horizontally in response to changes in environmental conditions. The stock near Ghana overwinters in deeper offshore waters and migrates onshore for spawning with juveniles appearing in February and March and between July and September. Females produce up to 20,000 small eggs which are deposited in gelatinous tubes on sandy to muddy bottoms. This species feeds on fish and crustaceans with cannibalism being common. They live to approximately two years in females and three years in males (Roper *et al* 1984).

The common octopus occurs in in depths from 0 to 200 m and is inactive in waters of 7°C and colder. It is known to undertake limited seasonal migrations, usually overwintering in deeper waters and occurring in shallower waters during warmer summer months. There are two main spawning events each year, the first around May/June and the second, more important, in September. Food consists of bivalves and crustaceans while octopus larvae and juveniles are preyed upon by tuna species and adults by finfishes (Roper *et al* 1984).

The deep-sea rose shrimp is found on the continental shelf and upper slope, between 50 and 400 m depth over sandy seabed. The size of individuals increases with depth. It is found from Portugal to Angola in the east, and from Massachusetts, USA, to French Guiana in the west. It spawns throughout the year, with peaks in July and December. Eggs are demersal and the larvae are planktonic. Juveniles are concentrated between depths of 50 and 70 m, where recruitment into the adult population takes place.

The other shrimp species, southern pink shrimp, caramote prawn and Guinea shrimp, constitute the majority of the shrimp catch in Ghanaian waters. They are generally associated with sandy and muddy bottoms on the continental shelf, southern pink shrimp to a depth of 100 m, caramote prawn to 75 m, and Guinea shrimp to 60 m. Each species is found throughout the west coast of Africa. The biology of these species, in comparison to the rose prawn, is less well understood and little is known of their spawning grounds or seasons.

The royal spiny lobster species inhabits shallow water down to depths of 40 m, but is mostly found between 5 and 15 m. Although it inhabits a variety of habitats, it appears to prefer rocky bottoms (Holthuis 1991).

5.4.5 Deepwater Species

Deepwater sea species are those that inhabit areas beyond and below the depth of the continental shelf. These can be pelagic or demersal. Over 180 deepwater species have been reported off Ghana (Froese and Pauly, 2010), including approximately 110 that are principally pelagic, 60 that are principally demersal and 10 that frequently migrate between the bottom land higher layer of the seabed. Of these deepwater species, approximately 90 from 28 families have been reported to have been found within the depth range in the TEN fields (1,000 and 2,000 m). There is little detailed information on the distribution of these species within the project area and within Ghanaian waters generally.

Some studies have been conducted elsewhere in West Africa. The SERPENT project(1) for example uses Remotely Operated Vehicles (ROVs) around oil and gas installations to investigate deep sea fauna. In Nigerian waters, which have similar fish fauna to that of Ghana, sharks (Squalidae), chimaeras (Chimaeridae), grenadiers (Macrouridae), rays (Rajidae) and jellynose (*Guentherus altivela*) of the Ateleopodidae family, have been observed in deep water. In Angola, at depths only slightly below those of the TEN fields, Portuguese dogfish (*Centroscymnus coelolepis*), arrowtooth eel (*Synaphobranchus kaupii*), white-head hagfish (*Myxine ios*), several species of snailfish, snub-nosed eel (*Simenchelys parasitica*) and eelpout (*Pachycara crassiceps*) have been recorded.

5.4.6 Endangered Species

Sensitive fish species in Ghanaian waters according to the IUCN red list are presented in *Table 5.1*. None of these species are found in depths below 550 m with most being found shallower than 200 m. As suggested in the previous section, this may be in part due to the lack of detailed information on the composition of deepwater species. The shark fishery in Ghana and non-specific fishing gear which catch untargeted species pose threats to some species listed as 'Endangered' or 'Critically Endangered' on the IUCN Red List (IUCN 2011).

In addition, there is a global concern regarding tuna stocks. Bigeye tuna, is listed as 'Vulnerable' on the IUCN Red List and southern bluefin tuna (*Thunnus maccoyii* or *Thunnus thynnus maccoyii*) is listed as 'Critically Endangered'(2). No significant catch of bluefin tuna is landed in Ghana.

(1) SERPENT Project website. Available at www.serpentproject.com [Accessed July 2011].

(2) Latin names have been used to determine status, since there are often multiple common names for one species and common names can overlap between species. For example, the entry for *Thunnus thynnus* on the IUCN Red List, reportedly has both common names 'Northern Bluefin Tuna' and 'Southern Bluefin Tuna' and is listed as 'Data deficient' whereas southern bluefin tuna *Thunnus maccoyii* or *Thunnus thynnus maccoyii*, is 'Critically Endangered'.

ICCAT has listed bigeye tuna as the species of greatest concern after the bluefin tuna, in terms of its population status and the unsustainable levels of exploitation exacted on this species.

Table 5.1 Threatened Fish Species in East Central Atlantic Waters and Native to Ghana

Scientific Name	Common Name	IUCN Red List
Epinephelus itajara	Goliath Grouper	Critically Endangered
Pristis pectinata	Wide Sawfish	Critically Endangered
Pristis perotteti	Largetooth Sawfish	Critically Endangered
Squatina aculeata	Sawback Angelshark	Critically Endangered
Squatina oculata	Smoothback Angelshark	Critically Endangered
Dasyatis margarita	Daisy Stringray	Endangered
Epinephelus marginatus	Dusky Grouper	Endangered
Raja undulata	Undulate Ray	Endangered
Rhinobatos cemiculus	Blackchin Guitarfish	Endangered
Rhinobatos rhinobatos	Common Guitarfish	Endangered
Rhynchobatus luebberti	Lubbert's Guitarfish	Endangered
Rostroraja alba	Bottlenose Skate	Endangered
Sphyrna lewini	Scalloped Hammerhead	Endangered
Sphyrna mokarran	Great Hammerhead	Endangered

5.4.7 Commercially Important Fish Species

A summary of the commercially important pelagic and demersal fish species and shellfish species in Ghanaian waters are presented in *Table 5.2*. The ecology of these species is described in the previous sections.

Table 5.2 Commercially Important Fish Species in Ghanaian Waters

Small Pelagic Species	Large Pelagic Species	Demersal Species	Shellfish Species
Round sardinella (*Sardinella aurita*)	Skipjack tuna (*Katsuwonus pelamis*)	Cassava croaker (*Pseudotolithus senegalensis*)	Cuttle-fish (*Sepia officinalis*)
Flat sardinella (*S. maderensis*)	Yellowfin tuna (*Thunnus albacares*)	Bigeye grunt (*Brachydeuterus auritus*)	Squid (*Loligo vulgaris*)
European anchovy (*Engraulis encrasicolus*)	Bigeye tuna (*Thunnus obesus*)	Red pandora (*Pellagus bellottii*)	Octopus (*Octopus vulgaris*)
Chub mackerel (*Scomber japonicus*)	Swordfish (*Xiphias gladius*)	Angola dentex (*Dentex angolensis*)	Lobster (*Panulirus regius*)
	Atlantic blue marlin (*Makaira nigricans*)	Congo dentex (*Dentex congoensis*)	Deep-sea rose prawn (*Parapenaeus longistrostris*)
	Atlantic sailfish (*Istiophorus albicans*)	West African Goatfish (*Pseudupeneus prayensis*)	Shrimps (mainly *Penaeus notialis, Penaeus kerathurus, Parapeneopsis atlantica*)

5.5 *FISHING FLEETS*

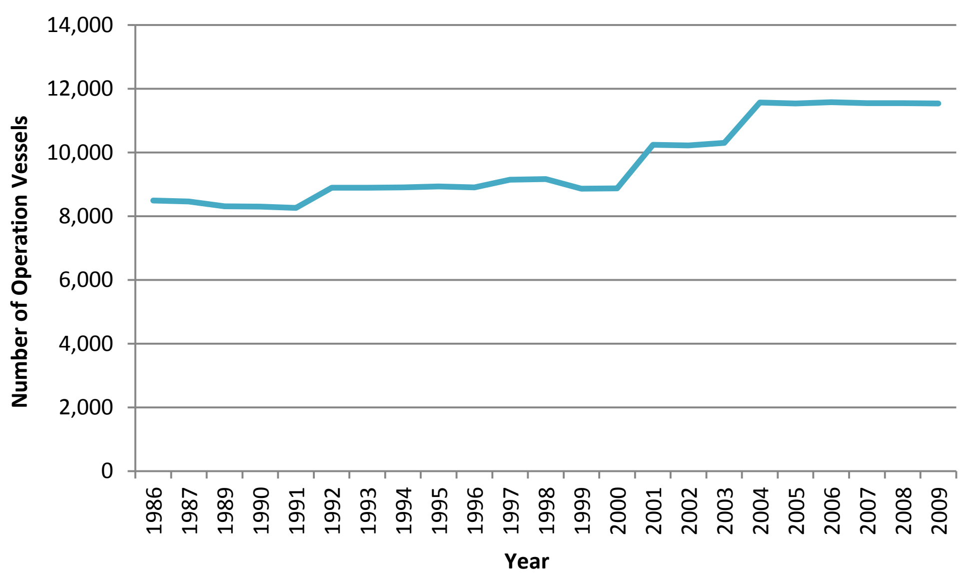
The marine fishing fleet in Ghana consists of three main sectors: artisanal, inshore (semi-industrial) and industrial. The number of operational vessels in Ghana from 1986 to 2009 for each of these categories is presented in *Table 5.3*, and the total number of vessels is shown in *Figure 5.1*.

Table 5.3 Number of Operational Marine Fishing Vessels in Ghana

Year	1986	1987	1988	1989	1990	1991	1992	1993
Artisanal	8,214	8,214	-	8,052	8,085	8,052	8,688	8,688
Inshore	201	189	-	199	183	146	152	151
Industrial	38	29	-	24	30	27	28	27
Tuna	34	34	-	35	33	32	29	27
Total	8,487	8,466	-	8,310	8,298	8,257	8,897	8,893
Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Artisanal	8,688	8,688	8,641	8,895	8,895	8,610	8,610	9,981
Inshore	141	157	165	149	173	167	173	178
Industrial	43	52	66	68	62	52	49	52
Tuna	28	33	36	36	35	34	37	33
Total	8,900	8,930	8,908	9,148	9,165	8,863	8,871	10,244
Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Artisanal	9,981	9,981	11,219	11,219	11,219	11,219	11,219	11,219
Inshore	152	233	253	240	255	231	240	226
Industrial	54	49	60	52	70	63	60	63
Tuna	36	37	37	26	32	34	33	34
Total	10,223	10,300	11,569	11,537	11,576	11,547	11,552	11,542

Source: MFRD 2011a

Figure 5.1 Number of Operational Vessels in Ghana (1986-2009)



Note: There is no data for 1988.
Source: MFRD 2011a

The vast majority of operational vessels are involved in the artisanal sector (more than 97%). There were stepped increases in the number of artisanal vessels in 1992, 2001 and 2004. The number of vessels involved in the inshore sector decreased in 1991 before increasing again in 2003. Vessels involved in the industrial sector increased sharply in 1995/1996 and have shown a more steady increase since. The number of tuna vessels has remained relatively stable over the period. There has been an overall increase of 36% from 1986 to 2009.

5.5.1 Artisanal Fishery

The artisanal (or small scale) fisheries sector is characterised by the use of several gears including purse seine nets, beach seine net, set nets, drifting gill nets and hook and line operated from wooden canoes. There are four types of canoe in Ghana ranging from 3 to 5 m small dugout canoes mainly propelled by paddle, through medium 6 to 11 m wooden canoes propelled by paddle, sail and outboard engine, to large 12 to 18 m wooden canoes mainly motorised by outboard engine (Doyi 1984). The most commonly observed outboard engine in the Western region was the 40 horse power (hp) Yamaha. Each canoe type is used for particular fishing method(s) and crews for the larger canoes range between 4 and 30, depending on the canoe size and fishing gear. There are over 11,200 canoes and more than 124,000 fishers operating actively in Ghana (FAO 2010).

Artisanal fishers operate anywhere in the Ghana EEZ, although most fishermen operate in the inshore, shelf waters and do not venture out into the deeper offshore waters. Ghana also has an Inland Exclusion Zone (IEZ) which goes from 0 to 30 m depth. No industrial vessels are allowed into the IEZ, although due to limited enforcement it is reported that they do enter this zone, sometimes interfering with artisanal fishing activities.

Fishers are mobile following the small pelagic fish stocks which in turn are dependent on the location of the upwelling which can vary along the coast during the fishing season (Marquette *et al* 2002).

There are no traditional fishing grounds for fishing villages with fishers in any one village tending to concentrate their fishing effort on a specific fishing gear or target species. Villages close to each other do not, however, always use similar gears or target the same species. The type of fishing gear used generally depends on the species being targeted and there are different general geographic distributions along the Ghanaian coast. For example, beach seine is widely used in the Volta Region to the east of Ghana, particularly around the mouth of the Volta River and other estuarine areas, to exploit juvenile fish. These areas are nursery grounds for several important fish species such as mullet, carangid and croakers as well as shrimps. Purse seine nets are prominent in the Greater Accra and Central regions where small pelagic species are heavily exploited. Drift gill nets and set-nets are the most common gear used in the Western and Central regions.

In the past, fishing was localised, particularly for *Sardinella* species, but with increased development and demand for fish, fishermen began to use outboard motors and can therefore go further afield. Approximately 50 to 60% of the canoes are powered by outboard motors with engine power of up to 40 hp (FAO 2010; Kwadjosse 2009) while the smaller craft use sail power. Various different artisanal gears target different resources, principally small pelagic and demersal species but also large pelagic species and some molluscs and crustaceans *ie* they exploit all the different fish groups, with the possible exception of some deepwater species. *Table 5.4* provides more detail on some of the key gear types operated.

The small pelagic species are mainly exploited by the artisanal purse seines and beach seines, particularly during the upwelling periods, when these species move into coastal waters to spawn. During this period purse seiners target adult *Sardinella* species and chub mackerel and beach seiners just the *Sardinella* species and during the non-upwelling periods, both target anchovies and juvenile *Sardinella* species in coastal waters or beach areas respectively. Hook and line, and beach seines are the main artisanal gears used to exploit demersal resources. Hook and line canoes operate in deep waters of about 80 m on hard bottoms. Some of the hook and line canoes have facilities for storing ice to preserve fish and are therefore capable of staying up to three days at sea. Some are equipped with electronic fish finding devices such as echo sounders (FAO 2010).

The main species they target are seabreams (*eg* pink dentex, bluespotted seabrean and Canary dentex), snappers (*eg* golden African snapper, Gorean snapper) and groupers (*eg* white grouper). The beach seine fleet exploits both adult and juvenile demersal fish but mainly juvenile fish. Some of their target species include grunts (*eg* bigeye grunt), goatfishes (*eg* West African goatfish), mullets and cutlassfish (FAO 2010).

Some drift gill nets deployed by artisanal fishers are used to target the small pelagic species, but other drift gill nets are used offshore to exploit mainly large pelagic species such as tunas, sailfish, swordfish and sharks (FAO, 2010). Artisanal gears are also used to exploit molluscs and crustaceans. Beach seines are used to exploit shrimps, mainly adult and juvenile Guinea/white shrimp and tiger shrimp/camarote prawn and juvenile pink/candied shrimp as they move from the estuaries into marine waters. Lobster set nets target royal spiny lobster, on rocky bottoms and in depths of about 40 m. In addition cephalopods (common cuttlefish, common squid, common octopus) are targeted. This sector provides both employment in coastal communities and a relatively cheap but rich source of protein, estimated to contribute 70 to 80% of the marine fish output in Ghana (FAO 2010)(1).

(1) Also using data provided to ESL/ERM by MFRD for 2008-2010. Small Scale/Artisanal fisheries are represented by 'Canoes', Inshore/Semi-industrial fisheries by 'Inshore Vessels' and the remainder are attributed to the 'Industrial' fisheries sector.

Table 5.4 Information Regarding Key Artisanal Gear Types Used along the Western Coast of Ghana

Local Name	Best English Equivalent Name	Main Species Targeted	Mesh Sizes (Inches. 1 inch = 2.54 cm))	Rope Sizes (Grade)	Notes
Watcha	Purse Seine	Small pelagics including herrings	Sack: 1 Surrounding: 1 ¾; 1 5/8; 1 7/8	6; 9	Can combine different mesh sizes
Poli	Purse Seine (smaller sack size)	Anchovies	Sack: 0.5 Surrounding: 1; 1 ¾; 1 7/8	6; 9	
Twee	Beach Purse Seine	Mainly shrimps, ribbonfish *eg* largehead hairtail / cutlassfish and West African ilisha	Sack: 1 Surrounding: 1 5/8; 1 7/8; 2;	21	Can take 30 people either side of the net up to 8 hours to pull in. Largely dependent on state of the sea and length of net. Can combine different mesh sizes with mesh size decreasing towards sack. Set to about 8 m depth.
Ali / Adzi / Ashekwan	Drift Gill Net	Small pelagics including herrings	1 ¾; 1 5/8; 1 7/8	3; 4; 6	
Pateku / Nifa-Nifa	Drift Gill Net (different mesh size to Ali)	Larger fish such as blue shark, hammerhead sharks, blue marlin, sailfish, rays, skipjack tuna, yellowfin tuna and some larger mackerel species.	4; 4 ½; 5	9; 12; 15; 18; 21	'Pateku' traditionally related to fishermen who go far offshore. 'Nifa' means 'right' and this net came into existence when driving changed from left to right in 1974.
Kada	Bottom Set Net	Burro, grunts, cassava fish, rays, soles, snappers, groupers and lobsters.	3; 3 ½; 4; 5; 6	9; 12	
Tonga	Bottom Set Net (different mesh size to Kada)	Small demersal species such as West African ilisha, burrito, West African goatfish, lesser African threadfin.	1 7/8; 2	Mainly 6	Mesh available in nylon microfilaments
Egugu Bua / Mpatoa Bua	Cast net	Small pelagics	½	3	Usually used in lagoons but also along marine shore.
n/a	Hook and Line	Demersals	n/a	n/a	

Source: ERM/ESL fisheries consultations 2011

5.5.2 *Inshore Fishery*

The inshore (or semi-industrial) fishing fleet consists of locally built wooden vessels fitted with inboard engines of up to 400 hp ranging between 8 m and 37 m in length. Vessels with lengths less than 12 m are referred to as small-sized while those between 12 and 22 m are referred to as medium-sized vessels (FAO 2010). There are about 300 inshore vessels, operating from seven landing centres; the larger centres are Takoradi, Tema, Elmina and Sekondi and the smaller centres are Apam, Axim, Mumford. *Figure* 5.2 in *Section 5.6* below shows the locations of these sites.

The vessels are mainly multi-purpose and carry both purse-seine and bottom trawl gear, operating as purse-seiners during the upwelling periods and switching to bottom trawling for the rest of the year.

These vessels use ice for preserving fish at sea and a fishing trip usually varies between 3 and 5 days. Most purse-seine nets measure 400 to 800 m long, are 40 to 70 m deep and have a mesh size of approximately 25 to 40 mm. Bottom trawl gear has a mesh of 40 mm at the end of the net (codend), 45 m head rope and 40 m foot rope.

The fleet exploits both small pelagic and demersal species. The purse-seiners target the small pelagic species including *Sardinella* species, chub mackerel, fishing in the same coastal waters as the artisanal fleet during the upwelling seasons. Demersal species are targeted through trawling, with the small-sized vessels targeting species including grey triggerfish. The medium-sized trawlers exploit seabreams (bluespotted seabream and canary dentex), snappers (*eg* golden African snapper, Gorean snapper), grunts (*eg* bigeye grunt), croakers (*eg* red Pandora, cassava croaker) and groupers (*eg* white grouper) (FAO 2010). Bottom trawling is undertaken in waters greater than 30 m depth.

The disappearance of grey triggerfish from Ghanaian waters in the late 1980s greatly affected the performance of the inshore sector since the species was the main resource base for many of these vessels. This sector is estimated to land about 2% of the total marine fish production (Kwadjosse 2009)[(1)].

5.5.3 *Industrial*

The industrial fleet comprises large, steel-hulled, foreign-built trawlers, shrimpers, tuna baitboats (pole-and-line) and tuna purse-seiners. The industrial fleet underwent an expansion in numbers after 1984 when the policy of the Government of Ghana targeted industrial fishing as a mechanism for promoting non-traditional exports. The industrial fleet has freezing facilities for preserving fish at sea and can stay for months at sea. In 2009 there were 119 industrial trawlers licensed to fish in Ghanaian waters and the

(1) Also using data provided by MFRD for 2008-2010. Small Scale/Artisanal fisheries are represented by 'Canoes', Inshore/Semi-industrial fisheries by 'Inshore Vessels' and the remainder are attributed to the 'Industrial' fisheries sector.

fleet was considered to be relatively old and inefficient and did not meet international sanitary and phytosanitary standards (NFDS 2009; Kwadjosse 2009). With the introduction of the *Fisheries Act 2010* pair trawling has been prohibited.

Trawlers are normally over 35 m in length and have engines of over 600 hp. As deep-sea vessels, they are required by the *Fisheries Act of 2002* (Act 625) to operate outside the IEZ *ie* in waters greater than 30 m depth, but as they cannot trawl in depths greater than 75 m their operational area is limited. It is reported that trawling does take place within the IEZ. Trawlers used to operate off the west and south-west coast of Africa particularly in the area from Sierra-Leone to Mauritania and in the area between Angola and Namibia, however, this is no longer permissible since enforcement of the 200 nautical mile EEZ by these countries (FAO 2010).

The trawlers mainly exploit the valuable demersals, including sole and flounders, groupers (*eg* white grouper) and cuttlefish (*eg* common cuttlefish) as well as shrimps and pelagic tunas. They also target other species including porgies or seabreams, jacks (*eg* false scad), snappers, croakers (*eg* cassava croaker), goatfish (*eg* West African goatfish) (FAO 2010).

In the past, commercial shrimpers were up to 30 m in length with engines of over 350 hp and restricted by law to operate between latitude 1° 45' W to 2° 30' W and 0° 15'E to 1° 12' E (between Shama and Axim) and in waters with a greater depth than 30 m. Commercial shrimping resumed in 1986 and the number of vessels increased to 22 (16 operational) by 1996 with the majority of shrimp landings being exported to Europe and the Far East. Shrimp production has declined since 1996 and there are only two shrimpers in Ghana at present, neither of which have been operational since 2009 with no shrimp landings recorded for 2009 or 2010. Many shrimping companies have converted their vessels to target other species. Despite Turtle Exclusion Devices (TEDs) being compulsory for shrimpers according the *Fishers Regulation 2010, Section 16*, it is reported that not all these vessels use them.

These vessels mainly target pink shrimp but in a normal trip, there are significant proportions of bycatch comprising small inshore fishes such as jacks (*eg* Atlantic bumper), grunts (*eg* bigeye grunt), porgies or seabreams, sole and flounders, croakers (*eg* cassava croaker) and goatfish as well as cuttlefish (*eg* common cuttlefish) (FAO 2010).

In April 2011, there were approximately 39 tuna vessels in the industrial fleet licensed to operate in Ghanaian waters and this number has remained fairly stable for approximately five years as ICCAT has a cap on the number of vessels allowed. Vessels operate on a joint-venture basis, with Ghanaian owners having at least 50% of the shares, as required by the *Fisheries Act 2002*. Of the 39 vessels, 14 are purse-seiners and 25 pole and line (baitboat) vessels but some vessels are not operational, so operating vessel numbers vary. The extent of tuna boats vessels using longline gears in Ghanaian waters is not clear.

Most tuna vessels operate outside the continental shelf, with an area demarcated by FAO as Major Fishing Area 34 being the main fishing location and tuna fishers usually fish in 60 to 450 m of water (1).

In the early 1990s, techniques such as the use of bird radar to find birds feeding on fish shoals and the use of FADs (2) were employed to enhance the capture of targeted tuna species and the *Fisheries Act 2010* obliges all vessels to conform to ICCAT regulations with regard to the use of FADs. Tuna baitboats and tuna purse-seiners employ over 15,000 FADs in capturing the resources (ICCAT 2009). Since the late 1990s the fleets have reportedly been collaborating with each other, often sharing the catch during fishing operations.

The main tuna species targeted by the tuna boats of the industrial fleet, are skipjack tuna (over 50%), yellowfin tuna and bigeye tuna. Other minor tuna-like species especially the little tunny are also exploited by the fleets and the tuna baitboats use European anchovy and other small pelagic species as bait for their operations. The level of effort in targeting different species is different for each tuna species and differs between years.

The industrial fleet lands approximately 25 to 30% of the total fish production with the large majority of this accountable to tuna species landings.

5.6 SUPPORTING INFRASTRUCTURE

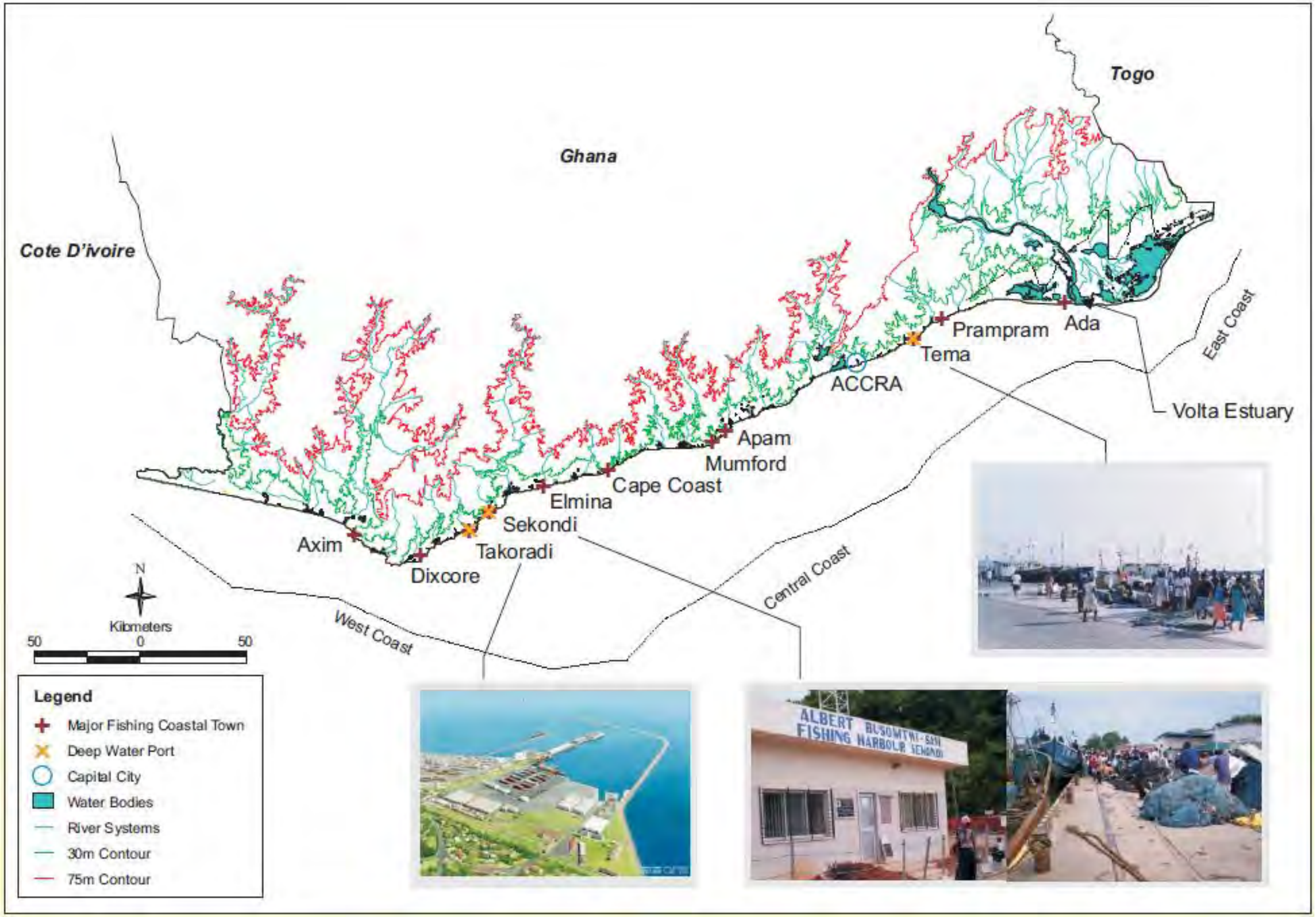
5.6.1 Fishing Ports

The Ghana Ports and Harbours Authority manages all ports and harbours in Ghana and provides facilities for bunkering, stevedoring and handling, electricity and water supplies. The main ports in Ghana are located at Tema in the east and the twin towns of Takoradi and Sekondi in the west, and provide berthing facilities for industrial fishing vessels and inshore vessels as well as large canoes. In the Western Region there are four other ports at Apam, Mumford, Elmina and Axim that provide landing facilities for inshore vessels, as well as some other major fishing coastal towns such as Dixcove and Cape Coast, used for artisanal landings. *Figure 5.2* shows the locations of some major fishing coastal towns in Ghana and some images of the main ports.

(1) See http://www.fao.org/fishery/area/Area34/en

(2) Fish Aggregation Devices are constructed of debris and floating objects and are placed on the water surface to attract large shoals of tuna. The FAD and the tuna shoal underneath are then surrounded by a net and the entire shoal caught.

Figure 5.2 Major Coastal Town in Ghana



Tema is a multi-purpose, deepwater, commercial port with a dedicated container terminal. The 'Fishing Harbour' at Tema is a separate facility which comprises a commercial and industrial fishing port composed of four main areas; both an inner and outer harbour, a canoe basin and a commercial area. The fishing harbour has a number of supporting infrastructures that includes:

- a fish market hall for the sale of fresh and frozen catch;
- a quay area for minor repairs of wooden boats;
- fish handling shed;
- an ice plant; and
- a bath house and administration building.

The deepwater outer harbour can accommodate tuna vessels as well as medium and small trawlers (inshore vessels). It is the main landing site for tuna in Ghana, while the canoe basin is under the control of the Chief Fisherman and caters for artisanal fishers accounting for up to 70% of economic activity at the port (GPHA 2006). The canoe basin is normally occupied by approximately 400 canoes but this can increase especially during the peak fishing season (July to October) as an additional approximately 100 canoes belonging to fishing communities further away from Tema, land their catch at the port (GPHA 2006).

At Takoradi and Sekondi there are two adjacent ports; the deepwater naval Takoradi Port with berthing facilities that include four multipurpose berths with drafts between 9 and 10 m and buoys with a maximum draft of 11 m, and the smaller medium depth Albert Bosomtwe-Sam Fishing Harbour which has about 3.5 m draft. Albert Bosomtwe-Sam Fishing Harbour is a key landing site for artisanal canoes and inshore vessels and has both an open and covered market, with some facilities associated with it, such as an ice-making facility and administration buildings as well as areas dedicated to fish smoking.

5.6.2 Artisanal Fishing Landings Sites

Artisanal fishers use over 300 landing sites along the coastline of Ghana (Sarpong *et al* 2005; FAO 2010). In the Western Region there are several major artisanal landing towns including Dixcove, Axim, Sekondi-Takoradi's Albert Bosomtwe-Sam Fishing Harbour, Elemina and Mumford, all shown on *Figure 5.3*. The typical artisanal catch landings sites are the beaches adjacent to the fishing communities. For many of these areas there is generally very little physical infrastructure and canoes are launched from the beaches.

Each landing site is under the control of a Chief Fisherman and various institutions at the community level manage the fishing activities, including:

(i) the chief (*omanhene*) and lineage elders (*mpanyinfo*);
(ii) the chief fisherman (*apofohene*) and the fisher woman or queen of the fish traders (*konokohene*); and
(iii) fishing companies linked to old military (*asafo*) companies in the community (Marquette *et al* 2002).

5.6.3 *Boatbuilding, Repairs and Maintenance*

There are two boat building companies located in Tema and Sekondi that construct inshore vessels (Tema Boatyards Corporation and Sekondi Boatyards Corporation). These companies were Government owned until the early 1990s when they were privatised. Due to the high cost of materials and the low demand for fishing vessels the current capacity for boat building is low.

The Tema Boatyards and Drydock Corporation also provide dry-docking and repair facilities for all categories of fishing vessels and there is one other repair facilities at Tema. A number of private companies in Tema, Accra and Takoradi operate engineering workshops with foundries to undertake fishing vessel maintenance and repairs, although these facilities are in the need of investment to allow them to be fully operational.

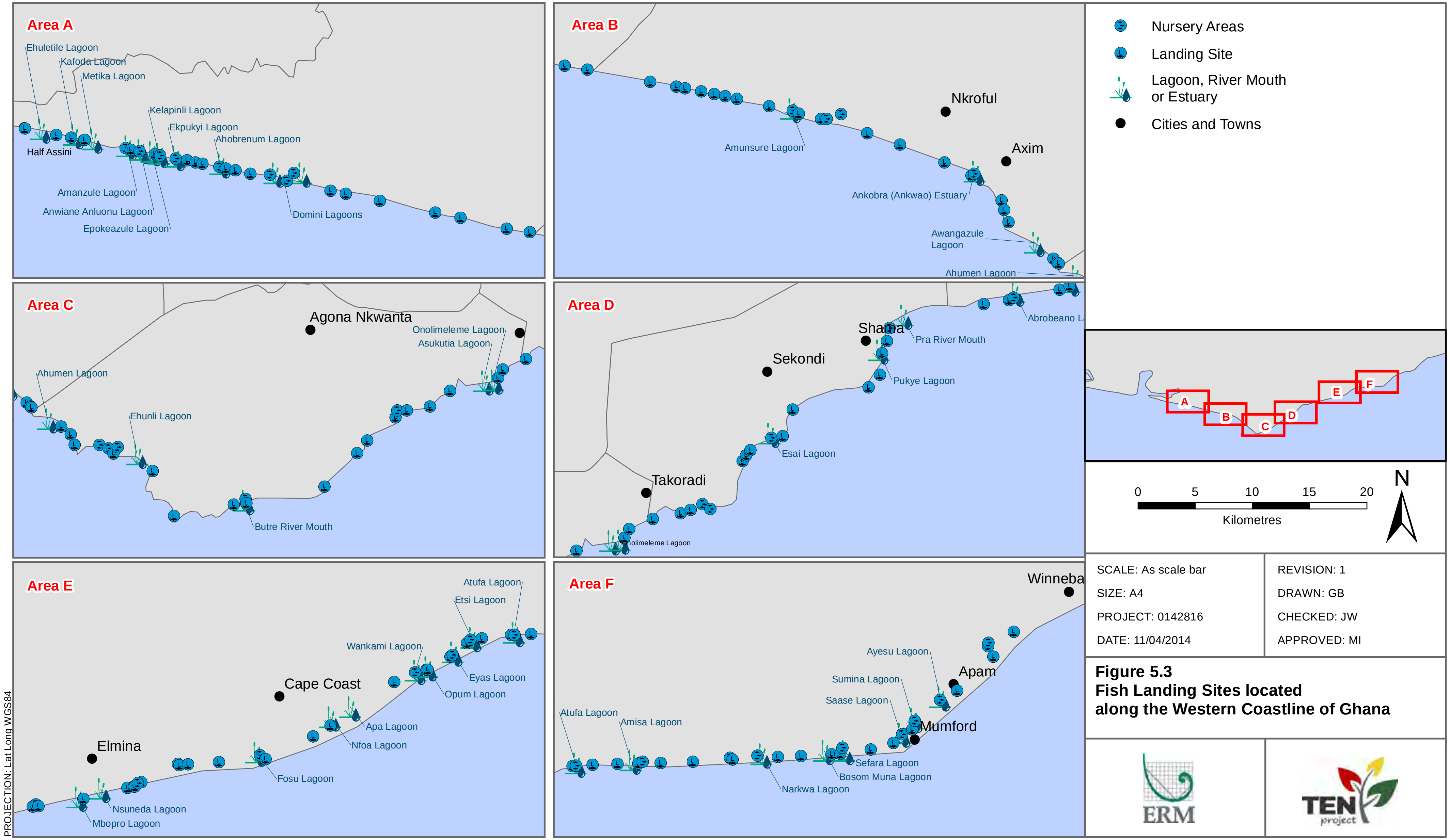


Figure 5.3
Fish Landing Sites located along the Western Coastline of Ghana

SOURCE: Tullow

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_LandSites_Rev0.mxd

5.7 *FISH LANDINGS*

Data from 1998 to 2009 show that overall landings in Ghana are declining, particularly in the small pelagic resources (see *Figure 5.4*). Large pelagic landings have remained fairly stable, demersal species show a general increase, while landings of molluscs and crustaceans have remained consistently low.

In the Western Region of Ghana, data from 2006 to 2010 also show a declining trend of overall catch. While small pelagic catches have declined slightly, there is a more marked decline in the key small pelagic species (namely round sardinella, flat sardinella, chub mackerel and European anchovy) as illustrated in *Figure 5.5*. Large pelagic landings have fluctuated quite considerably annually although landing of key large pelagic species, namely, bigeye tuna, yellowfin tuna and skipjack tuna appear to have increased slightly. Catches of demersal species show a similar trend to that seen in Ghana overall up to 2008, but then fall off sharply in 2010. As per in Ghana overall, landings of molluscs and crustaceans have remained consistently low.

It should be noted that catch landings do not directly reflect on stock status since no account has been made for the level of fishing effort to attain these quantities of catch.

The following sections give more detail on each of the fish categories. Status of stocks is briefly discussed where data is available.

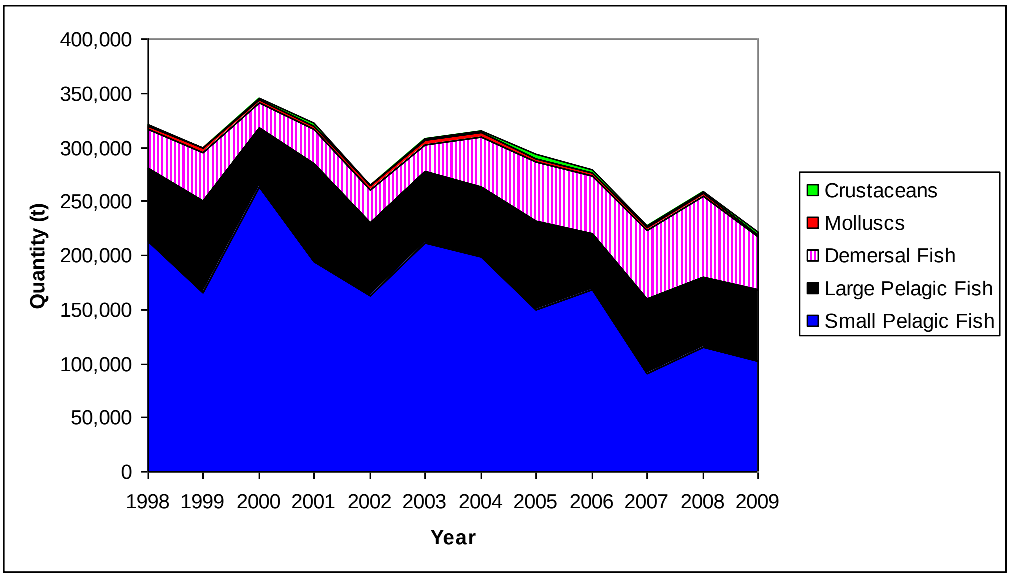
5.7.1 *Small Pelagic Fish Species*

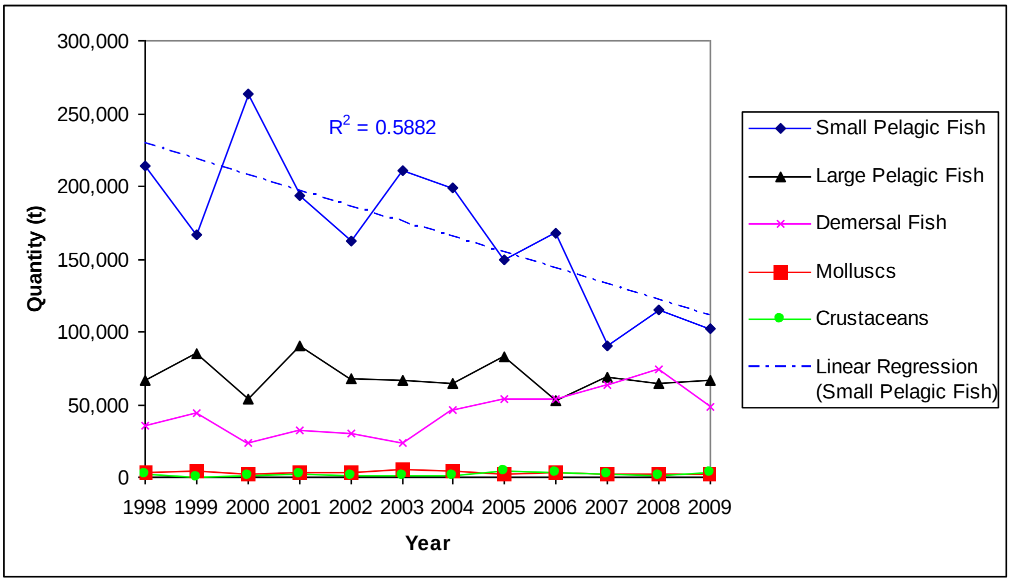
The four species of the highest economic value are round sardinella, Madeira/flat sardinella, European anchovy and chub mackerel. The potential annual yield of these species was estimated to be in the region of 200,000 tonnes (t) in 2004 (MoFA 2004) but data from 1988 to 2009 show an average annual catch landing of 169,465 t (Standard Deviation: 50,626) for these species.

The annual landings of round sardinella have fluctuated widely over the past two decades to 2009 (most recent available data) from a peak catch of 125,814 t in 1992 and over 102,000 t in 2000 to under 20,000 t in 2000. Equally the European anchovy reported a peak catch of around 98,340 t in 1996 and was at an all-time low of approximately 10,000 t in 2007. The trend is that of a general decline in the past two decades for the both round sardinella and European anchovy (*Figure 5.6*).

During that same time period, the catch levels of the other two key small pelagic species, flat sardinella and chub mackerel, have always been under 20,000 t, with the exception of the 2004 and 2006 catches for flat sardinella and 1991, 1998 and 2000 for chub mackerel. *Figure 5.6* illustrates the annual reported catches of the key four small pelagic species from 1988 to 2009.

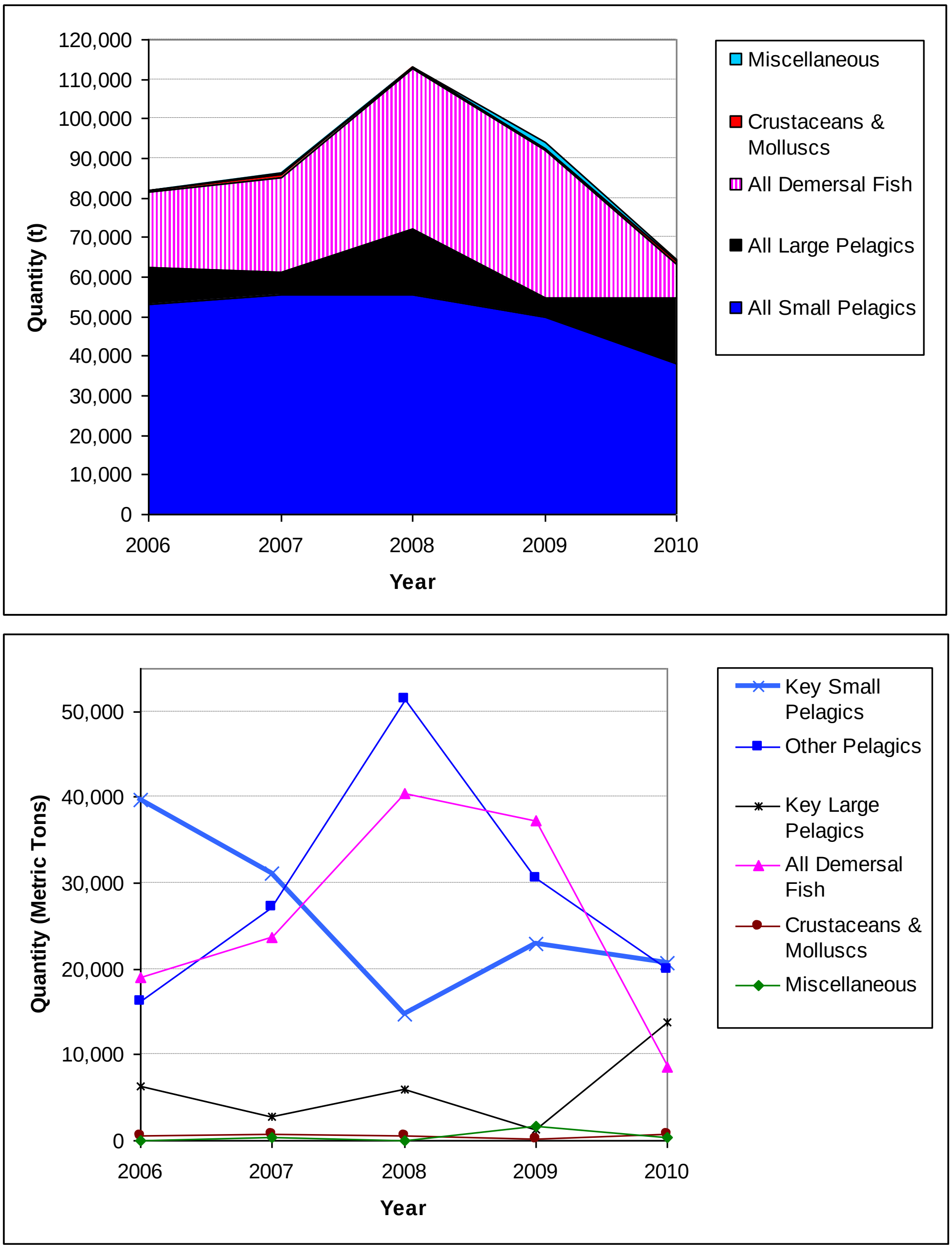
Figure 5.4 Total Overall Ghanaian Landings of Major Target Groups 1998 to 2009





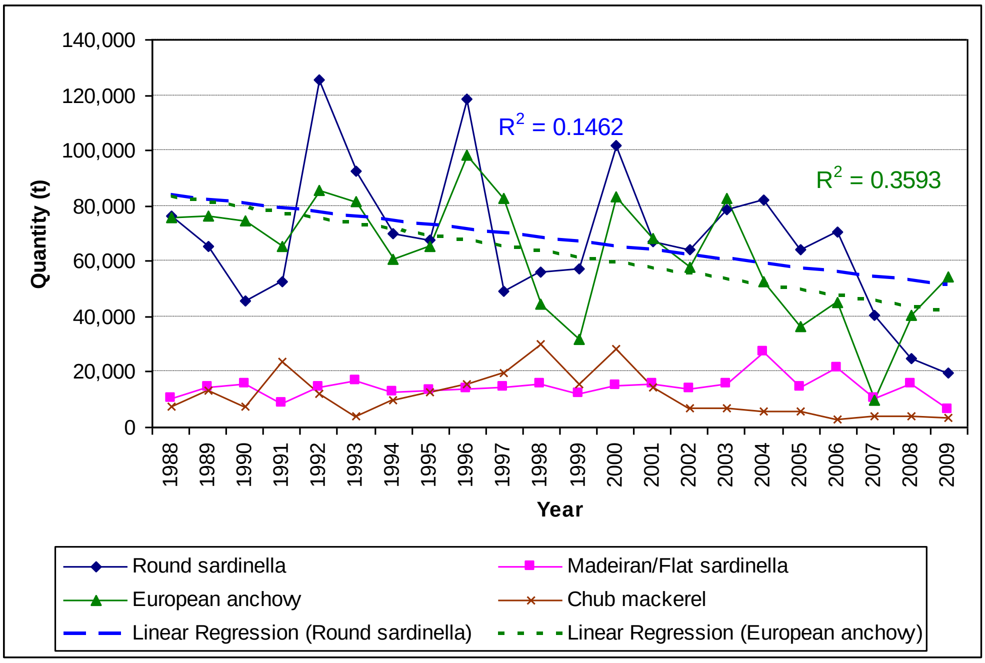
Source: FAO FishStat 2011

Figure 5.5 Total Landings from Western Region of Ghana 2006 to 2010



Key: small pelagics = round sardinella, flat sardinella, chub mackerel and European anchovy
Source: MFRD 2011b

Figure 5.6 *Annual Ghanaian Landings of the Four Key Small Pelagic Fish Species*

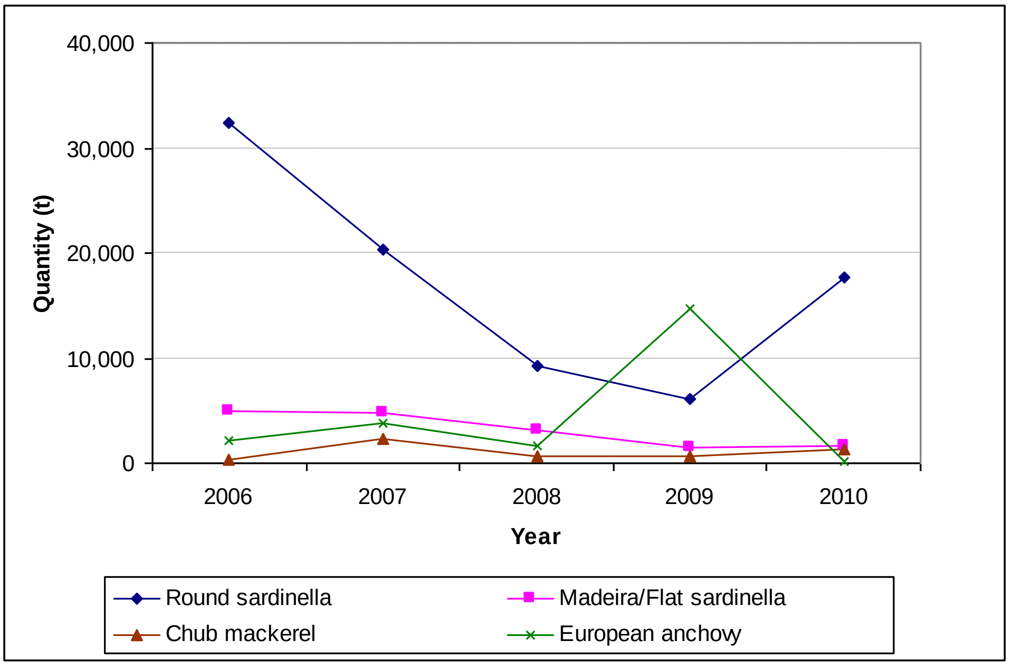


Source: FAO FishStat 2011

In the Western Region of Ghana, data from 2006 to 2010 also show landings of round sardinella diminishing, although there was an upturn in 2010. Flat sardinella catches have declined slightly over this period in this region, but European anchovy has shown no consistent trend, only an exceptionally low catch in 2010, of under 109 t, compared to over 14,700 t the previous year.

Data from the Western Region for the four key small pelagic fish species also show seasonal variation as illustrated in *Figure 5.7*. Round sardinella consistently the predominant species landed of these four species and on average landings peak between May and September and again around February. Flat sardinella catches peak between April and July on average, with chub mackerel catches peaking sharply in August. European anchovy conversely appears to peak between January and April on average, with almost no landings in June and July. Overall combining the catch landing data for all the four key small pelagic species, there is a small peak between May and September and a distinct low season between October and December. *Figure 5.6* shows how variable recorded catch landing data are between years, and it is notable that the seasonal variations inferred from the monthly averages (see *Figure 5.7*), are unlikely to be reliable year on year.

Figure 5.7 *Annual Landings of the Four Key Small Pelagic Fish Species in the Western Region of Ghana 2006 to 2010*



Source: MFRD 2011b

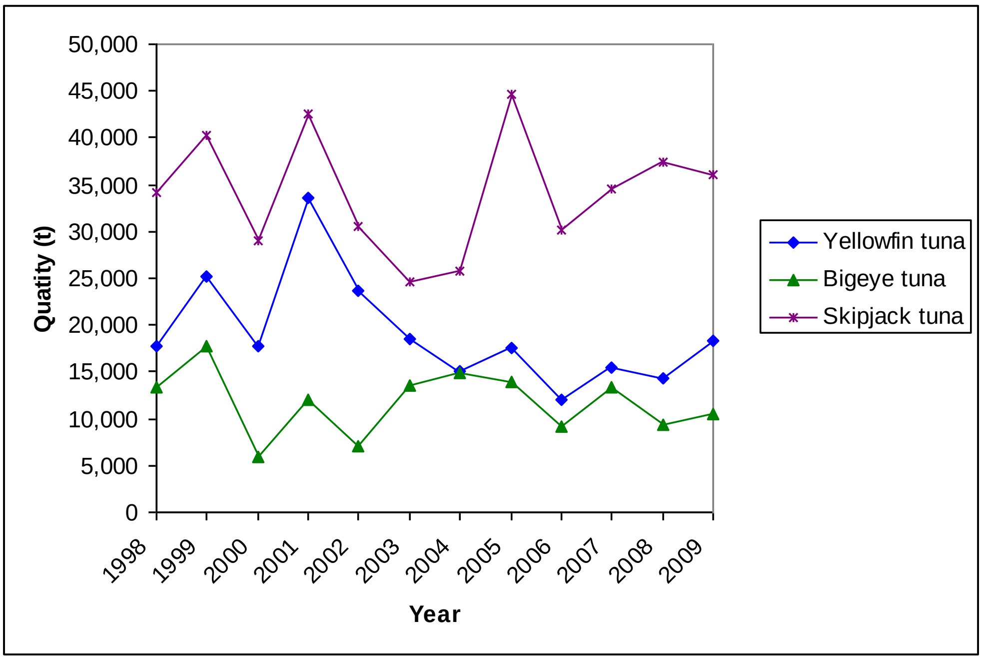
5.7.2 *Large Pelagic Fish Species*

The tuna and billfish species that occur in Ghanaian waters are part of a wider population found throughout the Atlantic Ocean. Tuna baitboats are the main exploiters of tuna in Ghanaian waters, using live anchovy and other small pelagic species as the main bait for their operations. In addition, the use of bamboo rafts as FADs is common, although their use has recently come under tighter regulation. The use of FADs is banned during a seasonal (1 Nov to 31 Jan) Moratorium period in the main spawning area. This was introduced by ICCAT in 1999 to 2004 to examine the impacts of FAD fishing on tuna populations.

Total Ghanaian annual landings of yellowfin tuna, bigeye tuna and skipjack tuna have fluctuated between approximately 51,000 and 88,000 t from 1998 to 2009 with catches of skipjack tuna consistently being larger than the other two. Catches of yellowfin tuna reached a peak in 2001 at just over 33,500 t and has shown a steady decline since. Catches of skipjack tuna and bigeye tuna have shown a high degree of variability, with no obvious trend over this timeframe (see *Figure 5.8*).

In general, over 60% of all tuna species caught are skipjack tuna due to this species hardly migrating from their spawning/breeding grounds in Ghanaian waters. Ghanaian tuna fishing usually occurs in spawning areas such that the tuna caught are not mature and according to ICCAT, approximately 60% of the tuna caught are undersized.

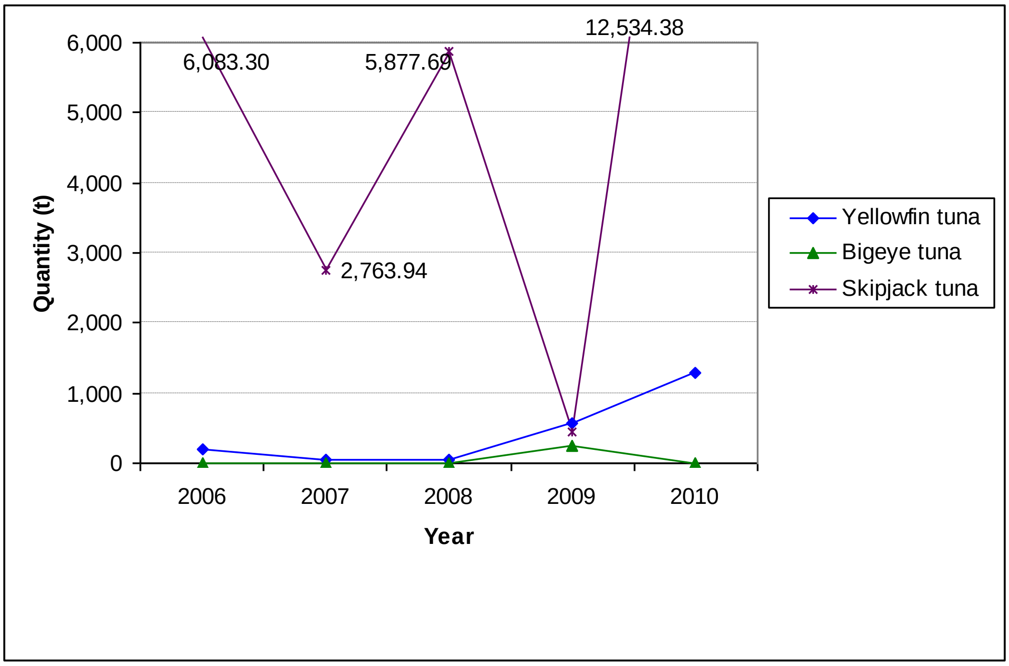
Figure 5.8 ***Annual Ghanaian Landings of Three Key Large Pelagic Fish Species***



Source: FAO FishStat 2011

In the Western Region of Ghana, data for the key large pelagic species from 2006 to 2010 show almost no bigeye tuna were landed, except in 2009 when 258.08 t were reportedly caught. Landings of yellowfin tuna were minimal until 2009 and more than doubled from 2009 to 2010. Skipjack tuna is the most abundant of the three tuna species, but catch landings have fluctuated hugely from over the past five years. *Figure 5.9* illustrates these trends.

Figure 5.9 ***Annual Landings of the Key Large Pelagic Fish Species in the Western Region of Ghana, 2006 to 2010***



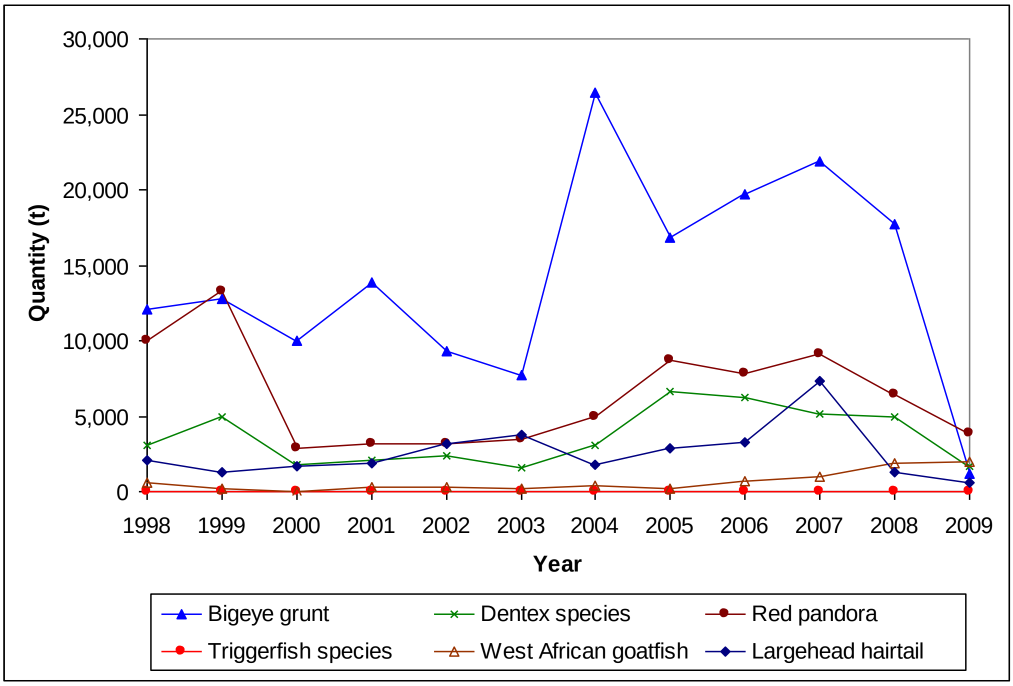
Source: MFRD 2011b

5.7.3 *Demersal Fish Species*

The total annual demersal landings by all fleets from 1998 to 2009 is shown in *Figure 5.10* and shows a general trend indicating a progressive increase in demersal landings since 2004 with catches in the region of 74,000 t in 2008. Catch landings for key demersal species (no data for bluespotted seabream) have varied considerably from 1998 to 2009. There was a marked increase in the landings of bigeye grunt up to 2007, after which landings have fallen. Red pandora landings were consistently low between 2000 and 2004, with higher levels between 2005 and 2007, after which catch has been declining. Generally landing of the key demersal species has declined in recent years with the exception of the West African goatfish landings which appear to have increased steadily since 2005.

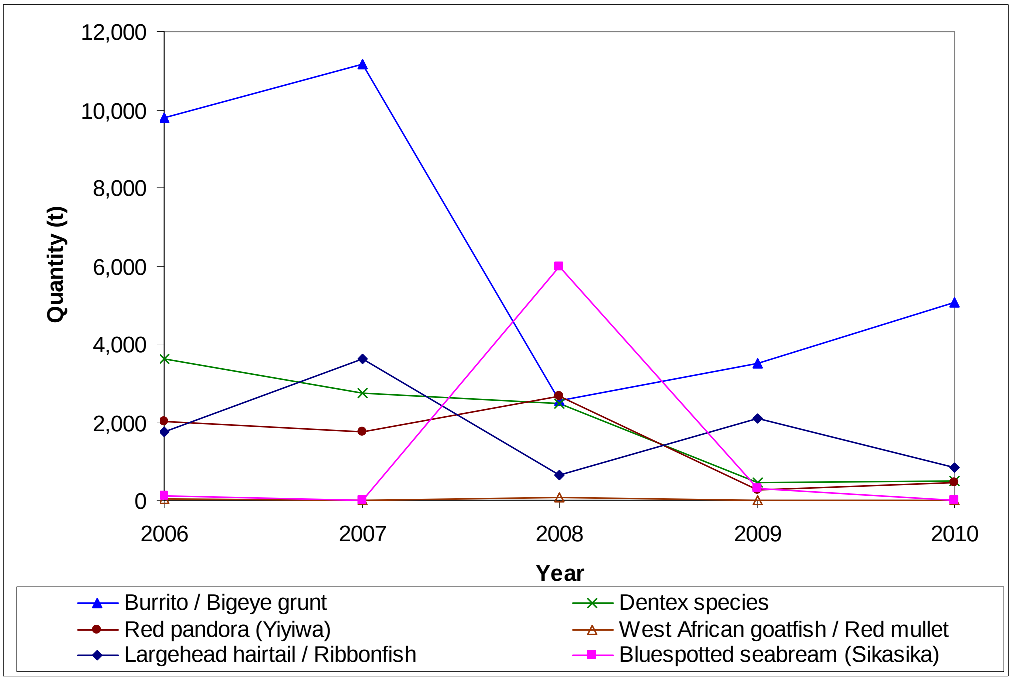
In the Western Region of Ghana, data for the key demersal species from 2006 to 2010 show a general decline with the exception of bluespotted seabream for which the highest catches were recorded in 2008 (the FAO data set does not include any blue-spotted seabream data for Ghana overall for comparison). *Figure 5.11* illustrates these trends, noting no trigger fish species are recorded in the catch landing data for the Western Region over the five year period.

Figure 5.10 ***Annual Ghanaian Landings of Key Demersal Fish Species***



Source: FAO FishStat 2011

Figure 5.11 Annual Landings of the Key Demersal Fish Species in the Western Region of Ghana, 2006 to 2010



Source: MFRD 2011b

Information regarding the demersal resources of the Gulf of Guinea (CECAF Area 34 – approximately from Sierra Leone to Benin[(1)]) is generally limited, but a Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources in 2003 (CECAF 2003) does discuss the status of the main species of demersal fishes exploited in Ghana, including croakers, red pandora, *Dentex* species, bigeye grunt and lesser African threadfin taking into account catch levels and stock biomass. For all these species or groups of species, the report concludes that the stocks are overexploited.

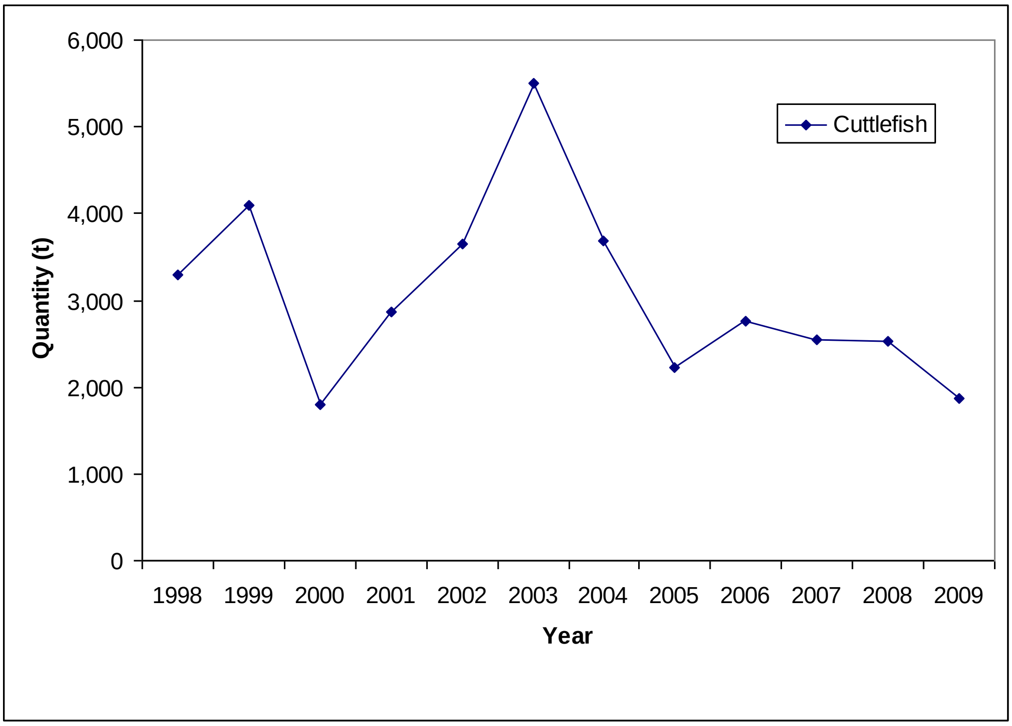
5.7.4 Molluscs and Crustaceans

Molluscs and crustaceans contribute to demersal catches and constitute another component of the demersal resources targeted in Ghanaian waters. Of these, cuttlefish are the most important. Annual landings of cuttlefish peaked in 2003 and then declined to 2000 levels from 2005 to 2009 (*Figure* 5.12). These data represent the total annual catches and do not indicate fishing effort which is one influential factor for quantity of catches.

In the Western Region of Ghana, there is only data for cuttlefish/inkfish from 2006 (72.83 t) and 2010 (12.21 t) and otherwise catch landing data have not been recorded for the intervening years (MFRD 2011b).

(1) See http://www.fao.org/fishery/area/Area34/en

Figure 5.12 Total Annual Landings of Cuttlefish 1998 to 2009



Source: FAO FishStat 2011

5.7.5 *Other Catch of Value*

Bycatch

Bycatch from the industrial sector are important commercially in Ghana as trawlers sell unwanted bycatches of non-target species to smaller vessels at sea (Marquette *et al* 2002; Nunno 2009). The efficiency of this process has been enhanced by the use of modern communications and navigation equipment (Nunno 2009).

The operation of the bycatch business is centred mainly in Elmina, Apam and Tema, but it is difficult to quantify the importance of this trade, since most of the bycatch is not recorded as catch by fisheries officers at the landing beaches. This market has led to offshore vessels to fish closer to shore and it has been reported that illegal mesh sizes have been used to enhance bycatch quantities.

Some key species of bycatch traded in this way are snakefish (*Trachinocephaleus myops*) (approximately 32%), wedge sole (*Dicologoglossa cuneata*) (approximately 25%), pearly razorfish (*Xyrichtys novacula)* (approximately 13%), and Atlantic bigeye (*Priacanthus arenatus*) (approximately 6%) (Nunno 2009).

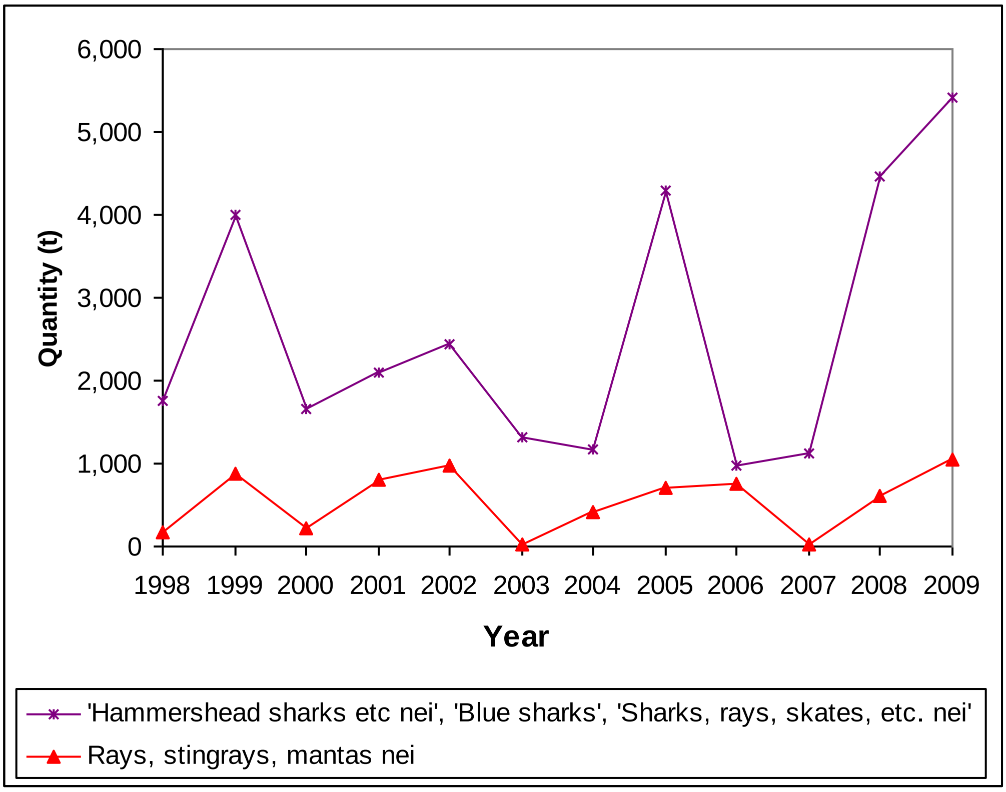
Sharks and Rays

Some shark and ray fishing is officially reported for Ghana, however, little data is available. Catch statistics are available from the FAO database, FishStat(1) and these are shown in *Figure 5.13.*

In the Western Region of Ghana, data for the for shark and ray catch landings from 2006 to 2010 show shark landings have increased recently. Landings of rays have also increased, but to a lesser degree (*Figure 5.14*).

Comparing the local Ghana MFRD data for the Western Region to the FAO data highlights some issues with comparison between these data sets. Shark landings in the Western Region appear to account for roughly half shark landings in the whole of Ghana, however landings of rays (classified as Manta ray, Eagle/Whip ray, Sting ray and Rays unspecified in the MFRD dataset) appear to be higher in the Western Region than in the rest of Ghana from 2007 to 2009 (996 t versus 19 t; 1,371 t versus 600 t; 563 t versus 1,061 t respectively). The FAO dataset however has one category that groups sharks and rays together ('sharks, rays, skates, *etc* nei'). Since it is not possible to distinguish rays and sharks from within these data, they have been added to the general shark quantities for *Figure 5.13*, which may explain the discrepancy.

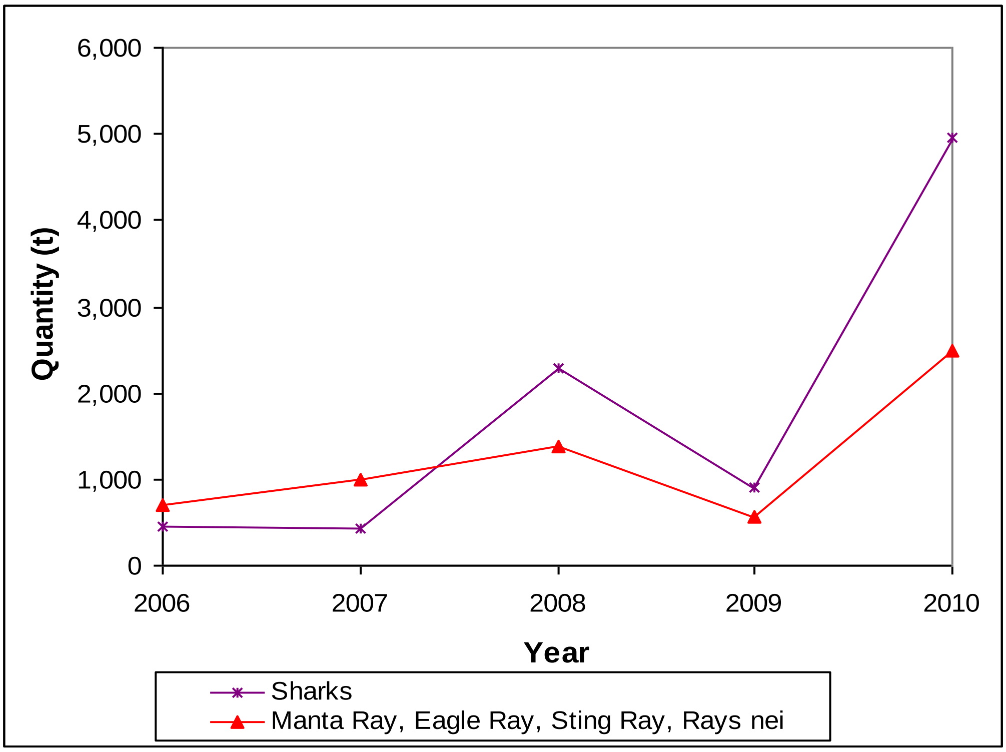
Figure 5.13 Total Annual Landings of Shark sand Rays 1998-2009



Source: FAO FishStat 2011. Nei = not elsewhere included in the database

(1) Available at http://www.fao.org/fishery/statistics/cecaf-capture-production/query/en [Accessed July 2011]

Figure 5.14 ***Annual Landings of the Sharks and Rays in the Western Region of Ghana, 2006 to 2010***



Source: MFRD 2011b

The exploitation of shark fins has become a widespread business in Ghana. Dixcove is one town where many fishermen fish for sharks and there is a trade in shark fins. Shark fishing is a year-round operation with a peak season in October and December (IMM 2003). Shark fishing is conducted by different types of vessels, including artisanal, inshore and industrial and as many as 150,000 fishermen might be involved in it (Mensah and Koranteng, 1988).

The sharks are caught using driftnet and species comprise blue shark (*Prionace glauca*), hammerhead sharks (*Sphyrna* spp) as well as silky shark (*Carcharhinus falsiformis*), black tip shark (*Carcharhinus limbatus*), oceanic whitetip shark (*Carcharhinus longimanus*), sandbar shark (*Carcharhinus plumbeus*) and night shark (*Carcharhinus signatus*). In addition, sharks can be caught as bycatch by purse-seiners as well as bottom set gill nets. The shark fin fishery poses threats to some species listed as 'Endangered' or 'Critically Endangered' on the IUCN Red List.

6 SOCIO-ECONOMIC BASELINE

6.1 INTRODUCTION

This chapter provides a description of the current socio-economic and health services baseline against which the potential impacts of the TEN Project can be assessed. The baseline description focuses on the Western Region and the six coastal districts that are located nearest to the offshore TEN fields (*Figure 6.1*). The coastal districts include, from west to east, Jomoro District, Ellembelle District, Nzema East Municipality, Ahanta West District, Sekondi-Takoradi Metropolis (STM) and Shama District [(1)].

The chapter includes a demographic, cultural and economic overview and also describes the physical infrastructure and services. This chapter is structured as follows.

- Administrative structures.
- Demographics.
- Land tenure and land use.
- Economy and livelihoods.
- Education system.
- Health care services.
- Utilities, infrastructure and services.
- Marine infrastructure.
- TGL Social Investment projects.

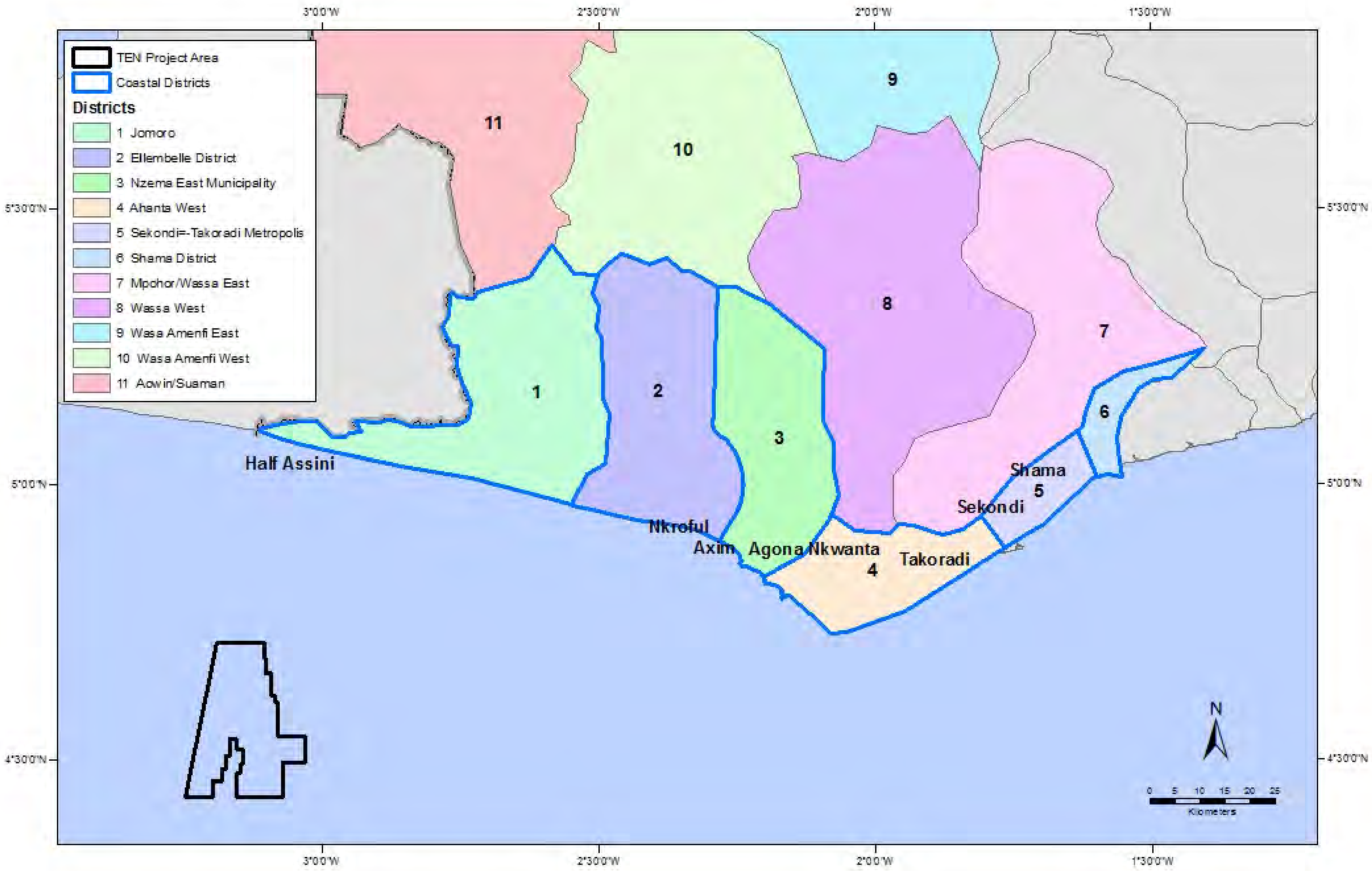
6.2 DATA SOURCES

The baseline draws on available secondary data (*eg* district development plans) and primary data collected for the purposes of the EIA. Secondary data included the 2000 Population and Housing Census (GSS 2005), provisional, regional-level results of the 2010 Population and Housing Census (GSS 2012), medium-term district development plans, district water and sanitation development plans and district annual health reports. The more recent Ghana Living Standards Survey undertaken in 2012-2013 has not yet formally reported the full results of the survey.

Primary data was collected through a series of semi-structured, qualitative Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). These discussions and interviews were undertaken as part of the community consultation process in March 2012.

(1) The term 'District' is used in this report to cover all three types of Administrative area.

Figure 6.1 Coastal Districts with the Western Region



Consultation meetings and interviews were delayed in Jomoro due to raised levels of tension related to the relocation of the gas processing facility from Bonyele. Consultation meetings in Jomoro District were subsequently undertaken in June 2012. The socio-economic baseline data gathering study focussed on 34 representative communities within the six coastal districts in the Western Region (*Table 6.1*).

The communities were selected from a total of 102 communities in the districts based on a set of socio-economic criteria that was developed by the socio-economic specialists and TGL[1]. Further details regarding the consultations are provided in *Attachment I*.

Table 6.1 Communities Visited During Baseline Data Gathering Study

District	Communities	District	Communities
Shama	1. Aboadze 2. Shama Apo 3. Shama Benstir	Nzema East	15. Upper Axim 16. Lower Axim
STM	4. Bakakyir. 5. European Town (Sekondi). 6. New Takoradi. 7. Ngyeresia. 8. Sekondi.	Ellembele	17. Ankobra 18. Essiama 19. Atuabo 20. Azelenloune 21. Engyambra 22. Enokyi
Ahanta West	9. Busua 10. Butre 11. Cape Three Points 12. Dixcove 13. Princess Akatakyir 14. Princess Town	Jomoro	23. Effasu 24. Ahobre 25. Bonyere 26. Half Assini 27. New Town 28. Beyin 29. Beyinyilin* 30. Ngelekazo* 31. Elloin* 32. Ekebaku* 33. Kegeni* 34. Keyian *

* The Paramount Chief invited community members from surrounding villages to attend the Beyin community consultation meeting

(1) The key criteria included: communities located in the six coastal districts in the Western region; population size (small, medium and large per district); dependence on fishing activities as main source of livelihood; traditional heads of each district; coastal communities likely to be affected in the event of a catastrophic oil spill; coastal communities located near estuaries; level of vulnerability, access to infrastructure, levels of services, employment/ income-generating opportunities, and number of female-headed households.

FGDs were undertaken with community leaders and men, fishermen and women and KIIs were undertaken with educators and healthcare professionals. Feedback received through the community consultation process has been used to inform the baseline. Questionnaires were used to gather information on demographics, administrative structures and governance, local economy and livelihoods, education services, health services and local utilities and infrastructure.

Stakeholder comments made during the consultations are summarised in a Register of Issues which is attached in *Attachment I*, *Appendix 6*.

6.3 ADMINISTRATIVE STRUCTURES

6.3.1 Formal Structures

The government administration in Ghana is made up of ten administrative Regions subdivided into 216 metropolitan, municipal and district areas, each with an administrative assembly comprised of a combination of appointed and elected officials. Each area has a District Chief Executive (DCE) who heads the local assembly. The DCE is nominated by the President of the country and is confirmed by the assembly through balloting.

The local government system, as defined under the *Local Government Act 462 of 1993,* is made up of the Regional Coordinating Council (RCC), four-tier Metropolitan and three-tier Municipal/District Assemblies with Urban/Town/Area/Zonal Councils Unit Committees. The RCC is the head of the local government system. There are ten RCCs corresponding to ten Regions in the country. The Council is made up of the Regional Minister as Chairman and his deputies, Presiding Member of each district assembly, DCE of each district, two Chiefs from the Regional House of Chiefs, Regional Coordinating Director and Regional Heads of decentralised ministries. The RCC is a non-executive administrative/coordinating body rather than a political and policy making body and is responsible for monitoring, coordinating and evaluating the performance of the District Assemblies and any Agency of the central government.

The Western Region currently comprises 22 districts including three municipalities, and one Metropolis, namely the Sekondi-Takoradi Metropolis. The districts and their district capitals are presented in *Table 6.2*.

Table 6.2 District and Capitals of the Western Region

Districts	Administration Type	Capitals
Shama *	District	Shama
Sekondi Takoradi (Shama Ahanta East)*	Metropolis	Sekondi
Ahanta West *	District	Agona Nkwanta
Nzema East *	Municipality	Axim
Ellembele *	District	Nkroful
Jomoro *	District	Half Assini
Aowin	District	Enchi
Bia	District	Essam
Bia East	District	
Bibiani/Anhwiaso/Bekwai	District	Bibiani
Bodi	District	Bodi
Juabeso	District	Juabeso
Mpohor	District	Mpohor
Mpohor/Wassa East	District	Daboase
Pristea Huni Valley	District	Bogoso
Sefwi Akontombra	District	Sefwi Akontombra
Sefwi-Wiawso	Municipality	Sefwi-Wiawso
Suaman	District	Dadieso
Tarkwa Nsuaem (Wassa West)	Municipality	Tarkwa
Wasa Amenfi Central	District	Manso Amenfi
Wassa Amenfi East	District	Wassa Akropong
Wassa Amenfi West	District	Asankragua

* **Coastal Districts** that form part of this study in bold. Source: GSS 2005, Ghana Districts website

6.3.2 *Traditional Structures*

The traditional system of authority is managed through the Ministry of Chieftaincy and Culture. Their mission is to preserve, sustain and integrate the regal, traditional and cultural values and practices. The Paramount Chiefs are the regional traditional heads of the people and custodians of the land and hold great influence. Their position is recognised by the formal administrative structures.

Below the Paramount Chiefs are Chiefs and sub-chiefs. Communities are headed by sub-chiefs or *odikro*, literally meaning the owner of the village. Each family group or clan within a community is headed by an *abusuapanyin*, the elder of the clan.

The Chiefs, supported by their traditional councils, have their own territory and arbitrate and decide political and economic questions in their areas. This can extend to family and property matters, including divorce, child custody and land disputes, however, they do not handle criminal cases.

Each Chief has an entourage of a priest or priestess (*okomfo*), a stool wife and one or more linguists (*okyeami*).

6.4 DEMOGRAPHIC PROFILE

The population of Ghana is approximately 24 million according to the 2010 census (GSS 2012), with the Western Region having a total population of 2.3 million or 9% of the national population. The Western Region has a population density of 97 people per square kilometre, making it the fifth most densely populated Region in the country. The population in the Region is estimated to have grown by 21% since the 2000 Population Census from 1.9 million to 2.3 million. This is lower than the national population growth rate of 28%, and low compared to the 66% growth between 1984 and 2000. The decline in the growth rate (compared to the previous period) may be attributed to the decrease in the numbers of people migrating into the area as well as the increase in the people migrating out of the area in search of employment.

The population characteristics of the districts and the communities consulted are presented in *Table 6.3* and *Table 6.4*, respectively. STM has the highest population and population density compared to the other districts.

Table 6.3 Population Distribution in the Project Affected Districts

District	Population Size (Census 2000)	Expected Population Size (Census 2010)	Density (people/ km^2) (2010 est.)	Percentage Urban (Census 2000)
Shama	369,166*	81,966	381	100*
STMA		559,548	11,191	
Ahanta West	95,140	106,215	180	20
Nzema East	142,871**	60,828	30	26.6**
Ellembelle		87,501	60	
Jomoro	111,348	150,107	112	29.6

* Figure for Shana-Ahanta East before the district divided into Shama District and STM.

** Figure for Nzema East before district divided into Nzema East Municipality and Ellembelle District.

Table 6.4 Populations Sizes of Selected Communities from Baseline Study (March 2012)

District	Community	Population
Shama	Shama Apo Shama Besnstir	10,062
	Aboadze	9,596
STM	Bukakyir	400
	New Takoradi	18,668
	Sekondi	50,772
	Ngyeresia	4,752
	European Town	3,500
Ahanta West	Dixcove (Upper & Lower)	30,000
	Butre	1,356
	Egyembra	4,265
	Busua	1,580
	Princess Town	3,207
	Princess Akatakyi	3,000
	Cape Three Points	900
Nzema East	Upper Axim Lower Axim	24,500
Ellembelle	Ankobra	2,500
	Atuabo	1,500
	Essiama	6,513
	Azelelounu	600
	Enokyi	840
Jomoro	-	-

Note: No data has been gathered from Jomoro District.

6.4.1 *Age and Gender Distribution*

The population in the Region is relatively young, with a high concentration of people aged between 0 and 14 years (*Table 6.5*). Ahanta West, Jomoro, Shama and STM have a slightly higher proportion of the population (>50%) aged between 15 and 64. The high proportion of youth has led to a relatively high dependency level in the Region. It was reported during consultations that this dependency places a demand on the economically active sector of the population in the District making it difficult for households to maintain/improve on their standards of living.

Table 6.5 Age Distribution in Selected Communities as Percentage of Population

District	0 -14 Years	15 – 64 Years	Over 65 Years
Shama	44.8	51.9	3.3
STM	44.8	51.9	3.3
Ahanta West	42.6	52.3	5.1
Nzema East	-	-	-
Ellembelle	43	51	6
Jomoro	41.3	53.4	5.3

Source: ERM 2009; District Profiles: Shama, STM, Ahanta West, Nzema East and Ellemebelle 2012

The population in the communities consulted is also young with the majority aged between 0 and 35 years old. Consultees indicated that this trend can be attributed to the high cases of teenage pregnancy and the lack of family planning provision.

Gender distribution within the coastal districts is shown in *Table 6.6*. Across Ghana and also in the coastal districts there are more females than males. The male to female sex ration within the coastal districts range between 1.03 and 1.12.

Table 6.6 Gender Distribution within the Coastal Districts (2010)

District	Male	Female	Sex Ratio
Shama	38,704	43,262	1.12
STM	273,436	286,112	1.05
Ahanta West	50,999	55,216	1.08
Nzema East	29,947	30,881	1.03
Ellembelle	42,317	45,184	1.07
Jomoro	73,561	76,546	1.04

Source: GSS 2012

6.4.2 Ethnicity, Language and Religion

English is the official language of Ghana and the main medium of teaching at schools. Nationally, the Akans constitute the largest ethnic group representing 49% of the population. The Akan group comprises a number of smaller ethnic groups each of which has its own language with the two most dominant being Twi and Fante. Other ethnic or language groups include Ewe, Dagomba, Dangwe, Dagaare, Ga, Nzema, Gonja and Kasem. In the Western Region Akans constitute more than two-thirds of the population, of which Fantes, Wassa, Safwis, Evalue, Ahanta and Aowins comprise almost 70%. Other ethnic groups who have migrated into the area include the Mole-Dagbon (8%), Asantes (7%), Ewes (6%), Ga-Dangme (4%), Brongs (3%), Kusasis (3%) and the remaining 9% is formed by other minority ethnic groups. In the communities consulted, Fante is widely spoken in the selected communities and most common ethnic group, followed by Nzema, Ahanta, Ewe and Ga (*Table 6.7*).

Christianity is the main religion (81%) in the country and the Western Region, followed by Islam (8.5%). The majority of the population in the coastal districts is Christian and consist mainly of Methodists and Catholics, followed by Islam and Traditional African Worshippers. Information provided on the religious beliefs practiced in the communities consulted are summarised in (*Table 6.7*).

Table 6.7 Ethnic Composition and Religion at Selected Communities from Baseline Study (March 2012)

Community	Main Ethnic Groups	Religion
Shama		
Shama Apo	Fante, Ewe	Christianity
Shama Benstir	Fante, Ewe	-
Aboadze	Fante, Ewe, Gas (migrants)	Christianity; Islam
STM		
Bukakyir	Fante, Ewe, Hausas, Ahanta	Christianity; Islam
New Takoradi	Ahantas, Ewe, Ga, Fante	Christianity; Islam
Sekondi	Fante, Ga, Ahanta	Christianity; Islam
Ngyeresia	Ahanta, Fante	Christianity
European Town	Fante, Ga, Ahanta	Christianity
Ahanta West		
Dixcove (Upper & Lower)	Ahanta, Fante	Christianity
Butre	Fante	Christianity
Egyembra	Fante	Christianity
Busua	Ahanta	Christianity
Princess Town	Fante	Christianity Traditional African Church
Princess Akatakyir	Fante, migrants	Christianity; Islam
Cape Three Points	Nzema	Christianity
Nzema East		
Upper Axim	Nzema	Christianity
Lower Axim	Nzema, Ga, Simpas	Christianity
Ellembelle		
Ankobra	Fante, Ewe, Nzema	Christianity
Atuabo	Nzema, Fante	Christianity
Essiama	Nzema	Christianity Traditional African Church
Azelelounu	Nzema, Fante	Christianity Traditional African Church
Enokyi	Nzema, Fante	Christianity

6.4.3 Migration Pattern

There is a high level of migration within the Region, primarily in search of employment opportunities. People migrate to areas with more employment opportunities such as Ahanta West and STM. The Region also attracts many male migrants from other Regions in Ghana due to the employment opportunities in the cocoa-growing and mining sectors within the Western Region. Seasonal migration is also a common practice, particularly amongst men who migrate to the coast during the fishing season and return to the inland areas during the farming season.

A similar trend exists in the communities consulted, as people of economically active age migrate to the cities and larger towns in search of employment opportunities. The following examples of migration were obtained from the community consultations.

- STM has experienced the highest in-migration as compared to other communities consulted due to the increasing number of new companies moving into the area and the discovery of oil and gas. There has been a large influx of people from other Regions.

- In Nzema East seasonal migration is high as a large portion of the population is engaged in both farming and fishing. These people move to the coast during the fishing season and move back inland during the crop farming season.

- Ellembelle District experiences in-migration, which is attributed to seasonal fishing activities, jobs seekers searching for employment at the mines, small-scale miners (artisanal) and refugees.

- Jomoro District has an immigrant population of almost 15.8%, mainly settled in the northern part of the District. About 53% of immigrants are male and 58% are in the age group of 18 to 35 years.

Members of communities consulted considered the level of out-migration from the coastal districts to be high due to a lack of employment opportunities. Many of the people who move out of the consulted communities migrate to bigger cities including Accra, Takoradi and Kumasi. Others move to Cote d'lvoire, Liberia, Nigeria and Togo. Not many migrants return to the communities once they have left. With the discovery of oil and gas off the coast, district authorities are expecting an influx of employment seekers to the Region. Overall, more males migrate compared to females.

6.5 *LAND TENURE, SPATIAL PLANNING AND LAND USE*

6.5.1 *Land Tenure*

Ghana maintains a plural land tenure system, comprised of state and customary land. It is estimated that 80% of land is owned and governed by traditional authorities and 20% is owned by the government. Under the *1992 Constitution*, the following three distinct-level land tenure systems are recognised.

- *Public land* is owned by government, or has been acquired by the government for public use (specifically for infrastructure development).

- *Stool (or skin) land* is communal land held by traditional communities or confederation of communities, including stools, skins and families. This type of land is characterised by varying tenure and management systems.

- *Private freehold land* is not owned by government or traditional authorities, but is held by families or groups who are members of the community.

Within the coastal districts land is bought or leased from the Chief or the family that owns it. Under the traditional system, any person who wants to buy or lease land has to request permission from the Chief and follow the correct traditional protocols. Family land can be bought or leased. If leased, the family and the leasee have to agree on the rent before the transaction is regarded as complete, whereas if the person wants to buy the land they have to agree on the selling price. Once this transaction is completed the buyer becomes the legal owner of the land.

In addition, land ownership is also determined by the systems of matrilineal (maternal) and patrilineal (paternal) inheritance; women have the right to own and sell land in Ghana. Family or clan land will often be held in trust for the family/clan by the eldest person, usually the male (abusuapanyin).

6.5.2 Spatial Planning

Spatial planning and land use management in Ghana is regulated under the *Town and County Planning Ordinance of 1945* (CAP 84) (as amended by *Act 30 of* 1958 and *Act 33 of 1960*) and the *Local Government Act (Act 462) of 1993*. There is currently a Land Use and Spatial Planning Bill which is undergoing consultation.

The Town and Country Planning Department (TCPD) has the overall responsibility to determine land use in Ghana. At the District level the Local Planning Authorities are required to prepare the required land use plans and to manage and control development. All decisions on land-use are made in consultation with relevant stakeholders.

Spatial planning and land use policy is guided by the National Development Planning Strategy and associated spatial plans that are prepared by TPCD, including, Spatial Development Frameworks (SDFs), Structure Plans and Local Plans. SDFs provide guidance for development on the national, regional and district level, including expectations on what types of development should occur, where they should be located and to what degree development should take place.

A Regional SDF has been developed for the Western Region which was approved in 2014, creating a platform for the development of district level spatial plans which will include control of petroleum-related and other activities in the region.

6.5.3 Land Use

Most of the land in the Western Region is used for the commercial exploitation of natural resources. The Region is the country's largest producer of cocoa, coconuts, palm oil, timber and gold. There are also rubber plantations (near Cape Three Point and Atuabo), the only rubber processing factory in the country is located in Agona Junction; there are other factories in Takoradi and Shama (*eg* GHACEM, WAMCO, cement, timber processing factories) [(1)].

In the coastal districts, land is mostly used for community infrastructure and subsistence farming. Most of the farming undertaken at community level is small-scale, due to the use of traditional farming methods. This, in conjunction with the distance between the towns and farming plots, and the poor soil quality, means that many people in the communities cannot afford to farm on a larger scale.

6.6 *ECONOMY AND LIVELIHOODS*

6.6.1 *National Economy*

Until recently, Ghana was classified by the World Bank as a low income economy, with a gross national income per capita of less than USD 1,000. On 1 July 2011 the World Bank reclassified Ghana from a low-income to lower middle-income status country (World Bank 2011). The reclassification was primarily linked to accelerated growth in Gross Domestic Product (GDP) of 14.4% in 2011, boosted by the new oil production and a recovery of the construction sector (World Bank 2012a). Ghana was positioned as the fastest growing economy in Sub-Saharan Africa in 2011 (World Bank 2012a). Despite Ghana's economic growth, other development indicators remain relatively low, especially in rural areas and the anticipated socio-economic benefits of the new oil and gas industry are yet to be felt on the ground. An overview of Ghana's national economy is provided in *Box 6.1*.

Ghana's service sector is the largest sector of the economy contributing approximately 48.5% of the GDP (2011 estimate) (World Bank 2012b). This is followed by industry which contributes approximately 25.9%, based on the manufacturing as well as mining and oil and gas sectors. Agriculture (including fishing) contributes approximately 25.6%. The industry sector recorded the highest growth rate of 41.2%, followed by the services sector at 8.3% and agriculture had by far the lowest growth rate at 0.9% (2011 estimates) (World Bank 2012b).

(1) Shama and STMA, District Profiles, 2012

Box 6.1 Selected Indicators of the National Economy

- Ghana's GDP is $32.2 billion (2010 estimate), ranking number 86 against other countries.
- Monetary policy contained inflation within the target single digit range at 9%.
- The fiscal deficit was reduced to 4.1% of GDP due to improved revenue collection, in line with government's objectives.
- The 2011 current account deficit widened by 38% to 9.7% of GDP as a result of higher import growth and large increases in profit repatriation by extractive industries. This is despite new oil export revenues.
- 2011 export receipts grew strongly (particularly in cocoa and gold) as did private remittances totalling 2.4 billion USD.
- Ghana exported 2.7 billion USD of crude oil (24 billion barrels) but imported 3.3 billion USD oil products. The import amounts were similar but oil price increases had a negative effect on the balance of payments.
- Food inflation dropped from 4.8% to 4.3% over 2011 mainly as a result of government intervention around fertiliser subsidies, irrigation, buffer stock management and seed improvement.
- Tax revenues increased from 13.1% to 15.4% of GDP between 2010 and 2011. This was largely due to improved tax administration, increased taxable import volumes and modernised customs valuation at the country's borders.
- Oil tax revenue accounted for 1.2% of GDP and mining's contribution increased from 0.9% (2010) to 1.5% (2011). This was mainly due to two companies paying corporate taxes after the expiry of their capital allowances.
- Non-tax revenue doubled to 1.9% of GDP from the sale of gold and oil-related activities.

Source: World Bank Website: Ghana: Country Brief 2012b

6.6.2 *Regional Economy*

The Western Region's economy currently revolves around agriculture (including fishing), which employs about 53% of the workforce, mainly small landholders and artisanal fishers. Other major sources of employment include mining and quarrying (employing approximately 15% of the population) and manufacturing (employing 11% of the population).

The Western Region has considerable natural resources, which gives it a high level of economic importance within the context of the national economy and it is the highest contributor to the country's GDP, at 55%. It is the largest producer of cocoa, rubber (including rubber processing) and coconut, and one of the major producers of palm oil. In addition, the Region has a wide variety of minerals including gold, bauxite, iron, diamonds and manganese. There are five major gold mines in the Region namely Teberebie and Iduapriem, Prestea/Bogoso, Tarkwa and Aboso gold fields. Other economic activities undertaken in the Region include imports and exports, and, to a limited extent, tourism.

The deep-water port at Takoradi handles about 62% of total national export and 20% of total national imports annually. The main exports are manganese, bauxite, cocoa beans and forest products (mainly sawn timber). The main imports are clinker (for cement production), containerised cargo, lime products, petroleum products and wheat.

6.6.3 *Economic Activities of the Coastal Districts*

Agriculture (which includes both fishing and farming) is the main economic activity practiced across the coastal districts, with the exception of STM. An average of 58% of the population is engaged in agriculture and agro-processing activities across the district. An overview of each district's economy is provided below. *Figure 6.2* illustrates the various agricultural activities in the coastal districts.

Figure 6.2 Agricultural Activities in the Coastal Districts

Plantain grown as food crops in Nzema East

Cassava plants growing in Shama District

Coconut tree plantation in Jomoro District

Rubber tree plantation in Ahanta West District

Fish landing site in STM

Harvesting of wood for making charcoal

Source: ERM 2009

Shama District. Farming and fishing are the main economic activities practiced in this District, with approximately 80% of the population engaged in either fishing or the production of food and cash crops. Fishing occurs along the coastal stretch of the District whilst farming is carried out inland towards the northern parts of the District. The major crops grown are cassava, plantain, cocoyam, maize, rice, palm oil and vegetables, with oil palm as a major cash crop. The major fishing communities in the District are Abuesi, Shama, Aboadze and Anlo Beach. These communities occupy approximately 70% of the district coastline. They have a total of approximately 1,500 registered sea-worthy canoes and an annual catch of about 30,000 tonnes. Varieties of livestock and poultry are also raised on a commercial basis. Large deposits of Birimian rock deposits have been found in the District and only small to medium scale quarry companies have started mining the rock reserves. There are no major industries in Shama except for the 550 MW Takoradi Thermal Power Station near Aboadze.

STM. The major economic activities in STM are related to the port. The area is the third largest industrialised centre in the country and there are industrial and commercial activities in the manufacturing sector (*eg* food processing, spirits production, textiles, metal fabrication) and resource sector (*eg* timber, clay). The manufacturing industry includes cement, household utilities, cocoa processing and wood processing. The major food products processed in this district are fish, cassava, and palm oil. Crop production is almost non-existent in the Metropolis but in some area it is practiced at a small scale. Fishing is the predominant agricultural activity, with up to 1,800 people engaged in fishing along the coastline from Takoradi to Ngyeresia. Commercial livestock and poultry farming is largely non-existent in the metropolis, however, many urban dwellers keep sheep, goats and poultry on free range and household level.

Ahanta West District. Farming (mainly subsistence farming) is the main economic activity undertaken by the population in this district (approximately 65%). Other economic activities include informal trading and processing of agricultural produce, mainly palm oil, cassava and rubber. Other trading undertaken includes hairdressing, dressmaking, carpentry, block-making, auto-electricians, and others. Oil palm and rubber are the main cash crops and NORPALM and Ghana Rubber Estates Limited (GREL) are the two largest companies involved in cultivating oil palm and rubber in the District. Food crops include cassava, maize, plantain and other vegetables. Fishing is also an important part of the District's economy. Dixcove is recognised throughout the Region for its catch in sharks, tuna and lobsters. Other important fishing communities are New Amanful Fuunkoe, Butre, Princess Aketekyir, Akwaidaa, Adjua, Egyambra and Cape Three Point.

Nzema East Municipality. It is estimated that over 65% of the economically active population are engaged in agriculture (including fishing) and agro-processing. Before 1965, the major cash crops grown in the area was coconut and cocoa with cassava and plantain being the major food crops. In 1965, however, the lethal yellowing disease of coconut locally called Cape St. Paul's Wilt Disease (CSPWD) destroyed almost half of the plantation along the south-eastern coastline. This caused a major shift from coconut farming to rubber farming. Trading is done on small scale (*eg* household goods, fruit and vegetables). Tourism is also a new and fast growing economic sector in the District with hotels and resorts being important tourist destinations.

Ellembelle District. It is estimated that over 65% of the economically active population in this District are engaged in agriculture (including fishing) and agro-processing. The major cash crops grown are coconut, oil palm, rubber and cocoa/ while cassava and plantain are the major food crops. Other food crops grown in the District include maize, rice and cocoyam; they are grown extensively both for subsistence and for cash. Vegetables such as garden, peppers and tomatoes are also cultivated. Rice is also grown in some low-lying areas like Asanta, Kikam, Essiama and Kamgbunli. However, the absence of efficient processing and storage facilities has meant that post-harvest losses are high and farmers' incomes are usually very low. Fishing and more recently mining are also major economic activities in the District. The Nzema Gold Mine which first declared commercial production in April 2011.

Jomoro District. The economy of Jomoro District consists of a large traditional agricultural sector made up of mostly small-scale farmers, a growing sector of small informal traders, artisans and technicians, and a small processing and manufacturing sector. Approximately 54% of the population is engaged in the agricultural sector, comprised of 39% farming and 15% fishing. Major crops grown are cassava (40.5%), coconut (16%), maize (15%), cocoa (9.4%), and plantain (9.4%). The use of traditional farming methods, which include slash and burn and the extraction of wood fuel, is resulting in deforestation. Both inland and sea fishing is another major economic activity and is characterised by the use of canoes with out-board motors and dragnets. The District has extensive rainforest and wood harvesting takes place around Mpataba, Nuba, Ankasa, Tikobo No. 1, Ellenda and Anwiafutu area. There are, however, no established timber processing companies in the district. Larger industries in the District include the Wienco factory which manufactures erosion control mats from coconut husks. There is also the Effasu Power Plant which the District planner reported was due to be re-commissioned in the near future.

6.6.4 Economic Activities in the Consulted Communities

Fishing Activities

Chapter 5 provides a baseline description of fish and fisheries in Ghana. Artisanal fishers use over 300 landing sites along the coastline of Ghana. There are several major artisanal landing towns in the Western Region, including Dixcove, Axim and Sekondi-Takoradi's Albert Bosomtwe-Sam Fishing Harbour. A large portion of the households in the consulted communities are involved in small-scale artisanal fishing and fish processing activities.

Figure 6.3 shows a range of fishing activities at consulted communities. Fishing is mainly undertaken by men whereas women are involved in the processing and selling. It is the main source of livelihood for approximately 90% of the households in the consulted communities.

Figure 6.3 Fishing Activities

Canoe manufacturer in Upper Axim

Fishmonger preparing fish

Landing beach in New Takoradi

Landing beach in New Takoradi

"Dynamite" fishing pan in New Takoradi

Fish smoking in Aboadze

Source: ERM 2012

Artisanal fishermen use several types of fishing gear, including purse seine nets, beach seine net, set nets, drifting gill nets and hook and line operated from wooden canoes (see *Chapter 5*, *Section 5.5.1*). The typical artisanal catch landings sites are the beaches adjacent to the fishing communities. For many of these areas there is generally very little physical infrastructure and canoes are launched from the beaches. Each landing site is under the control of a Chief Fisherman.

The fishers sell most of their catch to the fishmongers for processing and selling. The fish is sold in pans, weighing about 50 kg each and it is usually sold for approximately GHc 100 (USD 55). Approximately 5% of the catch is consumed by the fishers and the rest is sold. Some fishers own their own canoes, however a large portion of fishers rent canoes from owners. Due to declining fish catches resulting in a reduction in revenue from fishing many fishers are in debt to canoe owners and to fishmongers and traders.

Consultees reported a decline in fish catches over recent years which corresponds with other sources that report a general decline in abundance of targeted fish species in the Gulf of Guinea, including Ghana, since the mid-1980s (Atta-Mills *et al* 2004; Finegold *et al* 2010). Finegold *et al* (2010) suggest that high fishing pressure as well as unsustainable or illegal fishing practices have contributed to changes in fish community structure and decline in fisheries resources (Koranteng 1998, cited in Koranteng and Pauly 2004; Aggery-Fynn 2007).

The fishermen who were consulted raised a number of concerns about the potential effects of oil and gas activities on their fishing activities. These included the following.

- Concerns over loss of access to fishing grounds due to safety zones around offshore installations and fish being attracted to these offshore installations due the presence of the structures and the lights on the structures.

- The oil field supply and service vessels associated with oil and gas industry causing loss or damage to fishing nets when on transit to and from the ports and the oil fields and the absence of a compensation mechanism.

- Poor relationships with the Ghana Navy and confiscation of fishing gear for fishermen operating near the Jubilee FPSO and drilling rigs.

- Concern that observed increases in algae which affects net fishing activities may be linked to oil and gas production operations.

Farming Activities

The majority of households within the consulted communities undertake small-scale and subsistence agricultural activities. The produce is primarily used for household consumption and the surplus is sold to generate income for the household. The primary agricultural products are cassava, banana, plantain and corn. Some of the small-scale farmers within the consulted communities grow rubber, palm nuts, ground nuts, cocoa (Cape Three Point), cassava, plantain, raffia (Enokyi) and coconuts which are sold to agro-industrial companies that operate in the Region. In Engambra, Princess Town and Cape Three Point farming is undertaken by 90% of the population. Some of the produce sold in the local markets includes cassava, palm nuts, tomatoes, peppers, maize, plantain and banana (*Figure 6.4*).

Figure 6.4 Farming in Consulted Communities

Plantain in Azelaloane

Coconut plantation in Anokyi

Source: ERM 2012

Small-scale farming is usually undertaken by family units using traditional farming methods. The percentage of produce consumed compared to that sold varies depending on the particular household and the type of produce grown, however, approximately half of produce will be consumed and the other half sold at local markets.

Farmers who were consulted mentioned a number of challenges they face, including the following.

- Poor quality soil.
- Use of traditional farming methods and rudimentary tools such as hoes and cutlasses, which make farming difficult.
- Shortage of land available for farming activities.
- Lack of formal irrigation system.
- Theft of produce from the gardens because gardens are not fenced and located away from dwellings.

Livestock farming is carried out on a much smaller scale than crop farming in the consulted communities. Most households do, however, keep a few chickens, dwarf goats, sheep and pigs. These animals are reared predominantly for ceremonial occasions and for honoured guests rather than for home consumption.

Trading

Small and large scale trading is undertaken throughout the consulted communities. In most communities, trading often takes place on the side of the main road in small kiosks or at small tables (*Figure 6.5*). Much of the trading is directly related to fishing and agriculture, although some manufactured goods are also sold. Trading is limited due to most traders not having sufficient money to buy goods to sell. Most of the trading is undertaken by women and youth and the goods are mainly sold to the local communities. The communities purchase their goods in Agona-Nkwanta, Axim and sometimes in Takoradi, whereas traders in STM buy most of their goods in big cities such as Accra, Kumasi and Abidjan. Some of the main goods traded in the area include, amongst others, fish products, agricultural products, food and beverages, household products, medicines and cosmetics, clothing and electronic products.

Figure 6.5 Typical Trading Activities

Trading stall in Butre

Trading stall in Upper Axim

Source: ERM 2012

6.6.5 *Growth of Tourism in the Region*

Tourism in Ghana is one of the fastest growing sectors of the Ghanaian economy. The number of tourist arrivals and amount of tourist expenditure has steadily increased in recent years, while both public and private investment activity in various tourism sub-sectors have expanded. International tourist arrival numbers for Ghana has increased by 36% since 2007 to 803,000 in 2009 (World Bank 2012c).

Ghana has a wide range of natural, cultural and historical attractions, which provides the basis for the growing tourism industry. Apart from the economic benefits, tourism is used to present Ghana's unique cultural, historical and environmental heritage to the international community and to educate Ghanaians about their own heritage.

The tourism potential in the Western Region is related to the number and extent of pristine tropical beaches as well as wildlife parks, forests and game reserves featuring tropical rainforests, inland lakes and rivers. Existing wildlife and nature reserves in the Western Region include Ankasa Conservation Area, Nini-Suhien National Park, Amansuri Conservation Area and Bia National Park. Some of the most popular recreational beaches along the western coastline are located at Biriwa, Brenu Akyinim, Busua, Butre, Cape Coast, Egyembra, Elmina, Komeda, Sekondi and Takoradi. Hotels are generally located at popular beach destination and at commercial centres. Along the western coastline, hotels and resorts are located at Axim, Birwa, Busua, Cape Coast, Elmina and Takoradi. Public sector investment projects include beach resort developments at waterfronts such as Axim, Beyin, Busua, Butre, Cape Coast, Dixcove, Elmina, Sekondi, Shama and Takoradi.

The Western Region also has the second largest concentration of historic forts and castles in the country, accounting for seven out of the country's fifteen tourist forts along the western coast of Ghana which have been registered under the Museums and Monuments Board. These monuments are listed in *Table 6.8* and shown in *Figure 6.6*. Some of the tourism attractions identified during consultations are listed in *Table 6.9*.

Table 6.8 Historical Monuments along the Western Coastline

Town	Monument
Beyin	Fort Appolonia built in 1770 by the British
Axim	Fort St Antonio built in 1515 by the Portuguese
Princess Town	Fort Gross Fredericksburg built in 1683 by the Brandenburg-Prussians
Akoda	Ruins of the old Fort Dorothea
Dixcove	Fort Metal Cross built in 1692 by the British
Butre	Fort Batenstein built in 1656 by the Dutch
Sekondi	Fort of Orange built in 1656 by the Dutch
Shama	Fort St Sebastian built in 1523 by the Portuguese
Komeda	Ruins of Fort Vredenburg built in 1682 by the Dutch
	Fort English built in 1687 by the Dutch
Elmina	Elmina Castle (St George's Castle) built in 1482 by the Dutch
	Fort St Jago built in 1665 by the Portuguese
Cape Coast	Cape Coast Castle built in 1653 by the Swedish
Moree	Fort Nassau built in 1612 by the Dutch
Anamabo	Fort Charles built in 1630 by Dutch
Abandze	Fort Amsterdam built in 1631 by the British

Table 6.9 Tourism Attractions in the Consulted Communities

District	Community	Tourism Attraction
Shama	Shama Apo Shama Besnstir	Fort Sabastian, Pra River Golf Links, Shama Beach Resort and Alabama Beach Resort
	Aboadze	Fontana Beach Resort
STM	Bukakyir	Lagoon-side Hotel, Lagoon Spot and Essei Gardens
	New Takoradi	None
	Sekondi European Town	Fort George and Orange
	Ngyeresia	Esenam Hotel
Ahanta West	Dixcove (Upper & Lower)	Fort Metal Cross
	Butre	Butra Lagoon, Beggar Rock, Fort Batenstein and Coconut Beach
	Egyembra	Elezule Lagoon (which is also a crocodile pond)
	Busua	Busua Beach Resort, African Rainbow Resort, Busua Inn, Alaska Beach Resort and Duckson Lodge
	Princess Town	Fort Frederickburg and Monkey Sanctuary
	Princess Akatakyi	Epuho Lagoon (which is a crocodile pond)
	Cape Three Points	Lighthouse
Nzema East	Upper Axim Lower Axim	Old and New Catholic Churches, Old European Catholic Cemetery, York Hall, Quandohor Building, Axim Beach Resort and Fort St Antonio
Ellembelle	Ankobra	Ankrobra River Estuary
	Atuabo	Borazo Island; Nzulezu Village on Stilts
	Essiama	None
	Azelelounu	Amanzule River Estuary
	Enokyi	None

Note: This list does not include all tourist attraction in the districts; only those identified during the consultations. Source: ERM 2012

Figure 6.6 Historical Monuments along the Western Coastline

6.6.6 *Occupations, Employment and Unemployment*

The major industrial activities in the Region are agriculture, excluding fishing but including forestry and hunting (58%); mining and quarrying (2%); manufacturing (10%) and wholesale and retail trade (10%) (GSS 2005). Employees of private and public sector employers comprise of 14% and 6%, respectively.

More than 65% of the economically active population in all the districts are self-employed workers (75% females compared to 62% males); they have no employees. Employees who work for private and public employers constitute 32% of workers in Shama and STM, which is the highest proportion of formally employed people in the Western Region.

In the communities consulted a large portion of the population is not formally employed and is solely reliant on natural resources for their livelihoods (mainly fishing and farming). Most formally employed people in the communities work in the public sector as *eg* teachers, nurses or in District Assemblies. A small portion is employed by private companies such as the Volta River Authority (*ie* Aboadze community), rubber plantations, cement factories, palm oil producing companies and logging companies. The dependency on agricultural activities has also caused a lot of seasonal unemployment whereby people who are involved in fishing and farming are unemployed during the off seasons.

Child Labour

The relatively young age structure of the Region's population has both social and economic implications for the Region's manpower supply and level of participation in economic activity. Legally, persons under the age of 15 years are not allowed to engage in any economic activity; however, approximately 36% of children aged between five and 14 years in the Region are reported to be engaged in some economic activity (ILO 2007). This situation was confirmed during the consultations. School teachers stated that the main cause of absenteeism at schools amongst pupils is due to their participation in agricultural activities (especially fishing). For instance, whenever the fishermen return from the sea, children leave the school at break and do not return to school for a few days because they are busy helping their parents with the preparation or processing of fish.

6.6.7 *Household Expenditure*

A large portion of the cash earned by households is used to pay for children's education. The education expenditure relates to purchase of uniforms, printing of learning materials, Information Communication Technology and Parent-Teacher Association levies. Other expenditure includes food, clothing, health care and transportation.

6.6.8 *Poverty and Vulnerability*

Table 6.10 illustrates the poverty profile in Ghana based on 2005/2006 data. The incidence of poverty in the Western Region ranked third lowest in the country. The Region contributed about 6.5% to the national poverty level (Etsey 2009).

Table 6.10 Poverty Profile in Ghana 2005/2006

Region	Population Share (%)	Average Income (000's Cedis)	Poverty Incidence (%)
Upper West	3.6	2,354.4	87.9
Upper East	4.8	3,409.3	70.4
Northern	12.2	4,779.8	52.3
Volta	7.5	9,590.9	31.4
Brong Ahafo	9.2	6,718.2	29.5
Ashanti	16.8	8,284.9	20.3
Central	8.8	8,394.3	19.9
Western	10.1	7,813.3	18.4
Eastern	13.4	7,805.7	15.1
Gt. Accra	13.9	1,0871.2	11.8

Source: Etsey 2009

In the consulted communities poverty levels are high given the dependency on the declining fisheries sector. There are relatively high illiteracy levels and a lack of employment opportunities. It is common to find people of economically active age still dependent on their parents for their livelihoods (*eg* food, shelter and clothing). The lack of income is also seen in the low number of business ventures undertaken in the communities and failure of small businesses in the communities due to the lack of disposable income.

Marginalised and Vulnerable Groups

Vulnerable groups are defined as people who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage, or social status may be more adversely affected by social change than others and who may be limited in their ability to claim or take advantage of assistance and related development benefits (IFC, 2010). Generally, vulnerable groups are those who have no productive assets, lack vocational skills, are isolated or excluded, and lack guidance and social support structures. The communities in the consulted communities are mostly reliant on subsistence-based livelihood activities that rely on natural resources. There are few alternative livelihoods sources available to the local population. During the consultation process, the following three broad groups of vulnerable people were identified.

Women. Women in the area have a relatively stable income through their fish processing and farming activities. They sell fish and sometimes own small shops where they sell household products, vegetables and smoked fish. They use most of their income for their children's education, as well as for household expenses such as food and healthcare. A major factor contributing to the women's vulnerability is that men who cannot fish leave the area in search of other work and frequently do not return, leaving the women to provide for their children.

Children. Many children in the consulted communities are left in the care of their grandparents as their parents leave the area in search of employment opportunities. Many parents do not return to the area or send money home to their children. As the grandparents are too old to work, the children are often required to provide for themselves. As a result, children (12-13 years) leave school to work or pursue other opportunities. Boys primarily become fishermen and girls marry early or get involved in prostitution which result in teenage pregnancy and illegal and unsafe abortions.

Elderly. The elderly (aged 65 and above) represent a small percentage of the population, however, they play an important role in taking care of grandchildren. They seldom have an income or the means to take care of these children.

6.7 EDUCATION

Ghana has a basic education system that is compulsory up to the age of 15. There are three years of primary school education, three years of junior high school education, three years of senior high school and three years if tertiary level education.

The medium of teaching at schools is English, however, pupils are also taught in one of the eleven national languages during primary school. Prior to attending basic education, children are encouraged to attend two years of kindergarten, even though this is not legislated. Schools are predominantly government-run but there are also many schools that are run privately or by religious organisations, especially the Roman Catholic and Methodist churches.

6.7.1 Education Facilities

There are currently 1,320 primary schools in the Region, of which 1,240 are public and 80 are private. These schools are mostly evenly distributed across ten of the Region's districts with Jomoro having fewer primary schools compared to the other districts (*Table 6.11*). The Ministry of Education's policy states that there should be a basic school within five km of a community. In Jomoro District however, some pupils have to travel up to 16 km to reach the nearest basic school.

There are 694 junior secondary schools and only 42 senior high schools in the Region. Approximately 40% of these are found in Ahanta West. As a result some pupils have to travel up to 30 km to reach the nearest senior high school.

A limited number of senior high schools provide boarding facilities, and even those which have, do not have adequate facilities to cater for all the qualified students. Many children, particularly those from the rural areas, are therefore unable to access education, especially senior high schools, due distance and affordability. *Figure 6.7* shows typical school infrastructure found in the consulted communities.

Table 6.11 ***Number of Schools per Coastal District***

District	Kindergarten	Primary	Junior Secondary	Senior Secondary	Tertiary Institutions
Shama STM	*177	161	144	19	4
Ahanta West	*92	85	53	2	1
Nzema East	59	64	67	2	2
Ellembelle	73	74	45	2	1
Jomoro	-	68	53	2	-

Sources: *ERM 2009; Ellembelle, Ahanta West District Profiles 2012.

Figure 6.7 ***School Buildings***

Princess Town

Princess Akatakyir

Dixcove

Ankobra

Source: ERM 2012

Although basic public education is free in Ghana, there are numerous costs that the families are responsible for including the purchase of school uniforms and exercise books, printing of exam papers, Information Communication and Technology fees and occasionally the purchase of textbooks. Parents are also responsible for the payment of Parent Teacher Association levies for the maintenance of the school.

6.7.2 Literacy Levels

Within the Region, literacy levels are low with an average literacy rate of 42% in the coastal districts. This could be attributed to high levels of employment in the agricultural and fishing sectors requiring no formal education. Furthermore, schooling was not free until 1992 and many parents could not afford education or preferred to keep their children at home to help with the processing and selling of fish and other agricultural produce.

A similar trend was observed in the consulted communities, where the majority of people aged 35 years and older are illiterate. Consultees indicated that youth have become more interested in gaining a formal education, especially due to the possibility for employment in the developing oil and gas industry.

6.7.3 Challenges Facing Education in the Consulted Communities

Consultees reported a number of challenges for the education system, including the following.

- Parents cannot afford levies or costs associated with sending their children to school (*eg* boarding or transport costs).
- Parents in the fishing sector do not send their children to school as they believe that education is not necessary in their occupations.
- Children leave school to help their parents with fishing or trading.
- There is a shortage of qualified teachers.
- There is a lack of facilities at schools *eg* water, electricity, sanitation , teachers' quarters and boarding facilities for pupils.
- There is a lack of equipment, especially computers, and education materials (*eg* textbooks).
- Teenage pregnancies are prevalent and results in girls leaving school early.

6.8 HEALTH CARE

The Ghana Ministry of Health is responsible for the health system in Ghana and includes the Ghana Health Service (GHS) and the Teaching Hospitals. The GHS oversees the provision of health services and the TH oversees training of health professionals.

The National Health Insurance Scheme (NHIS) was established in 2003 by the Government of Ghana to provide basic healthcare services to persons resident in the country through mutual and private health insurance schemes. Three types of health insurance schemes were set up under the NHIS, namely the:

- District-Wide Mutual Health Insurance Scheme;
- Private Mutual Health Insurance Scheme; and
- Private Commercial Health Insurance Scheme.

Insurance plans and premiums vary depending on a person's level of income and certain groups of people are exempted from paying premiums such as children under the age of 18 and elderly over 70 years of age. The district mutual health insurance scheme under the NHIS also covers people who cannot afford insurance premiums. One of the major challenges facing the health care system in Ghana is a lack of qualified personnel which has been attributed to the general lack of training resources.

6.8.1 Health Care Facilities

Health care facilities include hospitals, clinics, polyclinics, health centres, Community-based Health Planning and Services (CHPS) compounds and pharmacies. The government owns 50% of such facilities, while 40% are owned by the private sector, 9% are owned by mission institutions and the remaining 1% is owned by semi-governmental bodies (Arhinful 2009).

Approximately 90% of the population in the Region live within a five kilometre radius of a medical facility, with the exception of the former Nzema East District where some people live approximately 31 km away from the nearest hospital (*eg* Cape Three Point). One of the main challenges facing the provision of medical services is the general lack of ambulances. This is a common problem across the coastal districts, even for some private hospitals.

An overview of health facilities in the districts is provided below.

- **Shama District.** There are two hospitals, two health centres and one clinic in the District. According to the District planning officer, the Shama Health Centre is being upgraded into a district hospital to serve as a referral point for all satellite health facilities. Many remote areas have no access to health facilities. The Shama District in conjunction with the District Health Directorate is planning to establish CHPS compounds in ten communities to improve geographic access to health services delivery.

- **Sekondi-Takoradi Metropolis.** STM has the highest concentration of health delivery facilities and services in the Region. There are 31 private hospitals, five government health centres, and a further five community clinics/maternities, some of which offer 24 hour maternity and casualty services. The metropolitan area also has a rehabilitation clinic for mentally ill patients. In addition, there are 18 private general medical practitioners, five private registered midwives, a total of 186 Traditional Birth Attendants, and three private medical laboratories. Substantial success has been achieved in delivering healthcare to the populace and in eradicating endemic diseases (Ghana Districts 2009).

- **Ahanta West District.** The District has a number of health facilities including one hospital at Dixcove, two health centres at Agona Nkwanta and Apowa, five clinics, seven CHPS compounds, two private health facilities, 82 Out-Reach Points. The District has only two doctors and two medical assistants.

- **Nzema East Municipality and Elembelle District.** A number of health facilities exist in the area. Data for the former Nzema East District indicates a total of two hospitals, six health centres and a number of health promotion and preventive facilities, including traditional birth attendants.

- **Jomoro District.** There is one hospital at Half-Assini, four health centres at Tikobo 1, Ekabaku, Samenye and Elubo, and five community clinics located in some of the larger settlements. CHPS compounds exist also at Takinta, Mpataba, Bonyere Junction, Nungua and Kengen. In addition, there are three primary health care facilities which function as first point of call for basic health care services.

All consulted communities have a health centre. There are 66 medical facilities (including hospitals, health centres and clinics) in the five coastal districts. Most of the medical care in the consulted communities is provided by nurses with doctors only being available at clinics and health centres. Most respondents stated that these facilities adequately treated the majority of their ailments. *Figure 6.8* shows the typical health care facilities in the region.

Traditional Healers and Practitioners

The use of traditional healers is common in Ghana and is also recognised by the GHS as part of the CHPS. In most districts there is a traditional healer within a ten kilometre radius. In all districts between 60 and 92% of the communities have traditional healers. The Department of Health offers basic training to traditional healers such as first aid, midwifery, identifying signs of anaemia and good hygiene for the mother and midwife. The Department also provides materials such as cotton wool, aprons, gloves and a booklet for recording patient details.

Figure 6.8 *Health Care Centres and Hospital*

Princess Town

Eikwe Hospital

New Takoradi

Butre

Source: ERM 2012

6.8.2 *Health*

Overview of Health Status

District specific health data were sourced from Medium-Term District Development Plans and district health directorate annual reports. Data from most districts were limited with the most comprehensive data available for STM.

STM and Shama District. Malaria continues to be the most common disease reported at Out-Patient Departments (OPD), followed by acute respiratory infections and acute eye infection (*Table 6.12*). Cases of epidemic diseases diagnosed in STM in 2008/9 included cholera and diarrhoeal diseases (GHS 2009). Data from the HIV/AIDS Sentinel Report for 2008 indicates a decrease in the prevalence rate in STM from 3.2% in 2007 to 2.9% in 2008. The record shows an alternating increase and decrease in the prevalence rate from 2003 to 2006 but a consistent decrease in the rate from 2006 to 2008. The disease affects all age groups with the highest incidence occurring between ages 15 to 49. This is in line with the national trend which shows that the disease affects the youth who are sexually active and those in the economically active group. Nationwide it was identified that in 2007 68% of those infected were female.

Table 6.12 Top Ten Causes of OPD Attendance in STM First Half of 2008 and 2009

No	Disease	No of Cases	% of Total	No	Disease	No of Cases	% of Total
2008				**2009**			
1	Malaria	60,862	40.7	1	Malaria	82,430	42.3
2	Acute Respiratory Tract Infections	14,697	9.8	2	Acute respiratory tract infections	12,009	6.2
3	Skin diseases and ulcers	7,236	4.8	3	Acute eye infections	9,138	4.7
4	Acute eye infections	5,694	3.8	4	Diarrhoeal diseases	8,721	4.5
5	Diarrhoeal diseases	4,891	3.3	5	Skin diseases and ulcers	7,206	3.7
6	Hypertension	3,585	2.4	6	Hypertension	2,485	1.3
7	Chicken pox	2,884	1.9	7	Intestinal worms	2,485	1.3
8	Intestinal worms	2,006	1.3	8	Acute Urinary Tract infections	2,434	1.2
9	Rheumatism/Joint disease	1,838	1.2	9	Gynaecological conditions	2,192	1.1
10	Dental caries	1,803	1.2	10	Chicken pox	1,952	1.0
	Total cases	149,580			Total cases	194,961	

Source: Ghana Health Service Sekondi-Takoradi Metro Mid-Year Report (2009)

Ahanta West. Malaria is the most common disease in the District. The people in the District also suffer from diseases which include gastroententis, upper respiratory tract infection, hypertension, typhoid, anaemia, cholera and others. The HIV/Aids prevalence rate in the District has decreased from 3% in 2004 to 2.8% in 2006. The decrease in the prevalence was mainly due to the formation of peer educators in schools and communities to educate the people on the causes and prevention of HIV/AIDS as well as condom distribution throughout the District.

Nzema East Municipality and Ellembelle District. Health data is only available for the former Nzema East District. Most common diseases in the area include malaria, anaemia and diarrhoea. Other diseases include gastroenteritis complications in pregnancy, hypertension and bronchopneumonia. Diseases such as elephantiasis, guinea-worm and goiter are common in the District. The HIV/AIDS prevalence rate of 15.5% for the District is very high compared to the national average of 3.2%.

Jomoro District. Malaria ranks the first of the top 10 diseases in the District. In 2008, malaria recorded 48.2% in OPD cases and 72.5% of hospital admissions. The ten top diseases in Jomoro as at 2008 are as follows (JDA 2009): malaria, anaemia, cerebrovascular accidents, diabetes mellitus, hepatitis, hypertension, infestation worms, tuberculosis, meningitis and HIV/AIDS. HIV/AIDS is prevalent in the District and has the highest rate of infection in the Region. The high infection rate is attributed to the regular cross border activities between Ghana and Cote d'Ivoire with long distance truck drivers staying over in border towns such as Elubo while waiting for their goods to be cleared.

Common Illnesses and Associated Issues in Consulted Communities

In the communities that were consulted, the most common illness affecting the population is malaria. Stagnant water is prevalent in many communities and serves as breeding ground for mosquitos that transmit the disease (see *Figure 6.9*). Other common illnesses include diarrhoea and typhoid. In addition, Acute Respiratory Infection is very common in all communities. Other common illnesses affecting the population of the communities include:

- rheumatism and joint pains;
- skin infections and ulcers;
- pregnancy and related complications;
- intestinal worms;
- acute eye infection; and
- Sexually Transmitted Infections (STI).

Figure 6.9 Stagnant Water in Butre and New Takoradi

Butre (stagnant water with algae)

New Takoradi (drainage system)

Source: ERM 2012

Teenage Pregnancy

Teenage pregnancy is one of the most common challenges facing the consulted communities, with girls as young as 12 years old falling pregnant. Illegal and unsafe abortions are also common. As a result, the Department of Health started a peer education programme in 2009. The main objectives of this programme are to increase awareness and to educate the youth about STIs, sexually appropriate behaviour and the dangers of drug and alcohol use.

Teenage pregnancy rates are gradually declining, due to the introduction of free contraceptive pills, however, condoms are not freely available at the clinics. NGOs visit some of the health centres on a monthly basis to distribute family planning materials and contraceptives free of charge. They also run sex education programmes at schools and in communities.

HIV/AIDS and Other STIs

According to the annual HIV sentinel surveys conducted among antenatal attendants, the HIV prevalence in the country seemed to be on a downward trend from 3.6% in 2003 to 2.7% in 2005. The prevalence rate increased to 3.2% in 2006, reduced to 2.2% in 2008 and increased to 2.9% in 2009 (Ghana Aids Commission 2012). The HIV prevalence from the sentinel survey was 2.0% and 2.1% in 2010 and 2011 respectively.

In 2004 the government developed a National HIV/AIDS and other STI Policy, as well as a National HIV/AIDS Strategic Framework (2006 to 2010) and a five-year Strategic Plan of Work (2006 to 2010). In spite of these policies and strategies, the incidences of HIV/AIDS in consulted communities are said to be on the increase, however, no figures are available as people are generally not tested. The majority of people tested for HIV/AIDS are antenatal attendants. The majority of the health centres offer HIV testing but they do not provide Anti-Retroviral Treatment.

6.8.3 Challenges Facing Health Care in Consulted Communities

Consultees reported a number of challenges facing the health care system in their communities including:

- shortage of medical facilities, with some communities (*eg* Cape Three Point);
- lack of medical professionals and training centres;
- shortage of infrastructure (*eg* beds and wards) and equipment (*eg* computers, x-ray machines, ultra-sound, disinfectants);
- old buildings require renovations;
- shortage of staff accommodation;
- lack of ambulances at most facilities;
- inefficient delivery of medication (delivery of medication takes up to two weeks);
- unreliable electricity supply; and
- general lack of security (most facilities are unfenced).

6.9 UTILITIES, INFRASTRUCTURE AND SERVICES

6.9.1 Water Sources

In the Region, 32% of houses have access to treated piped water with 8.5% having this available within their dwellings. The highly urbanised districts have almost 100% availability of, or accessibility to, piped water. This is in contrast to rural districts where over 60% of households use rivers, streams, dugouts, spring or rain water as their main source of water, with only approximately 9% having access to processed piped water. Others use wells as their main source of water. The consulted communities mainly rely on wells as the main source of water (see *Figure 6.10*). Water from rivers is not potable due to poor water quality. Drinking water is generally bought from the local vendors in small plastic sachets or 500 ml bottles.

Figure 6.10 ***Water Pump in Butre and Well in Upper Axim***

Source: ERM 2012

6.9.2 *Sanitation*

The indiscriminate disposal of solid waste in gutters, open spaces and the sea has led to unsanitary conditions in some districts. Over 40% of dwellings in the Region have no toilet facilities or have to use public toilet facilities. The environs of these public toilets are being turned into solid waste dumps with serious health hazards in many of the urban and peri-urban localities. Where facilities do exist in the region, the most common types are Kumasi Ventilated-Improved Pit (KVIP), pit latrine or a bucket/pan system. Where no facilities exist, people are forced to make use of the beaches, outlying bushes and gutters.

The sanitation system in the consulted communities is generally poor. In all the villages there are communal toilets built by the district authorities, usually pit latrines (see *Figure 6.11*). There are people employed to clean these toilets, however, they are often occupied and unhygienic. A few households have their own toilets, which are typically made from coconut leaves, cane or bricks. These commonly do not have a roof or a door. People hang sheets on the door when using the toilets to indicate that it is occupied. Even though communal toilets are available in each community, people still tend to use the bushes or sea as it is often cleaner.

6.9.3 *Settlement Pattern and Housing*

The villages visited during the consultation programme are mainly constructed in a linear pattern, alongside the main road. Most of the shops are located along the main road, while some are located in the small lanes between the houses. The space behind the houses usually extends to the beach or bushes. The majority of houses are built of local materials such as clay, cane/bamboo, or sandcrete blocks (for walls). The roof is usually made of palm fronds and corrugated iron. *Figure 6.12* shows typical houses found in the consulted communities.

Figure 6.11 Typical Traditional and Communal Toilet Structures


Traditional toilet - Ankobra


Communal toilet - Aboadze

Source: ERM 2012

Figure 6.12 Typical Housing in the Consulted Communities


Enokyi


Azelaloune


Upper Axim


New Takoradi

Source: ERM 2012

6.9.4 *Fuel Sources*

Electricity and kerosene lamps are used as the main sources of lighting in the Western Region, providing lighting needs in about 99% of the of households. In the urban areas, the majority of households use electricity while in the rural districts, kerosene lamps are the main source of lighting. Rural households are also gradually gaining access to electricity through a rural electrification programme.

Charcoal and fuel wood are the main sources of cooking fuel in the Region (even for quite a sizeable number of urban dwellers), however liquid petroleum gas (LPG) and coconut husks are also used in some districts as a source of cooking fuel. The use of electricity for cooking is limited to STM where there is more access to electricity.

The local power plant is the Takoradi Thermal Power Plant which lies on the coast approximately 17 km east of STM, and relies on marine water for cooling purposes. The power plant started operation in 1997, and was initiated by the Volta River Authority to complement the existing Hydro Plant at Akosombo and Kpong. The power plant (*Figure 6.13*) is, therefore, a facility of strategic importance for meeting Ghana's energy needs. The plant has historically been fuelled by crude or fuel oil but conversion to use of natural gas from the West Africa Gas Pipeline (WAGP) occurred in 2008 though initial flows have been intermittent.

Figure 6.13 Takoradi Thermal Power Plant

Source: ERM 2009.

There are three bulk fuel storage facilities in STM, namely the Cirrus, Shell and GOIL depots located between Poasi and New Takoradi (*Figure 6.14*).

Takoradi Port also has dedicated oil berthing facilities. Fuel is distributed via road tanker to filling stations in the coastal district either from Tema or Takoradi. Other than the effects of intermittent national fuel shortages, none of the districts experience problems with fuel availability.

In the consulted communities, firewood and electricity are the main sources of energy used in all households. The majority of the firewood is collected from the nearby fields and mangrove areas adjacent to communities such as Ankobra. The collection of firewood is usually done by women. *Figure 6.15* shows a pile of firewood and a typical electricity transformer found in most communities.

Figure 6.14 GOIL Bulk Fuel Storage in Takoradi

Source: ERM 2009.

Figure 6.15 Firewood and Electricity Transformer

Aboadze

Source: ERM 2012

6.9.5 *Transport and Road Infrastructure*

The Ghana Private Road Transport Union (GPRTU) and other transport organisations provide transport services within the districts in the Region. The most common means of transport is by road where there are privately owned or state owned buses. The state owned buses usually operate within the urban areas. In the villages, private taxis and small buses owned by private individuals are operational. The road network in the Region is limited and the conditions of the roads can be very poor, particularly in the rainy season. Goods such as bauxite, manganese, timber and timber products and cocoa are transported by rail on the Western Line which runs from Takoradi to Kumasi and Awaso.
An overview of the transport and road infrastructure in the districts is provided below.

Shama and STM. Most of the roads in STM, particularly those within the urban centres are tarred and are overused, due to the rapid development and most people having to come through the town to access other parts of the Region. Approximately 52% of the roads are in a good condition, 28% is fair and 20% in poor condition. In 2006, the total length of all the weathered roads extended to over 400 km.

Ahanta West District. The road networks (mostly feeders roads) have been improved by 10% which has opened up the District for easy access to farming communities and market centres. In 2006, for example, 14 feeder roads underwent maintenance. Due the poor conditions of some of the feeder roads, some parts of the District are not easily accessible, especially during the rainy season.

Nzema East and Ellembelle Districts. The road networks in the Districts consist of 154 km of trunk roads, of which 64 km are metalled. The metalled trunks form part of the Trans-West Africa Highway. The rest of the trunk roads are gravel or earth-surfaced. Apart from the trunk roads, the Districts have a total of 253 km of feeder roads, of which 40% is in poor condition. Over 70% of the feeder roads are the southern half of the Districts.

All main roads are tarred in the consulted communities, whereas secondary roads are gravel or sandy (*Figure 6.16*). During the rainy season, most of the secondary roads are flooded. Minibuses and passenger vehicles (locally known as tro-tros*)* are generally used for transportation, although many people walk to their destinations as they do not have the money to pay for these fares. Buses are also used by long distance travellers.

Figure 6.16 Road Infrastructure

Busua

Aboadze

Source: ERM 2012

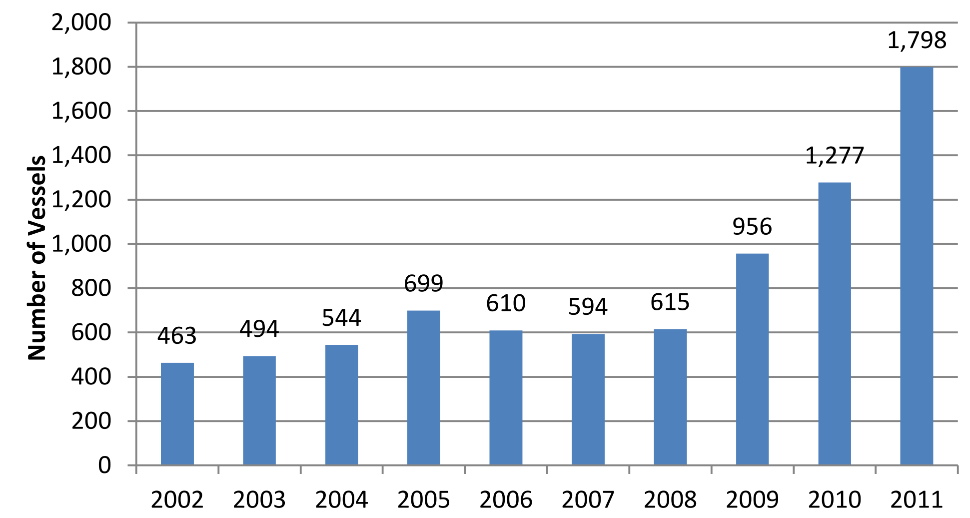
Ports and Harbours

The Port of Takoradi was built as the first commercial port of Ghana in 1928 to handle imports and exports to and from the country. The port has a covered storage area of 140,000 m^2 and has an open storage area of 250,000 m^2. It has a wide range of vessels supporting its operations including tugboats, lighter tugs, a water barge and a patrol boat. Berthing facilities at the port include eight berths with lengths ranging between 120 and 225 m. The maximum draft at the wharf is 10 m.

The port handles both domestic and transit cargoes and between 2002 and 2011 handled an average of 805 vessels per year (*Figure 6.17*), with substantial growth in the previous three years. The main exports include manganese, bauxite, cocoa and forest products. The main imports are clinker, containerised cargo, oil products and wheat. Import/export traffic between 2002 and 2011 is shown in *Figure 6.18*.

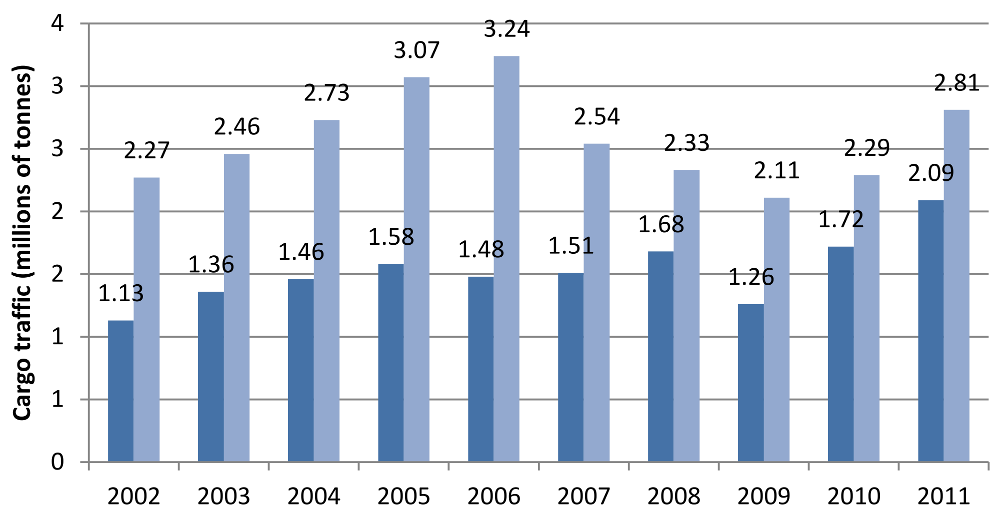
The Port of Takoradi also has a fishing harbour located at Sekondi, which has an ice plant that can accommodate vessels with up to 3 m draft (see *Chapter 5, Section 5.6.1*).

Figure 6.17 Total Takoradi Vessel Traffic (2002 to 2011)



Source: Adapted from GPHA 2012

Figure 6.18 Import (Dark Blue) / Export (Light Blue) Cargo Traffic for Takoradi Port (2002-2011)



Source: Adapted from GPHA 2012

The Port of Tema is the largest port in Ghana and opened in 1962. Tema port handles approximately 80% of Ghana's import and export cargo, including containerised cargo, petroleum and other non-petroleum liquid bulk, and agricultural bulk. The port has 12 container and multipurpose berths, a dedicated oil berth, a dockyard and warehouses. The port has open and closed areas for cargo storage, including a 77,200 m² paved area for containers, steel products and other conventional cargo. The closed storage area, consisting of six warehouses, is 25,049 m² with a storage capacity of 50,000 tonnes. A refrigerated fruit terminal with a holding capacity of 2,000 tonnes was completed in 2007 which has contributed to the increased export of fruit in recent years.

Airport

The Takoradi Airport is the only commercial airport in the Region. The airport has only one runway. The airport is located within the Ghana Air Force compound. Commercial airline flying to the airport include Antrak Air, CityLink, Fly540 and Startbow Airlines.

6.9.6 *Waste Disposal*

Waste management is a serious issue in the Region like many others in Ghana. The predominant means of waste disposal is either by dumping, at specified sites, or indiscriminately burning or burying refuse (see *Figure 6.19*). Approximately 60% of all households in all the districts use a specified public dump while an additional 29% use an unauthorised dumping place.

Only 2% of households have their rubbish collected by a waste contractor or local authorities for disposal. Burning and burying of waste accounts for about a tenth of household waste disposal. Households in Sekondi Takoradi, more than any other district, use collection agencies and public dumping sites. Liquid waste is discharged into gutters, on the compound of the house or into the street outside.

A private waste contractor in STM provides waste treatment, recycling and disposal services for non-hazardous and certain hazardous waste streams, including oily water treatment and incineration.

Figure 6.19 Waste Disposal Area

Upper Axim

Abaodze

Source: ERM 2012

6.9.7 *Fire Service*

Fire response capability in Takoradi exists through the National Fire Service and the Ghana Ports and Harbours Authority Fire Service Department. There are reportedly a total of five fire tenders at the National Fire Station's disposal in case of emergencies. The port has two fire tenders and the airport has one.

6.9.8 *Police Service*

Police services in the Region are provided by the Ghana Police Service. Most communities have a Police Station and every district capital has a District Police Headquarter with a Regional Police Headquarter in the regional capital. The Western Region Command of the Ghana Police Service is located in Takoradi. Apart from the Police Service, chiefs and elders in the communities have responsibilities for settling disputes.

6.9.9 *Telecommunications*

Two main types of telephone systems are in operation in the country. These are the fixed line telephones and the mobile telephone systems. Other systems being operated are wireless, radio telephone and satellite communication systems. Vodafone Ghana Telecom Company operates over 95% of the fixed line telephones in the country. In the Western Region there are 0.3 telephones per 100 persons, which is below the national average of 0.7. Of the 12,985 fixed lines recorded in the Western Region in 2000, 11,046 (86%) were located in STM. The Western Region is extensively covered by the following mobile telephone operators: MTN, Vodafone, Ghana operators of Vodafone, Tigo, Kasapa and Zain. The Region has the second highest locality coverage by MTN, which is the largest mobile telephone system in the country.

6.10 MARINE INFRASTRUCTURE

6.10.1 *Oil and Gas*

Exploration and appraisal drilling activities in the DWT and WCTP concession blocks are on-going during 2012.

In the Jubilee Field subsea equipment (wellheads, manifolds, umbilicals and flow lines) was installed in 2010 and the FPSO *Kwame Nkrumah* is currently located on 60 km from the western coast (E 511990 m, N 508074 m). Production started in November 2010. Crude oil stored on the FPSO is transferred to an export tanker approximately every five to seven days at peak production. The Jubilee Phase 1A development is currently undertaken which will add eight new oil production and water injection wells to the Jubilee development that will tie-in to the Kwame Nkrumah FPSO. A 500 m safety exclusion zone centred at the FPSO turret and a further 10 km radius advisory zone covers the entire Jubilee field area.

6.10.2 *Pipelines and Cables*

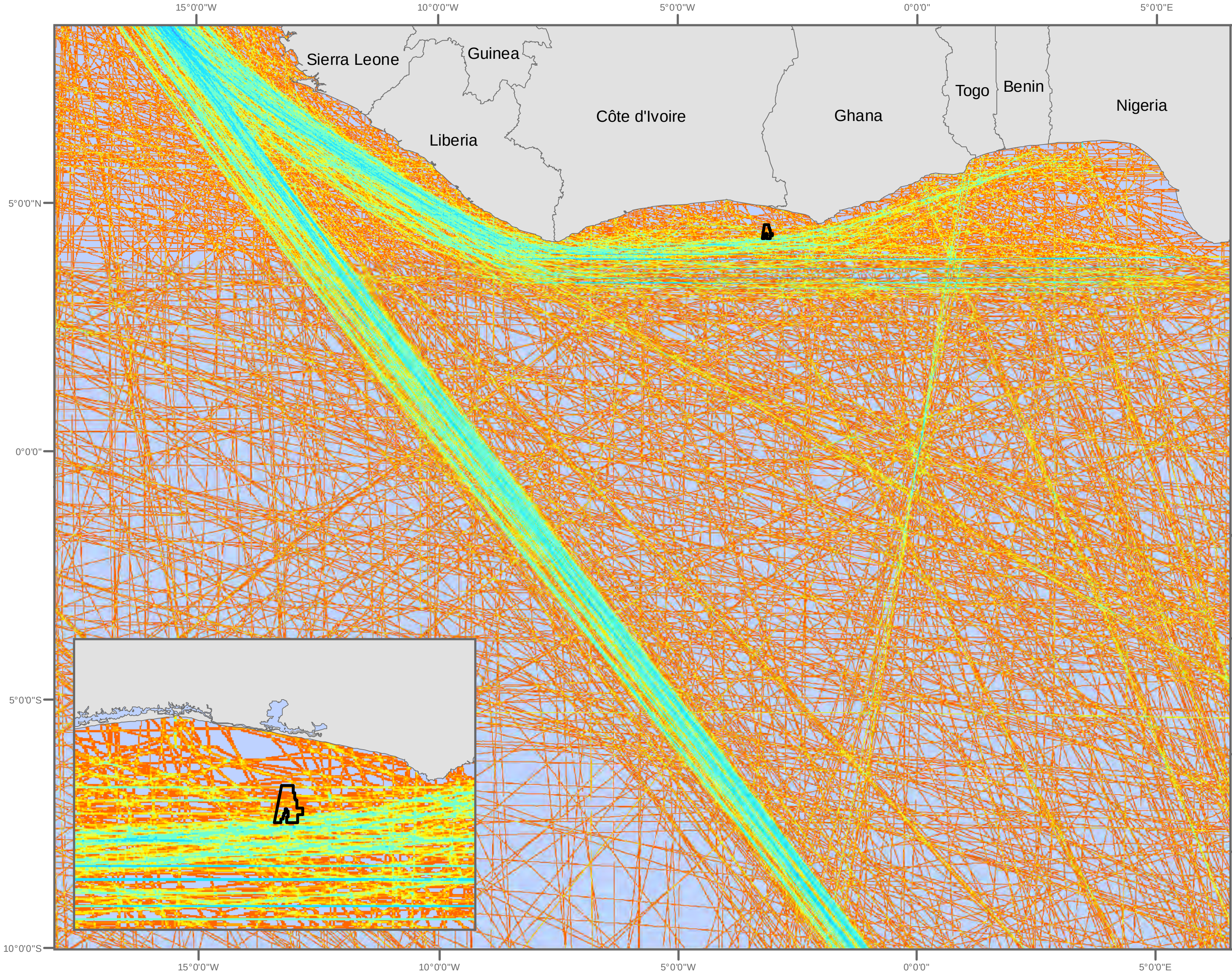
There are several existing and planned submarine cables and pipelines offshore Ghana although none are in the vicinity of the DWT Block.

6.10.3 *Shipping and Navigation*

Commercial vessel movements analysed by the National Centre for Ecological Analysis and Synthesis (NCEAS) [1] are shown in *Figure 6.20*. Higher intensity shipping lanes run parallel to the West African coast and, offshore Sierra Leone, diverts in a south easterly direction to Southern Africa. In the Gulf of Guinea vessel traffic is associated with ports such as Abidjan (Ivory Coast), Tema (Ghana), Lomé (Togo), Porto-Novo (Benin) and Lagos (Nigeria). Shipping intensity within the DWT block is generally between one and four ships per square kilometre per year but can be as high as 10 ships per square kilometre per year along the southern edge of the block. Shipping traffic with an intensity of 10 ships per km^2 per year or more occur just south the block.

No unauthorised incursions or other issues have been reported regarding commercial vessel movements and interference with the Jubilee field operations.

(1) NCEAS analysed voluntary ship location data from World Meteorological Organisation Voluntary Observing Ships Scheme for a 12 month period beginning October 2004 to generate ship tracks as presented in *Figure 6.20*.



TEN Project Area

Maximum number of ships in km² cell

- 0
- 0.1 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- 30 - 60
- > 60

0 100 200 300 400 500
Kilometers

N

SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 11/04/2014	APPROVED: MI

Figure 6.20
Shipping Lanes off West Africa

ERM

TEN project

PROJECTION: WGS 1984 UTM Zone 30N
SOURCE: Tullow

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816ShippingActivity.mxd

6.11 TGL SOCIAL INVESTMENT PROJECTS

To date, TGL, on behalf of Tullow and its partners, has implemented a number of Social Investment (SI) projects as part of its social performance activities. *Table 6.13* provides a sample of these projects.

Table 6.13 Social Investment Community Projects in Ghana

Project	Location	Description	Status
Education			
Kindergarten	Ayensudo, Central Region	Construction of 3 Kindergartens for 4-5 year olds; using locally available sustainable materials such as bamboo pozzalana, palm kernel and coconut fibre.	Project completed in 2011 and accommodates approx. 120 school children.
Kindergarten	Amenano, Shama District	Construction of 3 Kindergartens for 4-5 year olds; using locally available sustainable materials such as bamboo pozzalana, palm kernel and coconut fibre.	Project is scheduled to be completed in Q4 2013 and will accommodate approx. 120 school children when completed.
Jubilee Technical Training Centre	Takoradi Polytechnic, Sekondi Takoradi Metropolis	Construction of a technical training centre at Takoradi Polytechnic. Takoradi Polytechnic will partner with TTE for the delivery of apprenticeship programmes and technical training across.	Project was inaugurated in Q2 of 2013 and has started running a full suite of NVQ 2 and other relevant short courses eg NEBOSH.
Legacy Project- Legon Hall Rehabilitation	Legon Hall, University of Ghana- Accra.	Re-roofing the Legon Hall Annex A and B and constructing of an underground concrete water storage system to solve the perennial water problem of the hall.	Project completed in September 2013.
Atuabo Community Library Project	Atuabo, Ellembelle	Supply of library books and Ghana Education Service approved curriculums	December 2010 – June 2011
ICT	Dixcove, Ahanta West	Support for ICT Centre in Dixcove	July – September 2011
Science Laboratory Project	Half Assini Secondary School	Refurbishment and furnishing of science laboratory to enhance teaching and learning of science	Project was completed in 2008 as the first Tullow funded project in Ghana. The facility has attracted experience science tutors to the school and has enhanced the enrolment of science students and over all science performance of the school.
Health			
STAR CHPS	Six Coastal Districts of the	To strengthen the existing health network by	This 5 year health capacity building project was

Project	Location	Description	Status
	Western Region	supporting CHPS compounds with training, capacity building, and operational support. JHPIEGO, a US-based NGO affiliated with Johns Hopkins University, was selected to design and implement the project.	launched in May 2011 and has successfully built a capacity of approximately 60 Community Health Officers across 18 CHPS Compounds, established 18 Community Health Management Committees and supported the 18 CHPS Compound to attained the National Health Insurance Accreditation status.
Clean Water Project	Jomoro and Ellembelle District	To remediate 19 faulty boreholes previously constructed and improve the quality of water to WHO standard.	Due to commence in Q3 2013
Community Health Check	Six Coastal Districts of the Western Region	Community Health Checks in partnership with GHS	Project commenced in 2010 for a two year period. Approx. 5,000 people have been screened for diabetes, hypertension, HIV/AIDS, breast cancer, eye, ear and nose infections.
Enterprise Development			
Enterprise Development centre	Six Coastal Districts of the Western Region	Basic training, capacity building, advisory services, access to market, information dissemination and business support. The project will provide a variety of business support services to ensure that SMEs can meet international quality requirements for potential work in the oil and gas supply chain.	Project inaugurated in Q2 2013.
Livelihood Enhancement and Enterprise Development	Six Coastal Districts of the Western Region	Delivery of basic business management, facilitating market and credit access to fishermen and fishmongers. Youth internships, improved ice making and fish smoking technique.	Project commenced in 2012.
Environment			
House of Chiefs Guest House	Sekondi, STM	Western Region House of Chiefs –Guest House rehabilitation	July 2011-February 2012
Community Focused Oil Spill Awareness.	Six Coastal Districts of the Western Region	To improve the environment of the six coastal districts by partnering with working groups to remove refuse, improve sanitation and develop oil spill response capacity at the community level as part of oil spill contingency plans.	To date 940 community members have been trained in the use of PPE, shoreline containment, waste segregation and equipment mobilisation.

Project	Location	Description	Status
Sponsorship			
Osagyefo Cup Competition - Sponsorship	Nkroful, Ellembelle	Sponsorship for inter schools competition in memory of Dr. Kwame Nkrumah, the first President of the Republic of Ghana	August –September 2011
Fishermen Annual Regatta	Six Coastal Districts of the Western Region	Annual regatta festival participated by fishermen from the six coastal districts of the Western Region. The event provides platform for Jubilee Partners and Fisheries Commission to sensitise fishermen on the need to refrain from fishing within the Jubilee Field exclusion zone.	Regatta takes place annually and hosted rotationally among the six coastal districts.

Source: TGL 2013

In addition, TGL has a Community Liaison Officer (CLO) based in each of the six coastal districts. Each CLO is a resident in their respective district and are responsible for managing a community grievance procedure as well as maintaining regular communications with key stakeholders in their district (*eg* traditional authorities, district assemblies, NGOs, youth groups and opinion leaders).

7 *IMPACT IDENTIFICATION AND ASSESSMENT*

7.1 *INTRODUCTION*

The objectives and legal basis for environmental assessment in Ghana are described in *Chapter 1* and *Chapter 2*, respectively. This chapter provides an assessment of the environmental and social impacts that may result from the TEN Project and provides details of the mitigation measures and management actions that will be implemented to avoid, reduce, remedy or compensate for significant adverse effects and, where practicable, to maximise potential positive benefits and opportunities from the project.

The assessment methodology used in this EIA is outlined below. Impacts from well drilling, completions, subsea and FPSO installation, commissioning and operations are addressed in this chapter. Impacts associated with the decommissioning phase were considered to be similar to the commissioning phase. A provisional decommissioning plan is provided in *Chapter 10*.

The significance of the impacts that remain following application of the mitigation measures (also called residual impacts) is then assessed. The key impacts are summarised in *Chapter 12*.

Key impacts are assessed under the following headings:

- Project Footprint;
- Operational Discharges;
- Emissions to Atmosphere;
- Greenhouse Gas Emissions;
- Waste Management;
- Fisheries Impacts;
- Socio-economic and Community Health Impacts;
- Oil Spill Risk;
- Cumulative Impacts; and
- Trans-boundary Impacts.

The approach adopted for the EIA was to identify the impacts that are likely to be significant and those impacts that are not likely to be significant are excluded (scoped out) from the assessment. This process does not take into account the application of mitigation measures, other than those that are built into the design of the project. Worker occupational health and safety topics are not addressed within the ESIA process as these issues are more comprehensively assessed and controlled through project and health and safety management plans and site procedures.

Where there is uncertainty in this process the potential impacts are included in the assessment, therefore, there will be potential impacts included in the assessment that that are ultimately judged to be not significant.

7.1.1 *Scoping, Consultation and Identification of Potential Impacts*

In undertaking scoping, the EIA team identified key issues for further assessment in the EIA based on its knowledge of sources of potential impact associated with offshore oil and gas development and production, previous project experience and results of consultations.

The outcome of the scoping consultations and impacts identified for assessment in the EIA were presented in the Scoping report, issued in January 2012. Additional issues were identified through community consultations that were held in March and June 2012. A register of the issues that were raised during consultations is included in *Volume I: Attachment 1 (Appendix 5).* Some of the recurring issues and concerns that were raised, and references to where these issues are addressed in the EIA, are provided in *Table 7.1*.

Table 7.1 Key Issues from EIA Community Consultations

Issue	EIA Reference
Communities were concerned about environmental impacts in general and in particular about the effect of seaweed blooms on fishing activities and hold the perception that the oil and gas operations are a contributing factor.	Operational discharges (including ballast water) are assessed in *Section 7.4*. Fisheries impacts are assessed in *Section 7.8*.
Communities believe that the oil and gas operations have caused a decline in fishing resources.	Fisheries impacts are assessed in *Section 7.8*.
Fishermen are concerned about exclusion from the safety zone. They also claimed that they are harassed by the Navy, that their fishing gear is confiscated by the Navy and that their fishing gear is damaged by support vessels.	Fisheries impacts are assessed in *Section 7.8*.
Communities perceive a lack of community benefits and lack of employment opportunities from the oil and gas industry.	Employment and skills development are discussed in *Section 7.9.3*. Issues relating to heightened community expectations are discussed in *Section 7.9.6*.
Communities believe that TGL has not fulfilled all its promises/ commitments.	Issues relating to heightened community expectations are discussed in *Section 7.9.6*.
Communities expect the oil and gas industry to improve infrastructure (*ie* schools, medical facilities, roads and electricity) and support small businesses (*eg* flexi loans especially for women).	Issues relating to heightened community expectations are discussed in *Section 7.9.6*. Procurement of goods and services, including support for local businesses, are discussed in *Section 7.9.4*.
Communities expect the oil and gas industry to support alternative livelihoods.	Issues relating to heightened community expectations are discussed in *Section 7.9.6*.

7.2 ASSESSMENT METHODOLOGY

The impact assessment methodology is outlined below.

7.2.1 *Predicting the Magnitude of Impacts*

The impact assessment describes what will happen by predicting the magnitude of impacts and quantifying these to the extent practicable.

The term 'magnitude' covers all the dimensions of the predicted impact to the natural and social environment including:

- the nature of the change (what resource or receptor is affected and how);
- the spatial extent of the area impacted or proportion of the population or community affected;
- its temporal extent (*ie* duration, frequency, reversibility); and
- where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

Table 7.2 provides definitions for the spatial and temporal dimension of the magnitude of impacts used in this assessment.

Table 7.2 Magnitude Definitions

Impact magnitude – the degree of change brought about in the environment	
Spatial Scale	**Local** – impacts that are limited to the TEN Project area or Takoradi onshore base and the surrounding area. **Regional** – impacts that are experienced beyond the local areas to the wider region, *eg* Western Region or the TEN Project area. **National** – impacts that are experienced at a national scale. **Trans-boundary/International** – impacts that are experienced at an international scale *ie* affecting another country.
Temporal Scale	**Short-term** - predicted to last only for the duration of the drilling or installation operations (*ie* up to approximately two years). **Medium-term** - predicted to last from two years to the end of the project life (*ie* 25 years). **Long-term** - predicted to continue beyond the project life but will cease in time. **Permanent** – impacts that cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime. **Continuous** – impacts that occur continuously or frequently. **Intermittent** – impacts that are occasional or occur only under specific circumstances

Magnitude, therefore, describes the actual change that is predicted to occur in the resource or receptor (*eg* the area and duration over which disturbance of the seabed will occur; the degree of impact on the livelihoods of a local community; the probability and consequences in terms of accidental events). An assessment of the overall magnitude of an impact is, therefore, provided that takes into account all the dimensions of the impact described above to determine whether an impact is of small, medium or large magnitude.

Impacts on ecological resources consider the effect on long-term functioning of ecosystems and the abundance of the habitat or size of a species' population. For impacts on ecological resources, the criteria used to assess the magnitude of impacts are presented in *Box 7.1* (based on Duinker and Beanlands 1986).

For social impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact and the ability of people to manage and adapt to change.

Box 7.1 Magnitude Criteria for Ecological Impacts

- A **Large Magnitude Impact** affects an entire population or species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations of the affected plants or animals. A high magnitude impact may also adversely affect the integrity of a site, habitat or ecosystem.

- A **Medium Magnitude Impact** affects a portion of a population and may bring about a change in abundance and/or distribution over one or more generations of the affected plants or animals, but does not threaten the integrity of that population or any population dependent on it. A moderate magnitude impact may also affect the ecological functioning of a site, habitat or ecosystem but without adversely affecting its overall integrity.

- A **Small Magnitude Impact** affects a specific group of localised individuals within a population over a short time period (one generation of the affected plants or animals or less) but does not affect other trophic levels or the population itself.

It should be noted that the restoration potential of an affected habitat also needs to be considered in applying the above criteria.

7.2.2 *Quality/Importance/Sensitivity of Resources and Receptors*

The significance of the impacts resulting from an impact of a given magnitude will depend on the characteristics of resources and receptors to that impact in terms of their quality, importance or sensitivity.

For ecological resources importance or quality can be assigned as low, medium or high based on the conservation value (including protection status) of habitats and species and their ecosystem functions. For habitats these are based on factors such as naturalness, extent, rarity, fragility, diversity and importance as a community resource. For species, protection, conservation status and ecosystem role are considered.

For species, *Table 7.3* presents the criteria for deciding on the value or sensitivity of individual species(1). This approach follows the guidelines produced by the Energy and Biodiversity Initiative (EBI 2003)(2). For socio-economic and health impacts sensitivity is based on individuals' ability to adapt to changes and maintain their livelihoods and health (*Table 7.4*).

Where required, specific criteria for assessing sensitivity are presented under the relevant impact assessment sections

Table 7.3 Species Value / Sensitivity Criteria

Value / Sensitivity	Low	Medium	High
Criteria	Not protected or listed and common / abundant; or not critical to other ecosystem functions (*eg* key prey species to other species).	Not protected or listed but: a species common globally but rare in Ghana; important to ecosystem functions; or under threat or population decline.	Specifically protected under Ghanaian legislation and/or international conventions *eg* CITIES (3). Listed as rare, threatened or endangered *eg* IUCN(4)

Table 7.4 Socio-economic and Health Sensitivity Criteria

Sensitivity	Low	Medium	High
Socio-economic Receptors			
Criteria	Those affected able to adapt with relative ease and maintain pre-impact livelihoods	Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support	Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods
Health Receptors			
Criteria	Those affected will be able to adapt to health impacts and maintain pre-impact levels of health	Those affected will be able to adapt to health impacts, but with difficulty and maintain pre-impact levels of health only with support	Those affected will not be able to adapt o to health impacts and continue to maintain pre-impact health levels.

(1) The above criteria should be applied with a degree of caution. Seasonal variations and species lifecycle stage should be taken into account when considering species sensitivity. For example, a whale population might be deemed as more sensitive during the breeding period and when mothers are accompanied by young calves. Fish species might be deemed more sensitive during their spawning period than at other times of year.
(2) A framework formed by several leading oil and gas companies working alongside conservation organisations to form a partnership designed to produce practical guidelines, tools and models to improve the environmental performance of energy operations, minimise harm to biodiversity, and maximise opportunities for conservation wherever oil and gas resources are developed.
(3) Convention on International Trade in Endangered Species of Wild Fauna and Flora.
(4) The International Union for the Conservation of Nature and Natural Resources.

7.2.3 *Evaluation of Significance*

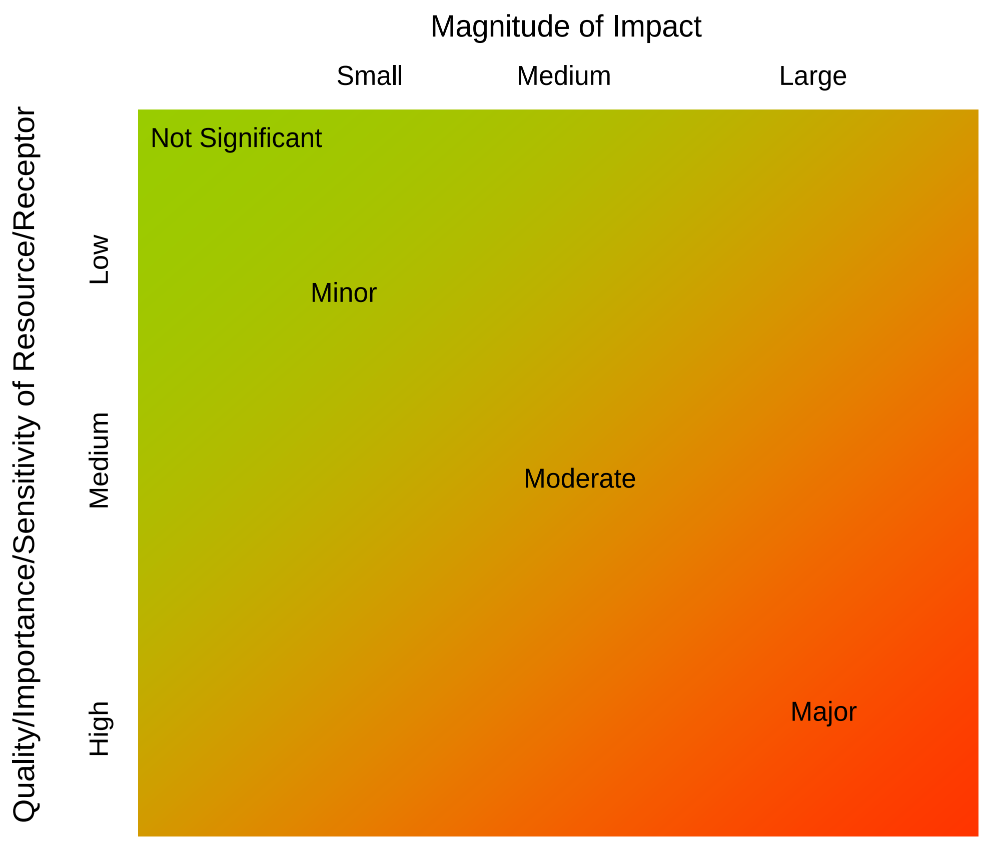
Virtually all human activity imposes some disturbance to aspects of the natural and social environment because of physical impacts on natural systems or due to interactions with other human activities. To provide information to decision makers and other stakeholders on the importance of different project impacts an evaluation of the significance of each effect will be made by the EIA team.

As there is no statutory definition of significance, the evaluation of significance in the EIA will be subjective. The evaluation of impacts presented in the EIA will be based on the judgement of the EIA team, informed by legal standards, national and regional government policy, current industry good practice and the views of stakeholders. Where specific standards are either not available or provide insufficient information on their own to allow grading of significance, evaluation of significance will take into account the magnitude of the impact and the quality, importance or sensitivity of the affected resource or receptor.

The quality or importance of a resource will be judged taking into account, for example, its local, regional, national or international designation, its importance to the local or wider community, its ecosystem function or its economic value. The assessment of the sensitivity of human receptors, for example a fishing community or wider social group, will consider their likely response to the change and their ability to adapt to and manage the effects of the impact.

Magnitude and receptor quality/importance/sensitivity are looked at in combination to evaluate whether an impact is, or is not, significant and if so its degree of significance (defined in terms of *Minor, Moderate* or *Major).* Impacts classed as *not significant* include those that are slight or transitory, and those that are within the range of natural environmental and social change. This principle is illustrated schematically in *Figure 7.1*.

Figure 7.1 Evaluation of Significance



7.2.4 *Mitigation Measures*

One of the key objectives of an EIA is to identify and define socially and environmentally acceptable, technically feasible and cost-effective mitigation measures. Mitigation measures are developed to avoid, reduce, remedy or compensate for the significant negative impacts identified during the EIA process, and to create or enhance positive impacts such as environmental and social benefits. In this context the term mitigation measures includes operational controls as well as management actions.

Where a significant impact is identified, a hierarchy of options for mitigation is explored as follows:

- avoid at source – remove the source of the impact;
- abate at source – reduce the source of the impact;
- attenuate – reduce propagation of the impact between the source and the receptor;
- abate at the receptor – reduce the impact at the receptor;
- remedy – repair the damage after it has occurred; and/or
- compensate or offset – replace in kind or with a different resource of equal value.

Mitigation measures are often established through industry standards and may include the following.

- Changes to the design of the project during the design process (*eg* changing the development approach or selection of more energy efficient power generating equipment).
- Engineering controls and other physical measures applied (*eg* use of effluent treatment equipment or spill prevention technology).
- Operational plans and procedures (*eg* notification to other marine users, navigation safety plans or waste management plans).

For impacts that are initially assessed during the EIA process to be of *Major* significance, a change in design is usually required to avoid, reduce or minimise these, followed by a reassessment of significance. For impacts assessed during the EIA process to be of *Moderate* significance, where appropriate the discussion explains the mitigation measures that have been considered, the one selected and the reasons (*eg* in terms of technical feasibility and cost-effectiveness) for that selection. Impacts assessed to be of *Minor* significance are usually managed through good industry practice, operational plans and procedures.

EIA is intended to help decisions on projects to be made in full knowledge of their likely impacts on the environment and society. As noted below, the residual impacts and their significance reported in this EIS are based on the proposed TEN Project as described, *ie* inclusive of all proposed mitigation.

The mitigation measures and monitoring plans discussed in this chapter are presented in more detail in *Chapter 8* and *Chapter 9*, respectively, and incorporated into the provisional EMP in *Chapter 11*.

7.2.5 Assessing and Reporting Impact Significance

Reporting the significance of a residual impact in the EIS is based on:

- the predicted magnitude of an impact, taking into consideration all the mitigation measures the project team is committed to that are relevant to that impact; and (where appropriate); and
- the quality/importance/sensitivity of the receptor.

The degree of significance attributed to residual impacts is related to the weight the EIA team considers should be given to them by the authorities in making decisions on the proposed TEN Project and developing conditions for approval.

Impacts of *Major* significance, whether positive or negative, are considered to warrant substantial weight, when compared with other environmental, social or economic costs and benefits, for those making decisions on the TEN Project; conditions will be expected to be imposed to control and, if necessary, monitor adverse impacts and deliver benefits.

Impacts of *Moderate* significance are considered to be of reducing importance to making decisions, but still warranting careful attention to conditions regarding mitigation and monitoring, to ensure the most appropriate (technically feasible and cost-effective) mitigation measures are used and to ensure benefits are delivered.

Impacts of *Minor* significance are brought to the attention of decision-makers but will be identified as warranting little if any weight in their decision; mitigation will be achieved using normal good practice and monitoring may be required to confirm that impacts are as predicted.

7.2.6 *Uncertainty*

Even with a final project description and an unchanging environment, predictions of impacts and their effects on resources and receptors can be uncertain. Predictions can be made using varying means ranging from qualitative assessment and expert judgement through to quantitative techniques (*eg* discharge modelling). The accuracy of predictions depends on the methods used and the quality of the input data for the project and the environment. Where uncertainty affects the assessment of impacts a conservative (*ie* reasonable worst case) approach to assessing the likely residual impacts is adopted with mitigation measures developed accordingly. To verify predictions and to address areas of uncertainty, monitoring plans are proposed.

It is noted that the air dispersion and produced water modelling studies were based on emission and discharge rates associated with higher production profiles than those outlined in *Chapter 3*. The emission and discharge rates and the impact assessment are therefore considered to be conservative.

7.3 *PROJECT FOOTPRINT*

7.3.1 *Scope of Assessment*

This section provides an assessment of the potential impacts from the physical footprint of the TEN Project and discusses measures to be implemented to mitigate those impacts. The term 'physical footprint' incorporates both the physical presence of the offshore and onshore structures and equipment and the effects of these on the physical environment and associated resources and receptors. Impacts from the physical footprint include impacts from noise and light sources.

The following impacts are considered of potential significance with regard to the physical footprint of the project.

- Impacts to benthic fauna communities during the installation and long-term physical presence of subsea infrastructure on the seabed.

- Impacts to marine organisms from underwater sound produced by the project.

Impacts of FPSO, MODU and vessel presence on fish populations are assessed in *Section 7.8*.

The potential impacts that have been scoped out of the detailed assessment due to being considered to be *not significant* include the following.

Impacts from FPSO, MODU Lighting and Flaring

Artificial lighting may disturb and disorientate seabirds feeding or passing through the area resulting in collisions with the MODU or FPSO. However, experience from other offshore installations around the world has indicated that this is not a significant issue and although some collisions may occur, birds generally become accustomed to the presence of the FPSO and associated vessels.

There is the potential that turtles will be attracted to the FPSO at night where hatchlings could be subject to increased predation by birds and fish that are also attracted to the structures. The FPSO is 60 km from the nearest shore and would not be visible from the shore and any turtle nesting beaches. The risk of any impacts on turtles and turtle hatchlings from the FPSO lights is considered to be *not significant.*

Impacts to Marine Mammals and Turtles from Vessel Collision and Marine Debris

Collisions have been known to occur worldwide and also in West Africa (Félix and Van Waerebeek 2005; Van Waerebeek *et al* 2007) and increased marine vessel traffic between the TEN Project and Takoradi port will increase the risk of collisions. The increased risk of collision is considered to be low given the relatively low volume of project related traffic and the speed that they move at (typically moving at less than 12 knots). Marine mammals and marine turtles are most sensitive in areas with fast moving vessels which frequently change direction and are more able to avoid the large, relatively slow moving support vessels associated with the project. No collisions between vessels and marine mammals have been reported from the Jubilee field.

Disposal of waste to sea will not occur from the FPSO, MODU or support vessels, with the exception of treated organic kitchen waste and treated sewerage.

The risks to marine mammals and marine turtles from vessels collisions and damage from marine debris associated with the project are considered to be low and are assessed as *not significant*.

Impacts from Aerial Noise

Activities in the TEN Project area will be located approximately 60 km offshore, away from any sensitive noise receptors. Onshore noise at the port in Takoradi from the project is assessed as *not significant* as activities will be within an existing busy port.

Noise from helicopter flights to and from the Air Force base at Takoradi and the TEN Project area has the potential to cause disturbance. Flight planning to avoid sensitive areas will avoid significant impacts. This includes a minimum flight height of 2,300 feet (710 m) above the Amansuri Wetland IBA to avoid disturbance to wildlife.

7.3.2 *Subsea Infrastructure*

Description of Potential Impacts

The TEN Project will have a physical footprint on the seabed through placement of infrastructure during the construction and commissioning of subsea infrastructure and from the permanent presence of some of this infrastructure. This will result in habitat loss or disruption to defined areas of the seabed and impacts to benthos (animals living in or on the seabed) and demersal fish.

The main impacts are expected to arise from the following sources.

- Short-term disturbance directly to the seabed (*eg* from sediment suspension), with secondary impacts on the benthic and demersal community, during installation of subsea infrastructure.

- Permanent habitat and associated species loss or damage from coverage of areas of seabed by moorings, well manifolds, well heads, riser bases, flowlines, umbilicals and the gas export pipeline.

- Permanent changes to the habitat arising from the physical presence of subsea infrastructure (*eg* sediment disturbance and reef effects from marine organisms growing on subsea infrastructure).

*Table 7.5*summarises the main infrastructure components, their dimensions, area of seabed disturbance and nature of impacts anticipated from their installation and permanent presence. More details on the purpose of the seabed infrastructure and a schematic of the various subsea infrastructure components are given in *Chapter 3*.

Table 7.5 Potential Seafloor Disturbance

Component	Total Seafloor Area Affected (km^2)	Potential Impact
1. FPSO		• Loss of, or damage to, habitats and communities beneath the equipment during placement. • Smothering and secondary effects from sediment disturbed during equipment installation. • Changes to sediment structure and composition. • Creation of new substrate and potential habitat. • Creation of a barrier precluding movement / migration of benthic organisms.
Mooring piles	0.0003	
Mooring lines	0.4800	
2. Subsea Trees		
Oil Production Trees	0.0002	
Gas Production Trees	0.0000	
Water Injection Trees	0.0002	
Gas Injection Trees	0.0000	
3. Structures		
Production manifolds	0.0006	
PLEMs	0.0003	
Water injection ILTs	0.0012	
Riser base manifolds	0.0003	
PLETs	0.0013	
4. Production Flowlines		
Enyenra	0.0027	
Ntomme	0.0020	
Tweneboa	0.0008	
5. Injection Flowlines		
Water injection	0.0082	
Gas injection	0.0094	
Gas lift line Enyenra	0.0004	
6. Umbilicals		
Production	0.0055	
Water injection	0.0063	
Gas injection	0.0010	
7. Gas Export Pipeline	0.0094	
Total	**0.5223**	

Mitigation Measures

The following measures will be taken to mitigate potential impacts on the seabed from the installation and long-term presence of subsea infrastructure.

- The layout of the subsea infrastructure will be designed to avoid seabed features such as reef areas and areas of potential geo-hazard which will potentially have more diverse habitats and species.

- Most in-field subsea flowlines and the gas export pipeline will be laid directly on the seabed and flowline burial using methods such as dredging and jetting which creates sediment plumes will be avoided.

Impact Assessment

Effects from sediment disturbed during infrastructure installation.
Sediment may become disturbed and suspended in the water column by project activities undertaken on or near the seabed such as installation of flowlines, well conductors, moorings, manifolds, riser bases and gas export

pipeline. Suspended sediment could lead to the smothering of sessile species and possible secondary effects such as impacts to the respiration of benthic organisms and demersal fish. Current data (see *Chapter 4: Section 4.5.4*) shows currents of up to 0.2 ms^{-1} at the seabed (approximately 1,000 m) which is indicative of a good dispersive capacity. Therefore, any suspended sediments in the water column will likely dissipate relatively quickly. The duration of installation activity is relatively short-term and localised. The overall magnitude of the impact is considered to be low.

Loss of or damage to marine habitats. The positioning of subsea infrastructure, in particular flowlines and the gas export pipeline, will result in the loss of or damage to seabed habitats and associated communities. The total area of seabed that will be directly affected by the physical presence of subsea infrastructure is relatively small at approximately 0.52 km^2. For comparison the TEN Project area is approximately 450.76 km^2 therefore the area of direct impact represents approximately 0.12% of this area. Mortality of all individuals immediately beneath installed infrastructure is likely, particularly for sessile species (which are typical to benthic communities) where avoidance and vertical migration is generally not possible. The impact on seabed habitats and species will be localised with the area affected being small in relation to the similar habitats in this offshore, deepwater location and consequently the loss of areas of muddy/silty habitat is considered to be of small magnitude.

Loss of fish prey organisms. The loss of or damage to seabed habitats and associated communities will reduce prey availability to demersal deep water fish species in the area. The impacts to benthic organisms are considered to be localised and the total loss will represent a very small portion of the available food to fish predators. In addition, the fish species impacted are highly mobile, travel large distances for food and will be able to source prey from other locations. The impact is therefore considered to be of small magnitude.

Changes to sediment structure and composition. Changes to sediments may occur from a variety of processes, *eg* from compaction or changes to water current flow caused by the presence of the infrastructure. Any change to habitat conditions is anticipated to be localised and small scale (*ie* limited to the footprint of subsea infrastructure).

Barriers precluding movement / migration of benthic organisms. Flowlines and pipelines of significant linear length have the potential to create a physical barrier to mobile benthic organisms such as crustaceans. However, the height of the flowlines (up to 30 cm diameter) is not expected to create a significant barrier, especially as flowlines are likely to settle into the soft sediments by approximately 30 to 50% of their diameter. The impact is therefore considered to be of small magnitude.

Creation of new substrate and potential habitat. The placement of seabed equipment, in an otherwise uniform and relatively featureless habitat, could also provide some positive benefits by providing solid relief features on the seabed offering a protective and stable substrate which could be colonised over time. This 'reef effect' will be at a small scale and localised but nevertheless would add to local biodiversity.

The conservation evaluation criteria presented in *Table 7.3* have been applied to the known benthic habitats and seabed conditions in the TEN Project area and along the pipeline route to the Jubilee field. The habitat has been assessed as low importance given the generally featureless benthic habitat and relatively homogeneous benthic fauna across the survey area (CSA 2011a).

The installation and presence of structures on the seabed constitute small magnitude impacts to habitats and species which are assessed as being of low conservation value and sensitivity. The negative impacts of seabed structures on benthic communities are assessed as being of *Minor* significance within the TEN Project area. The positive impacts from the small scale introduction of new substrates for colonisation by benthic organisms are also assessed as being of *Minor* significance.

7.3.3 Underwater Sound and Marine Fauna

Sources of Underwater Sound

Sounds in the marine environment can be categorised as either naturally occurring or anthropogenic (human produced) in origin. Natural sources of sound include marine mammal vocalisations, sounds from other marine life, and sounds from wind, rain and waves. Anthropogenic sounds come from shipping, fishing, dredging, oil and gas exploration and production activity, sonar (navigation, fishing and defence), seismic survey sources and construction (*eg* percussive piling). Most sound sources are intermittent in a given area, *eg* vessel movements (other than in busy shipping lanes where they are near continuous).

The main sources of underwater sound associated with the project can be categorised as follows.

- **Drilling Activities.** The majority of sound produced by drilling activities on the seabed are continuous and of low frequency.

- **Propeller and Thrusters (on the MODU)**. Noise from propellers and thrusters is predominantly caused by cavitation around the blades whilst moving at speed or operating thrusters under load in order to maintain a vessel's position (*ie* dynamic positioning). The noise produced is typically broadband noise, with some low tonal peaks.

- **Machinery Noise.** Machinery sound is often of low frequency, and often becomes dominant for vessels when stationary or moving at low speeds. The source of this type of sound is from large machinery, such as large power generation units (diesel engines or gas turbines), compressors and fluid pumps. Sound is transmitted through different paths, *ie* structural (machine to hull to water) and airborne (machine to air to hull to water), or a mixture of both. The nature of sound is dependent on a number of variables, *eg* number and size of machinery operating, coupling between machinery and deck. Sound is typically tonal in nature.

- **Equipment in Water.** Sound is produced from equipment such as flowlines, valves and caissons. Noise produced will tend to be relatively low for drill casing, but possibly more significant for sub-sea valves.

For offshore operations the fixed installation will produce continuous or near continuous sound as well as intermittent sound from visiting vessel movements.

The propagation of sound through water is affected by spreading (distance) losses and attenuation (absorption) losses with sound energy decreasing with increasing distance from the source. The losses are also influenced by factors such as water depth, temperature and pressure (McCauley *et al* 2000). The potential for sound produced by the TEN Project to impact marine species will therefore be influenced to a large extent by the distance between the sound source and the marine species, and the sensitivity of these species to sound.

Sound Power Level (SPL) which measures the sound energy is the metric that has most often been measured or estimated during disturbance studies, however, it is recognised that the Sound Exposure Level (SEL), which takes into account the duration of exposure, also influences behavioural changes. Sound frequency is the property of sound that most determines pitch and is measured in Hertz (Hz)[1].

Measured Sound Levels

Gardline (2011c) undertook an underwater survey to characterise sound levels around the operating Jubilee FPSO. The sound levels around the proposed TEN FPSO will likely be similar given the similarities in design and operations. The measured FPSO sound output during normal operation ranged mainly from 25 Hz to 2 kHz with a broadband source level of 182 decibels (dB)[2]. The source level peak occurred between 100 to 200 Hz. A higher frequency sound of around 13.5 kHz was also recorded which may have resulted from high speed rotating equipment. Sound levels during oil off-loading operations ranged from mainly from 400 Hz to 16 kHz with a broadband source level of 176 dB. The broader frequency range during offloading was thought to be due to propeller noise from the handling tug with possible cavitation. The measured sound levels broadly correspond with frequency ranges reported by Richardson *et al* (1995) (*Table 7.6*).

(1) Sound frequency is expressed in Hertz. Sound frequency is an indication of the pitch of a sound.
(2) Sound pressure level is expressed on a decibel(dB) scale. It is an indication of the amplitude or loudness of a sound.

Table 7.6 Indication of Sounds that may be Produced by Project Activities

Project Activity	Approximate Highest Sound Levels (dB re 1 µPa @ 1m)*	Peak Frequency Band – Indicative Ranges (Hz)**
Tug	170 dB	50 - 1,000
Pipelay vessel	180 dB	1,000 - 100,000
Supply vessel	180 dB	10 - 1,000
Export Tanker	190 dB	10 – 100
Subsea choke valve	120 dB	1,000 - 100,000
FPSO	160 dB	1,000 - 100,000
MODU	174 to 185 dB	10 - 10,000

*Sound pressure is expressed on a decibel scale (dB) and referenced to 1 micro Pascal at 1 m from the source. [dB re 1 µPa @ 1m]
** Sound frequency is expressed in Hertz. Only the approximate range of peak frequencies is presented, frequencies outside this range are likely to exist but be lower in sound level.

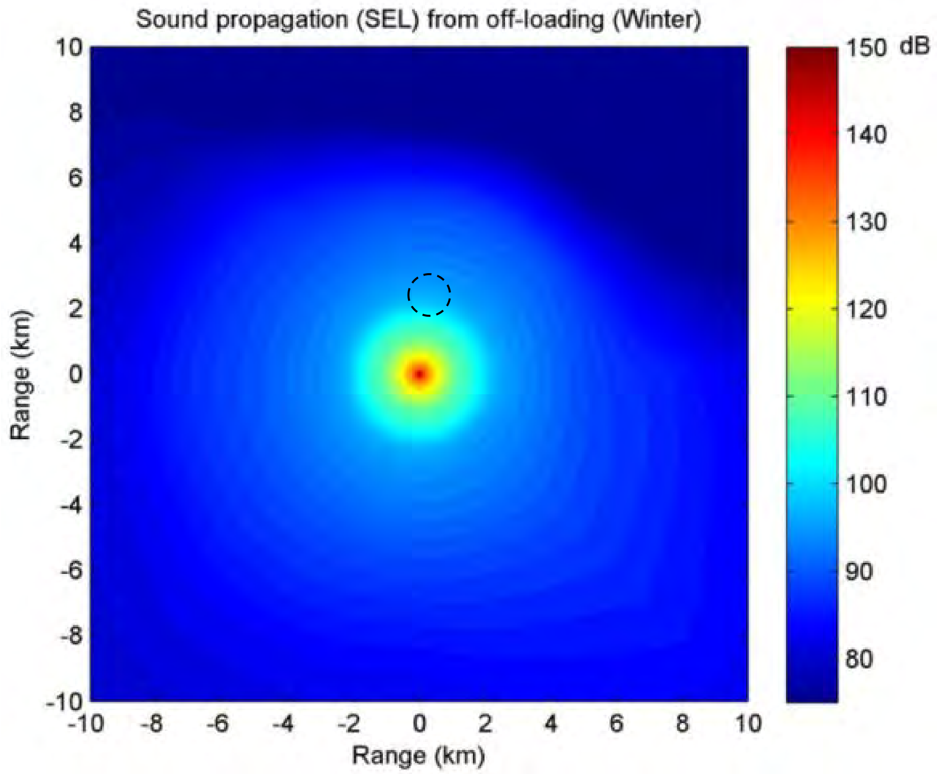
Sound Propagation Modelling

Gardline (2011c) undertook modelling to estimate sound levels and propagation over distance from the measured sound data to create two-dimensional sound maps of the area around the FPSO. The two-dimensional modelling approach used parabolic equations and sound speeds were calculated using local water temperature and salinity data. A sound map showing noise propagation during offloading for a winter profile is shown in *Figure 7.2* which is representative of a worst case scenario due to better propagation of sound in denser, colder water. Based on the propagation maps it can be determined that the FPSO, during normal operations, will radiate noise levels near the surface that should decline to around 120 dB[1] at a range of less than 500 m. Off-loading operations will radiate noise levels near the surface which should decline to around 120 dB at a range of less than 1 km (*Figure 7.2*).

Figure 7.3 shows modelled vertical transmission loss as a function of water depth and distance from the surface source. The plot indicates that there is greater sound attenuation in deeper water compared to shallower water. The darker colours indicate a higher loss of sound at a particular point. In deeper water (*eg* >1,000 m), sound levels would be expected to be at levels that may result in disturbance behaviour of marine mammals within 5 to 6 km of the FPSO. At a depth range of approximately 500 m below the sea surface, elevated sound levels (from a surface source), which may result in disturbance behaviours of marine mammals, are likely to extend to approximately 3 km of the FPSO.

(1) A conservative threshold level of 120 dB represents a level at which behavioural responses (such as avoidance) may occur for continuous noise sources by sensitive species.

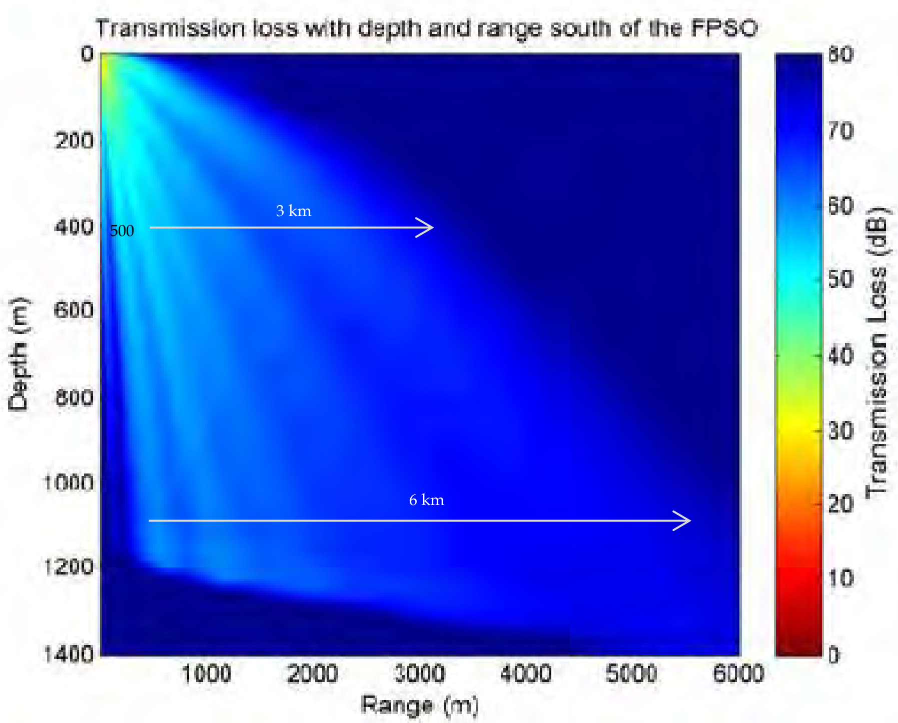
Figure 7.2 *Sound Map of Surface Sound Level Propagation Away from the FPSO during Offloading Operations (dB re 1 μPa².s)*



Note: Received Level range for 40Hz to 16kHz SEL and winter speed profile. Dotted line shows approximate 120 dB noise level contour.

Source: Gardline 2011c

Figure 7.3 *Transmission Loss Away from the FPSO at 200 Hz (south)*



Source: Gardline 2011c

Other vessels, such as support and pipe-lay vessels, associated with the project have sound levels of up to approximately 180 dB. It is expected that these sound levels would decay to a level of 120 dB within a 1 km radius of the source. The MODU could also generate relatively high sound levels of up to 174 to 185 dB, although at relatively low frequencies. Richardson *et al* (1995) reported that broadband levels from the dynamically positioned SEDCO 708 (154 dB re 1 μPa-m) did not exceed ambient levels beyond 1 km from a well drilling operation, although weak tones were received approximately 18 km away. The semi-submersible rig was drilling in waters 114 m deep. Generally noise from MODU activities is at a similar level to noise from shipping activities, although MODUs are generating these noises when stationery.

Receptor Sensitivity

Localised sound sources, if sufficiently loud, may be detrimental to certain marine species under some circumstances and can cause physical harm or behavioural changes. The sources and effects of anthropogenic underwater sound have been reviewed by Richardson *et al* (1995). Of particular concern are the impacts of underwater sound on some species of marine mammals due to their known reliance on sound for activities such as communication and navigation. Turtles are less reliant on sound and are considered less sensitive to sound from marine activities such as seismic surveys (Weir 2007) and are unlikely to be affected by sound levels expected from the TEN Project.

West African manatees are present in Ghana almost exclusively in nearshore waters and do not occur in deep offshore waters.

Available information on marine fish, shellfish and birds indicate that they are not particularly sensitive to underwater sound. Although fish are likely to be attracted to the FPSO, MODU and support vessels while stationary, the energy and nature (generally continuous) of operational sound are unlikely to result in startle reactions to fish. Fish may be attracted by the noise of operational vessels (Røstad *et al* 2006) but are likely to avoid areas where noise levels are at a level to cause harm. Physical damage to fish is possible at high noise levels in the range 180 to 220 dB (Evan and Nice 1996) which would only exist very close (a few metres) to the source and these areas are likely to be avoided by fish.

As discussed in *Chapter 4*, although current knowledge of the distribution and ecology of marine mammals (whales and dolphins) in the Gulf of Guinea is limited, there is evidence derived from bycatches and strandings that show that the variety of marine mammals in Ghanaian waters is moderately diverse. Marine mammal observer reports (Gardline 2011b; 2012) confirmed the presence of some of these species.

Current data indicate that there are 18 species belonging to five families comprising one species of baleen whale (humpback whale) and 17 species of odontocetes (toothed whales and dolphins) that occur in Ghanaian water. Of the odontocetes, one species, the sperm whale, is categorised as vulnerable by the IUCN. Against the sensitivity criteria in *Table 7.3*, this species is considered to be of high value, due to the IUCN categorisation. Nominal species values assigned by the EIA team based on IUCN categorisation for the purposes of this impact assessment are shown in *Table 7.7*.

In addition, a number of marine mammal species were identified during the marine mammal observations (Gardline 2011b; 2012) that had not previously been identified from bycatches and strandings. These include the common dolphin, Brydes whale, sei whale and striped dolphin. Of these, the sei whale is categorised by the IUCN as Endangered and is therefore considered to have a high value while the others are classified as Least Concern or Data Deficient.

Table 7.7 Whales and Dolphins of Ghana, IUCN Conservation Status and Species Value

Species	IUCN Status	Value
Delphinidae		
Common bottlenose dolphin (*Tursiops truncatus*)	LC	Low
Clymene dolphin (*Stenella clymene)*	DD	Medium
Spinner dolphin (*Stenella longirostris*)	DD	Medium
Pantropical spotted dolphin (*Stenella attenuate)*	LC	Low
Atlantic spotted dolphin (*Stenella frontalis*) (G. Cuvier, 1829)	DD	Medium
Long-beaked common dolphin (*Delphinus capensis*)	DD	Medium
Fraser's dolphin *(Lagenodelphis hosei*)	LC	Low
Rough-toothed dolphin (*Steno bredanensis*)	LC	Low
Risso's dolphin (*Grampus griseus*)	LC	Low
Melon-headed whale (*Peponocephala electra*)	LC	Low
Pygmy killer whale (*Feresa attenuata*)	DD	Medium
Short-finned pilot whale (*Globicephala macrorhynchus*	DD	Medium
Killer whale (*Orcinus orca*)	DD	Medium
False killer whale (*Pseudorca crassidens*)	DD	Medium
Ziphiidae (beaked whales)		
Cuvier's beaked whale (*Ziphius cavirostris*)	LC	Low
Kogiidae (pygmy sperm whales)		
Dwarf sperm whale (*Kogia sima*)	DD	Medium
Physeteridae (sperm whales)		
Sperm whale (*Physeter macrocephalus* or *Physeter catodon*)	VU	High
Balaenopteridae (rorquals)		
Humpback whale (*Megaptera novaeangliae)*	LC	Medium

VU = Vulnerable; LC = Least Concern; DD = Data Deficient

Marine mammals rely on sound for echolocation, detection of predators and prey and communication within or between social groups. Auditory damage can be caused by sudden pressure changes and ranges from minor damage with temporary (minutes to days) hearing loss, to severe damage with permanent hearing loss and damage. Repeated or continual exposure to high level sound can cause shifts of hearing thresholds (*ie* hearing impairment) in some species (Richardson *et al* 1995). However, marine mammals are unlikely to intentionally approach operations producing continuous or semi-continuous sounds that are powerful enough to lead to auditory damage. At lower sound levels there may be behavioural changes such as changes to diving patterns and avoidance behaviour, particularly when the noise source is intermittent. Continued exposure often results in habituation to the sound, followed by a recommencement of normal behaviour.

McCauley (1994) suggested that auditory injury of marine mammals could occur around 220 dB and injury is expected to become more severe with an increase in sound levels. The work of Southall *et al* (2007) of the Marine Mammal Criteria Group suggests that, in order to cause instantaneous injury to marine mammals resulting in a permanent loss in hearing ability that is referred to as Permanent Threshold Shift (PTS), the sound level must exceed 230 dB re 1 micro Pascal (peak) (such as underwater sound from a seismic survey).

Southall *et al* (2007) reviews data for activities involving multiple noise pulses (*eg* seismic survey noise sources) separately from more continuous, non-pulsed, noise (*eg* vessel engine noise). The document defines broad groups of marine mammals that are expected to have similar sensitivity to noise. The groups are divided into low, medium and high frequency cetaceans.

- **Low frequency.** The low frequency cetacean hearing group includes the baleen whales (such as humpback, fin, blue and sei whale) which may exhibit subtle behavioural responses at sounds of received levels above 120 dB, significant behavioural responses at 140 to 160 dB and avoidance behaviours at levels greater than 150 to 180 dB (McCauley 1994, 2000; Malme *et al* 1985; Southall *et al* 2007). Studies on the effects of low frequency seismic sound on odontocetes (toothed whales) suggest that these marine mammals appear to have greater tolerances to high level sounds (Rankin and Evans 1998; Davis *et al* 1990; Madsen *et al* 2002).

- **Medium frequency**. The majority of species found in Ghanaian waters are in the mid-frequency cetacean hearing group (delphinidae, ziphiidae and physeteridae). The combined data for this group do not indicate a clear tendency for increasing reaction with noise level. However, studies by Madsen *et al* (2002) showed no observable reaction by sperm whales to an air gun array at noise levels of 120 to 140 dB (re 1 micro Pascal).

- **High frequency.** The high frequency cetacean hearing group includes the dwarf sperm whale and a criterion of 140 dB is suggested for behavioural responses (Southall *et al* 2007).

A conservative threshold level of 120 dB represents a level at which behavioural responses (such as avoidance) by sensitive species may occur for continuous noise sources. The sound characteristics such as amplitude, frequency and duration are also important. This sound threshold level and sensitivity to sound characteristics will differ between marine mammal species and within individuals depending on age, sex and activity (*eg* feeding, migration). In general, the sound frequencies to which a particular marine mammal is most sensitive tends to coincide with those frequencies it uses for echolocation, navigation and communication as these can be masked by anthropogenic sounds. In general, it is believed that whales will avoid areas in which significant masking occurs, or they may increase sound pressure levels of calls in order to overcome masking effects.

Mitigation Measures

The following mitigation measures will be adopted to minimise the potential for disturbing marine animals and to obtain further information on marine mammal presence in the area in an effort to reduce the potential adverse impacts of the project and future activities on marine mammals.

- TGL will enforce its policy and procedures to minimise noise disturbance to marine mammals from traffic and operations of drilling vessels, support vessels and helicopters. The policy and procedures were originally developed for Jubilee Phase 1 and will be reviewed and updated to include the TEN Project requirements. For example, vessels will not be allowed to intentionally approach marine mammals and, where practicable, will alter course or reduce speed to further limit the potential for disturbance.

- TGL will continue with its current marine mammal observation and monitoring programme at and in the vicinity of its operations to obtain additional information on marine mammal distributions in the area. The programme records incidental sightings of marine mammals from vessels operating in the Jubilee and TEN fields. The sightings data are reviewed and consolidated into a report by a third party marine biologist and submitted to the EPA on an annual basis. The data typically include the date and time of sightings, coordinates, number of animals, behaviour and species (if identified). Seismic survey vessels operating in the Jubilee and TEN fields have dedicated Marine Mammal Observers (MMOs).

Impact Assessment

None of the noise sources from the project are capable of causing instantaneous injury because the source levels are not high enough, even at very short ranges.

For the purposes of this assessment a 120 dB sound level threshold has been used as an indicative minimum where responses to disturbance such as avoidance of the area may be seen by some individuals of the sensitive species such as humpback whales. Noise levels above this level are likely from a number of project activities. As most noise sources from the offshore operations are continuous or near continuous it is considered very unlikely that marine mammals would approach the source of noise to reach a point where auditory damage could occur (*ie* more than 180 to 200 dB). The loudest noises are likely to be generated during oil offloading (due to propeller cavitation).

Based on the noise modelling results it is expected that marine mammals may exhibit avoidance reactions to the FPSO and other larger project vessels within an area of 1 to 3 km radius around the FPSO for non-diving species and 6 km radius for diving species such as sperm whale (recognising that more than one vessel may be operating in an area). However, the supply or support vessels may have a greater potential to temporarily disturb over a wider area in relation to their sound level, due to the fact they regularly move between Takoradi port and the TEN fields.

Marine mammals in the general area of drilling and production activities will already be exposed to noise from shipping activity in the area. The main east-west shipping route along the Ghana coast is approximately 8 nmi (13.5 km) south of the TEN Project area. Therefore, marine mammals occupying or passing through the area will be accustomed to a degree of anthropogenic underwater noise.

The impacts on the marine mammal species understood to occur in Ghanaian waters can be summarised as follows.

- **Balaenopteridae (rorquals).** The hearing frequency sensitivity of rorquals such as Brydes, humpback and sei whales is likely to coincide with the low frequency noise levels produced by vessel propellers and thrusters and therefore it is considered the most likely sensitive receptor to noise. The area in which behavioural changes may be anticipated is likely to be small (0.5 km radius from TEN field activities). Rorquals may tolerate low levels of continuous or nearly continuous sounds, such as those associated with this project and are expected to avoid areas where continuous or nearly continuous sounds levels may cause disturbance. Given the sound levels from project activities and the continuous nature of the sound, these whales are expected to avoid the immediate area around the TEN Project area during installation and operational activities. Brydes whales are classified as Data Deficient by the IUCN, humpback whales as Least Concern and sei whales as Endangered by the IUCN. These species are sensitive to the low frequency noises produced by the project and are likely to avoid being closer than a few kilometres from the sound sources. Given the small magnitude, the impact on behavioural response of these species is assessed to be of *Minor* significance.

- **Delphinidae, Ziphiidae (beaked whales) and Physeteridae (sperm whales).** The hearing frequency sensitivity of these whales and dolphins is not likely to coincide with the frequency range containing most of the sound energy from vessels or other operations. Sperm whales, which are classed as Vulnerable by the IUCN and dive in deep waters, are expected to avoid areas (less than 6 km radius from project activities) where sounds may cause disturbance [(1)]. Given the scale of the area affected by noise in

(1) The sound modelling (CSA 2011c) has shown that noise levels could extend further in deeper water (*ie* >1,000 m) relative to shallow water (<500 m).

an open sea location, the impacts of relatively low frequency underwater sound on these whales and dolphins is assessed as being of *Minor* significance.

- **Kogiidae (pygmy sperm whales).** The dwarf sperm whale is classified by IUNC as Data Deficient and is considered sensitive to high frequency sounds. Most noise from the project will be in the low frequency range and impacts on this species are assessed as being *not significant.*

In conclusion, the TEN Project activities are unlikely to generate sound levels which could cause auditory damage to marine mammals, even in the unlikely event that marine mammals approach the sound sources at very close proximity (*ie* within 10 m). It is likely that sound levels from some activities (for example the FPSO or other large vessels) will reach levels that could result in avoidance behaviour of some marine mammals (*ie* more than 120 dB). These sound levels are likely to be limited to less than 1 to 3 km around the project facilities for most species and up to 6 km radius for deep diving species (see *Figure 7.3*).

Offloading operations may have a higher sound level, which may extend to approximately 1 km. However, offloading operations represent temporary noise sources with a single 24 hour offloading event about every 13 days. The zone within the TEN Project area that will have noise levels over 120 db will vary depending on project activities and on the location of the MODU and support vessels but in most cases will be limited to within 6 km of the extent of the TEN Project area.

Humpback and sei whales are considered to be the most sensitive marine mammals in the area due to their hearing frequency sensitivity. Most other marine mammal species (*eg* sperm, beaked whales and dolphins) are less likely to be disturbed if exposed to noise as their hearing frequency ranges overlap less significantly with that expected to be produced by the project. Overall the residual impacts are anticipated to be of *Minor* significance taking into account the nature of the activities, the type of marine mammals present in the area, and the small size of the area where sound levels are at a level that could lead to avoidance behaviour.

7.4 *OPERATIONAL DISCHARGES*

7.4.1 *Scope of Assessment*

This section provides an assessment of the potential impacts from the operational discharges associated with the TEN Project. Operational discharges are defined here as any liquid or solid discharges to sea that may occur during the well drilling and completions, subsea installation, commissioning and operation of the project. Emissions to air and waste management are addressed in *Section 7.5* and *Section 7.7* respectively.

Impacts are assessed from routine operational discharges that are likely to continue throughout the project lifespan (20 years) and from process discharges that are mainly associated with the drilling and commissioning phases or maintenance works. Accidental events at offshore operations that could lead to discharges of crude oil or diesel into the marine environment are addressed in *Section 7.10.*

The following project vessels and installations will contribute to operational discharges.

- The MODU operating offshore during well drilling, completions or well workover activities and associated support or supply vessels.

- Installation vessels such as pipe-lay vessels, umbilical vessels and associated support and supply vessels during installation, and commissioning of the offshore project infrastructure.

- The FPSO once it is installed offshore and its support and supply vessels (*eg* tugs, crew change vessels) during operation of the project.

- Visiting export tankers.

The majority of discharges will originate from the MODU and FPSO and the main sources and volumes of these discharges are outlined in *Chapter 3: Section 3.8*. In addition, discharges from the onshore logistics bases via spillage and run-off from storage areas could affect soils and enter ground waters and surface waters.

The main receptors and resources that could be affected by offshore discharges are the receiving waters (*ie* direct impacts on water quality) and the biological resources that depend on them (*ie* secondary impacts on marine ecology). The following key types of discharges are addressed in the subsequent sections.

- Black water, grey water and food waste (from FPSO, MODU, construction and supply/ support vessels).

- Deck drainage and bilge water possibly contaminated with traces of hydrocarbons (from FPSO, MODU, supply and support vessels).

- Produced water (from FPSO).

- Water based mud and cuttings discharged to sea.

- Treated NADF drill cuttings (from MODU).

- Completion fluids and occasional discharge of workover fluids (from MODU).

- Chemically treated hydrotest waters from the subsea infrastructure during installation and commissioning.

- Hydraulic fluid from subsea valve activation.

- Occasional discharge of ballast waters (from export tankers and other vessels).

The following discharges that are not considered likely to result in significant impacts are discussed below and are not assessed further.

Produced sand. Sand from the formation may be transported with the crude oil from the wells through the flowline system and deposited in the separation process on the FPSO. The well completions include the installation of a series of downhole sand control systems (*eg* mechanical sieves) to significantly reduce the potential volume of medium and coarse sand particles produced. Finer sediments such as fine sands, silts and clay in the reservoir formation can pass through the sand control systems and will remain suspended in the oil and water streams and will be deposited in the oil cargo tanks (where it has to be manually dug out during annual FPSO shutdowns) or more likely be removed with the produced water and discharged to sea. The geological information from the wells drilled to date indicates that produced sand is not expected to be a significant issue for the TEN fields, particularly with the downhole sand control systems installed during the well completions. Any sand that is produced will form a waste that is either shipped to shore for treatment and disposal (if the residual oil content is more than 1% dry weight) or mixed with seawater and discharged to sea through the produced water system if the oil content is less than 1% dry weight. Discharged produced sand is expected to settle on the seabed in a similar way to fine drill cuttings (see *Section 7.4.7*). Impacts from the generation of small quantities of produced sand are assessed as *not significant.*

7.4.2 Assessment Methodology

The assessment of impacts from marine discharges considers the magnitude of the discharges and the sensitivity of the receiving environment. The magnitude of the discharge is defined as a combination of the volume, frequency and the composition (*ie* chemical make-up and toxicity). The sensitivity of the receiving environment includes the scale and nature of likely effects on habitats and species and the conservation importance of these habitats and species.

In deepwater offshore areas such as the TEN Project area the main environmental receptors are the waters in the vicinity of the discharges and the marine organisms that occupy these waters (*ie* plankton, larger invertebrates, fish and their predators). The sensitivity of these environmental receptors is discussed below.

- The results of the EBS (CSA 2011a) showed that waters in the TEN Project area are of good quality, as would be expected in an offshore, deepwater area. The water depth, distance offshore and hydrography provides a high level of dilution and dispersion for any discharges. Taking the existing good water quality and the dispersive nature of the open water area the overall sensitivity of the area is considered to be medium.

- In the event that significant impacts on water quality occurred, there could be secondary impacts on plankton, larger invertebrates (*eg* squid), fish and their predators such as marine mammals. Plankton have limited mobility and can be sensitive to impacts on water quality. Mobile species such as larger invertebrates, fish, turtles and mammals will be exposed to discharges but are considered less sensitive as they would be present in the areas of high discharge concentrations for limited periods.

The key mitigation measure is the control of the concentration of pollutants in discharged waters, and thereby allowing natural dispersion and dilution in the open water areas to reduce the concentration to harmless levels beyond the point of discharge. Dispersion modelling was undertaken for produced water and drill cuttings discharges assuming a concentration of hydrocarbon of 40 mgl^{-1} at source (see *Section 7.4.10* below and *Volume II: Annex D*). Although not specifically modelled, the discharges of effluents with lower oil in water concentrations and in smaller quantities will be dispersed within shorter distances from the discharge point than the modelled discharges.

7.4.3 Ballast Water

Description of Potential Impacts

As part of the operations of the FPSO, MODU, supply/support and installation vessels and export tankers, sea water will be pumped into designated ballast tanks and released to sea as required in order to maintain the respective vessel at its proper flotation/trim level. This water is known as ballast water and if not managed appropriately can have a potential impact on the marine environment. The main potential impacts associated with ballast water include:

- discharge of ballast water that contains oil or other potential polluting chemicals; and
- the possibility that invasive foreign marine species and pathogens may be introduced into Ghanaian waters that can adversely affect native marine biodiversity.

Mitigation Measures

TGL will implement the following mitigation measures in relation to ballast water management.

- The FPSO will be designed with segregated ballast tanks from other process systems. The primary means of maintaining an even keel, stability and trim on the FPSO will be through management of the distribution of crude oil within the storage tanks, therefore the requirement for ballast water intake and discharge will be minimal.

- Visiting export tankers and other vessels discharging ballast water will be required to undertake ballast water management measures in accordance with the requirements of the *International Convention for the Control and Management of Ships Ballast Water & Sediments*. This includes requirements for a ballast water management plan on each vessel and ballast water exchange at least 200 nmi from the nearest land and in water at least 200 m deep to minimise the transfer of organisms. Exceptionally, discharges are permitted 50 nmi from land in water depths of less than 200 m. The tanker vetting procedures will include demonstration of compliance with ballast water management requirements.

Impact Assessment

The FPSO and supply/support and installation vessels will exchange ballast in the high seas before they enter Ghanaian waters and will thereafter be operational in Ghanaian waters which will remove the risk of introducing foreign marine species.

The export tankers that will arrive at the TEN fields approximately every 13 days for cargo transfer will have come from different parts of the world and could potentially introduce invasive species if ballast taken onboard elsewhere in the world is discharged into Ghanaian waters during cargo transfer. Export tankers will be required to exchange ballast water beyond 200 nmi as per the *International Convention for the Control and Management of Ships Ballast Water & Sediments*, before entering the Ghanaian EEZ which will remove the risk of introducing foreign marine species from export tankers.

The discharge of invasive foreign marine species into deep water at the location of the TEN Project (1,000 to 2,000 m) and 60 km offshore is unlikely to have a significant impact on existing species or habitats as it is mainly a concern when ballast waters are discharged in coastal or enclosed water bodies and harbours.

The project vessels and FPSO are unlikely to release contaminated ballast water to sea as the vessels are or will be designed such that ballast water does not come into contact with oily or other contaminated areas and does not therefore require treatment before discharge to the marine environment.

With ballast water management plans in place the risk of introduction of alien species through ballast water discharge is likely to be negligible. In the event that ballast water was exchanged in the TEN Project area, potential impacts are assessed as *not significant* given the distance from shore and water depths in the TEN Project area.

7.4.4 *Black Water, Grey Water and Food Waste*

Description of Potential Impacts

Discharges from the TEN Project will include liquid and solid wastes from the FPSO living quarters and similar wastes from the other marine vessels operating as part of the project *eg* the MODU, installation vessels and support or supply vessels. These will include the following.

- Black water (treated sewage) will be discharged from the MODU (including installation and support vessels) during the well drilling and completion, and installation phases and from the FPSO (including support vessels and export tankers) during the operational phase. During well drilling and completions, and installations when the maximum number of personnel will be working offshore, the average rate will be approximately 59 m^3 per day and during the operation phase the average rates will be approximately 27 m^3 per day.

- Grey water (domestic wastewater) will be discharged from the MODU, (including installation and support vessels) during the well drilling and completion and installation phases at an average rate of 138 m^3 per day and from the FPSO (including support vessels and export tankers) during the operational phase at an average rate of 64 m^3 per day.

- The predicted volumes of macerated food waste from the FPSO and MODU will amount to approximately 96 tonnes per year. The volumes discharged from support / supply vessels and possibly installation vessels will be much smaller as the crew numbers are much less (approximately 10 tonnes per year).

Mitigation Measures

The discharge of black water and food waste from the FPSO, MODU, installation/construction vessels and support and supply vessels will be carried out in accordance with the following MARPOL 73/78 Annex IV and Annex V requirements and good industry practice.

- Black water will be treated prior to discharge to sea. Approved sanitation units onboard will achieve discharge standards of no floating solids, no discolouration of surrounding water and a residual chlorine content of less than 1 mgl^{-1}. There will be no discharges from vessels within 12 nmi of the nearest land.

- Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged more than 12 nmi from land with no floating solids or foam.

- Residual concentrations of hypochlorite in discharge waters will be set at 1 mgl^{-1}.

Impact Assessment

The discharge of organic food waste and raw sewage to sea can create a health hazard while it remains in coastal areas. Organic material and sewage can also lead to oxygen depletion and visual pollution. However, only the support/supply vessels are likely to be operating regularly in coastal waters. With regard to the FPSO and MODU, the discharge of sewage, domestic wastewater and macerated food wastes will cause a localised increase in the Biological Oxygen Demand (BOD) in the receiving surface waters.

The discharge of these waste streams will introduce relatively small amounts of nutrients and organic material to well-mixed, well-oxygenated surface ocean waters resulting in a minor contribution to local marine productivity and possibly attracting some opportunist feeders. The sewage and domestic wastewater discharge may contain a low level of residual chlorine from the sewage treatment facility on the FPSO or MODU, but this will not be significant taking into account the relatively low total discharge.

Impacts from discharges of sewage, grey water and food waste to the marine environment are assessed to be of *Minor* significance given the medium sensitivity of the receiving waters, relatively small discharge volumes and high dilution factor in the offshore marine environment.

7.4.5 Completion and Workover Fluids

Description of Potential Impacts

Completion and well workover fluids will include weighted brines or acids, methanol and glycols and other chemical systems. As described in *Chapter 3*, these fluids are used to clean the wellbore and stimulate the flow of hydrocarbons, or to maintain downhole pressure. Once used these fluids may contain contaminants including solid material, oil and chemical additives.

The completion of the TEN wells will be undertaken in batches. Each completion operation will be a one-off activity and the average time required to complete each of the wells will be approximately 30 days. The TEN wells have been designed for a 20 year lifetime with no planned interventions. Unplanned interventions or workovers may be occasionally required, however, this is not expected to be more than once a year across the whole field, with each operation expected to take no more than 30 days.

Most of the chemicals used during completion and workovers will be re-used, remain downhole or will be injected into the formation. Some completion chemicals such as upper completion chemicals and flowback fluid chemical will be flared off after use. Other completion fluids, such as wellbore clean-up fluids, will be discharged overboard. These will include:

- Completion Brine (calcium chloride), 845 tonnes per well;
- Diatomaceous Earth Filter Aid (*eg* Celite 545), 5.3 tonnes per well;
- Surfactant (*eg* Tetraclean-105), 5.9 tonnes per well; and
- Surfactant Booster (*eg* Tetraclean-106), 3.3 tonnes per well.

The displacement of drilling fluid out of a well with brine or seawater and subsequent cleaning of the casing in a well can generate large volumes of fluid with low levels of oil contamination. These fluids will be treated to remove free oil and then discharged to sea subject to successful passing of sheen tests as a minimum. It is not possible to use the standard in-line monitoring or offshore laboratory tests used for produced water discharges to measure the oil in water concentration of these fluids due to the presence of the surfactants therefore the common industry practice is to use the US EPA Static Sheen Test to determine the presence of free oil.

Mitigation Measures

TGL will implement the following mitigation measures to reduce the potential impacts associated with the disposal of used completion and workover fluids.

- TGL will manage the selection and use of each chemical taking into account its concentration, toxicity, bioavailability and bioaccumulation potential, with selection based on the least environmental potential hazard.

- Where possible, used fluids will be injected into the formation, flared, or collected in a closed system and shipped to shore for recycling or treatment and disposal.

- TGL will only discharge completion and wellbore clean-up fluids to sea after treatment to remove free oil (tested using the US EPA Static Sheen Test).

- TGL will return to the MODU any acidic completion and workover fluids that are used where well fluids will be neutralised by mixing in soda ash, or similar, to attain a pH of 5 to 7 before disposal to sea.

Impact Assessment

The chemicals to be used will be essentially non-toxic to the marine environment according to the Offshore Chemical Notification Scheme (OCNS

Category E – PLONOR [(1)]/CHARM [(2)] Gold), meaning that these chemicals are of low toxicity, readily biodegradable and are non-bioaccumulative. Impacts to water quality and subsequent impacts to marine organisms are assessed as being of *Minor* significance given the low toxicity and low quantity of the discharges, the area affected, rapid dilution in receiving waters and the duration of the impacts.

7.4.6 *Deck Drainage and Bilge Water*

Description of Potential Impacts

Water that accumulates in the drains and bilges of the FPSO, MODU and other support vessels is likely to become contaminated with low levels of hydrocarbons and other chemicals. Unmanaged discharge of this water to the sea represents a potential impact on local water quality and marine organisms.

Mitigation Measures

Although the volumes of discharges from the drains and bilges of the FPSO and other vessels are not expected to be significant, there are a number of mitigation measures outlined below that will be implemented to reduce the impact on water quality and marine organisms.

- The FPSO and MODU deck and drainage system will include coamings [(3)] around the main decks to contain leaks, spills and contaminated wash-down water to minimise the potential for uncontrolled overboard release. The open drain system will collect oily rainwater drainage from drip pans and drain boxes throughout the topsides, rainwater on FPSO decks, and deluge water from the modules. A closed drain system will collect hazardous fluids from process equipment in hydrocarbon service. If the deck becomes contaminated, oily deck drainage will be contained by absorbents or collected by a pollution pan for recycling and/or disposal.

- The FPSO, MODU and marine vessels will treat oily water (*eg* from open and closed drain systems, bilges and slop tank water) in accordance with the MARPOL Annex I requirements (15 parts per million (ppm) oil and grease as a maximum limit) and discharge to sea.

- Oil discharge monitors are used to prevent oil in water content targets being exceeded. Records will be maintained of all discharges and oil content to verify controls in place are working effectively.

(1) Graded by OSPAR as a chemical that Poses Little of No Risk to the Environment (PLONAR) and is permitted for discharge to sea in the OSPAR countries.
(2) The Chemical Hazard and Risk Management (CHARM) model used in the UK Offshore Chemical Notification Scheme (OCNS) to manage chemical use.
(3) A coaming is any vertical surface on a ship designed to deflect or prevent entry of water. In this context it refers to metal deck plating preventing deck draining to run off into the marine environment.

Impact Assessment

The total volumes of drainage water produced by the FPSO, MODU and support vessels as part of the TEN Project will, to a degree, be dependent upon weather conditions (*ie* rainfall) and deck cleaning and other activities that create run-off. The most significant discharges are likely to be from the FPSO and MODU, because of the nature of activities being carried out and their greater surface areas, rather than from the support vessels. Discharges from the FPSO are estimated at approximately 113 m^3 per day.

The volumes to be discharged constitute relatively small scale inputs into deepwater offshore with good capacity for dilution and dispersion. Based on dilution factors derived from the produced water modelling (see *Section 7.4.10*), discharges with a hydrocarbon concentration of approximately 15 mgl^{-1} at source will rapidly dilute to a an ambient seawater concentration of 0.015 mgl^{-1} within 100 to 200 m from the source. This will mean that only localised and temporary effects on water quality around the point of discharge will occur. With the suitable drainage and treatment systems described above, the residual impacts on water quality and marine organisms associated with discharge of drainage water will likely be of *Minor* significance.

7.4.7 Drill Cuttings and Fluid

Impacts from cuttings discharge on the marine environment are assessed in this section. To quantify the magnitude of these potential impacts cuttings dispersion modelling studies were undertaken by RPS-ASA (see *Annex D*).

Disposal Options and BPEO Study

The generation of drill cuttings is an unavoidable result of drilling, and generates a waste stream which can be managed in a number of ways. For drill cuttings generated from offshore wells there are three main disposal options, namely:

- ship to shore for onshore treatment and disposal;
- cuttings reinjection into existing or new wells; and
- offshore discharge after treatment.

It is recognised that different approaches to treatment and disposal of drilling cuttings are applied in different countries and that there is no standard practice. In particular, different approaches are taken by some countries for shallow water near shore fields and deeper water offshore fields. In most countries that do not have developed onshore treatment facilities, cuttings are discharged to sea.

TGL commissioned a drilling cuttings BPEO study to assess the various treatment and disposal options (Aquatera 2012). The study considered the environmental sensitivity of the field location, available technical options in-country, energy use, emissions, cost and health and safety considerations. The study assessed and determined the BPEO for drill cuttings management for the TEN Project. A copy of the report is attached in *Volume II: Annex F*. From the evaluation of treatment options undertaken, the study recommends offshore treatment and discharge using Thermal Desorption Technology.

TGL is planning to use the more recently developed Thermal Desorption Unit (TDU) on its MODU to reduce oil on cuttings further prior to overboard discharge. These are proposed for the main drilling campaign and where it is practical and economical to do so. For drilling campaigns that involve a small number of wells (for example the two proposed wells to be drilled in early 2014) this will not be possible given the available MODU therefore cuttings will be treated using the traditional solids control methods prior to being discharged overboard. This assessment will present the impacts from both the conventional and TDU solids control methods.

Dispersion Modelling

Drilling discharges simulations were completed using RPS-ASA's MUDMAP modelling system. MUDMAP is a numerical model developed by RPS-ASA to predict the near and far field transport, dispersion, and bottom deposition of drilling mud and cuttings. The modelling reports for the conventional and TDU solids control are provided in *Volume II: Annex D1* and *Volume II: Annex D2*, respectively. In each report, dispersion modelling was completed for nominal well sites in the northern and southern parts of the development area representative of varying water depths.

An analysis of the HYCOM(1) currents dataset close to each of the nominal well sites was undertaken to evaluate the range of potential current conditions (see *Chapter 4: Section 4.5.4*). Based on the analysis of current data, the months of April and December were chosen to represent distinct seasonal periods that could result in differences in the trajectory of discharges released from the well sites, particularly from discharges are the sea surface. In April, currents are relatively strong and most commonly oriented to the east, while in December currents are more variable in direction and typically weaker throughout the water column.

Conventional Solids Control

A total of four scenarios were simulated cuttings and fluids discharge using conventional solids control, corresponding to the two well sites for the two seasonal conditions (*Table 7.8*). For each of the four scenarios, vertically and time varied currents derived from the HYCOM currents dataset were used to simulate the movement of the discharged solids.

(1) A multi-institutional consortium sponsored by the National Ocean Partnership Program, as part of the US Global Ocean Data Assimilation Experiment (GODAE), to develop and evaluate a data-assimilative hybrid isopycnal-sigma- pressure (generalised) coordinate ocean model (called HYbrid Coordinate Ocean Model or HYCOM). See http://hycom.org/

Table 7.8 Drill Cutting Modelling Scenarios

Scenario	Location	Water Depth (m)	Season
1	EN-7	995	April
2	EN-7	995	December
3	EN-22	1,851	April
4	EN-22	1,851	December

The mud programme that was modelled consisted of four well sections using a combination of both WBM and NADF. *Table 7.9* provides specifications of the TEN well drilling programme that was modelled.

Table 7.9 Specifications for the Drill Cutting Scenarios

Drill Section	Cuttings Volume (m^3)	Drilling Fluid Volume (m^3)	Drilling Fluid Type	Duration (days)	Release Depth
36"	55	190	WBM	0.5	5 m above seabed
26"	245	1,200	WBM	1.3	5 m above seabed
16"	97	3% of cuttings [~5.8 m^3]	NADF	1.1	15 m below surface
12 ¼"	87	3% of cuttings [~5.2 m^3]	NADF	5.5	15 m below surface
Total	**484**				

Results of the drilling fluid and drill cuttings simulations were presented in terms of maximum predicted water column concentrations, predicted seabed deposition thickness and hydrocarbon concentration on seabed.

Sediment Plume

The modelling study showed that water column concentrations are primarily due to drilling fluid solids, since these particles have lower settling velocities and remain suspended in the water column for longer periods of time. In contrast, discharged cuttings settle to the seabed very quickly. Water column concentrations of discharged material are a function of the discharge amount and ambient current strength/direction.

Concentrations of Total Suspended Solids (TSS) exceeding background levels are known to decline quickly with increasing distance from the discharge site due to dilution of the plume and rapid settling of larger particles. For this reason, relatively high concentrations are expected in the immediate vicinity of the well site with a sharp reduction at increasing distance away from the release location.

Table 7.10 summarises the maximum distance of observed excess water column TSS concentrations for 10 mgl^{-1} and 100 mgl^{-1} for each of the four scenarios. The results represent the maximum concentrations predicted during the discharges of all four well sections for each discharge scenario.

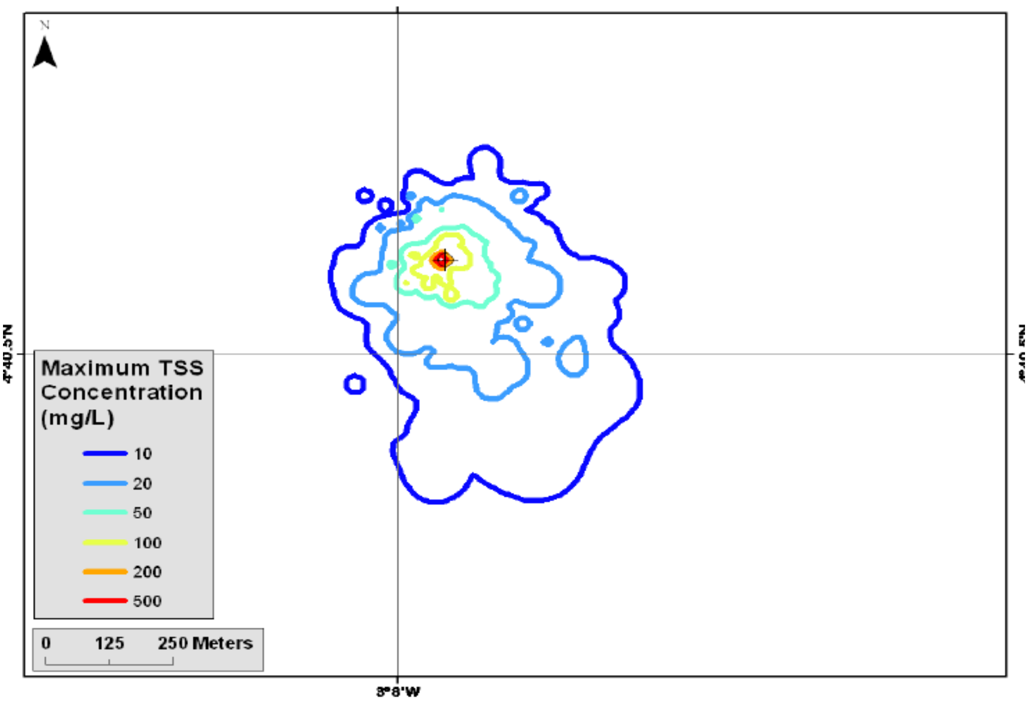
Table 7.10 ***Maximum Distance of Maximum Predicted Water Column Concentrations***

TSS Concentration (mgl^{-1})	Maximum Extent from Discharge Point (m)			
	EN-07		EN-22	
	April	December	April	December
10	560	470	600	470
100	95	85	70	90

Drilling discharges at the sea surface from the bottom well sections (16 and 12 ¼ inch) primarily contribute to elevated TSS concentrations relative to top well sections (26 and 36 inch) with discharges at the seabed. Elevated concentrations are typically observed to extend further from the source in April relative to December, due to typically stronger currents in April.

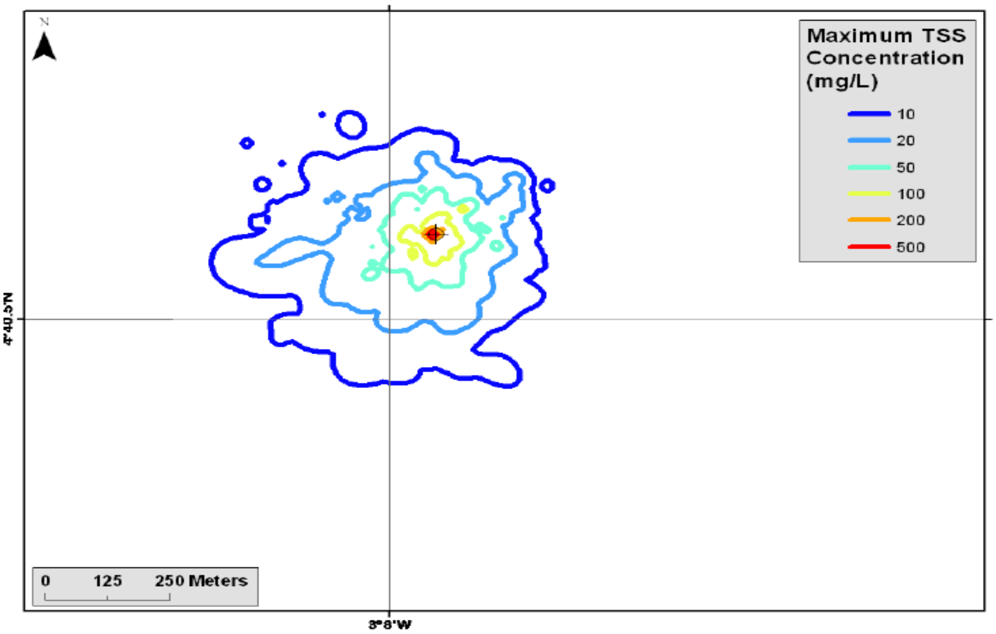
Figure 7.4 and *Figure 7.5* show the maximum TSS concentrations for the entire drilling programme (cumulative from four well sections) for EN-7 in April and December. Plots for EN-22 are available in *Volume II: Annex D1.*

Figure 7.4 ***Drilling Discharges Maximum Predicted TSS Concentrations at EN-7 in April***



Source: RPS-ASA 2013

Figure 7.5 *Drilling Discharges Maximum Predicted TSS Concentrations at EN-7 in December*



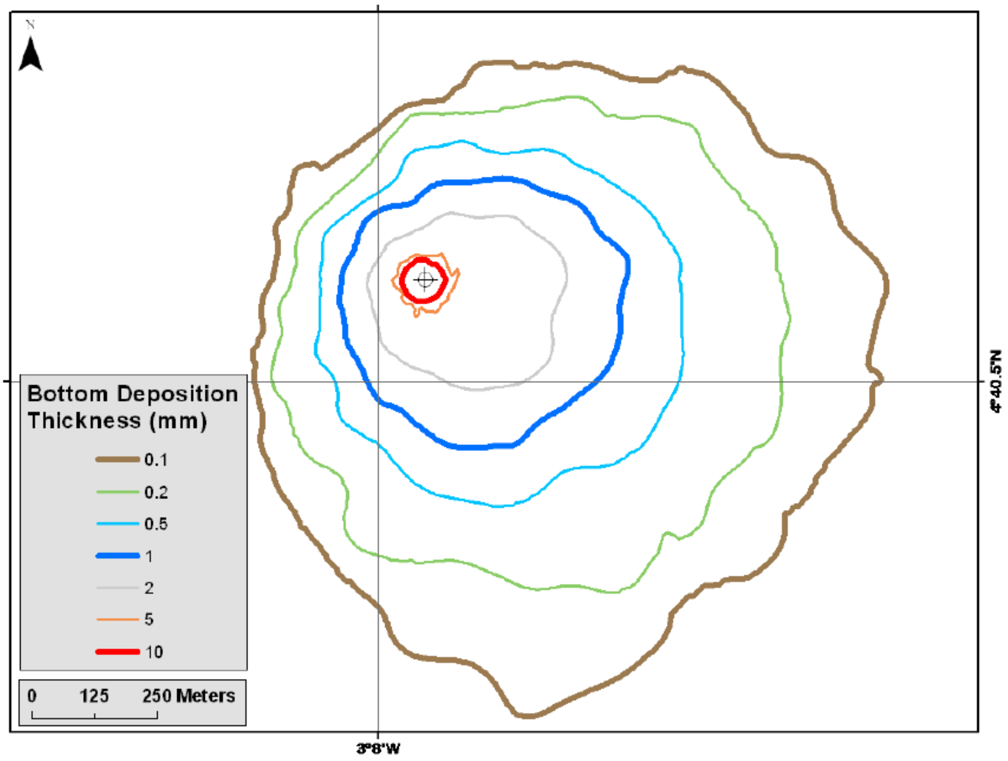
Source: RPS-ASA 2013

Seabed Footprint

When drilling in deep water (more than 500 m), which is the case for both EN-7 and EN-22 locations, discharges from near the water surface make only a very small contribution to the thickness of the layer of cuttings that form at the seafloor (footprint). Due to dispersion of particles through the water column, drilling discharges will settle on the seabed in a thin layer (typically less than 1 mm) over a larger area. The top two well sections, with material released near the seabed, will result in significantly more deposition near the well site than the material released near the surface.

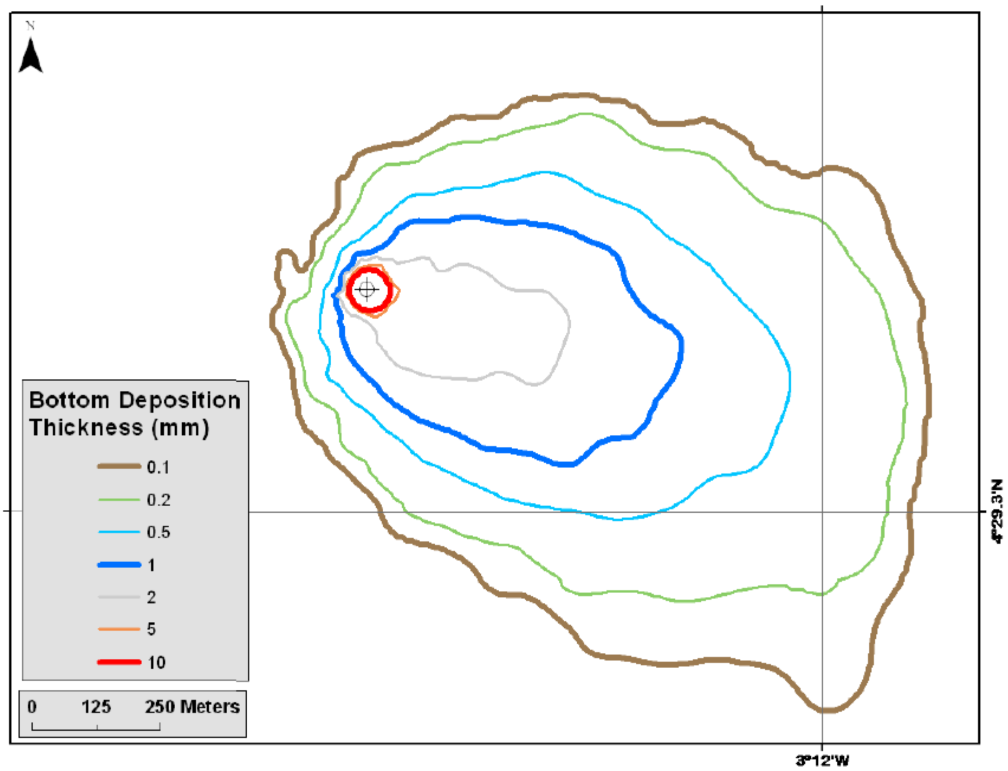
Figure 7.6 and *Figure 7.7* present model-predicted deposition patterns from drilling discharges released from all well sections for simulation runs at EN-7 and EN-22 respectively. These deposition patterns are for simulation runs with the April environmental conditions.

Figure 7.6 Drilling Discharges Predicted Deposition Plot: EN-07 in April



Source: RPS-ASA 2013

Figure 7.7 Drilling Discharges Predicted Deposition Plot: EN-22 in April



Source: RPS-ASA 2013

Table 7.11 presents the extent of model-predicted deposition footprints classified by thickness for each of the scenarios.

The extent and pattern of deposition vary depending on the site (*ie* water depth) and period of discharges (*ie* environmental conditions in April/December). The following are key observations of the modelling results.

- During April, the cumulative footprint of discharges extends farther from the well sites, likely due to stronger currents speeds.
- Discharges at EN-7 tend to cover a larger cumulative area than the equivalent run for EN-22, primarily owing to the difference in depth and variability in currents between the two sites.

Depositions greater than 10 mm will be limited to 50 m from the well sites, in all directions, for all scenarios. For location EN-22, deposition footprints of 1 mm and 0.1 mm may extend up to 620 m and 1,220 m from the well site, respectively, with stronger currents during April.

Table 7.11 Predicted Extent of Deposited Material Classified by Thickness

Deposition Thickness (mm)	Cumulative Area (km^2)			
	EN-7		EN-22	
	April	December	April	December
0.1	1.179	0.999	1.070	0.998
0.2	0.782	0.695	0.824	0.734
0.5	0.414	0.418	0.434	0.409
1	0.236	0.241	0.228	0.229
2	0.108	0.113	0.076	0.103
5	0.010	0.014	0.007	0.011
10	0.005	0.006	0.005	0.006
20	0.004	0.004	0.003	0.004
50	0.002	0.002	0.002	0.002

<u>Seabed Hydrocarbon Concentrations</u>

For the purposes of the assessment, it was assumed that cuttings from the bottom well section will contain up to 3% (by weight) NADF that will adhere to cuttings after passing through standard solid control equipment on the MODU. Cuttings and entrained NADF, containing some hydrocarbons, will be discharged overboard. The MUDMAP model was used to predict accumulated hydrocarbon concentrations at the seabed assuming that NADF remained adhered to the discharged cuttings[(1)]. *Table 7.12* summarises the extent of the seabed that could be impacted by hydrocarbons.

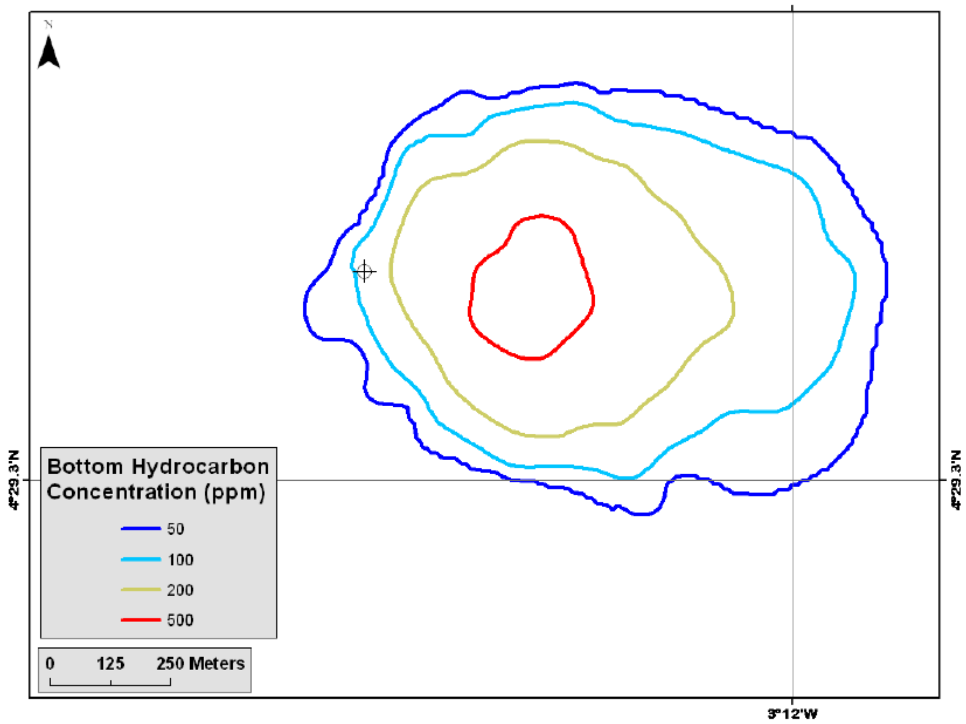
(1) It should be noted that these model predictions provide a conservative (worst case) estimate because it is assumed that the NADF remains adhered to the cuttings particles in the descent through the water column without any dissolution.

Figure 7.8 shows the model-predicted maximum hydrocarbon concentration contours for NADF concentrations at location EN-7 in December, representing a worst case scenario. The seafloor areas with hydrocarbon concentrations above 500 ppm extend in all directions around the well sites and, in some scenarios, may extend over 1 km laterally from the well site. It is predicted that concentrations in excess of 50 ppm could be present up to 475 m from the well site.

Table 7.12 Predicted Extent of Deposited Material Classified by Hydrocarbon Concentration

Hydrocarbon Concentration (ppm)	Cumulative Area (km^2)			
	EN-7		EN-22	
	April	December	April	December
50	0.750	0.656	0.788	0.773
100	0.518	0.583	0.577	0.556
200	0.314	0.312	0.301	0.334
500	0.132	0.141	0.054	0.094

Figure 7.8 Drilling Discharges Predicted Sediment Hydrocarbon Concentrations from NADF Well Sections at EN-22 in April



Source: RPS-ASA 2013

TDU Solids Control

A total of four scenarios were simulated for cuttings and fluid discharge using a TDU, corresponding to the two well sites for the two seasonal conditions (*Table 7.13*). The TDU modelling used an updated HYCOM dataset.

Table 7.13 Drill Cutting Modelling Scenarios

Scenario	Location	Water Depth (m)	Season
1	EN-07	1,330	April
2	EN-07	1,330	December
3	EN-13	1,990	April
4	EN-13	1,990	December

The mud programme that was modelled consisted of four well sections using a combination of both WBM and NADF. *Table 7.14* provides specifications of the TEN well drilling programme that was modelled.

Table 7.14 Specifications for the Drill Cutting Scenarios

Section	Duration (days)	Cuttings Release Rate (MT/hr)	Mud Release Rate (m^3/hr)	Mud Type	Release Depth
36″	0.5	11.46	15.83	WBM	5 m above seabed
26″	1.5	17.01	33.33	WBM	5 m above seabed
16″	6	4.8	-	LTOBM	15 m below surface
12 ¼″	7	1.2	-	LTOBM	15 m below surface
Total Discharges		**1,642.68 MT**	**1,389.84 m^3**		

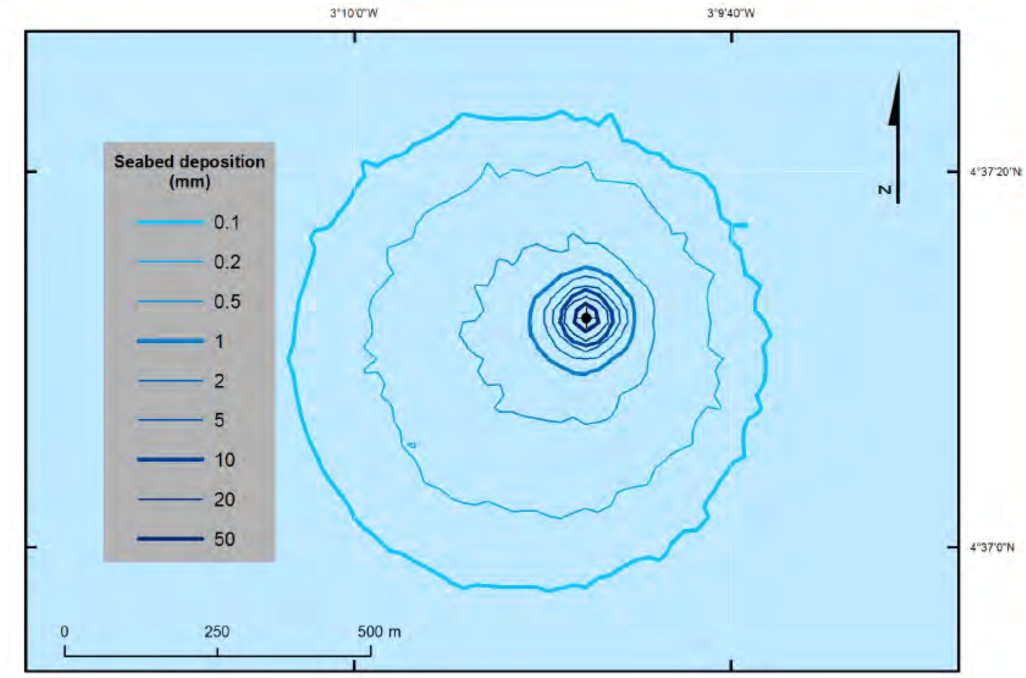
Results of the drilling fluid and drill cuttings simulations were presented in terms of predicted seabed deposition thickness and maximum predicted water column concentrations.

Seabed Footprint

The fine particle sizes produced by the TDU remained suspended in the upper water column until eventually dispersing below detectible levels and as a consequence the surface releases do not contribute significantly to the cumulative mass on the seabed. By contrast, the cuttings discharged directly at the seabed settle relatively quickly owing to the release depth, the size distribution and the relatively weak currents near the seabed. Seabed releases of WBM are transported farther from the discharge site by the prevailing currents resulting in the broad, thin deposition layers.

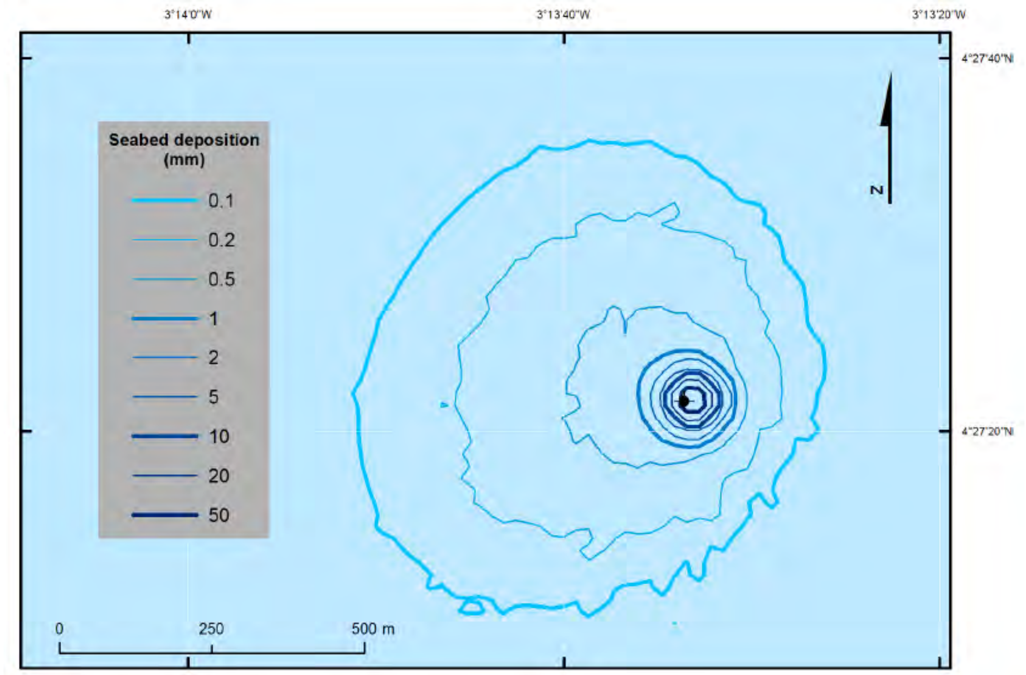
Figure 7.9 and *Figure 7.10* present model-predicted deposition patterns from TDU discharges released from all well sections for simulation runs at EN-07 and EN-13 respectively. These deposition patterns are for simulation runs with the April environmental conditions. *Table 7.15* presents the extent of model-predicted deposition footprints classified by thickness for each of the scenarios.

Figure 7.9 Drilling Discharges Predicted Deposition Plot: EN-07 in April



Source: RPS-ASA 2014

Figure 7.10 Drilling Discharges Predicted Deposition Plot: EN-13 in April



Source: RPS-ASA 2014

The results show that the extent and pattern of deposition are similar between the two well sites and for the two seasons. All scenarios predict a generally rounded and tight depositional footprint surrounding the well site. Contours representing a very fine footprint are slightly more elongate and extend up to

620 m from the release location. The similarities between the scenarios are due to the very weak bottom currents present at both well sites and the lack of any contribution to bottom deposition from the surface following TDU treatment.

Table 7.15 Predicted Extent of Deposited Material Classified by Thickness

Deposition Thickness (mm)	Cumulative Area (km^2)			
	EN-07		EN-13	
	April	December	April	December
0.1	0.471	0.44705	0.44665	0.44985
0.2	0.25426	0.23311	0.22233	0.22632
0.5	0.07185	0.05987	0.05907	0.05628
1	0.02195	0.01876	0.01876	0.01796
2	0.01317	0.01197	0.01277	0.01237
5	0.00758	0.00798	0.00838	0.00718
10	0.00599	0.00519	0.00479	0.00519
20	0.00319	0.00399	0.00479	0.00439
50	0.0012	0.0016	0.0016	0.0016
100	–	0.44705	–	–

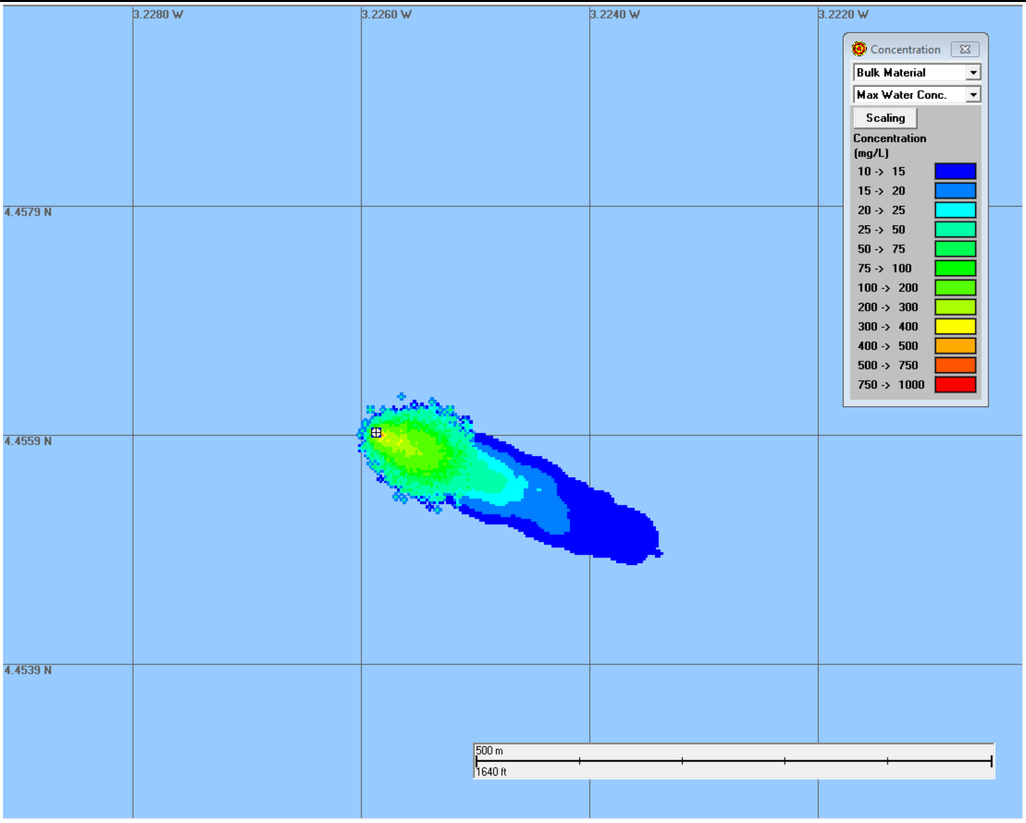
Sediment Plume

A significant portion of the powder discharged from the TDU is expected to remain suspended in the water column. Drilling is expected to occur throughout the year so eight representative scenarios were modelled to evaluate the range and trajectory of sediment plumes resulting due to the variability in seasons (April and December), currents (maximum and minimum) and well sites (EN-13 and EN-07).

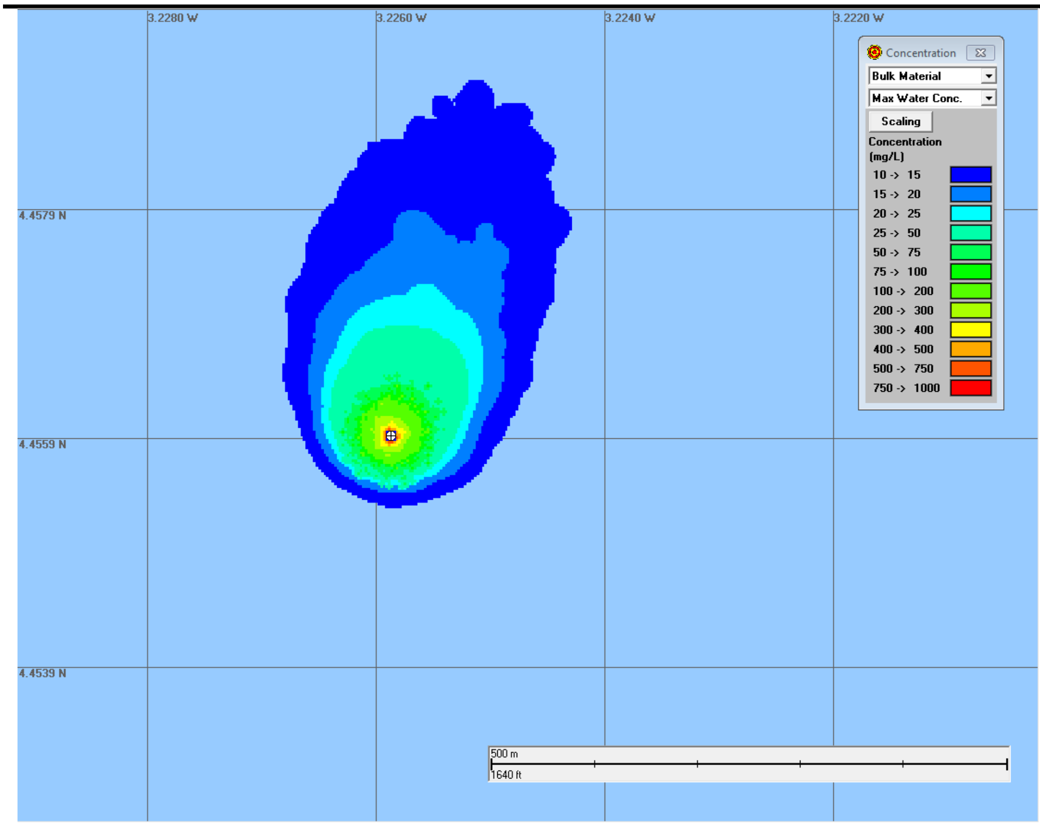
For each scenario the TDU discharge was simulated for four hours, allowing the water column to achieve a steady state of TSS. The transport and dispersion of the plume was then tracked until its maximum concentration is less than 10 mgl^{-1}. This conservative threshold was selected based on the minimum concentration of suspended solids recorded in the Jubilee field; 11.22 mgl^{-1} (TDI Brooks 2008).

Figure 7.11 presents the modelled TSS values for scenarios 1 and 2 as representative for all scenarios. The values presented do not represent any instantaneous snapshot of water column concentrations, instead showing the maximum, time-integrated TSS within the study domain for each modelled release. The maximum predicted concentration of suspended sediments in the water column ranges from a maximum of 896 mgl^{-1} for EN-07 during December (Scenario 8) to 467 mgl^{-1} for EN-13 during April (Scenario 1). Due to the small particle sizes resulting from the TDU treatment process and the relatively strong current speeds at the surface, most of the suspended sediment remains within the uppermost 30 m of the water column until dispersing below the 10 mgl^{-1} threshold.

Figure 7.11 Maximum Suspended Solid Concentrations (mgl-1)



Scenario 1: EN-13 during April 2012 – Maximum Current



Scenario 2: EN-13 during April 2012 – Minimum Current

Source: RPS-ASA 2014

Table 7.16 presents the maximum distance of observed excess water column concentrations for each of the eight scenarios. The trends observed in the model-predicted TSS plume are similar to those of the seabed deposition simulations, namely that the plume trajectory varies as a result of the flow regime occurring on the day of the release. In general, the extent of the plumes is greater during strong current conditions, while the maximum TSS concentrations increase during weak current conditions and persist for longer in the water column.

Table 7.16 Maximum Distance of Excess TSS concentrations for Discharge Scenarios

Water column concentration (mgl^{-1})	**Distance from Discharge Point (m)**							
	EN-13				**EN-07**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
10	302	355	312	230	325	360	309	340
50	99	62	78	55	88	59	72	57
100	75	41	59	37	62	42	45	41
500	-	8	6	8	-	7	7	8

Description of Potential Impacts

As described in *Chapter 3: Section 3.4.5*, a total of 24 wells are required for the mid case development. Seven of these wells have been drilled and 17 new wells are planned to be drilled. Discharges of drill cuttings to the environment have the potential to impact the water column and seabed.

The extent of the impact will to varying degrees be predominantly dependent on the following.

- Point of discharge, *eg* discharge at the sea surface or release on the seabed, and the volume and rate of discharge.
- The physical and chemical properties of the cuttings and base fluids (*eg* water based or oil based), which may include particle size distribution and particle cohesion, and its chemical characteristics.
- The extent of mixing and dispersion, which can be influenced by the currents present and the water depth in which the cuttings pass; and the presence and sensitivity of pelagic, demersal and benthic communities.

The impacts to marine organisms (which assume the stated discharges and releases) will arise from the following two types of cuttings and mode of discharge.

- Cuttings generated from the top sections drilled with WBM, which are released at the seabed from the well.
- Cuttings generated from the lower well sections will be drilled with NADF, which are treated to reduce the retention of oil on cuttings and

discharged at approximately 15 m below the sea surface from the MODU. The wells drilled in early 2014 will use conventional solids control, whereas the main drilling campaign will use a TDU.

Mitigation Measures

The following mitigation measures to minimise the impact of drill cuttings and fluid discharge on the marine environment will be adopted.

- Solid control systems will be used, including dryers, to reduce oil on cuttings to a target which meets the EPA (2010) discharge compliance limit. TGL will use a TDU for the main drilling campaign.

- Measures will be taken to comply with project effluent guidelines, including use of low toxicity (Group III) NADF, no free oil, and limits on mercury and cadmium concentrations.

Receptor Sensitivity

The effects of the disposal of drill cuttings are well documented from previous studies and the impacts from drill cuttings discharges depend largely on the quantity and nature of the discharged material, the area affected and the sensitivity of the receiving environment (*eg* the habitat/species potentially affected).

The following baseline studies have been undertaken in the TEN Project area that provides information on the nature of the receiving environment.

- **Seabed Topography.** Geotechnical and geophysical surveys by Gardline (2011a) showed that the seabed is generally flat and featureless around the areas where wells are planned. At a larger scale there are seabed features such as three seabed canyons (see *Chapter 4 Figure 4.17*).

- **Benthic Habitats and Species.** CSA conducted an EBS of the TEN Project area and along a proposed future pipeline route in March 2011 (CSA 2011a). The EBS included seafloor sediment sampling at 15 sampling stations and seafloor plan-view imagery. No sensitive habitats or threatened or endangered species were identified during the course of the TEN EBS. Polychaetes and crustaceans were numerically dominant in both the TEN Project area and the pipeline route. Within the TEN Project area, the benthic environment and fauna are relatively homogeneous with little variation from station to station. The variation that did exist seemed to be related to differences in sediment Total Organic Carbon concentrations, sediment particle size and water depth.

The conservation evaluation criteria presented in *Section 7.7.2* have been applied to the known benthic habitats and seabed conditions in the TEN Project area. The habitat has been assessed as relatively low value given the generally featureless benthic habitat and homogeneous benthic fauna.

Impact Assessment

Impacts on the water column and seabed are assessed below.

Biological Impacts to the Water Column

For the wells drilled for first oil using conventional solids control, cuttings discharged at the surface will pass down through the water column (*ie* water depths of between 1,000 to 2,000 m) and gradually be dispersed before settling on the seabed. During this time, marine life, such as pelagic fish, may become exposed to suspended solids (*eg* fine particles that may interfere with respiration) or toxic substances (such as certain metals or organic compounds) associated with the suspended solids or dissolved in the surrounding water. An oxygen demand may also be exerted on the water. However, these impacts on the water quality are unlikely to represent a concern as NADF cuttings from conventional solids control do not disperse readily in seawater and tend to settle rapidly through the water column and onto the seabed.

For the longer drilling campaigns after first oil a TDU may be used where it is economically viable to use this technology. The TDU will discharge a much finer particle size which is expected to remain mostly in the upper 30 m of the water column until dispersing below ambient concentrations. The finer particle size and greater persistence in the water column but will have lower concentration of NADF (predicted to be less than 1%) and therefore less potentially harmful substances dissolving into the surrounding water. In addition, most pelagic species are sufficiently mobile to avoid being exposed periods of time that could potentially be harmful.

For conventional solids control the discharge plume with a TSS concentration greater than 100 mgl^{-1} will be limited to 70 to 95 m from the well site under environmental conditions in April and 85 to 90 m in December. TSS concentrations up to 10 mgl^{-1} are predicted to extend up to 560 and 600 m in April and 470 m in December. For the TDU discharge the plume with a TSS concentration greater than 100 mgl^{-1} will be limited to within 41 to 75 m for all the modelled scenarios.

In the case of both solids control technologies, predicted TSS concentration for the drilling discharges will predominantly occur when the bottom sections of each well are drilled. The elevated TSS concentrations are expected to dissipate rapid as a result of the dispersion capacity of the local marine environment. Given the small magnitude of impacts to water quality, the effect on biological receptors will be of *Minor* significance.

The effects of discharges of drill cuttings and associated NADF into the marine environment are, therefore, primarily on the seabed sediments and associated fauna since there is little effect on water quality.

Biological Impacts to Seabed

As cuttings and WBM used to drill the upper sections of each well are released from the well at the seabed, the large or heavy cutting particles accumulate in the immediate vicinity of the well. Thereafter NADF cuttings released at the surface will spread over a wider area subject to currents or disperse to below ambient concentrations depending on the solids control technology.

Dispersion modelling results showed that the majority of cuttings from all the well sections will be deposited in the immediate vicinity of the well site. For both solids control technologies depositions with a thickness of more than 10 mm are limited to an area of between 0.005 and 0.006 km^2 around the well site and extend between 40 and 50 m from the well site. The total area to be covered by depositions of more than 10 mm thick is approximately 0.09 to 0.10 km^2 for the 17 new TEN mid case wells. Deposits of more than 1 mm thick could cover a larger total area of approximately 3.88 to 4.10 km^2 for the 17 new TEN mid case wells.

The finer particles from WBM released at the seabed during drilling of the top two well sections are likely to form a dense plume which may interfere with the respiration of benthic and demersal communities downstream of the release point. However, the plume is expected to occur over a relatively short duration whilst the top sections of the wells are drilled and effects are likely to be local to the well (< 600 m from well). WBM is generally considered less harmful compared to NADF as it contains water, rather than oil, as its base fluid and has been demonstrated to have only a limited effect on the environment.

The major components of WBM are barite and bentonite which are considered as inert and non-toxic (*ie* graded by OSPAR as a chemical that Poses Little or No Risk to the Environment (PLONAR) and is permitted for discharge to sea in the OSPAR countries).

The barite and bentonite used in drilling muds may contain trace amounts of metals as mineral impurities. The effects of metals associated with drilling muds such as barium, chromium, mercury, cadmium, nickel, arsenic, vanadium, zinc and lead on the seabed ecology have been shown to be minimal(Neff 2008, Pettersen and Hertwich 2008), because they are at low concentrations and the metals are bound in minerals and therefore have limited bioavailability to marine organisms. The bulk supplies of barite are routinely analysed for mercury and cadmium.

The EBS (CSA 2011a) undertaken in the TEN field showed some of the sediment samples to have slightly elevated levels of arsenic compared to the Canadian guideline standards. These were found across the survey area including areas away from the drill sites. These levels are considered to be naturally occurring and associated with the minerals that comprise the seabed sediments. Trace levels of arsenic that may be associated with drill cutting discharges are not likely to result in any measureable changes to the natural arsenic levels or to cause any biological effects. Routine analysis of the barite supplies will include analysis for arsenic as part of the TEN monitoring programme to provide information on concentrations from this potential source (see *Chapter 9*).

NADF and oily cuttings can have an effect on seabed biology due to the toxicity of the hydrocarbons and an increase in sediment redox potential due to the anaerobic degradation of the organic material (E&P Forum/UNEP 1997). Cuttings deposits of more than 10 mm thick in the vicinity of the well are expected to result in the smothering, and often mortality, of benthic organisms (and mainly sessile species). This is a conservative threshold, especially in the context of a deepwater environment where benthic communities are adapted to soft sediment. Last *et al* (2012) assessed the tolerance of different benthic species to burial in fine sand against a benchmark of 50 mm burial depth. The study found that tolerance to burial varies considerably between benthic species. In general, burrowing species such as polychaetes had a high tolerance to burial, while encrusting species such as ascidians and bivalves have a lower tolerance. The EBS (CSA 2011a) showed that benthic communities in the TEN Project area are dominated by burrowing species (polychaetes), therefore, the communities are assumed to have a lower sensitivity to smothering effects.

Smothering impacts will be limited to a small area around each well. Different faunal groups are tolerant to different degrees of smothering, for example burrowing animals are more tolerant than surface living filter feeders, and therefore, smothering will result in local changes to the benthic community composition. Recovery will occur in time as the new sediment surface layers are re-colonised. Sedimentation can also reduce oxygen diffusion and poor water exchange in marine sediments leading to anoxic conditions.

Other effects from NADF cuttings could include organic enrichment of sediments through organic carbon loading and toxicity from organic enrichment and the drilling fluids (including bioaccumulation and bio-magnification through the food chain). These effects are related to the degree of accumulation of drill cuttings on the seabed and the toxicity of the drilling fluids.

The type of NADF that will be used for the mid and lower sections of each well is low in aromatics and readily biodegradable in aerobic conditions. Anaerobic conditions slow down the rate of biodegradation and increase toxicity of the sediments. To reduce the area that is affected by a build-up of drill cuttings, and potentially anaerobic conditions, effective dispersion of drill cuttings over a wider area will be attained by treating cuttings using a TDU to reduce the oil on cuttings to a target concentration of less than 1%, for the main drilling campaign.

Hydrocarbons are widely considered the main toxic agent of cuttings in the marine environment, primarily as a consequence of their concentrations which are relatively high compared to other components. The NADF to be used has been classified as having low toxicity and low levels of aromatic hydrocarbons and has been tested on a range of marine organisms. The proposed NADF to be used for the TEN wells, ESCAID 120 does not have a hazard ranking by CHARM and there are no Hazard Quotient values assigned. It is classified under the OCNS and has been classified as Group C. Group C is assigned because even though the product has more than 60% biodegradation and low toxicity, tests show it has a low potential to bio-accumulate in marine species.

In order to quantify the extent of potential effects on benthic communities, a very conservative petroleum hydrocarbon concentration threshold of 50 to 60 ppm in sediment was assumed for effects on benthic communities (CSA 2011b). Based on a worst-case modelled scenario for the conventional solids control treatment, areas affected by deposited material with a hydrocarbon concentration of more than 50 ppm will be limited to 0.788 km^2 around each well for the early 2014 wells. The model predicts hydrocarbon concentrations of 50 ppm extending up to 1 km from a well site. This corresponds with the results of the cuttings study (CSA 2011b) which detected Total Petroleum Hydrocarbons (TPH) concentrations in seabed sediments of 65 to 199 ppm up to 1 km from a previously drilled well site in the Jubilee field. The TDU will achieve less than 1% NADF on cuttings for the main drilling campaign which are not expected to settle onto the seabed.

The biological impact of drilling discharges on the seabed (from the 17 mid case wells) could occur in the long term over an area of up to 0.10 km^2 for smothering effects. Biochemical effects on the seabed are only expected for the wells drilled in early 2014 using conventional solids control. Given the low sensitivity of the benthic environment in the TEN Project area, this impact is assessed to be of *Minor* significance.

<u>Summary</u>

- The sediment plume will be primarily due to drilling fluid solids. Only water based mud solids will be discharged for the top sections of the well. The plume is thus expected to occur over a relatively short duration whilst the top-sections of the wells are drilled.

- The area of seabed predicted to be impacted by cuttings (more than 1 mm thick; 4.10 km^2 for the 17 new TEN mid case wells) is considered small (approximately 0.9%) in comparison to the total TEN Project area.

- Smothering impacts will be limited to a small area of 0.10 km^2 around the 17 new TEN mid case wells where deposition thickness will be more than 10 mm. The majority of this material would comprise WBM cuttings from drilling the top well sections.

- The benthic environment in the TEN Project area has been assessed as low importance given the generally featureless benthic habitat and homogeneous benthic fauna and low sensitivity given the high tolerance of dominant benthic to these effects.

Given the type of drilling fluid being used, the use of improved drilling fluids and cleaning technology, the local hydrographic conditions in the TEN Project area (currents and depth) which favour good dispersion, and the localised and temporary nature of impacts it is considered that the proposed discharges will have impacts of no more than *Minor* significance.

Discharges from cuttings treatment are not expected to impact the recently reported area of coral reef in the north of the DWT block. A suspended solids concentration of more than 10 mgl^{-1} (*ie* above background concentrations) is expected to occur only within 360 m of the discharge location, whereas the closest well to the reef area (Enyenra 3A) is 10.8 km to the south of the reef area.

7.4.8 Hydraulic Discharges from Subsea Equipment

Description of Potential Impacts

Subsea hydraulic production control systems are used to control valves. In deepwater facilities open loop systems are the industry standard due to their reliability and low maintenance requirements. With this system there is a release of small volumes of hydraulic control fluid into the marine environment each time the valve is activated or during system shutdowns.

Mitigation Measures

The hydraulic fluids used will be a water based glycol control fluid which has a low toxicity and bioaccumulation potential and is readily biodegradable.

Impact Assessment

Valves on the production manifolds and trees are required to be tested by actuating them at least once every 3 to 6 months. Manifolds have 10 valves and trees have 4 valves each. This would result in 88 valves activated four times a year. This will result in the discharge of approximately 281.6 l of hydraulic fluid per year (based on four production manifolds and 12 production trees each discharging an average of 0.8 l per valve). Valves on water and gas injection manifolds are actuated by remotely operated underwater vehicles, so they will not release any fluid. In the event of a shutdown or during annual tests the system may be emptied with the release of 1 to 2 m^3 of hydraulic control fluid.

The small volume and intermittent discharges of fluid from the open loop system will be rapidly diluted and dispersed in the receiving water column. The residual impact of the discharge of hydraulic fluids is deemed to be *not* *significant* given the small scale, localised and intermittent nature of the impact and the low toxicity and rapidly biodegradable fluid used.

7.4.9 *Pre-Commissioning and Line Flushing Fluids*

Description of Potential Impacts

Pre-commissioning operations will involve subsea pipeline inspection, hydro-testing and leak testing operations. Pre-commission of the flowlines and other components is necessary to prove integrity prior to production. These operations will involve filling the flowlines with seawater and added chemicals. The chemicals to be added will comprise biocide, oxygen scavenger, corrosion inhibitor and tracer dye.

Mitigation Measures

Proposed mitigation measures to reduce the potential impacts associated with the discharge of pre-commissioning chemicals include the following.

- TGL will develop a pre-commissioning disposal plan to control the rate of discharge, chemical use and dispersion. Dispersion will be improved by optimising the discharge rate, pressure and direction of the discharge at the release point. These procedures will be ready for pre-commissioning work.

- The volume of pre-commissioning water discharged to sea will be reduced by testing equipment onshore where possible, before it is loaded for offshore installation. Onshore hydrotesting will be undertaken using seawater and industrial grade water without hydrotesting chemicals.

Impact Assessment

Hydrotest water contains dye, oxygen scavenger, corrosion inhibitor and biocide. During FPSO leak detection and flowline dewatering operations, the total volume of pre-commissioning fluid that may be discharged to sea is approximately 5,000 m^3 (based on 5 m^3 of pre-commissioning fluid combined at 1,000 ppm with raw seawater). A similar quantity of pre-commissioning fluid will also be required for the export pipeline to the Jubilee field, giving a total of 10,000 m^3 of hydrotest water to be discharged to sea.

For the protection of umbilical tubing during storage and transport TGL is planning to use an MEG [(1)] based umbilical storage fluid. The volume (15 m^3) within the umbilicals will be discharged to sea when the umbilicals are being commissioned. The umbilicals will then be flushed using methanol (approximately 4 m^3) and this will be discharged to sea at the drill centres.

(1) Mono-Ethylene Glycol (MEG) is introduced into the pipelines as an antifreeze and anticorrosion agent.

MEG and methanol are rated as Category E in the OCNS (1), meaning they have the least potential for adverse environmental effects.

Prior to injecting into the water injection wells, the water treatment facilities will be commissioned. During this process approximately 30,000 m^3 of deoxygenated sea water will be discharged overboard. When the gas injection flowlines and risers are dewatered (*ie* the water is pumped out) MEG will be pumped through the pipelines to remove any remaining water. Typically 50 to 100 m^3 of MEG will be discharged to sea.

These releases will be at the seabed or the sea surface, depending on the equipment being tested and will temporarily expose seabed and sea surface dwelling organisms to the chemicals contained in the hydrotest waters. Typically oxygen scavengers react with water to consume oxygen and produce sulphates. This is a one-off reaction with no harmful by-products. In addition, a substantial proportion of the original scavenger dose is expected to be consumed inside the flowlines prior to release. In common with the oxygen scavenger, a proportion of the biocide chemical is also likely to be consumed/degrade in the flowlines depending on how long it resides there. Tracer dyes are typically poorly biodegradable but are water soluble and will rapidly disperse in the marine environment.

The discharges of these volumes of relatively low toxicity effluent will disperse rapidly in the receiving environment. The larger volumes discharged during hydrotesting may lead at most to temporary, small, localised effects to benthic communities on the basis of a horizontal discharge and little likely contact with the plume before it is greatly diluted. These effects are likely to be limited to a few tens of metres from the discharge point and will primarily relate to the nature and residual concentrations of the biocide and oxygen scavenger that are used; noting that these chemicals will be partially consumed while residing in the flowlines. Overall effects will likely be of *Minor* significance on the basis that it will be a localised one-off discharge, impacts will be short-lived and regeneration will be rapid. Secondary impacts higher in the food chain will be *not significant*.

7.4.10 Produced Water

Description of Potential Impacts

Produced water is a by-product of oil and gas hydrocarbons from under-ground reservoirs. Water is naturally present in these reservoirs as a portion of the produced fluids is water (either as a liquid with the oil or as a vapour in hydrocarbon gas). Produced water will be separated from the hydrocarbons on the FPSO and transferred to the produced water treatment system where it

(1) Offshore Chemical Notification Scheme (OCNS) – developed by the Oslo/Paris Commission, groups chemicals according to their environmental effect. Groupings are from A to E and indicate the potential environmental effect of chemical discharge to the marine environment with grouping E being those with least potential for adverse environmental effect.

will be filtered, cleaned and cooled prior to discharge to sea. The proportion of produced water will vary through the life of the reservoir (see *Chapter 3: Section 3.8.3* for a produced water profile based on estimated production profiles). Low volumes of produced water are expected in the early stages of the TEN Project. Based on production forecasts, an average produced water discharge rate of 31,751 bpd(1) is expected over the 20 year project lifetime with a peak discharge rate of 68,238 bpd in 2032. There is uncertainty in the forecast of produced water volumes.

TGL has undertaken a study to assess the feasibility of Produced Water Reinjection (PWRI). Preliminary results of the PWRI study indicate that reinjection may be possible. However, as PWRI has not been confirmed to be a feasible option at this stage it has been assumed for the purposes of the EIA that produced water will be discharged to sea from the TEN FPSO.

Given the possibility of a continuous discharge of relatively large volume of produced water, this is considered the principal effluent discharge from the TEN Project. To provide quantitative information to aid the assessment of the potential impact to the marine environment, the dispersion of produced water discharges was modelled by RPS-ASA (2013) using hindcast current data for the TEN Project area (see *Volume II: Annex D* for modelling report).

Modelling Results

Produced water discharge was modelled using CORMIX. CORMIX is a commercially available water quality modelling and decision report system supported by the US EPA. Four scenarios were modelled using two flow rates (37,500 bbl/day and 75,500 bbl/day) and two different current conditions, namely mean current velocities (0.355 ms^{-1}) and stronger 95th percentile current velocities (0.822 ms^{-1}) based on hind cast current data for the specific site. The model assumed a constant flow rate at a discharge depth of 3 m below the water surface, along the mid-ship portside of the FPSO. Produced water has been modelled at a maximum concentration of 40 mgl^{-1}(2) which is the EPA (2010) standard for the daily maximum discharge. The basis of design for the FPSO facilities has a maximum oil in water discharge of 30 mgl^{-1} and is designed to achieve 20 mgl^{-1} over a 24 hour period. Therefore, the model outputs are considered to be a conservative worst case.

Figure 7.12 shows the dilution as a function of distance of the initial discharge concentration of produced water. The concentration rapidly decreases within a short distance from the point of discharge (to less than 10 mgl^{-1} within a few metres) after which the rate of decrease slows. The concentration of the plume centreline is expected to be less than 2 mgl^{-1} (dilution factor of 20) within 20 m from the point of discharge for all scenarios.

(1) 1 barrel = 159 litre = 0.158 m^3
(2) 1 mgl^{-1} = 1 ppm

Mitigation Measures

Mitigation measures for produced water include the following.

- TGL will design the FPSOs produced water treatment system to include a three stage process of a water skim vessel, followed by hydrocyclones and ending with a flotation cell prior to discharge to sea. Dispersion of discharges will be increased using diffusers on the discharge pipe.

- TGL will continually monitor produced water and if oil in water (hydrocarbons) exceeds 40 mgl^{-1} as per EPA (2010), the water will be routed to the off-specification tank for further treatment prior to any discharge. Operations staff will be alerted to any rising trends by alarms at less than 40 mgl^{-1} in various stages.

- TGL will monitor discharge into the sea such that the 30 day average will not exceed 29 mgl^{-1} as per EPA (2010).

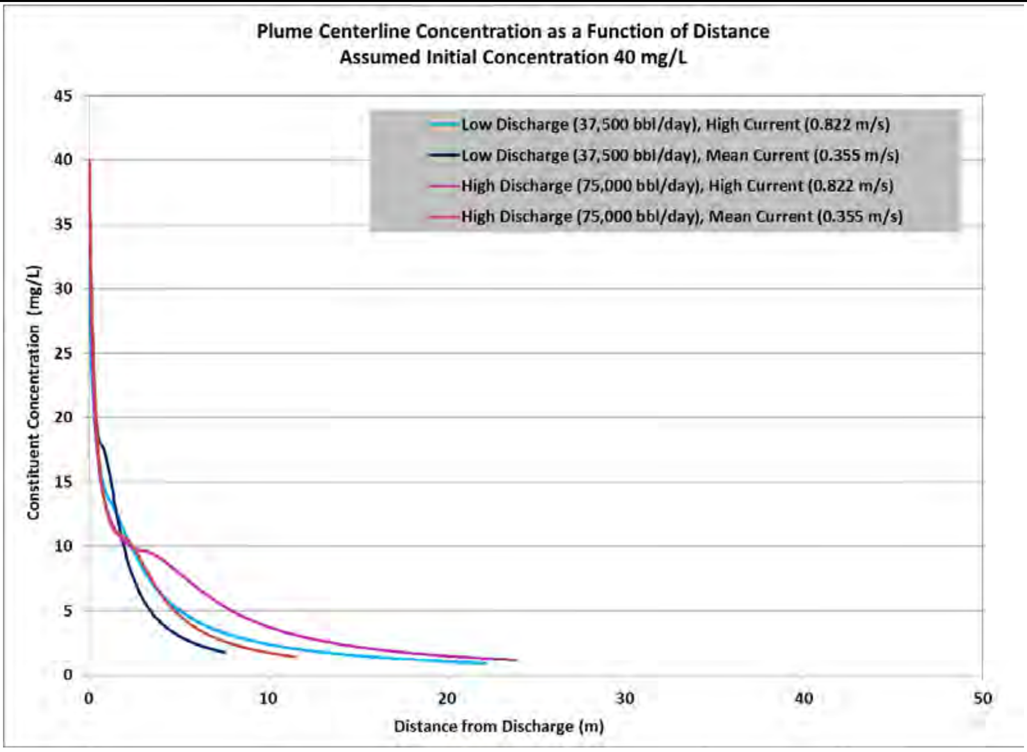
Discharge of produced water is planned at this stage pending the PWRI study to determine if later reinjection of produced water will be possible. The results of the PWRI will be available within two years of the start of production and at that stage, TGL can confirm if PWRI will be possible. The produced water process pipework on the FPSO has been designed to allow future water re-injection if it proves to be feasible.

Impact Assessment

There would be the potential for impacts on water quality (as a consequence of entrained hydrocarbons and other components such as metals) in the vicinity of the FPSO as a result of produced water discharges. There would also be possible secondary effects on marine organisms (*eg* plankton, larger invertebrates and fish). Phytoplankton and zooplankton communities seasonally present in the vicinity of the FPSO are likely to be the most sensitive group to impacts from produced water discharges (Gamble *et al* 1987) due to the elevated levels of hydrocarbons in the discharge.

Although fish will be present under and around the FPSO they are unlikely to be exposed to any significant impact as they are mobile and the residence time within the discharge plume will be short.

Figure 7.12   Plume Centreline Concentration as a Function of Distance



Source: RPS-ASA 2013

Toxicity studies on produced water discharges have shown that the concentrations of toxic chemicals in most produced waters are well below the test species 96 hour LC50 (lethal concentration for 50% of the individuals tested over a 96 hour period) indicating that acute toxicity is unlikely beyond the immediate vicinity of the discharge (GESAMP 1993).

Methanol is used by the oil and gas industry worldwide as antifreeze to inhibit the formation of gas hydrates (ice) within the subsea infrastructure. The methanol, being water miscible, returns to the FPSO in the produced water and will, therefore, be discharged to sea with the produced water. During planned system shutdowns up to 200 to 400 bbl of methanol will be used and returned with the produced water and therefore discharged to sea mixed with the discharged produced water. Methanol is readily biodegradable (half-life of 6 days), has a low toxicity to marine organisms and is graded by OSPAR as a PLONAR chemical and is therefore permitted for discharge to sea in the OSPAR countries.

The dispersion modelling has shown that even at the modelled worst case concentration of 40 mgl^{-1}, the hydrocarbon concentration will reduced rapidly with distance from the FPSO which is expected to lead to a localised and short-lived impact on water quality. The waters in the TEN Project area are considered to be of medium sensitivity. Marine organisms such as plankton within the mixing zone will be impacted, however, given the likely area of water affected the impact is assessed as being of *Minor* significance. No significant impacts on larger invertebrates, fish and predators such as turtles and marine mammals are expected.

7.4.11 *Cooling Water*

Description of Potential Impacts

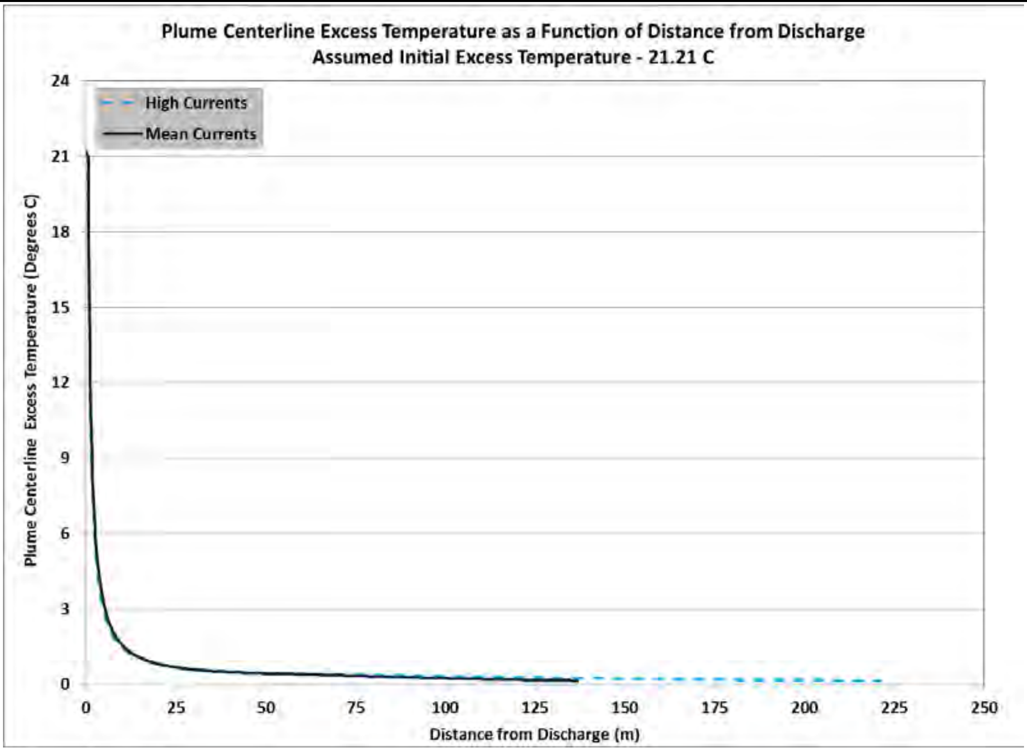
Discharge from the FPSO topsides and marine cooling water systems will be continuous at an average design rate of 221,090 bpd (up to a maximum of 560,000 bpd) and 208,850 bpd, respectively. Surface waters in the Gulf of Guinea are in the range 24 to 29 ˚C and cooling water is typically discharged at a temperature of approximately 55˚C for the topsides system and 30 ˚C for the marine system. The potential impacts of the discharge are predominantly the risk to marine biota such as fish species, plankton and sea turtles that are known to populate the surface waters. This may result from either the chemical content of the cooling water discharge or the temperature differential between the discharge and surface waters.

Modelling Results

Combined cooling water discharges were modelled using CORMIX under two different current velocities (0.35 ms^{-1} and 0.82 ms^{-1}). The model assumes the maximum discharge rate of 560,000 bpd for the topsides system and the design rate of 208,850 bpd for the marine system. The assumed initial excess temperature is 21.21°C above ambient surface water temperature. *Figure 7.13* presents the modelling results in terms of the plume centreline excess temperature as a function of distance from the discharge location. The results show that under both current conditions the excess temperature decreases rapidly, from the starting excess of 21.21°C to below 3°C within 10 m.

Excess temperature continues to decrease reaching ambient temperature at approximately 135 m and 225 m distance from the discharge location for mean and strong currents, respectively. The rapid dilution is due to the relative difference in characteristics between the discharge and receiving water. The above-surface discharge location allows the discharge to 'plunge' into the receiving waters which enhances mixing. The lower density of the discharge gives it buoyancy which then drives it back to the surface, further enhancing mixing. The ambient currents aid in advecting the plume which also contributes towards the high initial dilution.

Figure 7.13 Plume Centreline Excess Temperature as a Function of Distance



Source: RPS-ASA 2013

Impact Assessment

Good industry practice (IFC 2007a) for thermal discharges indicates that there should be no more than a 3˚C increase within 100 m of the discharge. The modelling shows that elevated temperatures will be experienced in the immediate vicinity of the discharge, however, given the high dispersion capacity of the open sea, cooling water discharges are expected to drop below this threshold at less than 10 m from the discharge point. Therefore impacts are assessed as *not significant*.

7.4.12 Desalination Brine

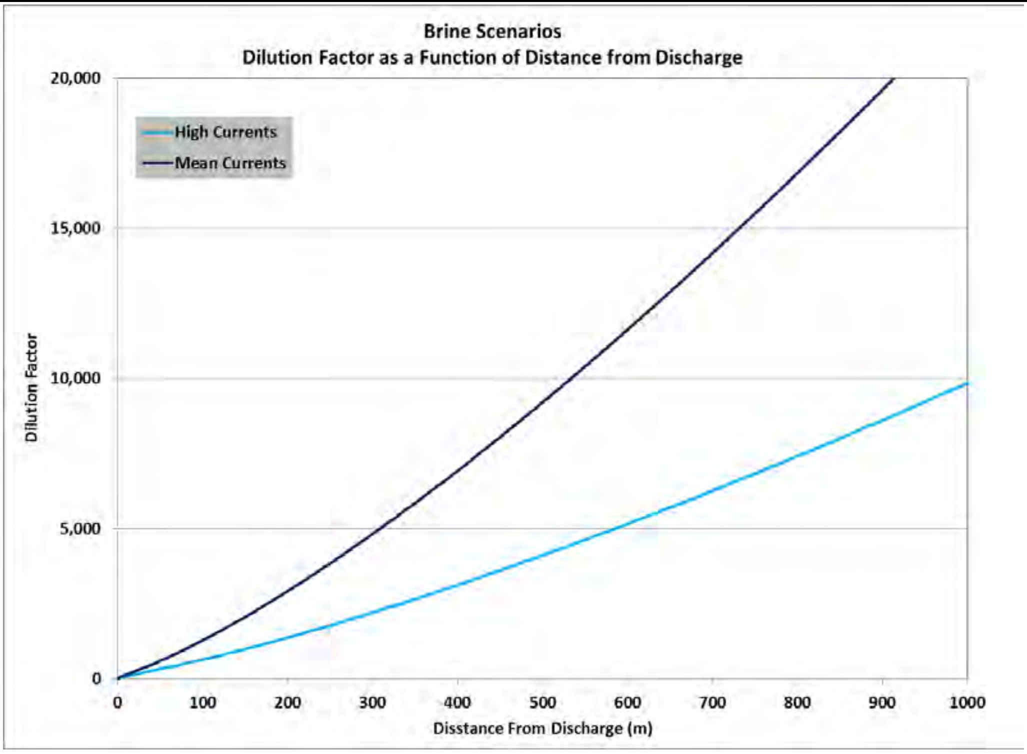
Description of Potential Impact

Hypersaline brine will be generated during freshwater generation on the FPSO and discharged to sea at a typical rate 6,000 bpd (approximately 704 m^3 per day) at ambient temperature. The discharge is expected to have a salinity concentration twice that of seawater (approximately 64 psu). The potential impacts of the discharge are predominantly the risk to marine biota such as fish species and plankton from salinity differential between the discharge and the surface water.

Modelling Results

From the point of discharge, brine will disperse to lower salinities away from the discharge point under local oceanographic conditions. The dilution factor was modelled using CORMIX based on two current velocities, namely 0.36 ms^{-1} and 0.82 ms^{-1}. *Figure 7.14* presents the modelling results in terms of plume centreline dilution of the initial discharge as a function of distance from the discharge point. The results indicate that the plume dilutes substantially within a short distance, with a dilution factor of over 1,000 at a distance of 100 m. The plume dilutes quickly over a short horizontal distance due mainly to the enhanced dilution from the vertical descent of the denser plume.

Figure 7.14 Brine Dilution Factor as a Function of Distance from Discharge



Source: RPS-ASA 2013.

Impact Assessment

Given the high dilution capacity of a discharge of this limited volume into the open sea, as demonstrated by the modelling results, impacts are assessed as *not significant*.

7.4.13 Combined Cooling Water and Brine Discharge

A combined discharge of cooling water and brine was also modelled using CORMIX. The model assumed that the mixing in the piping system is sufficient enough to produce a uniform discharge which, due to having a much larger volume than that of brine discharge, has similar properties to the cooling water discharge. The results (see *Annex D*) show that the initial excess temperature of 21.03°C decreased rapidly to less than 3°C within 10 m of the discharge. Furthermore at a distance of 100 m from the release origin, the plume centreline concentration is diluted by a factor of 60 and 90 for high and mean current conditions, respectively.

7.4.14 *Onshore Bases*

Description of Potential Impacts

The existing marine support base at Takoradi port will likely be used throughout the project lifespan (1) for dock space to serve as a loading/offloading point for equipment and machinery. It will also provide quayside facilities for dispatching fuel, chemicals and equipment and allow for temporary storage of spares, production chemicals, fuel and other supplies. The Air Force base will be used as a helicopter support base.

The storage and handling of liquid drilling fluid and production chemicals and fuel creates the potential for accidental releases from tanks, pumps, pipes and hoses including during loading and unloading from the bases to the supply vessels. Discharges from these activities could impact soil, groundwater and surface water quality. The two main causes of impacts are expected to arise from the following.

- Discharges directly into water courses, or via drainage channels, resulting from spills of chemicals or fuel oils.

- Leaks and spillages of chemicals from inappropriate storage and disposal of solid and liquid wastes leading to soil contamination and subsequent groundwater and/or surface water contamination due to rainwater run-off. Oil spills are addressed in *Section 7.10* but to avoid repetition, spill at the onshore bases are addressed here.

The type and volume of contaminated wastes discharged will depend on the type of chemicals being handled and the site drainage, containment and management systems and the degree of rainfall and site run-off area. Without appropriate management, such discharges could result in degradation of surface or groundwater quality.

Mitigation Measures

The following mitigation measures will be adopted to reduce potential impacts from shore based activities.

- Chemical and fuel storage areas will have appropriate secondary containment (bunds), and procedures for managing the containment systems. Secondary containment design will depend on the type of tanks and nature and volume of the materials being stored.

- Impervious concrete surfaces will be in place at all areas of potential chemical and fuel leaks and spills, including below gauges, pumps, sumps and loading/unloading areas.

(1) If the TEN Project use other locations as onshore bases in future then these would be subject to their own environmental assessment.

- Storage tanks and components will meet international standards, such as those of the API, for structural design and integrity.

- Storage tanks and components will undergo periodic inspection for corrosion and integrity and will be subject to regular maintenance of components such as pipes, seals, connectors and valves.

- Fuelling equipment will be inspected daily to check all components are in satisfactory condition.

- For chemical and fuel storage, handling and transfer areas, TGL will install stormwater channels with subsequent treatment through oil-water separators.

- Loading and unloading activities will be conducted by properly trained personnel according to formal procedures to prevent accidental releases and fire and explosion hazards.

- Spill control and response plans will be developed in coordination with the landowners (*ie* GPHA Takoradi and Takoradi Air Force base).

Impact Assessment

The onshore bases are located away (more than 1 km) from the nearest freshwater resources, however, discharges to coastal waters is possible from activities at the port. At the onshore logistics bases it is anticipated that TGL will have a close working and contractual relationship with the base operator (GPHA and the Air Force) and thus can anticipate a high level of control in relation to management and mitigation measures. Impacts on water and soil quality from effluent discharges and spills at the onshore logistics bases are assessed to be *not significant* given the scale of the project operations and the nature of materials being handled provided that the mitigation measures outlined above are implemented.

7.5 EMISSIONS TO ATMOSPHERE

7.5.1 Introduction

This section assesses the potential impacts on air quality from emissions associated with the TEN Project. This assessment estimates the air pollutants emitted during all phases of the development (drilling, commissioning, installation, commissioning and operations) and then evaluates the impacts on air quality using air dispersion modelling. Greenhouse gas emissions from the TEN Project are assessed in *Section 7.6*.

The assessment addresses the potential impact of emissions from the TEN facilities on onshore as well as offshore receptors. The section also addressed cumulative impacts from the TEN activities in combination with emissions from the Jubilee FPSO.

7.5.2 *Scope of this Assessment*

To support this assessment, an emission inventory was prepared for all phases of the development and this is presented in *Volume II: Annex A*. Significant emissions can be expected for subsea and FPSO installation phases, however, these activities will occur over a limited period of about 18 months. The emissions during the drilling/completions and operations phases of the project are the most significant from a total atmospheric loading perspective.

Based on this, the only phases of the project that can be considered to have sufficient emissions and dispersion to potentially impact the onshore receptors 40 to 60 kilometres away are drilling and completions, commissioning and operations. To confirm if emissions during well drilling and completion will be sufficient to influence onshore receptors, screening modelling was conducted for the point source emissions during this phase (see *Section 7.5.4*).

During commissioning and operation, the primary consideration will be emissions associated with the FPSO including flaring during commissioning and flaring during occasional process upsets and for safety reasons, and emissions from power generation.

Operations at the onshore bases at Takoradi Port and the Air Force base have been scoped out of the assessment on the basis of the scale of potential impacts from these sources. Onshore operations are primarily associated with crew transfers via helicopter as well as movement of equipment and supplies using Heavy Goods Vehicles between the Port and the Air Force base, estimated at about two movements per day. Emissions from these activities are not considered significant given the limited number of movements and the absence of large combustion sources.

Emissions from increased marine vessel movements between Takoradi and the TEN fields have also been scoped out of the detailed assessment. According to the UK's Local Air Quality Management (LAQM) Technical Guidance (DEFRA 2009), when there are less than 5,000 vessels per year using a port (13 vessels per day) and no sensitive receptors within 250 m of shipping activities there is no requirement to assess shipping emissions, as the risk of exceeding air quality standards will be negligible. The number of vessel movements during the drilling, installation and operational phases are expected to be well below this level of activity (see estimates of vessel numbers provided in *Volume II: Annex A*).

No detailed assessment has been made of fugitive emissions (*eg* leaks) or of the emissions arising from the venting of blanketing gas. This is because:

- these emissions will occur infrequently and be of small volume;

- they will have low upward velocity thus minimising the potential for air pollutants to travel the distance required to reach the onshore receptors; and
- where hydrocarbon exhaust gases are used, the emissions are already considered within the emission sources described in *Section 7.5.4*.

7.5.3 *Atmospheric Pollutants Considered*

Based on the proposed activities (power generation, oil processing and occasional gas flaring) and the applicable national and international air quality standards, the following pollutants are considered in this assessment:

- oxides of nitrogen (NO_X), including nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- carbon monoxide (CO); and
- particulate matter, including particles <10µm in aerodynamic diameter (PM_{10}) and particles <2.5µm in aerodynamic diameter ($PM_{2.5}$).

The air quality impact assessment has been carried out with reference, where appropriate, to Ghanaian national air quality standards and World Health Organisation (WHO) air quality guidelines in accordance with IFC (2007b). In addition, impacts at sensitive ecological receptors due to emissions of NO_X and SO_2 have been assessed.

7.5.4 *Dispersion Modelling*

Screening

To confirm that the impacts to onshore air quality receptors from the emissions generated at during drilling and completions (*ie* flaring and MODU power generation) are not significant, screening modelling was conducted on a single representative well. The model used in the assessment for screening is the United States Environmental Protection Agency's SCREEN3 dispersion model. The screening model inputs used are provided in *Table 7.17.* Given the distances of the wells from shore (approximately 40 to 60 kms) and the distance limitations of the model (50 km), process contributions to air quality were assessed in the range of 45 to 50 kilometres from the well. Using these input values, SCREEN3 then estimated the maximum 1-hr concentrations within 45 to 50 kilometres of the well. These are provided in *Table 7.18*.

Table 7.17 Stack and Emissions Details for Screening

Parameter	Unit	Flare	Engines for Power
Base Elevation	m	20	20
Release Height	m	100	43
Gas Exit Temperature	K	1,273	829
Gas Exit Velocity	ms^{-1}	N/A	11.2
Heat Release Rate	$cals^{-1}$	8,741,684,665	N/A
Inside Diameter	m	0.609	2.8
NO_x	gs^{-1}	0.077	117.7
CO	gs^{-1}	0.373	26.97

Assumptions:
For engines, assume exhaust parameters (flow, velocity, temperature, release height, stack diameter).
Assume a composite stack for all engines.
Assess for all meteorological conditions.
Assume rural conditions with simple terrain and now building downwash effects.

Table 7.18 Screening Results

Parameter	Unit	Flare			Engines for Power	
		Assessment Criterion	Maximum 1-hr Conc.	% Criterion	Maximum 1-hr Conc.	% Criterion
NO_x	μgm^{-3}	200	0.000122	0.00061%	39.45	19.7%
CO	μgm^{-3}	N/A	0.000593	N/A	9.04	N/A

Due to the relatively high expected NO_x concentrations of combustion emissions from engines on the MODU, it was considered necessary to include well drilling and completion activities in the primary air dispersion modelling.

Primary Modelling

Detailed air dispersion modelling has been used to predict concentrations of pollutants from emissions from TEN during drilling, completions, commissioning and operations, as well as the cumulative impacts resulting from TEN and Jubilee FPSOs. The model used in the assessment is the United States Environmental Protection Agency's AERMOD dispersion model. AERMOD is recognised by a number of regulatory agencies including the IFC, US EPA and the UK Environment Agency as being fit for purpose for this type of assessment.

Modelling Scenarios

The following operational scenarios were modelled.

- **Scenario 1.** Normal operation, TEN FPSO only.

- **Scenario 2.** Short term assessment only, normal operation with maximum flaring event, TEN FPSO only.

- **Scenario 3.** Normal operation, TEN FPSO and Jubilee FPSO.

- **Scenario 4.** Normal operation, TEN FPSO, drilling emissions from one MODU.

- **Scenario 5.** Short term assessment only, normal operation with maximum flaring event at TEN FPSO and Jubilee FPSO, drilling emissions from one MODU.

Further information on the emission sources that were included in the model for each scenario is provided in *Table 7.19.*

The modelling study considers scenarios where the MODU is operational in the field as a worst case estimate of emissions from drilling activities. These scenarios represent a combination of drilling and completions, commissioning and operation activities that may result in normal and worst case emissions. It should be noted that Scenario 5 has been included as an absolute worst case; however, the likelihood of all these emission sources operating simultaneously is highly unlikely.

7.5.5 Emissions Sources and Data

FPSOs

The sources from the FPSOs that have been considered in the assessment are as follows.

- Compressor combustion turbines (two operational units and one standby unit).

- Deck boilers (one operational unit and one standby unit).

- Two fire water pump engines.

- Emergency generator (one unit).

- Two deck crane engines.

- One combined High Pressure/Low Pressure (HP/LP) flare.

Table 7.19 Air Dispersion Modelling Scenarios

Sources	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	Normal operation TEN FPSO only with no flaring or drilling	Short term assessment only with maximum flaring event TEN FPSO only. No drilling.	Normal operation TEN FPSO and Jubilee FPSO without flaring	Normal operation TEN FPSO, drilling emissions from one MODU.	Short term assessment only with maximum flaring event at TEN and Jubilee FPSO. Drilling emissions from one MODU
TEN FPSO turbines (two operational units)	✓	✓	✓	✓	✓
TEN FPSO deck boilers (one operational unit)	✓	✓	✓	✓	✓
TEN FPSO fire water pump engines (two units)	✓	✓	✓	✓	✓
TEN FPSO emergency generator (one unit)	✓	✓	✓	✓	✓
TEN FPSO deck crane engines (two units)	✓	✓	✓	✓	✓
TEN FPSO flaring event (sixty minutes)	×	✓	×	×	✓
Jubilee FPSO turbines (two operational units)	×	×	✓	×	✓
Jubilee FPSO deck boilers (one operational unit)	×	×	✓	×	✓
Jubilee fire water pump engines (two units)	×	×	✓	×	✓
Jubilee FPSO emergency generator (one unit)	×	×	✓	×	✓
Jubilee FPSO deck crane engines (two units)	×	×	✓	×	✓
Jubilee FPSO flaring event (sixty minutes)	×	×	×	×	✓
MODU (engines and flares operational)	×	×	×	✓	✓

Of the emission sources on the FPSOs, only the turbines will operate continuously. To calculate long term impacts, the emission loads ($g\ s^{-1}$) of non-continuous emission sources have, therefore, been factored to account for the actual working hours per year. For the short term impacts no factor was used to reflect actual peak emission loads. As a consequence the short term emissions are substantially overestimated since the model assumes that all the emission sources will operate at the same time.

The stack parameters for the emission sources for the TEN FPSO and pollutant emissions data for these sources that has been used in the assessment are set out in *Volume II: Annex A*. Where design specifications were not available yet, emissions factors from literature were used as indicated in *Volume II: Annex A* (USEPA 1995).

For the purposes of the assessment and in the absence of specific data from the proposed TEN FPSO the emission sources from the existing Jubilee FPSO were used (with the exclusion of cold venting from the cargo tank vents as this has been designed out of the TEN FPSO).

Flaring

As previously stated, the TEN and Jubilee flares are assumed to be similar. Therefore, the stack parameters and emission rates for the TEN and Jubilee FPSOs flaring are set out in *Volume II: Annex A.*

MODU

The emissions from the MODU will arise from the use of diesel powered engines and from flaring of completion fluids. The model inputs for the MODUs are set out in *Volume II: Annex A*.

7.5.6 Meteorological and Climate Data

The meteorological data used in the model is representative of the local meteorological conditions at the TEN Project area. Five years of MM5 modelled meteorological data for 2007-2011 was sourced from Lakes Environmental (2012).

7.5.7 Other Parameters

Consideration of Terrain Effects

Changes in terrain elevations (*ie* hills or mountains) can have a significant impact on dispersion of emissions, in terms of funnelling of plumes and changing local wind flows. Terrain effects are typically considered important where there are sustained gradients of 1:10 or greater. Since the 'terrain' here is mostly open ocean, terrain was not considered in the model.

Conversion of NO_x to NO_2

The combustion process generates NO_X. In the exhaust gases from the stack, these are in the ratio of approximately 95% NO to 5% NO_2. With regard to the assessment of impact on human health NO_2 is the pollutant of interest as NO is largely inert in the human body. Within the atmosphere various processes oxidise NO to create NO_2 but this process will not occur quickly or completely before the plume reaches ground level. Therefore, it is overly conservative to assume 100% conversion from NO to NO_2 and it is necessary to use a factor to estimate ground level concentrations of NO_2 based upon total NO_X emitted.

A number of international agencies have developed guidelines for including in assessments the conversion of NO to NO_2. The guidelines indicate that a wide range of ratios to convert NO to NO_2 are recommended by different country agencies (see *Table 7.20).*

For this study, a conservative conversion factor of 50% for the short term and 100% for long term was adopted. This applies only to the assessment of impacts on sensitive human receptors, as when assessing impacts on sensitive ecological receptors total NO_X is assessed and therefore no conversion is required.

Table 7.20 Recommended NO to NO_2 Conversion Ratio

Country	Averaging Period	Recommended NO to NO_2 Conversion Ratio
United States Environmental Protection Agency	24 hour	75%
	Annual	75%
German Federal Environment Agency	24 hour	60%
	Annual	60%
United Kingdom Environment Agency	Short term (1 hour) (screening)	50%
	Annual (screening)	100%
Ontario Ministry of the Environment, Canada	24 hour	52%
	Annual	68%

Non-Routine Events

TGL will avoid routine operational gas flaring as a means of disposal of associated gas. Any flaring will be kept to a minimum during any production or well clean-up tests, and during plant commissioning, start-ups, operation and operational upsets. There will be no continuous operational flaring.

Non-routine flaring events are typically short term but have the potential to result in short term elevated emissions. Non-routine flaring may be required for the safe disposal of gas during upset conditions. This is achieved by diverting gas to flares where it can be burned off until the plant operations are restored to normal.

The FPSO design includes HP/LP flaring equipment to combust gas from non-routine events related to maintenance and emergencies. Typical flaring events will occur for less than 60 minutes. The flaring event selected for modelling represents the worst case volume of gas reasonable expected to be flared from anticipated non-routine events. Gas composition used for modelling flaring emissions is provided in *Volume II: Annex A*.

7.5.8 Air Quality Assessment Criteria

This assessment refers to Ghanaian and WHO ambient air quality standards. These are set out in *Table 7.21*. The WHO guidelines are assumed to apply at all locations- onshore and offshore. The Ghanaian air quality standards are assumed to only apply at onshore locations.

Impacts relating directly to air quality (*ie* NO_X, SO_2) are not habitat or species specific and are the same for all sites. In the absence of habitat specific national air quality standards the criteria used in this assessment are from the European Directive on Clean Air for Europe (2008/50/EC), and are set out in *Table 7.22*.

Table 7.21 Air Quality Guidelines

Pollutant	**Averaging Period**	**Guideline Value (μgm^{-3})**		
		WHO	**Ghana** **Residential and rural**	**Ghana** **Industrial/ commercial**
SO_2	1-year mean		50	80
	24-hour maximum	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)	50	100
	1-hour maximum		700	900
NO_2	1-year mean	40 (guideline)	-	-
	24-hour maximum		60	150
	1-hour maximum	200 (guideline)	200	400
PM_{10}	1-year mean	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline)	-	-
	24-hour assessed as the third highest 24 hour period (99th percentile)	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)	-	-
	24-hour maximum		70	70
$PM_{2.5}$	1-year mean	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)	-	-
	24-hour maximum	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)	-	-
CO	1 hour maximum	60,000	30,000	
	8 hour maximum	30,000	10,000	

Table 7.22 Air Quality Critical Levels used for the Assessment of Impacts on Sensitive Ecological Receptors

Pollutant	Averaging Period and Statistic	Assessment Criterion (μgm^{-3})
NO_x	Annual mean	30
SO_2	Annual mean	20

7.5.9 *Air Quality Significance Criteria*

The magnitude of impacts was quantified using predictive techniques based on dispersion modelling results. The magnitude of air quality impacts is related to the Process Contribution (PC). This is the impact arising solely from project related emissions. Consideration is required of existing baseline air quality in order to determine the significance of impacts.

IFC (2007) guidance differentiates the significance of impacts, based upon the existing baseline air quality in the vicinity of a proposed development. On the basis of a review of likely baseline conditions (see *Section 7.5.10*), and in the absence of comprehensive air quality data, the air quality in the coastal districts of the Western Region is assumed to be undegraded (*ie* existing pollution concentrations are within guidelines).

For this assessment, the significance of impacts is, defined in terms of the Process Contribution, and whether predicted concentrations are above or below the air quality standards as set out in *Section 7.5.8*. Using this approach, the significance criteria for air quality have been defined. These are set out in *Table 7.23*.

Table 7.23 Significance Criteria for Assessment of Airborne Pollutants

Significance of Impact	Magnitude of Impact
Not significant	PC <25% of Air Quality Standard (AQS)
Minor	PC between 25% and 50% of AQS and PEC <100% of AQS
Moderate	PC between 50% and 100% of AQS, and PEC <100% AQS; or
	PC between 25% and 50% of AQS, and PEC >100% of AQS
Major	PC > 100% of AQS

Note: The significance for humans and ecology are treated as the same in light of no alternative information.

7.5.10 *Baseline and Receptors*

TGL conducted ambient air quality monitoring at five locations: the Jubilee FPSO (indoors and outdoors), TGL's Accra offices and the Takoradi pipeyard and staff house. *Table 7.24* presents the minimum, maximum and average measurements for the three pollutants of interest. All the measured concentrations were within the permissible limits of the WHO, US EPA and Ghana EPA air quality standards presented in *Table 7.21*.

Table 7.24 Summary of Ambient Air Quality Monitoring (2013)

Location	NO_2 (µg m^{-3})			SO_2 (µg m^{-3})			O_3 (µg m^{-3})		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
FPSO indoor	2.9	10.0	4.7	0.4	15.9	3.0	9.5	25.8	19.3
FPSO outdoor	2.0	14.8	4.7	0.3	5.5	1.5	8.5	97.4	65.2
Accra TGL Offices	19.7	60.1	32.3	2.1	12.4	6.3	38.7	95.7	59.9
Takoradi pipeyard	4.7	23.4	9.4	0.7	13.8	3.3	39.9	97.1	64.9
Takoradi staff house	3.0	30.1	9.7	0.8	8.2	3.2	29.6	103.9	53.9

No baseline air quality monitoring data was available for coastal areas within the Western Region. The baseline levels of NO_X, NO_2, CO and SO_2 along the coastline are expected to be lower than those in Takoradi and Accra since there are very few large industrial facilities. The baseline conditions of PM_{10} and $PM_{2.5}$ may be elevated in the study area due to local and regional sources. These will primarily be natural sources, associated with the dry season and local industry. The maximum air impacts have been assessed for all onshore and offshore locations within the receptor grid and at designated points within identified, representative ecological sites.

Onshore receptors include settlements at or near the coastline. For the purposes of this assessment, three representative ecologically sensitive coastal receptors have been identified, namely Domini Lagoon and Amansuri wetland in Ghana, and Iles Ehotilé-Essouman wetland in Côte d'Ivoire(1).

The air quality standards and guidelines (see *Section 7.5.8*) apply primarily to fixed receptors on the coastline. Whilst artisanal fishing boats may occur closer to the FPSO, these receptors are considered to be transient and these will not be present around the FPSO for long enough periods. In addition, the maximum impacts will occur within 5 km of the FPSO and therefore within the ATBA around the FPSO.

7.5.11 Modelling Results and Impact Assessment

Predicted Impacts for Human Sensitive Receptors

The impact assessment focusses on Scenario 1, Scenario 3 and Scenario 4.

- Scenario 1 includes emissions from the TEN FPSO without flaring and is a representative normal TEN FPSO operations only.
- Scenario 3 includes emissions from the TEN FPSO and Jubilee FPSO and is representative of cumulative normal operations.

(1) Iles Ehotilé-Essouman wetlands are located along the east coast of Côte d'Ivoire ,near the border with Ghana. Although this receptor is located outside Ghana, it was included in this assessment due to its proximity to the TEN Project area.

- Scenario 4 includes the TEN FPSO and emissions from the MODU which represents worst case cumulative emissions from the TEN Project operations.

Table 7.25, Table 7.26, and *Table 7.27* present the emissions modelling results and impact assessment for Scenarios 1, 3 and 4 respectively. Results for Scenario 2 and Scenario 5 are provided in *Volume II: Annex A*. Each table sets out the following.

- Pollutants of interest.
- Averaging period.
- Air quality standard or guideline (WHO and Ghana).
- Process Contribution (PC).
- Percentage contribution of PC relative to standard or guideline.
- Significance of the predicted impacts according to *Table 7.21.*

The PCs presented are the highest predicted (offshore and onshore) for any of the five years of meteorological data. The results of the impacts that were predicted to exceed 50% of the WHO guideline value are presented in *Figure 7.15* to *Figure 7.19.*

The results of the dispersion modelling showed that for all the scenarios assessed there were no significant impacts or breaches of air quality standards at any onshore location, even when considered in addition to the ambient baseline conditions. The greatest impacts will be from NO_2 and SO_2 emissions close to the release points at the FPSO and, during commissioning, in close proximity to the MODU. On this basis, the defining of the exclusion zone to 500 m is a reasonable precaution to ensure that transient receptors are not exposed to unacceptable air pollution.

Predicted Impacts on Ecological Receptors

Table 7.28, Table 7.29, and *Table 7.30* set out the results of the impact assessment for Scenarios 1, 3 and 4 compared to Air Quality Critical Levels for sensitive ecological receptors(1). No assessment is required of the impacts of flaring events on sensitive ecological receptors as the small overall increase in impact associated with the short term use of flaring is anticipated to have a negligible effect on the overall annual mean concentrations. There is predicted to be no significant impact for all pollutants.

(1) European Directive on Clean Air for Europe (2008/50/EC)

Table 7.25 Summary of Maximum Predicted Impacts, for any Meteorological Year - Scenario 1

Location	Pollutant	Averaging Period	WHO (μgm^{-3})	GHANA (μgm^{-3})	PC (μgm^{-3})	PC/WHO (%)	PC/GHANA (%)	Significance	
								WHO	Ghana
All locations	NO_2	1 hour maximum	200	200	43	21	21	*Not Significant*	*Not Significant*
	NO_2	Annual average	40		2.2	5		*Not Significant*	*N/A*
	SO_2	Annual average		50	0.079		0.16	*N/A*	*Not Significant*
	SO_2	24 hour maximum	20	50	13	64	26	*Moderate*	*Minor*
	SO_2	1 hour maximum		700	41		5.9	*N/A*	*Not Significant*
	PM_{10}	Annual average	20		0.00240	0.012		*Not Significant*	*N/A*
	PM_{10}	24 hour maximum		70	0.5		0.7	*N/A*	*Not Significant*
	PM_{10}	24 hour 99-percentile, not to be exceeded more than 3 times per year	50		0.46	1		*Not Significant*	*N/A*
	$PM_{2.5}$	Annual average	10		0.00240	0.024		*Not Significant*	*N/A*
	$PM_{2.5}$	24 hour maximum	25		0.5	2		*Not Significant*	*N/A*
	CO	1 hour maximum	60,000	30,000	95.2	0.16	0.32	*Not Significant*	*Not Significant*
	CO	8 hour maximum	30,000	10,000	67.9	0.23	0.68	*Not Significant*	*Not Significant*
Coastal locations	NO_2	1 hour maximum	200	200	8.1	4	4	*Not Significant*	*Not Significant*
	NO_2	Annual average	40		0.211	0.53	0.	*Not Significant*	*N/A*
	SO_2	Annual average		50	0.00533		0.011	*N/A*	*Not Significant*
	SO_2	24 hour maximum	20	50	1.61	8	3.2	*Not Significant*	*Not Significant*
	SO_2	1 hour maximum		700	6.1		0.9	*N/A*	*Not Significant*
	PM_{10}	Annual average	20		0.000160	0.0008		*Not Significant*	*N/A*
	PM_{10}	24 hour maximum		70	0.061		0.06	*N/A*	*Not Significant*
	PM_{10}	24 hour 99-percentile, not to be exceeded more than 3 times per year	50		0.044	0.09		*Not Significant*	*N/A*
	$PM_{2.5}$	Annual average	10		0.000160	0.0016		*Not Significant*	*N/A*
	$PM_{2.5}$	24 hour maximum	25		0.061	0.2		*Not Significant*	*N/A*
	CO	1 hour maximum	60,000	30,000	13.2	0.02	0.04	*Not Significant*	*Not Significant*
	CO	8 hour maximum	30,000	10,000	8.0	0.03	0.08	*Not Significant*	*Not Significant*

PC: Process Contribution. N/A: Not Applicable

Table 7.26 Summary of Maximum Predicted Impacts, for any Meteorological Year - Scenario 3

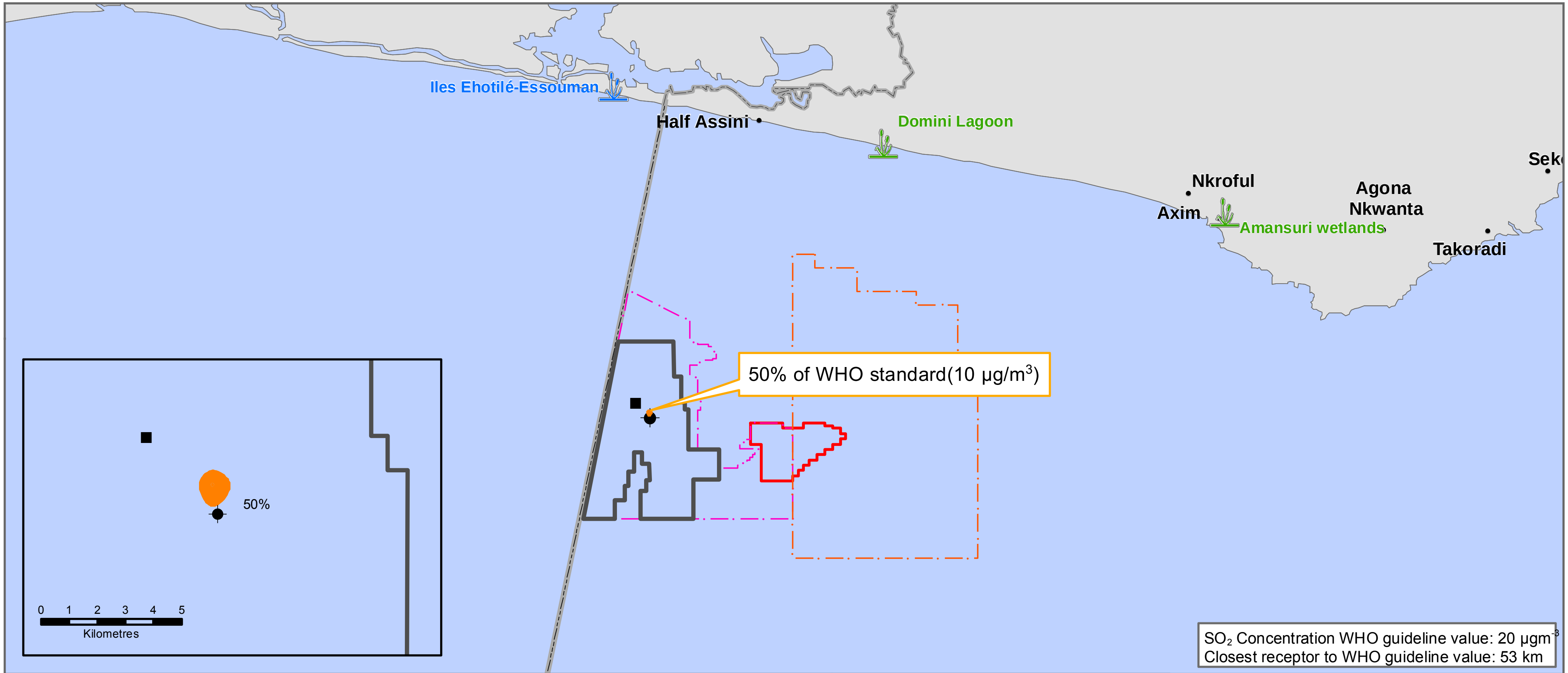
Location	Pollutant	Averaging Period	WHO (μgm^{-3})	GHANA (μgm^{-3})	PC (μgm^{-3})	PC/ WHO (%)	PC/ GHANA (%)	Significance WHO	Significance Ghana
All locations	NO_2	1 hour maximum	200	200	53	26	26	*Minor*	*Minor*
	NO_2	Annual average	40		2.2	6		*Not Significant*	*N/A*
	SO_2	Annual average		50	0.079		0.16	*N/A*	*Not Significant*
	SO_2	24 hour maximum	20	50	14	69	27	*Moderate*	*Minor*
	SO_2	1 hour maximum		700	53		7.6	*N/A*	*Not Significant*
	PM_{10}	Annual average	20		0.00240	0.012		*Not Significant*	*N/A*
	PM_{10}	24 hour maximum		70	0.5		0.71	*N/A*	*Not Significant*
	PM_{10}	24 hour 99-percentile, not to be exceeded more than 3 times per year	50		0.5	1		*Not Significant*	*N/A*
	$PM_{2.5}$	Annual average	10		0.00240	0.024		*Not Significant*	*N/A*
	$PM_{2.5}$	24 hour maximum	25		0.5	2		*Not Significant*	*N/A*
	CO	1 hour maximum	60,000	30,000	123.7	0.21	0.41	*Not Significant*	*Not Significant*
	CO	8 hour maximum	30,000	10,000	78.1	0.26	0.78	*Not Significant*	*Not Significant*
Coastal locations	NO_2	1 hour maximum	200	200	9.0	5	5	*Not Significant*	*Not Significant*
	NO_2	Annual average	40		0.376	0.9		*Not Significant*	*N/A*
	SO_2	Annual average		50	0.0095		0.019	*N/A*	*Not Significant*
	SO_2	24 hour maximum	20	50	1.97	10	4.0	*Not Significant*	*Not Significant*
	SO_2	1 hour maximum		700	7.0		1.0	*N/A*	*Not Significant*
	PM_{10}	Annual average	20		0.000290	0.0015		*Not Significant*	*N/A*
	PM_{10}	24 hour maximum		70	0.074		1.06	*N/A*	*Not Significant*
	PM_{10}	24 hour 99-percentile, not to be exceeded more than 3 times per year	50		0.055	0.11		*Not Significant*	*N/A*
	$PM_{2.5}$	Annual average	10		0.000290	0.0029		*Not Significant*	*N/A*
	$PM_{2.5}$	24 hour maximum	25		0.074	0.3		*Not Significant*	*N/A*
	CO	1 hour maximum	60,000	30,000	15.1	0.03	0.05	*Not Significant*	*Not Significant*
	CO	8 hour maximum	30,000	10,000	8.6	0.03	0.09	*Not Significant*	*Not Significant*

PC: Process Contribution. N/A: Not Applicable

Table 7.27 Summary of Maximum Predicted Impacts, for any Meteorological Year - Scenario 4

Location	Pollutant	Averaging Period	WHO (μgm^{-3})	GHANA (μgm^{-3})	PC (μgm^{-3})	PC/ WHO (%)	PC/GHANA (%)	Significance	
								WHO	Ghana
All locations	NO_2	1 hour maximum	200	200	272	136	136	*Major*	*Major*
	NO_2	Annual average	40		26.4	66		*Moderate*	*N/A*
	SO_2	Annual average		50	0.08		0	*N/A*	*Not Significant*
	SO_2	24 hour maximum	20	50	13	64	26	*Moderate*	*Minor*
	SO_2	1 hour maximum		700	41		5.9	*N/A*	*Not Significant*
	PM_{10}	Annual average	20		0.002	0.0		*Not Significant*	*N/A*
	PM_{10}	24 hour maximum		70	0.5		0.71	*N/A*	*Not Significant*
	PM_{10}	24 hour 99-percentile, not to be exceeded more than 3 times per year	50		0.46	1		*Not Significant*	*N/A*
	$PM_{2.5}$	Annual average	10		0.002	0.0		*Not Significant*	*N/A*
	$PM_{2.5}$	24 hour maximum	25		0.5	2		*Not Significant*	*N/A*
	CO	1 hour maximum	60,000	30,000	585.1	0.98	1.95	*Not Significant*	*Not Significant*
	CO	8 hour maximum	30,000	10,000	462.6	1.54	4.63	*Not Significant*	*Not Significant*
Coastal locations	NO_2	1 hour maximum	200	200	47.6	24	24	*Not Significant*	*Not Significant*
	NO_2	Annual average	40		1.80	4.5	2.25	*Not Significant*	*N/A*
	SO_2	Annual average		50	0.005		0.0	*N/A*	*Not Significant*
	SO_2	24 hour maximum	20	50	1.6	8	3.2	*Not Significant*	*Not Significant*
	SO_2	1 hour maximum		700	6.1		0.9	*N/A*	*Not Significant*
	PM_{10}	Annual average	20		0.0002	0.00		*Not Significant*	*N/A*
	PM_{10}	24 hour maximum		70	0.061		0.09	*N/A*	*Not Significant*
	PM_{10}	24 hour 99-percentile, not to be exceeded more than 3 times per year	50		0.044	0.1		*Not Significant*	*N/A*
	$PM_{2.5}$	Annual average	10		0.0002	0.00		*Not Significant*	*N/A*
	$PM_{2.5}$	24 hour maximum	25		0.061	0.2		*Not Significant*	*N/A*
	CO	1 hour maximum	60,000	30,000	94.0	0.16	0.31	*Not Significant*	*Not Significant*
	CO	8 hour maximum	30,000	10,000	54.0	0.18	0.54	*Not Significant*	*Not Significant*

PC: Process Contribution. N/A: Not Applicable



TEN Project Area
Jubilee Unit Area
DWT Block
West Cape Three Points Block
MODU
TEN FPSO
Wetlands
Ramsar Site
International Boundary

0 10 20 30 40
Kilometres
N

Figure 7.15
24 hour maximum SO_2 (µgm^{-3}),
TEN FPSO Emissions
(Scenario 1)

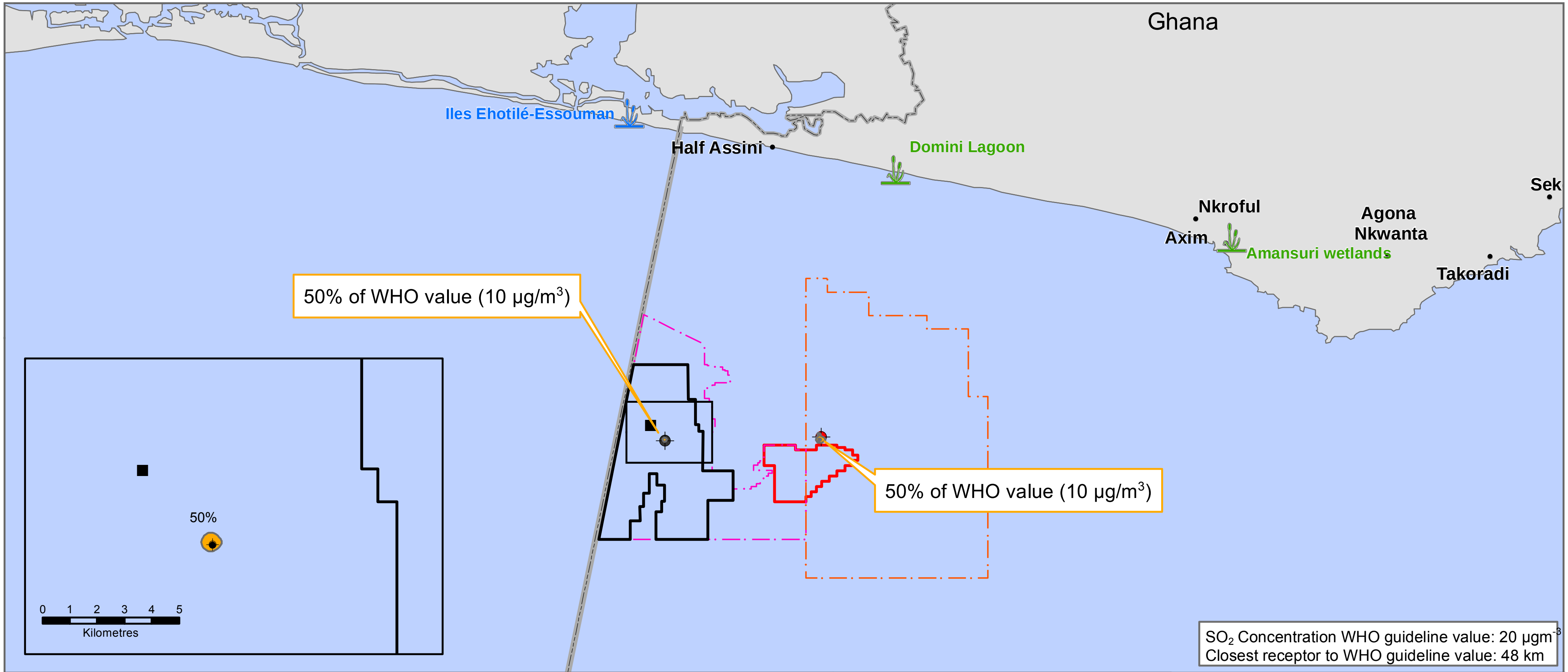
SCALE: 1:10,000
SIZE: A4
PROJECT: 0142816
DATE: 10/04/2014

REVISION: 1
DRAWN: GB
CHECKED: JW
APPROVED: MI

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow www.ramsar.org

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Air_SO2_24hr_S1_pc A01.mxd



TEN Project Area
Jubilee Unit Area
DWT Block
West Cape Three Points Block
MODU
TEN FPSO
Jubilee FPSO
Wetlands
Ramsar Site
International Boundary

0 10 20 30 40
Kilometres

N

Figure 7.16
24 hour maximum SO_2 (μgm^{-3}), TEN FPSO and Jubilee FPSO Emissions (Scenario 3)

SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

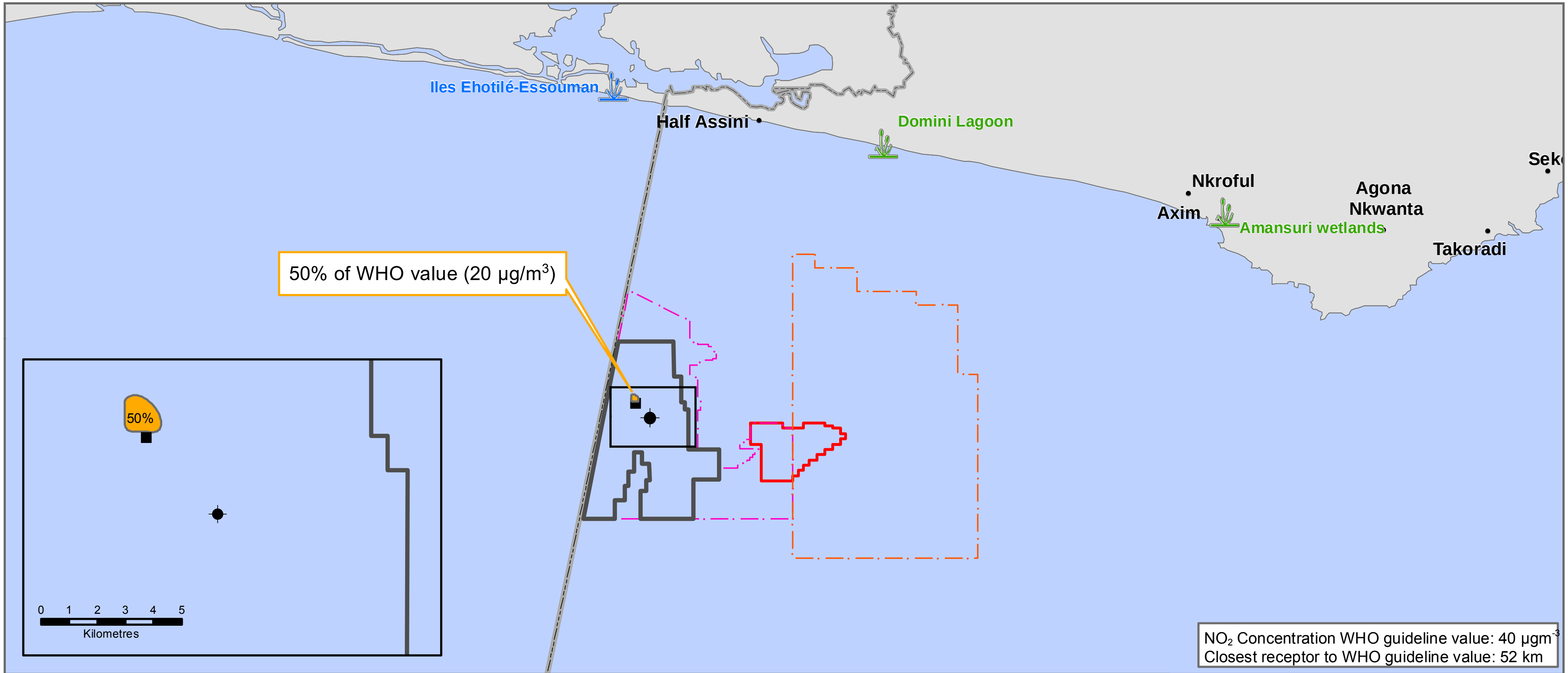
ERM

TEN project

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow www.ramsar.org

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Air_SO2_24hr_S3_pc.mxd



TEN Project Area
Jubilee Unit Area
DWT Block
West Cape Three Points Block
MODU
TEN FPSO
Wetlands
Ramsar Site
International Boundary

0 10 20 30 40
Kilometres
N

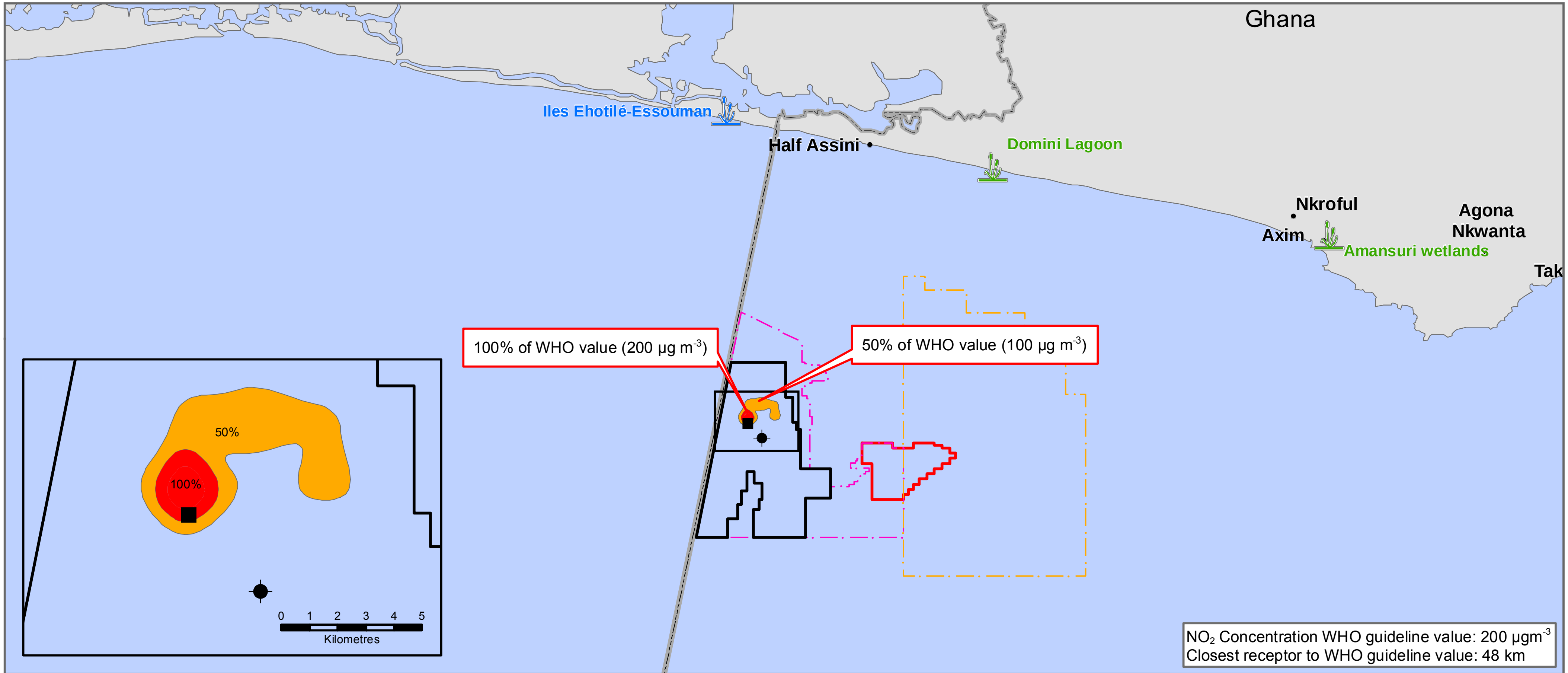
Figure 7.17
Annual mean NO_2 (μgm^{-3}), TEN FPSO, TEN Flare and MODU Emissions (Scenario 4)

SCALE: 1:10,000	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow www.ramsar.org

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Air_NO2_Ann_S4_pc A01.mxd



TEN Project Area
Jubilee Unit Area
DWT Block
West Cape Three Points Block

MODU
TEN FPSO
Wetlands
Ramsar Site
International Boundary

0 10 20 30 40
Kilometres

N

Figure 7.18
1 hour maximum NO_2 (μgm^{-3}), TEN FPSO, TEN Flare and MODU Emissions (Scenario 4)

SCALE: 1:10,000
SIZE: A4
PROJECT: 0142816
DATE: 10/04/2014

REVISION: 1
DRAWN: GB
CHECKED: JW
APPROVED: MI

ERM

TEN project

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow www.ramsar.org

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Air_NO2_1hr_S4_pc A01.mxd

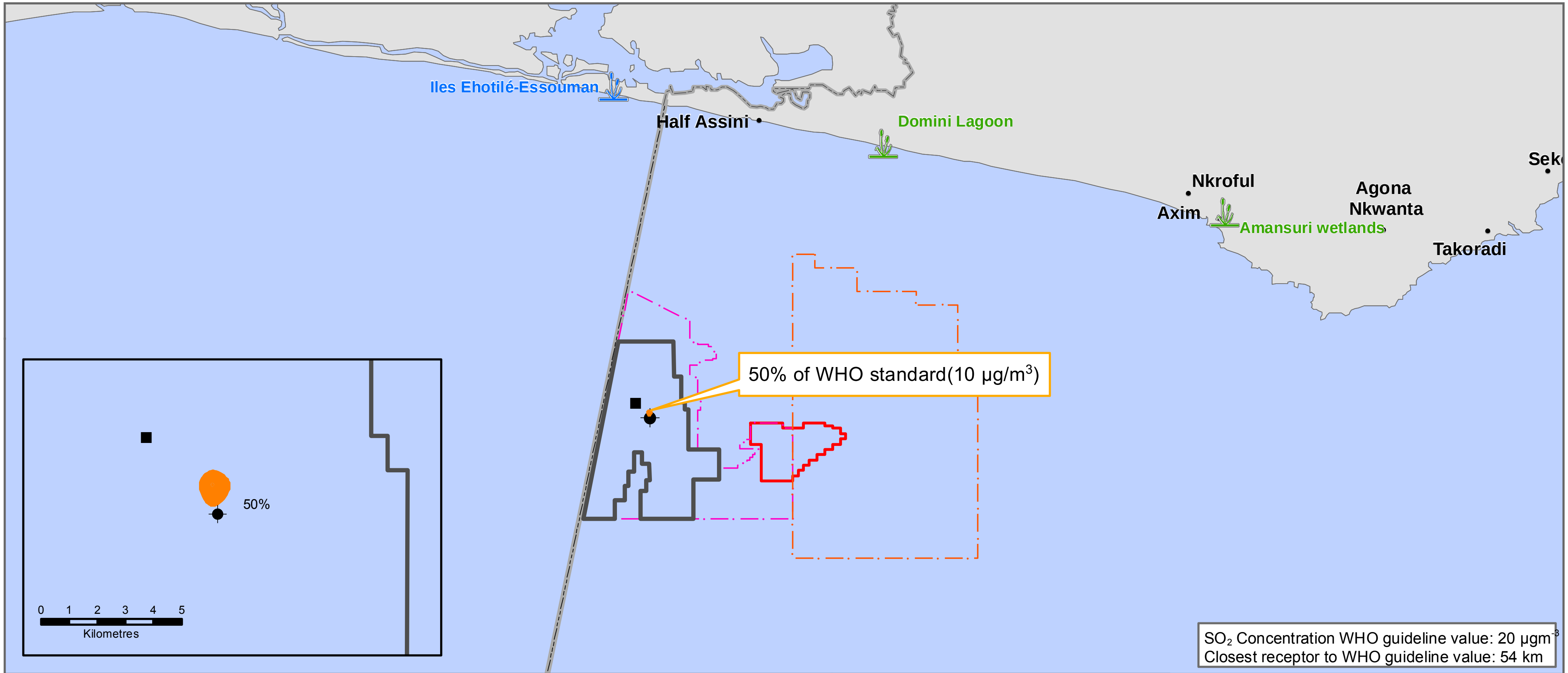


Figure 7.19
24 hour maximum SO_2 (μgm^{-3}), TEN FPSO, TEN Flare and MODU Emissions (Scenario 4)

SCALE: 1:10,000	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 10/04/2014	APPROVED: MI

PROJECTION: WGS 1984 UTM Zone 30N

SOURCE: Tullow www.ramsar.org

Path: T:\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Air_SO2_24hr_S4_pc A01.mxd

Table 7.28 Scenario 1: Predicted Annual Mean Concentrations of NO_X and SO_2 at Sensitive Ecological Receptors (TEN FPSO Emissions)

Habitat	Pollutant	Critical Level (μgm^{-3})	PC (μgm^{-3})	PC/ AQS (%)	Significance
Grand-Bassam Ramsar	NO_x	30	0.02148	0.072	*Not Significant*
	SO_2	20	0.000470	0.0024	*Not Significant*
N'Ganda N'Ganda Ramsar	NO_x	30	0.0434	0.14	*Not Significant*
	SO_2	20	0.001020	0.0051	*Not Significant*
Iles Ehotilé-Essouman Ramsar	NO_x	30	0.07969	0.27	*Not Significant*
	SO_2	20	0.00174	0.0087	*Not Significant*
Amansuri Wetlands	NO_x	30	0.07028	0.2	*Not Significant*
	SO_2	20	0.00143	0.007	*Not Significant*
Domini Lagoon	NO_x	30	0.18131	0.6	*Not Significant*
	SO_2	20	0.00432	0.022	*Not Significant*

PC: Project Contribution

Table 7.29 Scenario 3: Predicted Annual Mean Concentrations of NO_X and SO_2 at Sensitive Ecological Receptors (TEN FPSO and Jubilee FPSO Emissions)

Habitat	Pollutant	Critical Level (μgm^{-3})	PC (μgm^{-3})	PC/ AQS (%)	Significance
Grand-Bassam Ramsar	NO_x	30	0.0377	0.13	*Not Significant*
	SO_2	20	0.000810	0.0041	*Not Significant*
N'Ganda N'Ganda Ramsar	NO_x	30	0.0663	0.22	*Not Significant*
	SO_2	20	0.00153	0.0077	*Not Significant*
Iles Ehotilé-Essouman Ramsar	NO_x	30	0.111	0.37	*Not Significant*
	SO_2	20	0.00246	0.012	*Not Significant*
Amansuri Wetlands	NO_x	30	0.183	0.6	*Not Significant*
	SO_2	20	0.004	0.020	*Not Significant*
Domini Lagoon	NO_x	30	0.369	1.2	*Not Significant*
	SO_2	20	0.00914	0.046	*Not Significant*

PC: Project Contribution

Table 7.30 Scenario 4: Predicted Annual Mean Concentrations of NO_X and SO_2 at Sensitive Ecological Receptors (TEN FPSO and Drill Rig Emissions)

Habitat	Pollutant	Critical Level (μgm^{-3})	PC (μgm^{-3})	PC/ AQS (%)	Significance
Grand-Bassam Ramsar	NO_x	30	0.1751	0.58	*Not Significant*
	SO_2	20	0.00047	0.0024	*Not Significant*
N'Ganda N'Ganda Ramsar	NO_x	30	0.3824	1.27	*Not Significant*
	SO_2	20	0.00102	0.0051	*Not Significant*
Iles Ehotilé-Essouman Ramsar	NO_x	30	0.838	2.79	*Not Significant*
	SO_2	20	0.00174	0.009	*Not Significant*
Amansuri Wetlands	NO_x	30	0.432	1.4	*Not Significant*
	SO_2	20	0.00143	0.007	*Not Significant*
Domini Lagoon	NO_x	30	1.384	4.6	*Not Significant*
	SO_2	20	0.00432	0.022	*Not Significant*

PC: Project Contribution

7.5.12 *Mitigation Measures*

The following specific mitigation measures will be implemented to reduce the impact of the TEN Project on air quality.

- The FPSO and MODU, construction/installation and support/supply vessels will comply with MARPOL 73/78 Annex VI standards with regards to air emissions (see *Chapter 2 Table 2.2*). Annex VI sets limits on SO_x and NO_x emissions from ship exhausts and diesel engines and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. In addition incineration of certain products on board such as contaminated packaging materials will be prohibited.

- TGL will use of low-sulphur diesel fuel.

- Methods for controlling and reducing leaks and fugitive emissions, such as the use of fuel gas (*ie* reservoir gas processed for power generation on board the FPSO) for crude oil storage tank blanketing together with a vapour recovery unit, will be implemented in the design, operation and maintenance of the offshore facilities.

- Routine flaring will be avoided and non-routine flaring will be kept to minimum to maintain safe conditions or during short-duration activities such as start-up, re-start and maintenance activities.

- Routine inspection and maintenance of engines, generators, and other equipment will be carried out to maximise equipment fuel efficiency and minimise excess air emissions.

- A Vapour Recovery Unit (VRU) will be installed to collect the vapours from the gas treatment system's TEG dehydration reboiler unit to mitigate the venting of aromatic hydrocarbon compounds that can be released by these units.

7.5.13 *Conclusions*

The key findings of the assessment are that there will be *no significant* impacts (both for short term and long term) on onshore human or ecological receptors during normal operations. Even considering cumulative emissions, with both FPSOs operating whist drilling is taking place (Scenario 4), there will be no air quality standards exceeded in any circumstance at any onshore locations.

With regard to impacts on transient receptors, there are predicted to be significant impacts (mainly short term exceedances) in close proximity to the FPSO and the MODUs where these are in use. On this basis, setting an exclusion zone of 500 m around the FPSO and MODUs is reasonable to ensure that these receptors are not exposed to excessive air pollution.

A flaring study has been conducted for the Jubilee operations which found the modelled concentrations of NO_2 and CO are very low, with average concentrations experienced by receptors lower than 1% of the respective WHO criteria. This is to be expected from flaring gas which is discharged at height and at high temperature which increases the dispersion. The contribution of continuous flaring at Jubilee does not change the assessment of significance above.

7.6 *GREENHOUSE GAS EMISSIONS*

7.6.1 *Scope of Assessment*

Project activities will emit varying amounts of Greenhouse Gases (GHGs) (*eg* carbon dioxide (CO_2) and methane (CH_4)), believed to contribute to global climate change. This section aims to quantify and assess the significance of GHG emissions expected to be generated by project activities. GHG estimations include well drilling and completions, subsea and FPSO installations, commissioning and operations. Detailed emission calculations are included in *Volume II: Annex A*.

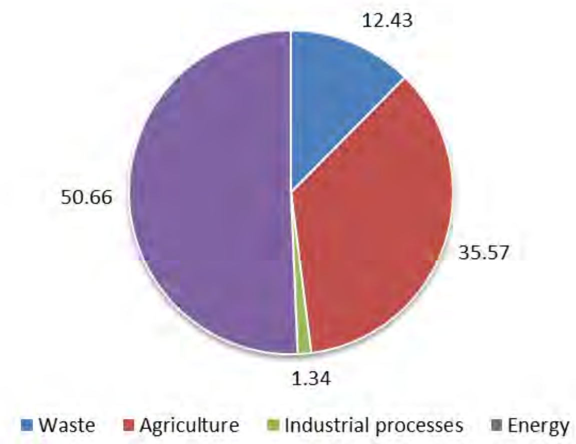
7.6.2 *Introduction*

The standards for reporting GHG emissions and country targets are managed by the United Nations Framework Convention on Climate Change (UNFCCC) which was ratified by Ghana in 1995.

According to the UNFCCC, the GHG emissions for Ghana in 2006 (the most recent year available) were 2.38×10^7 tonnes per year. This does not include any reductions associated with land-use change and forestry (LUCF). If these reductions are included, the country's GHG emissions drop to 1.82 x 10^7 tonnes per yr. From 1990 to 2006, GHG emissions have been increasing in Ghana, with the 2006 emissions equating to a 97.5% increase from 1990 levels (*ie* an average increase of 6% per year).

The approximate distribution of GHG emissions by sector is provided in *Figure 7.20*.

Figure 7.20 Breakdown of Ghana's GHG Emissions by Sector (Percentage)



Note: 'Solvents' and 'Other' categories = 0

Source: UNFCCC 2006; GHG emissions without LUCF

If the latest GHG data for Ghana (2006) were projected to 2012 by the same rates of increase as between 1990 and 2006 (*ie* 6% per year), then emissions for Ghana as of 2012 would be in the range of 3 x 10^7 tonnes/yr. In addition, taking into account the significant increase in oil and gas activity in Ghana over that time period, the energy sector will now be a more significant source of GHG emissions than in 2006.

7.6.3 Sources of GHG Emission

The GHGs of particular relevance to the TEN Project are CO_2 and CH_4. The principal sources of GHGs from the project will include the following.

- Main power generation systems (turbines) on the FPSO which are used to generate electricity for gas compression and water injection including gas turbine generators and the deck boiler. There are also other less significant combustion sources on the FPSO such as backup generators.

- Main power generation systems on the MODU for power generation during well drilling and completions.

- Engine emissions from project installation/construction vessels and supply/support vessels.

- No continuous flaring of hydrocarbon gases during normal operations is planned. During commissioning and due to upset, maintenance and emergency condition there will be flaring of gas for safety reasons.

7.6.4 *Predicted Project GHG Emissions*

When evaluating GHG emissions, the concept of a Global Warming Potential (GWP) is used to enable different GHG emissions to be compared to each other and expressed in terms of CO_2-e (carbon dioxide equivalents). Emissions of GHGs are thus given by using the GWP as weighting factors for the emissions of particular GHGs. The key GHGs for the TEN Project are CO_2 (with a weighting factor of 1) and CH_4 (with a weighting factor of 23). This calculation of carbon dioxide equivalents is as follows:

CO_2-e (tonnes) = 1 (tonnes of CO_2) + 23 (tonnes of CH_4).

To quantify these emissions, a detailed emission inventory has been produced. This inventory is provided in *Table 7.31*. Emissions from the drilling, subsea and FPSO installation and commissioning phases will occur over a defined period, while GHG emissions from the operations phase will occur throughout the operating life of the development. For the purposes of this assessment the overall annual GHG emissions for the project has been calculated as the sum of the average annual GHG emissions from all phases.

Table 7.31 Estimated Annual GHG Emissions by Project Phase

Phase	Estimated Emissions (tonnes/year)		
	CO2	**CH4**	**CO2 equivalent**
Well drilling and completions (all wells)	352,961	30	353,651
Subsea equipment installation	675,334	6	675,463
FPSO installation	72,776	1	72,794
Commissioning	987,473	3,503	1,068,044
Operations	384,809	657	399,912

Note: detailed calculations are provided in *Volume II: Annex A*

7.6.5 *Mitigation Measures*

As part of Tullow Oil's Environmental Standards, there is a commitment to reduce greenhouse gas emissions and minimise impacts to the environment.

Specifically, the standards state that TGL will undertake the following.

- Develop and implement a project flaring strategy for normal steady state production with a goal to eliminate and / or minimise flaring.
- Undertake a disposal options analysis where there is production of hydrocarbons outside the normal producing profile (*ie* excess gas).
- Develop an operational strategy to monitor, reduce and work to eliminate cold vent volumes.

- Establish a targeted maximum abnormal flaring rate of 5% of the monthly average gas production.

- Quantify annually total GHG emissions in order to identify areas of improvement as part of TGL's EHSMS.

Project-level mitigation for GHG emissions includes the implementation of measures for improving efficiency in energy consumption and options to reduce project-related GHG emissions. For the TEN Project, the mitigation measures are generally built into the design of the FPSO, such as the selection of the following.

- Fuel gas blanketing for cargo tanks coupled to a vapour recovery system to return hydrocarbons to the process.

- A closed flare system with a flare gas recovery unit.

TGL has undertaken Best Available Technology (BAT)[1] assessments to demonstrate that GHG emissions have been reduced to ALARP in relation to the following:

- efficiency of power generation;
- optimisation of overall energy efficiency;
- reduction in flaring; and
- reduction in venting.

7.6.6 *Impact Assessment*

As a benchmark of international good practice, the IFC's *Performance Standard 3 for Resource Efficiency and Pollution Prevention* require developers to use more efficient and effective GHG emission avoidance and mitigation technologies and practices (IFC 2007e) [2]. Under PS 3 the GHG reporting threshold for a single project is 25,000 tonnes CO_2-e per annum. The calculated emissions from each element of the project will exceed the reporting threshold with the highest contribution being from commissioning activities (see *Table 7.31*).

(1) Best Available Technology (BAT) is defined as the most effective and advanced stage in the development of an activity and its methods of operation, which indicate the practical suitability of particular techniques for providing, in principle, the basis for emission values designed to prevent or eliminate or where that is not practicable, generally to reduce an emission and its impacts on the environment as a whole.
(2) The IFC's (2007e) GHG reporting threshold is 25,000 tons CO2-equivalent per year for a single project.

Through the detailed design process the TEN Project has designed the FPSO to be energy efficient and will reduce the emissions associated with combustion (*ie* fuel use and flaring), through implementing the following measures.

- The FPSO has been designed with centralised electrical power generation, provided by high efficiency gas turbines(1), sized and configured to the FPSO power demand.

- The project design avoids the need for continuous flaring. TGL has established a targeted maximum abnormal flaring rate of 5% of the monthly average total gas production. BAT has been applied to the design and operation of the flare system. A flare reduction strategy has been documented and applied with BAT assessments to document decisions.

Assuming that TGL will implement technically and financially feasible and cost-effective measures to reduce the project GHG emissions, this impact is assessed to be of *Minor* significance. TGL will quantify annually total GHG emission from production and flaring activities in accordance with internationally recognised methodologies and reporting procedures(2). Where benchmarking data are available, TGL will make a comparison to establish the relative level of energy efficiency and GHG emissions (*eg* CO_2-e produced per barrel of oil).

7.7 *WASTE MANAGEMENT*

7.7.1 *Scope of Assessment*

The TEN Project will generate both hazardous and non-hazardous solid waste during the well drilling and completion, subsea installation, commissioning and operational phases. Waste arisings from the decommissioning phase are addressed in *Chapter 10*. The main solid wastes types expected to be produced from the project are outlined in *Chapter 3: Section 3.8.6*.

The following section discusses the potential environmental and social impacts of waste associated with the project throughout the following three stages of the waste management process.

- Waste segregation and storage at both offshore and onshore locations.

- Transportation of waste from the point of generation (mainly offshore) to onshore management locations.

(1) The BAT assessment will consider DLE and SAC turbine options.
(2) WRI Greenhouse Gas Protocol's Corporate Accounting and Reporting Standards and Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories 2006.

- Impacts associated with management practices of specific waste treatment and disposal sites.

For each of these three stages the potential impacts, mitigation measures and residual impacts are discussed. Effluent discharges as well as produced sand and drilling waste (drill cuttings and fluid) are discussed in *Section 7.4*.

7.7.2 *Waste Segregation and Storage*

Description of Potential Impacts

The main sources of potential environmental impact resulting from segregation and storage of generated wastes at the project sites include the following.

- Inappropriate offshore storage and containment of wastes on the MODU, FPSO or supply vessels that may result in accidental discharge or spillage of wastes to the marine environment leading to an adverse impact on localised water quality. This would include the spillage and discharge of liquid hazardous wastes such as used oil and chemicals, and impacts on the offshore marine biodiversity; and the overboard discard of solid wastes that can be ingested by seabirds (such as plastics), turtles or other marine species, or wash up on beaches as litter.

- Inappropriate storage and containment of wastes at the onshore supply base may result in accidental discharge and/or spillage of liquid wastes to soils and water resources. This could result in contamination of soils, surface water, groundwater, harbour or coastal waters and communities may be adversely impacted if contaminated water or soil resources are then used for drinking, washing, fishing or growing crops.

- Poor storage onshore may result in exposure of hazardous wastes to staff or the local population impacting on human health.

- Large quantities of waste stored in an unmanaged or uncontrolled way will have associated risk of fire.

- Proper segregation of waste streams facilitates recycling and reuse (which may allow for value recovery from the waste stream) leading to positive impacts.

Mitigation Measures

Designated areas for the temporary storage and segregation of waste will be available on the FPSO, MODU and supply vessels. The onshore bases at Takoradi Port and the Air Force base will also have designated secure waste reception and temporary storage facilities.

Mitigation of potential impacts related to storage and segregation of waste are by operational controls. The key procedures for controlling wastes from offshore and onshore are contained in the TGL Waste Management Plan (WMP) which will be updated with specific information relevant to the TEN Project.

The TGL WMP will require that facilities operated or controlled by TGL (including contractors based within TGL's shore base facilities) will adopt specific procedures for the management of wastes, including the segregation of non-hazardous and hazardous wastes at source and appropriate containment measure for specific waste types.

The WMP will cover both offshore and onshore project facilities. Offshore facilities include the TEN and Jubilee FPSOs, supply vessels, installation vessels and the MODU during well drilling and completions. The onshore facilities include the onshore support base at Takoradi Port and supply base, offices and helicopter facilities at Takoradi Air Force base.

Impact Assessment

Assuming that the mitigation measures are implemented as defined in the TGL WMP, the risk of significant accidental discharge or spillage of waste to the receiving environment will have been minimised through good waste management practices including safe and secure segregation, storage and containment. Proper segregation of waste will facilitate the re-use and recycling of suitable waste streams as identified in the WMP. The impacts from waste storage and segregation are predicted to be of *not significant*.

7.7.3 Transport of Waste

Description of Potential Impacts

Wastes from project facilities will need to be transported for waste treatment and disposal. The main sources of potential environmental impact that could result from the transport of wastes include the following.

- Inappropriate handling and containment of wastes during transport on supply vessels (*ie* taking waste from the FPSO onshore) may result in accidental discharge or spillage of wastes to the marine environment.

- Inappropriate management and control of vehicles and vessels transporting wastes up to and including the approved disposal site may result in potential impacts on both the environment (*eg* soils and groundwater) and local communities, for example due to littering, spillage of potentially hazardous wastes during transport, and poor security of waste.

Mitigation Measures

Mitigation of potential impacts of waste transport will be by the way of operational controls. These will be documented in the TGL WMP.

Operational controls will include the following.

- Waste will be transported in a safe manner, in accordance with the associated MSDS information for spent chemicals and other industry packaging and transport advice.
- Appropriate containers will be used, including skips and bins for specific types of solid or liquid waste. Containers will not be overfilled.
- Waste will be transported using properly maintained, legally compliant and pre-inspected and approved vehicles and vessels that are driven/crewed by appropriately trained operators.
- Vehicles and vessels to be used for the transport of wastes will be assessed and approved to meet minimum standards and TGL vehicle policy.
- Waste will only be transported by TGL and EPA approved waste contractors.

Impact Assessment

The risk of any significant accidental discharge or spillage of waste to the receiving environment will have been minimised through good waste transport and tracking practices and use of approved waste transporting contractors. The residual impacts are anticipated to be *not significant***.**

7.7.4 Waste Treatment and Disposal

Description of Potential Impacts

Project generated waste will require recycling, treatment or disposal of project generated wastes in a manner that avoids significant environmental impacts. The main sources of potential environmental impact that could result from the treatment and disposal of wastes from project operations include the following.

- Disposal of wastes at dump sites (non-engineered landfills) that are not specifically designed and operated to appropriate industry standard could potentially contaminate adjacent soils, groundwater and surface waters, and/or release vapour emissions. This would then have the potential to adversely affect water quality, air quality or cause a health risk to local communities.

- Open burning of wastes at facilities or dumpsites could impact on local air quality and increase health risks to staff and populations living in the vicinity.

- Low standards of waste management practices at sites without use of basic health and safety procedures or Personal Protective Equipment for staff handling wastes could put workers at risk.

- Illegal dumping ('fly-tipping') of hazardous wastes (solid or liquid) can contaminate soils, and surface or groundwater, potentially impacting on human health or ecosystems.

- Waste facilities or sites with inadequate security can potentially impact on local communities due to littering and health and safety risks associated with uncontrolled public access to wastes.

Mitigation Measures

Mitigation measures for potential impacts associated with waste treatment and disposal include the following.

- Only EPA approved contractors providing waste treatment and disposal services will be selected.

- Periodic audits of third-party waste facilities and sites will be undertaken to ensure wastes are being managed in line with standards and methods agreed in TGL waste contracts.

- Waste tracking procedures as defined in the WMP will be implemented to provide traceability from source of generation to end point. Waste Transfer Notes will be used to track waste consignments from offshore and onshore locations to specific waste contractor locations.

- Waste will be treated and disposed in accordance with procedures outlined in the TGL WMP. Proposed waste management options that have been identified for the main waste types are outline below and summarised in *Table 7.32*.

- Non-hazardous waste will be segregated and recycled where possible. TGL will continue to work with contractors to identify opportunities for further recycling of wastes such as paper and plastic to reduce quantities that are sent to landfill. No hazardous waste will be landfilled.

- Used oil and slops will be recycled offshore into the production crude stream via the closed drain system on the FPSO to avoid transfer for onshore disposal.

- Other hazardous wastes will be sent to an approved waste contractor in STM for recycling/treatment where possible. Unused chemicals will be returned to suppliers.

TGL will store small quantities of hazardous waste types where suitable in-country management options are not available in a dedicated waste holding area at its onshore bases in Takoradi.

In the medium-term, if suitable in-country solutions cannot be identified for hazardous waste streams that are stored, then export options for processing of wastes will be pursued to ensure sound management of all wastes.

Table 7.32 Proposed Waste Management Options for Specific Waste Types

Category	Waste Type	Waste Management Option Current	Long-term
Non-hazardous	General domestic waste	Landfill	Maximise segregation of recyclables and landfill residuals
	Wood	Reused	Reused
	Plastic	Recycled	Recycled
	Scrap metal	Recycled	Recycled
Hazardous	Oily rags and oil filters	Store	Oily rags incinerated, oil filters drained and metal recycled
	Used oil	FPSO - recycled in closed drain system Onshore - used at power station	FPSO - recycled in closed drain system Onshore - Recycled or used for energy recovery
	Batteries	Recycled	Recycled
	Clinical waste	Incinerated	Incinerated
	Oily slops	Recycled into process stream or recycled onshore	Recycled into process stream or recycled onshore
	Filter cartridges	Stored	Options to be evaluated
	Drums (with residues)	Cleaned and recycled	Cleaned and recycled
	Other wastes	Will be detailed in the WMP	Will be detailed in the WMP

Impact Assessment

The project will generate both hazardous and non-hazardous wastes that will require onshore management. The majority of hazardous and non-hazardous waste will be treated and disposed by TGL's waste contractors in line with international good practice. TGL will work with waste contractors to identify opportunities for further recycling of wastes such as paper and plastic to reduce quantities that are sent to landfill.

Small quantities of hazardous waste that, currently, cannot be treated in-country will be stored in a secure holding area for future processing or export. TGL will verify, through audits, that waste is treated and disposed of in accordance with international good practice, therefore, this impact is assessed to be of *Minor* significance. TGL will continue to work with waste contractors to facilitate the continuous improvement and upgrading of facilities.

7.8 FISHERIES IMPACTS

7.8.1 Scope of Assessment

This section addresses potential impacts on the local fish population and fisheries related impacts. Potential impacts include attraction of fish to the FPSO and other offshore facilities, loss of access to temporary and permanent safety zones, collision risks to fishing vessels, disturbance to fishing activities and damage to fishing gear from support vessels. Potential impact of noise emissions from the TEN Project on fish is addressed in *Section 7.3.3*.

Other issues that were raised by stakeholders during the community consultations include: effect of increasing seaweed offshore Ghana on fishing operations; concerns regarding the general decline of fisheries resources; and conflict with the Ghana Navy at the safety zone. These issues are also addressed in this section. Expectations regarding employment opportunities and skills development, support for alternative livelihoods and infrastructure development are addressed in *Section 7.9*.

Effect of Increasing Seaweed offshore Ghana on Fisheries

During the community consultations, stakeholders reported a marked increase in the quantities of seaweed offshore Ghana, in particular in the Western Region. Artisanal fishermen raised concerns regarding the effect of the seaweed accumulations on their fishing activities. Some stakeholders believed that oil and gas operations are contributing to this increase in seaweed. The seaweed (macro algae) has been identified as *Sargassum* sp. (A.K. Armah 2012 pers comm). *Sargassum* belongs to a group of macro algae found in the marine environment and large floating accumulations of *Sargassum* are known to occur in distinct areas in the North Atlantic Ocean. Some of the *Sargassum* is driven by regional winds and currents and may beach where it reaches land. The reason for the increase in *Sargassum* in Ghana is unknown but it is thought to be part of a regional or even global phenomenon. Some researchers suggest an increase in coastal nutrient concentrations (*eg* from run-off from land that has been fertilised), resulting in increased algal growth.

Discharges will be treated to meet operational discharge limits before discharged to the marine environment and are expected to disperse rapidly in offshore currents. Impacts from operational discharges of the TEN Project on water quality have been assessed to be of *Minor* significance (see *Section 7.4*). Any nutrient enrichment from discharges such as black water or macerated organics kitchen waste are expected to be short-term and of small magnitude and is not expected to result in subsequent algae blooms. The effect of increasing seaweed offshore Ghana on fisheries has been scoped out of the detailed assessment due to being considered to be *not significant*.

7.8.2 *Impacts of FPSO Presence on Local Fish Populations*

Description of Potential Impacts

Large pelagic fish species (*ie* tuna and billfish) and deep water fish species (demersal fish *ie* grunts and croaker) will be present in the TEN Project area. Pelagic species which inhabit the surface layers of the water column are likely to be impacted by the presence of the FPSO, MODU and support vessels as many pelagic fish species are known to readily associate with floating objects (known as Fish Aggregating Devices (FAD)) (Røstad *et al* 2006).

Fish may be attracted to the artificial lights on the FPSO, MODU and support vessels and lights in the event of abnormal flaring at the FPSO. Fish may also be attracted by warm discharges *eg* produced water (if it is not reinjected) and cooling water.

The deep water fish communities are likely to be affected by the installation and presence of subsea infrastructure.
Impact Assessment

The main pelagic species found in offshore deepwater locations in the Gulf of Guinea that are targeting by fishermen are highly migratory and will not be permanent residents in one area and those attracted to the FPSO and other infrastructure are not likely to spend significant periods of time under the FPSO. Although it is known that fish will congregate under structures such as the FPSO and MODU, the numbers of fish that are found beneath floating objects is not necessarily determined by its size (Nelson 2009). Generally, FADs work for only a relatively short period of time as large fish shoals moving around the east Atlantic Ocean will only be present for a number of days or weeks (Itano *et al* 2004) in one area. Although commercially exploited species associated with the FPSO, MODU and support vessels and their safety zones will be afforded some protection from fishing activity, the benefit to fish ecology is considered to be of *Minor* significance due to the temporary nature of the residency of fish near these structures.

Light is an important stimulus for many fish species and they are attracted to the surface waters when the moon is full (due to the vertical migration of zooplankton and other prey species). Fish aggregations around the FPSO, MODU and vessels may also be influenced by the artificial light at night as zooplankton and their fish predators are drawn towards the light generated by project facilities. The increased availability of prey species to pelagic fish may result in a benefit to a proportion of these pelagic fish populations, however, the scale of this impact will be very small in the context of the area over which these species range and the positive impact will be *not significant.* In addition, most species are only associated with FADs during daylight hours (Castro *et al* 2002) and will disperse during the night to forage in open waters.

Deep water fish are also known to aggregate around seabed structures, such as wrecks, as they provide a variety of habitats and areas of shelter for fish. The addition of the project seabed infrastructure is likely to attract deep water fish, however, the impact of this is not considered to be significant in terms of population ecology due to the size of the area occupied by the infrastructure in relation to the large area of seabed over which deepwater species range. Negative impacts due to disturbance during installation may occur, *eg* from suspended sediments, however this will be short-lived and impacts on mobile fish species that can avoid areas of suspended sediment are assessed as being *not significant.*

7.8.3 Impacts on Fisheries

Description of Potential Impacts

The TEN Project area is in a deepwater offshore area and the water depth at that location precludes trawling or other bottom fishing activities. Therefore, pelagic the fishing methods are used in these areas, mainly targeting large oceanic species, using passive gear (longlines) and active gear (pole and line, purse seines).

The main target species are the three tuna species know to be caught in Ghanaian waters (skipjack, yellowfin and bigeye) and billfish (swordfish and marlin). The range of these species will include the area around the TEN fields. Although these offshore fisheries are mainly targeting by the larger ocean-going vessels it is known that since the Jubilee field was developed fishermen operating from canoes have travelled to the Jubilee FPSO and MODUs to target the fish that have been attracted to these structures.

Potential impacts on fisheries can arise from three main sources.

- Loss of access to the area of the FPSO and MODU during completions, installation and operations due to presence of vessels, FPSO and MODU and the safety zones.
- Attraction of fish to the FPSO and MODU due to the stationary vessels / infrastructure acting as a FAD leading to a reduction in fish in the surrounding waters.

- Collision dangers to fishing vessels and fishermen due to fishermen being unaware of the locations of oil and gas field operations and fishermen being attracted to the infrastructure to target fish within the safety zones.

- Disturbance to fishing activities and damage to fishing gear from project support vessels and supply vessels transiting to and from Takoradi.

Mitigation Measures

The following mitigation measures will be implemented as precautionary measures to minimise any potential impact on the fishing industry.

- A TGL Community Liaison Officer (CLO) will be based in each of the six coastal districts to liaise between fishermen and TGL and to provide information to fishing communities regarding TGL's activities and notifying them of the requirements to keep away from the operations for safety reasons. The CLOs will also deal with any claims for gear damage through TGL's grievance mechanism and will monitor interaction with fishermen and other users of the area through the project's grievance procedure.

- TGL and its contractors will notify mariners of the presence of the FPSO and other marine operations within the TEN Project area and the safety and advisory areas will be marked on nautical charts as cautionary advice to all sea-users.

- The safety zones will be monitored with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (*eg* fishing vessels and commercial shipping) when potentially close to the FPSO or MODU (when present).

- Development of a code of practice (based on the UN Voluntary Principles of Security and Human Rights) and training for those responsible for maintaining the safety zones.

- A vessel transit route will be agreed with the GMA and communicated to fishermen and other marine users through the CLOs.

- TGL will continue to liaise with the Fisheries Commission to identify opportunities to improve understanding of current fishing activities within the Ghanaian EEZ and to investigate ways to reduce potential conflict between the oil and gas industry and the fishing industry.

Impact Assessment

The legally enforceable 500 m safety zone around the MODU and FPSO is required to reduce the risk of collisions at sea. This is an essential safety measure design to protect human life and is enforced in oil and gas fields throughout the world, therefore fishing vessels will not be able to fish within the safety zones at any time.

There will also be an advisory zone of 10 km radius centred on the middle of the TEN Project area, indicating the presence of an oil production area where non-essential users are recommended to stay outside. Fishing vessels will be allowed to enter the 10 km advisory zone at caution.

Fishing activities take place throughout the Ghanaian EEZ. The areas in the TEN field that fishermen will be excluded from is approximately 2.355 km^2 which is very small in comparison to the area used by their target species and available for fishing. The total area of the safety zones represents approximately 0.52% of the TEN Project area and 0.001% of the Ghanaian EEZ(1). This will result in a very small reduction in the available fishing grounds within the Ghanaian EEZ and will only affect those fishermen who fish in this offshore area. Given the area available to fish for the target species that occur in this offshore location, the impact on fisheries from the exclusion of fishermen from a small area around the FPSO and MODU is considered to be *not significant*.

Many of the pelagic fish species that are present in this area are attracted to floating objects and those commercial species attracted to the FPSO and MODU (including the three tuna species) will not be available to the fishery during the periods they are within the safety zones. The attraction of fish to floating objects and their residence times are discussed in *Section 7.8.2*. Given the large areas that pelagic species in this area occupy and the need for predators such as tuna to range widely for their prey a significant proportion of the population will be not be under the FPSO at any one time. Those fish that are attracted to the infrastructure will not occupy these areas permanently and will not therefore be lost to the fishery. The magnitude of the impact is small as only a very small proportion of the potential fishing grounds will be affected by the project. Impacts from the TEN Project on the availability of fish to the offshore fishing industry are assessed as of *Minor* significance at most.

Some fishing vessels use passive fishing gear not attached to a fishing vessel. Longlines in particular are used to target bigeye tuna in the eastern Atlantic, with the lines being set several meters below the surface and left for many hours. Thus there is the potential for this gear, which is left floating in the open ocean, to enter the safety zone, become entangled in the subsea infrastructure or on the FPSO and be lost to the fishermen. It is understood that the majority of tuna catches off the coast of Ghana are taken by pole and line vessels and purse seine vessels which use gear attached to the vessel (ICCAT 2009), therefore, the likelihood of interactions between these vessels and associated gear and the FPSO, MODU and subsea infrastructure is considered to be low. Impacts from the presence of the FPSO, MODU and

(1) EEZ = 224,908 km^2 (Seaaroundus 2012)

subsea structure on the livelihoods of offshore tuna fishermen using passive gear are expected to be *not significant.*

The movement of the MODU between drill sites and vessel movements to and from the onshore base during the installation and operational stages of the project have the potential to interact with fishing activity in the vicinity of the onshore bases and along the vessels' routes to and from land. Near shore artisanal fishing activities could be adversely affected through disturbance of fishing activity and the potential for damage to fishing gear. A vessel transit route will be communicated to fishermen through the CLOs so that these areas could then be avoided by fishermen to avoid damage to fishing gear.

During operations there will be on average one or two supply vessels a week operating between the port and the FPSO. During installation the number of vessels in the field will be higher, and an average of one port visit a day for food and water supplies, and for crew changes is expected. The infrequent nature of vessel movements during construction and the low frequency of vessel movements during operations mean the probability of an interaction between supply vessels and fishing activity is low. The likelihood of unanticipated interactions with industrial and semi-industrial fishery vessels is expected to be low given modern communication and navigation aids. Potential impacts on fishing activities will be localised and small scale and are assessed to be of *Minor* significance.

7.9 SOCIO-ECONOMIC AND COMMUNITY HEALTH IMPACTS

7.9.1 Scope of Assessment

This section addresses the socio-economic impacts which could arise from the project. These include those impacts that may be reasonably expected to affect Ghana at a national level and those that are likely to be experienced at a regional (*ie* Western Region) and local (*ie* individual coastal community) level, for example, impacts on human activities in the onshore coastal and offshore environments.

The EIA process included consultation at the national, regional and local levels. During the EIA, more than 28 community meetings, 66 focus group discussions and 33 key informant interviews were held, involving more than 2,800 participants. During the consultation process macroeconomics, social investment and employment opportunities were some of the key issues of concern raised by the stakeholders (see *Volume I: Attachment 1*).

Given that project activities will occur mainly offshore with limited direct interaction with population centres (except at existing onshore bases in Takoradi) the project is expected to have limited direct effect on the social environment. The project is, however, expected to have associated indirect and induced effects.

The main potential causes of impacts are expected to be:

- increased government revenue;
- employment and skills development;
- procurement of goods and services;
- influx of job seekers into the Region;
- issues with heightened and unmet expectations;
- impacts on commercial shipping;
- impacts from onshore bases; and
- community health impacts.

These are further described in the following sections. Impacts on fisheries are discussed in *Section 7.8.3*.

7.9.2 Increased Government Revenue

Description of Potential Impacts

Oil production from the TEN fields is expected to start in mid-2016 and in terms of output it will reach a plateau in 2017 of approximately 80,000 bpd. Gas export will start 12 months after first oil. It is expected that the total recovery of oil and gas will be approximately 312 million barrels of oil equivalent (mmboe) over the life of the project (20 years). The oil and gas production from the project will contribute to the Government of Ghana's revenue through:

- taxes, royalties and other fees paid by TGL and other TEN Partners; and
- direct equity share of the sale of oil and gas by GNPC.

Government revenue will be increased by the payment of royalties and taxes and other incomes in relation to production once the project is operational. The payment of royalties and taxes and other incomes will be undertaken in accordance with the DWT Petroleum Agreement between the GNPC and TEN Partners (March 2006).

The fiscal regime for the TEN Project will comprise the following elements: a 5% royalty for oil revenue and a 3% royalty from gas revenues; corporate tax at 35% and a supplementary tax (Additional Oil Entitlement) payable at increasing tax levels should the rate of return from the project exceed a series of threshold rates of returns, calculated on a derived net project cash flow.

Mitigation Measures

Ghana's ability to benefit from the economic gains that the project offers at a national level will depend on good governance and fiscal management. Both Ghana and TGL are signatories to the Extractive Industries Transparency Initiative (EITI) which is a global standard for transparency in oil, gas and mining. Following this programme would ensure that the revenues are managed to a high standard.

TGL has limited ability to directly optimise or manage potential impacts on the national economy but will contribute to impact mitigation and optimisation by working with Government of Ghana and other stakeholders throughout the life of the project to develop measures that align with the objectives of on-going government programmes.

TGL will work with the Government of Ghana to make payments of taxes and royalties in a transparent and accurate manner, utilising sound financial principles and accounting processes. This will be aligned to the EITI principles and criteria. Preceding decommissioning, TGL will communicate with the Government of Ghana regarding closure measures, schedule and potential implications to government revenues.

Impact Assessment

Projected government revenue figures are not yet available for the TEN Project, however, as an illustration of the potential revenue, the taxes, royalties and fees paid by TGL during 2011 (associated with the operation of the Jubilee field) are outlined in *Table 7.33*.

Table 7.33 TGL Taxes, Royalties and Fees Paid in 2011

Type of Payment	
Royalties (at 5% of net production)[1]	428,353 bbl
Value of State/State Oil Company Production	-
Profits/Income Tax	-
Licence Payments, Fees or Rental	USD 55,702
Profits/Dividends Paid to Government	-
Training Contributions	USD 168,247
Other fiscal benefits to Government	-

Source: www.tullowoil.com

Note: This table does not include the Ghanaian Government/GNPC's share in production derived directly under the DWT and WCTP Petroleum Agreements and it does not include payments made by other TEN Partners.

Royalties were calculated as 5% of net production (in bbl) as stipulated in the DWT Petroleum Agreement. In 2011, TGL did not make any additional payments or delivery of barrels to the Government of Ghana or the GNPC. Government of Ghana production interests were derived in accordance with the Petroleum Agreement and income tax was calculated at 35% of taxable income. In 2011, however, taxable income was zero as part of TGL's initial investment costs (USD 4 billion) were first recovered from profits before the payment of tax, thereby resulting in zero taxable income for 2011. The licence

(1) For illustrative purposes only, the price of a barrel of Brent Crude (as per the Financial Times) ranged between USD 88.49 and USD 128.40 over the last 12 months (from July 2011), but this does not indicate, and should not be used to calculate, the actual value of barrels of oil received by the Government of Ghana for its sale of Royalty Oil.

payments and training contributions represents TGL's net equity share for the DWT and WCTP licence blocks under obligations of the Petroleum Agreement. Corporate taxes and royalties were paid to the GNPC, the agent of the government, in the collection of all petroleum or money accruing to the government.

In addition to the revenue sources outlined above, the government will receive further revenue through other taxation such as personal income tax and duties on imported services paid by employees, contractors and supporting services to the project. The impact of project revenues cannot be accurately quantified as the allocation of increased government revenue to regional or national development or to other purposes is not known. The government will be solely responsible for the allocation of revenues based on the requirements of the *Petroleum Revenue Management Act (Act No. 815 of 2011),* internal government policies, and by the country's development needs.

In 2011, Ghana's economy grew at approximately 14% supported by new oil production and a recovered construction sector. With oil production predicted to reach a plateau in 2012, based on current production forecasts, GDP growth is expected to reduce to 7.5%. Ghana's medium-term economic growth outlook remains positive, driven by large investments in extractive industries, public infrastructure and commercial agriculture (World Bank 2012b).

As a result of the TEN Project, government revenue will continue to increase, having a direct positive impact on the national economy and to a lesser extent, at the regional level through CSR programmes. Government spending will in turn be experienced as an indirect positive impact by the people of Ghana. The project will also induce associated growth and development. The impact will occur over the 20 year life of the project (*ie* in the long-term) and will be of medium magnitude. The absolute value of the revenue from oil can be unpredictable as it depends on market prices and the management of the revenues requires good fiscal policy. The impact will benefit the national economy and consequently, the benefits of oil revenue will depend on the policies and actions adopted by the Government of Ghana. Overall, the impact of increased government revenue is predicted to be positive, long term and experienced at a national level and is therefore assessed to be of *Moderate* significance.

7.9.3 Employment and Skills Development

Description of Potential Impacts

The TEN Project will create direct and indirect employment opportunities in the Western Region, in particular STM, and at TGL's head office in Accra. Direct employment will be with TGL and indirect employment will be with contractors and suppliers. Given the nature of the project's activities, the majority of the jobs will require specialty skills and jobs would be filled with qualified and experienced personnel. As such, it is likely that the majority of people who will be employed on the project will be from outside the Western Region as there is a shortage of qualified and appropriately skilled people available in the Region. Job opportunities during the drilling, installation and commissioning phases will be temporary, while job opportunities during the operational phase will mostly be permanent.

Mitigation Measures

Realising the potential benefits from direct and indirect employment will require enhancement of relevant skills in the local workforce. The DWT Petroleum Agreement requires that the TEN Partners employ Ghanaian personnel as far as reasonably possible and provide opportunities for employment for such personnel. TGL's local content strategy aims to enhance sustainable economic and social development in Ghana by creating employment opportunities in the oil and gas industry. Similar requirements apply to the Jubilee project and as at June 2011, 88% of TGL's permanent employees were Ghanaian. TGL is currently training seconded staff from GNPC as required by the Petroleum Agreement and has graduate and apprentice training programmes across all departments.

TGL has in place, and will continue to implement, the following measures to enhance employment of Ghanaians and skills development.

- TGL will have local employment and skills development policies for the recruitment, training and development of national staff in its operations (known as 'nationalisation').

- TGL service contracts will transpose these employment and skills development requirements to contractors.

- TGL's recruitment practices will be based on ability, objectivity and fairness in line with relevant labour legislation and organisational policies and strategies.

- Employment opportunities will be advertised widely (*eg* in the national or local media). In addition, relevant job opportunities will be specifically communicated to communities in the coastal districts of the Western Region by the CLOs. CLOs will also provide information on job application procedures.

- TGL will implement mentoring and job shadowing programmes for national staff of TGL, to enhance the quality of employment and the longevity and sustainability of jobs.

In recognition of the current skills shortage in the Western Region and Ghana, TGL will undertake the following through its CSR Management Framework.

- Investigate potential partnerships with NGOs and other education organisations to provide support for primary and secondary level education, which may include funding for upgrading of facilities, sponsoring of books, training of teachers or scholarships.

- Investigate potential partnerships with NGOs and training organisations to support construction trade skills development programmes considering skills required by the oil industry.

- Provide support for education and training at tertiary level *eg* support to polytechnics and universities in developing curriculums, funding and sponsoring of students which could provide employment in the oil industry or other heavy industries.

- Provide apprenticeship programmes for suitable graduates in their operations.

Impact Assessment

Currently, employment in the six coastal districts of the Western Region is mostly informal and limited to small-scale income generating and subsistence-based activities, with an estimated 57 to 79% of the economically active population being self-employed (GSS 2005). Furthermore, literacy is low (less than 50%) amongst people in the rural districts. Despite a lack of skills and experience in the formal industrial sector, people in the region are still anticipating that the project will provide employment opportunities. More specifically, the communities are anticipating that jobs will be made available for the youth who are unemployed or who are employed but seeking alternate employment.

The number of direct employment opportunities is relatively small but the project does expect to fill a number of positions with Ghanaians. Drilling, construction and installation of the project infrastructure is planned to commence in 2014 and be completed by the end of 2017. During these phases engineers, technical and support personnel will be required by the MODU contractors and support services companies. An estimated 445 to 620 employment opportunities will be created, of these opportunities it is estimated that between 58 and 71% of the employees will be Ghanaians. An estimated 307 employment opportunities will be created during the operational phase of the project. Of these it is estimated that 63 to 88 % will be allocated to Ghanaians.

As the project moves into the operational phase, there will be the opportunity for progressively more Ghanaians employed through further skills development and creation of jobs that can be satisfied by the skill base available nationally. The direct benefits from employment and training will also provide sustainable employment opportunities in the longer term as individuals take on new jobs and reuse skills and experiences. Although the jobs will be long-term, and of good quality (because of training and career development programmes), the impacts from employment during all phases of the project are assessed to be of small magnitude because the number of jobs is limited.

Indirect employment will be created by the project through the sourcing of supplies and services that will be required by the project. The nature of the project means that indirect employment is likely to be limited in the number of jobs, particularly in the Western Region due to the limited number of people that will be employed from the regional labour pool. There may be further employment opportunities created by economic growth induced by the project (*eg* new companies formed to support the oil and gas sector) and by business growth to take advantage of the increased disposable income of workers across the supply chain.

The skills developed through training and experience when employed in the oil and gas sector will be transferred to other sectors of the economy and will provide further positive benefits. It will make Ghanaians more competitive in the international market place, facilitating increased opportunities and skills transfer.

Overall the impacts from direct and indirect employment will be long term, localised and relatively small scale and is assessed as being of *Minor* significance.
Residual negative impacts remain because the demand for skilled labour for this project will cause a draw on skilled labour from other sectors, although this is at a small scale as it is a short-term effect and the number of employees required is small. There is also likelihood that long-term employment expectations will not be met as the operation of the FPSO does not require significant numbers of personnel. The negative impacts from drawdown of skilled labour are assessed as *not significant* as a wider base of skilled staff will become available within a few years through training and as the industry develops. The issue about unmet expectations regarding employment is further discussed in *Section 7.9.6*.

7.9.4 Procurement of Goods and Services

This section assesses the impact of the economic opportunities generated through the procurement of goods and services associated with the project activities. Procurement will also lead to creation of indirect employment opportunities, as discussed in *Section 7.9.3.*

Description of Potential Impacts

The majority of the fabrication work for the FPSO will be undertaken outside Ghana with material sourced from international markets. Installation of offshore facilities will be carried out using specialist contractors and vessels also from sources outside Ghana. During the project lifetime there will, however, be procurement of goods and equipment (*eg* food, fuel, chemicals and other consumables), logistics support (*eg* drivers, supply vessel crew, and plane and helicopter support, pilots and cabin crew), and services (*eg* onshore admin support, accommodation staff, security, catering, cleaning) from national companies.

There will also be procurement of some engineering and technical services in Ghana for the fabrication of pipe connectors (*eg* welding and assembling pipes) and suction piles for the FPSO. In the longer term there will be a requirement for equipment refurbishment, electrical testing and tool refurbishment.

Mitigation Measures

Contracting and procurement of goods and services will be executed in accordance with the requirements of the DWT Petroleum Agreement, applicable laws and established project procedures and principles. In this regard, TGL's existing local content strategy is aimed at building the capacity and capability of Ghanaians and Ghanaian businesses to support the long-term development of the emerging oil and gas sector. The local content strategy includes objectives that support Ghanaian businesses to enter the industry's supply chain, either directly as suppliers to TGL or through its international supplier relations.

TGL has already demonstrated a commitment to local procurement in its current operations, where an average of 77% of contracts was awarded to Ghanaian companies in the first six months of 2011 (TGL 2012). Key TGL procurement indicators include:

- $259 million spent with Ghanaian suppliers in 2009 and 2010;
- $120m spent by TGL's major contractors in Ghana;
- 1,653 contracts with Ghanaian suppliers placed in 2009 and 2010; and
- 1,100 Ghanaians employed by TGL's major contractors.

In line with the strategy, TGL will develop a local content plan specific to the TEN Project that addresses local procurement. In particular, the following measures, many of which are already being done by TGL, will be taken to enhance procurement of goods and services from companies in Ghana.

- TGL will enter into contracts with companies in Ghana to establish longer term commitments to the businesses and to promote sustainable long term growth and help new businesses become established.

- TGL will carry out contractor vetting and develop contract conditions to ensure the requirement for local content and procurement is passed to contractors, so that goods and services are purchased regionally or nationally where possible, and employment rights and conditions are respected.

- TGL will work with and support suppliers in Ghana to help them meet the required standards in areas such as business operations employee rights, training, environment and health and safety, *eg* through pre-tender workshops and training.

- TGL will partner with organisations to develop a programme for strengthening the capacity of Ghanaian businesses to deliver identified goods and services to the industry. TGL is already working with an NGO in developing small businesses in the coastal districts of the Western Region.

In addition, TGL, on behalf of its partners, is currently implementing a number of capacity building projects as part of its social investment activities. TGL will continue to support these programmes during the TEN Project. A list and description of these projects is provided in *Table 6.13* (*Chapter 6*).

To monitor and track the effects of the strategy of maximising local content over the project lifespan from contractors, TGL will audit local content through facility visits and interviews.

Impact Assessment

Impacts from procurement of goods and services are likely to be positive through stimulating small and medium sized business development with investments in people (jobs and training) and generation of profits. Business investment in new and existing enterprises that provide goods and services can provide the basis for their longer term sustainable growth as they diversify to provide goods and services to other industries. Secondary wealth generation from the development and use of Ghanaian providers of goods and services can be reasonably expected to have a positive impact through the generation of revenue able to flow into the national economy.

There are, however, a number of challenges with regards to procurement of goods and services nationally for the oil industry, including lack of infrastructure and capacity levels, shortage of appropriate technical skills, inadequate or outdated equipment in Ghana, lack of domestic manufacturing and fabrication capabilities, and a lack of knowledge on industry standards and specifications covering the supply of goods and services. Initially Ghanaian companies may not be able to meet technical, commercial, quality or EHS requirements of the project, however, TGL will work with these companies to make them more competitive and help them meet these requirements to secure contracts and improve their performance in the longer term.

Enhancing procurement of goods and services nationally throughout the supply chain will contribute towards the creation of sustainable businesses in Ghana. Positive impacts will be long-term, relatively small scale and localised and are assessed as being of *Minor* significance.

7.9.5 *Influx of Job-Seekers into the Region*

In-migration of job-seekers to the Western Region in search of jobs and associated socio-economic issues are addressed in this section. The section also addressed the potential issues with the influx workers at the onshore bases.

Description of Potential Impacts

During the EIA scoping consultation, stakeholders reported an influx people into the Western Region in search of employment since the discovery of oil in 2007. There appears to be a general perception in Ghana that, with the developing oil industry, the Region offers more employment opportunities. According to stakeholders consulted, the influx has resulted in an increase in the cost of living, specifically property rents, negative social effects (*eg* prostitution and drug use), road traffic and informal settlements.

Mitigation Measures

Mitigation of the impact of influx of job seekers will focus on reducing influx caused by incorrect public perceptions about potential job opportunities and on addressing public expectations about project related job opportunities.

TGL will develop a Stakeholder Engagement Plan (SEP) to provide on-going engagement with the public and the communities in the six coastal districts in the Western region from project implementation to decommissioning. Further details of the SEP are provided in *Chapter 11: Section 11.8*. Through the SEP, TGL will address expectations with regards to job opportunities. TGL will regularly consult with communities to identify and addresses stakeholder issues and concerns. TGL will maintain a written register of stakeholder interactions in line with the SEP to track communications, commitments made and follow up actions taken.

Mitigation of the effect of the influx of job seekers will involve working with government in delivering Social Investment (SI) projects that could support infrastructure projects in the coastal districts.

TGL will develop a SI Framework which will provide details of TGL's commitment to creating and enhancing positive impacts of its activities. From the preliminary work undertaken on the strategy the key focus areas for the SI Framework are likely to be health, education and capacity building, environment and enterprise development. Details of these programmes and projects will be subject to further consultation with government agencies and communities in the coastal districts and TGL will actively seek feedback from stakeholders on proposed SI programmes and projects prior to implementation. These programmes will be designed to provide positive benefits to individuals and communities.

Impact Assessment

The population of the Western Region grew by 21% between 2000 and 2010 (GSS 2012). This is lower than the national population growth rate of 28%, and low compared to previous growth in the Region of 66% growth between 1984 and 2000. Despite the decrease in population growth rate in the Western Region, stakeholders reported that STM, in particular, has experienced high in-migration due to the increasing number of new companies establishing in the area since the discovery of oil and gas.

STM is densely populated (8,140 persons per km^2) and its infrastructure is under capacity and already under strain. Some of the infrastructure challenges facing STM are: inadequate roads for the current vehicle traffic volume; a lack of piped water supply; a lack of sewage and drainage systems; and limited number of health care facilities and schools. Stakeholders are concerned that there will be further influx at the start of the TEN Project, which will exacerbate the current infrastructure problems.

Even with better communication on the limits of potential jobs by TGL, it is likely that the levels of in-migration of job-seekers into STM will continue due to the perceived job opportunities and economic benefits. The impacts will be indirect in nature as the influx will be linked primarily to job-seekers, not to workers. No significant influx of workers at the bases is expected given the scale of the workforce requirements at the shore bases in relation to the existing port activities.

The impacts related to further influx of job-seekers into the area as a direct result of the oil and gas developments will have a negative effect on STM, however, the impact will be localised and small scale in relation to the extent of in-migration already experienced in the Western Region. Overall the impact is assessed to be of *Minor* significance.

7.9.6 *Issues with Heightened and Unmet Expectations*

This section addresses issues regarding heightened stakeholder expectations of TGL and unmet expectations of communities in the coastal districts.

Description of Potential Impacts

During the consultation process undertaken in March and June 2012, it was evident that stakeholders have high expectations of TGL, in terms of economic benefits, infrastructure development and general improvements to living conditions expected from the oil and gas industry. Stakeholders expressed expectations around the following[(1)]:

- provision of employment opportunities;

(1) These are a sample of the key issues raised during consultations. A full record of comments raised during consultations is included in *Volume I: Attachment 1*.

- provision of scholarships for school children and graduates;
- provision of micro loans for women to finance their businesses;
- general improvement of the communities' livelihoods;
- refurbishment of certain schools and health facilities;
- construction of senior secondary schools in various communities;
- provision of storage and cold rooms in the major fishing communities;
- construction of health centres in communities; and
- installation of electricity for communities.

The communities also expressed their dissatisfaction related to its unmet expectations linked to the Jubilee project and the manner in which TGL addressed problems that arose. These include:

- limited employment opportunities from the Jubilee project;
- small number of scholarships for graduates and no scholarships for basic schooling;
- damage to fishing gear leading to a loss of livelihoods;
- intimidation of fishermen by the Navy; and
- inadequate distribution of benefits in the coastal towns with benefits concentrated in a few locations and in the district capitals.

Mitigation Measures

Means to manage people's expectation are focussed on aligning the project's social benefits and community investments with government programme and community needs and with clearly communicating project plans and actions.

- TGL will undertake on-going engagement with communities in the six coastal districts of the Western Region in line with the SEP and address expectations though these engagements, in collaboration with government.

- TGL will develop its SI Framework with consideration of regional and district development plans and priorities. Further information on the focus and contents of the SI Framework is provided in *Chapter 11: Section 11.7*. Details of the SI programmes and projects will be subject to further consultation with government agencies and communities in the coastal districts of the Western Region.

- TGL and Partners will coordinate the planning and implementation its SI programmes and projects.

- The SEP will include a grievance procedure through which disputes and grievances will be addressed. Details of the grievance procedure are provided in *Chapter 11: Section 11.9*. TGL's CLOs will communicate the grievance procedure to communities and facilitate the grievance process. When a grievance has been brought to the attention of TGL staff it will be logged and evaluated, and action/responses recorded. Grievances will be monitored on an on-going basis.

- TGL will, through its employment and skills development and local content strategies and plans, build on the capacity and capability of Ghanaians and Ghanaian businesses to support the long-term development of the emerging oil industry (see *Section 7.9.3* and *7.9.4*).

Impact Assessment

The discovery and production of oil and gas in Ghana has raised expectations of stakeholders including regional and district level government, traditional leaders, communities and NGOs. For example, there are heightened expectations amongst district assemblies, traditional leaders and communities in the coastal districts of the western Region of job opportunities in the oil and gas industry as well as substantial socio-economic and infrastructural improvements.

The project is expected to have an impact of *Moderate* significance on government revenues (*Section 7.9.2*), however, the allocation of these revenues will be managed by the national Government and TGL can only support relevant government programmes. Oil revenue may provide budget support to current government infrastructure development and service delivery programmes but will comprise a small percentage of the overall national budget requirements. Therefore, district assemblies and communities may not experience direct benefits of oil and gas revenues.

The TEN Project is not labour intensive and requires high levels of technical skills. As such, employment opportunities will be limited where there is a lack of skills available in the coastal districts to meet the immediate requirements of the specialist roles. However, TGL will through its employment and skills development strategies and plans build on the capacity and capability of Ghanaians to enhance opportunities for employment within the industry.

TGL will address unmet expectations of communities through on-going communication in accordance with the SEP. TGL will also consider regional and district development plans and priorities in developing their SI Framework, programmes and projects and consult with government agencies and communities prior to its implementation. TGL will support Ghanaian businesses through their local content strategy and SI programmes that are aimed at enterprise development. These measures may not eliminate these issues but will serve to improve relations between TGL and stakeholders through pro-active management of issues and concerns.

Stakeholders' exceptions and perceptions can change and TGL will engage with the stakeholders to remain aware of these perceptions and expectations so that they can respond to issues as they arise. This impact is negative and will have a direct effect on TGL and the oil and gas operations in Ghana.

Heightened expectations are primarily localised to communities in the six coastal districts but may persist in the medium to long term for some stakeholders depending on the situation and the manner in which TGL resolves the on-going issues. Stakeholders will be able to adapt to varying degrees, thus the impact of unmet expectations is assessed as being *not significant* for some stakeholders and of *Minor* significance to more sensitive stakeholders.

7.9.7 Impacts on Commercial Shipping

Description of Potential Impacts

Figure 7.21 presents data from commercial vessel movements over a 12-month period in 2004/5(1) showing the general shipping lanes used in relation to the location of the TEN Project area.

Shipping lanes originating in Europe run adjacent to the West African coast. Offshore Ghana, some of the busier shipping lanes pass to the south of the TEN Project area.

The shipping intensity within the block is generally between one and four ships per square kilometre per year but can be as high as 10 ships per square kilometre per year along the southern edge of the block. Higher density routing (more than 20 ships per km^2 per year) starts just south of the block.

The main potential source of impacts to existing navigation and shipping traffic in the area are likely to arise as a result of the additional vessel movements associated with the project, in particular during the installation of the project offshore as more significant numbers of vessels will be involved. During routine operations an average of one or two supply vessel will sail into and out of Takoradi port on a daily basis.

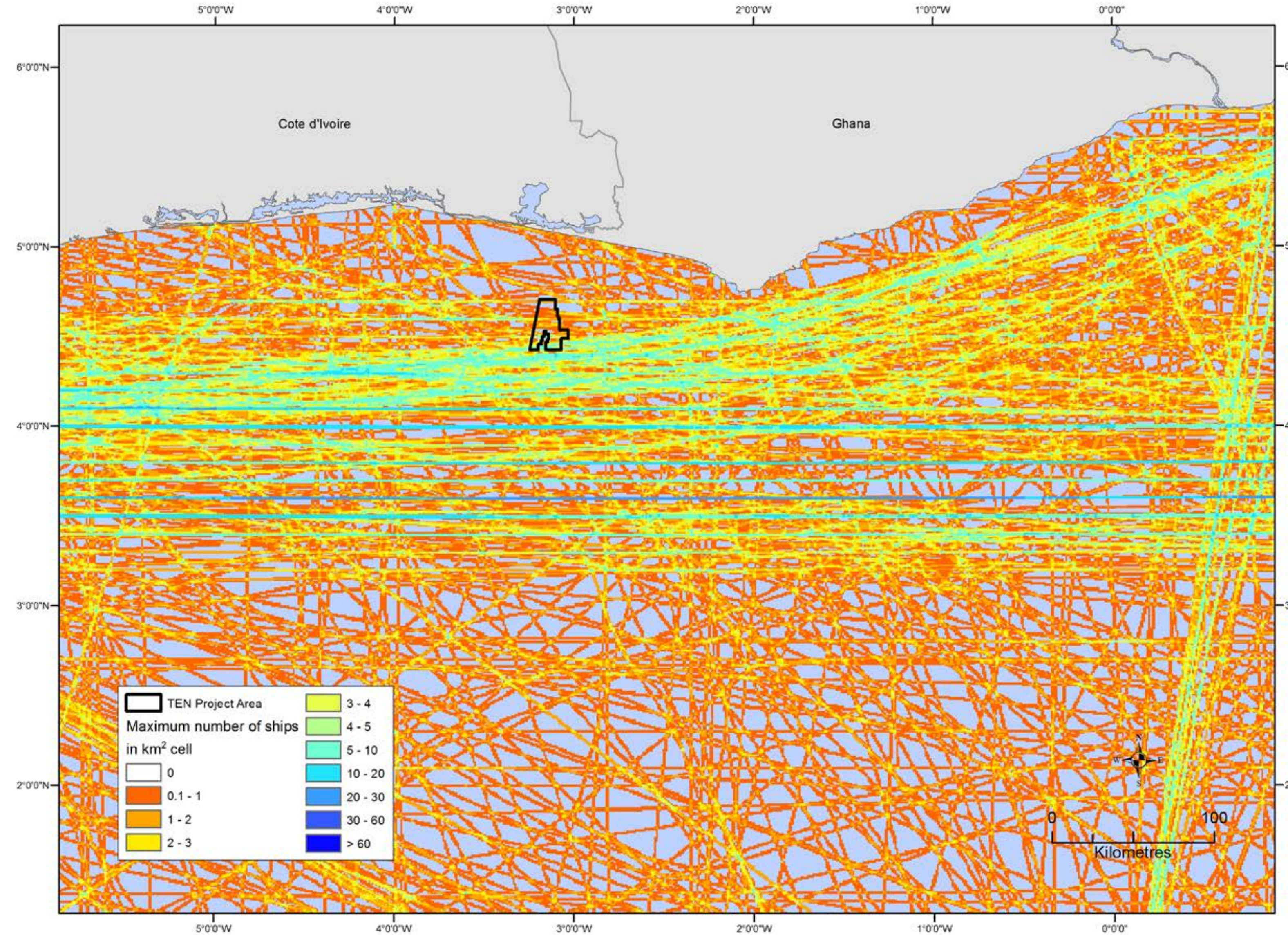
Mitigation Measures

The use of established shipping lanes, particularly in approaches to harbours and heavily travelled coastal waters, and standard vessel navigation and communication equipment (radar, ship to ship radio) and the presence of standby vessels and offloading tugs at the FPSO and MODU locations will reduce the risk of vessel collision with commercial vessels.

The 500 m safety zones around each installation and the 5 nmi (10 km) ATBA will be mapped on international nautical charts and formally designated by the GMA and endorsed by the IMO. Notification and liaison measures outlined in *Section 7.8*, to manage the potential impacts to fishing, will be equally applicable to minimising the risk of collision between shipping vessels and project vessels.

(1) Adapted from location data collected as part of the World Meteorological Organisation Voluntary Observing Ships Scheme

Figure 7.21 Shipping Lanes around the TEN Project Area



Communication and navigation equipment on the FPSO and project vessels will comply with requirements of the *International Convention for the Safety of Life at Sea, 1974 (SOLAS)* and vessel operations will be in accordance with the IMO's *International Regulations for Preventing Collisions at Sea 1972 (COLREGS)*.

Impact Assessment

Given the distance offshore where the majority of the project activity will be carried out it will not significantly affect smaller coastal vessels. Considering the location of the TEN fields in proximity to relatively busy commercial shipping routes, the navigational sensitivity of the area is considered to be medium. The mitigation measures proposed will provide notice and early warning to shipping that may use the area so that, if required, they can adapt their routes to avoid the area. As a result the overall residual impacts on shipping and navigation are considered to be *Minor*.

7.9.8 Impacts from Onshore Bases

Description of Potential Impacts

The existing supply facilities at Takoradi port are sufficient for the TEN Project although there will be relatively minor modifications within the port area. Future development of the port in the event of future oil and gas developments have the potential for greater positive and negative impacts but are outside the scope of this EIA. Activities at the onshore supply and transport base have the potential for both positive and negative impacts on surrounding communities.

While increased or sustained economic activity and employment at the onshore base will generally be a positive socio-economic impact there is also the potential for some negative impacts associated with the proposed onshore activities. These impacts will not all be a direct result of the project as they are associated with the existing activities at the port, nevertheless the project activities will contribute to these impacts. These impacts may include additional traffic and noise.

The potential exists for a negative impacts on the capacity of the utilities (*eg* water supply) and infrastructure (*eg* roads) that supply the existing base and consequential impacts on surrounding communities that share these.

Mitigation Measures

The environmental and social performance at the shore based locations that TGL operate in (port area and Air Force base) will be covered under TGL's EHSMS to ensure EHS policies and procedures are in line with TGL's expectations, particularly regarding community impacts such as interactions with neighbours, noise abatement, traffic management and storage of wastes.

TGL's contractors, *eg* drilling mud supplier, will also have operations at the onshore base. Contractor environmental and social performance will be managed through contractual mechanisms which will be achieved by the inclusion of suitable conditions within the contracts that TGL will seek to implement with its major direct contractors. The major direct contractors will be in a position to directly control the activities taking place at onshore bases through their own contracts with subcontractors.

A grievance procedure will be implemented and made known to the surrounding communities and the general public. TGL's CLO will disseminate information about the project to the community and process any suggestions, complaints or grievances received. SI projects as part of the Social Performance portfolio will seek to address specific community issues arising from the project activities.

TGL will undertake periodic audits and reviews of its shore based operations to review site EHS performance and take corrective actions as required. Periodic audits of third party operations and facilities will also be carried out. This will require routine management meetings with the main operators of these locations and the agreement of common environmental and social management measures.

Impact Assessment

Impacts associated with the proposed onshore activities will be managed in accordance with TGL's EHSMS, specifically with regards to interactions with neighbours, noise abatement, traffic management and storage of wastes.

Noise levels from the onshore base are not expected to increase above ambient noise levels from current activities. Operational discharges will be managed as discussed in *Section 7.4* and emissions to atmosphere as discussed in *Section 7.5*.

TGL's onshore freshwater supply requirements will be relatively small, however, to avoid potentially lowering of water pressure during peak demand periods (*ie* morning and evening), TGL installed a new 600 m^3 potable water tank on the main quay near to the drilling fluids storage area, which will be filled overnight when there is less demand from the general population. TGL has designated routes between the Air Force base and Takoradi Port to limit the effect of heavy vehicle movements on traffic. A new access road to the Air Force base was built in 2009 to minimise traffic safety risk and TGL will work with the STMA to maintain road infrastructure along designated routes between the Air Force base and Takoradi Port.

Potential impacts from small scale increases in road traffic, noise from port activities on communities in relation to existing activities in Takoradi is considered to be of *Minor* significance.

7.9.9 *Impacts on Community Health*

Description of Potential Impacts

The onshore presence of the TEN Project could result in impacts to the health and wellbeing of local communities, including:

- worker-community interactions resulting in increased transmission of STIs and communicable diseases;
- traffic movements resulting in the potential for accidents and injury; and
- increased pressure and possible drawdown on health care resources.

Mitigation Measures

The following mitigation measures will be implemented to reduce impacts on community health.

- TGL will ensure strict compliance with pre-employment screening protocols for all employees (including contractors and subcontractors) which will include testing for TB and other diseases appropriate to the individual's country of origin, vaccinations and voluntary testing for sexually transmitted disease.

- Regular health screening will be provided for all employees (including contractors and subcontractors). Adequate referral and support for on-going treatment programmes for workers found to have treatable conditions. Subcontractors will be required to do the same through contractual specifications.

- All employees, contractors and subcontractors will be required to follow, and will be trained in, the Worker Code of Conduct which includes guidelines on worker-community interactions, worker-worker interactions and alcohol and drug use.

- All employees, contractors and subcontractors will be trained and educated to improve awareness of transmission routes and methods of prevention of sexually transmitted infections, communicable diseases (such as TB) and vector borne diseases, notably malaria, as part of induction. Other diseases will be covered as appropriate.

- TGL will develop Emergency Response Plans (ERPs) for the TEN Project taking into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident.

- TLG will continue to implement a programme of stakeholder engagement including a grievance mechanism.

Worker-Community Interactions

The presence of the project-related workforce could lead to the potential for increased transmission of communicable diseases and sexually transmitted infections (including HIV/AIDS).

The interaction of the workforce, in particular the non-local workforce, with local communities has the potential to increase the transmission of communicable diseases. The profile of these diseases will be influenced not only by the existing disease profiles in Ghana but also the disease profile of other countries where workers may be sourced from. However, taking into account the size of the workforce and the fact that during peak periods they will mainly be housed offshore, the opportunities for interaction will be limited. Moreover, TGL's onshore supply base in Takoradi and offices in Accra have been established for some time, and are predominantly staffed by local and expatriate workers living in Ghana. Therefore, the impact of communicable diseases and sexually transmitted infections is considered *not significant*.

Traffic Accidents

Transport of goods and personnel to the existing supply facilities in Takoradi will be by heavy or light goods vehicles (HGV or LGV) as required. Takoradi port is open 24 hours a day; it is therefore possible that deliverables will be made at any time of the day or night. It is an existing working port located in an industrial zone which is used to experiencing frequent commercial traffic. Project related traffic will represent a small increase in the overall traffic volume, and will utilise existing routes through areas where people have become accustom to traffic movements. The risk of an accident leading to serious injury or fatality can never be removed altogether in any situation where project vehicles and other users are occupying the same areas. The potential for road traffic accidents will, however, be reduced through the implementation of specific journey management planning, driving codes of conduct and enhanced driver safety awareness training implemented following lessons learned from incidents that occurred during the Jubilee project. Overall the potential impact from traffic accidents is considered to be of *Minor* significance at the community level following the implementation of mitigation.

Increased Pressure on Health Care Resources

The presence of an external workforce and the potential for increased transmission of disease could lead to increased pressure on the existing health care facilities in Takoradi and other locations where workers are based. This could lead to decreased access for local communities to these facilities (including longer waiting times) which is likely to be associated with worse health outcomes. This is a particular risk in the case of incidents involving multiple casualties or patients from both the workforce and community where hospital level care is required or in the case of a disease epidemic.

Due to the relatively small size of the workforce and the measures that will be implemented to minimise transmission of diseases, promote workforce health and the provision of project health care facilities it is considered unlikely that there will be significant levels of increased pressure on health care resources. In the event of a pandemic or a major incident it may be difficult for existing health care facilities to cope with any increased demand of medical care. This would, however, be very short-term whilst alternative health care provision is provided to the workforce, alleviating any increased pressure on existing public facilities, and as such the impact would be of *Minor* significance.

7.10 OIL SPILL RISK

7.10.1 Scope of Assessment

The risk of an oil spill into the marine environment is inherent in all offshore oil developments. The likelihood (probability) of significant oil spills, *ie* those that can reach the shoreline or other sensitive areas from the TEN Project area is very low with most oil spills associated with offshore installations being small and having only limited environmental effects.

The industry approach to dealing with potential oil spills is to develop technology and operational procedures to reduce the likelihood of oil spills occurring whist at the same time planning appropriate responses to oil spills to reduce the severity of impacts in the event of an incident. The response procedures form part of the Oil Spill Contingency Plan (OSCP) which is one part of TGL's overall Emergency Management Plan for the project.

This assessment addresses potential oil spills and leaks from the MODU, subsea installations, FPSO and the vessels operating close to the FPSO.

7.10.2 Assessment Methodology

The assessment of the potential impacts of oil spills to the marine and coastal environment requires consideration of the likelihood of various types of oil spill scenarios occurring and the consequences of these spills.

To aid the assessment an oil spill model was set up and a number of oil spill scenarios were modelled. A representative range of credible oil spill events were identified for the TEN Project and modelled by RPS-ASA.

RPS-ASA's SIMAP model used meteorological (wind and temperature) and hydrographic (waves and currents) data for the TEN Project area.

For the spill scenarios selected, model input data included:

- information on the properties of the oil (crude oil and marine gas oil (MGO));
- varying volumes of spilled oil and the spill duration; and
- weather conditions that could influence the behaviour of oil in the marine environment.

The model was used to give an indication of the likely trajectories and fate of any spilled oil, and to provide an indication of the likelihood of a particular area of marine environment or coast being impacted in the event of a spill.

The results of the oil spill modelling work undertaken by RPS-ASA are summarised in this section and the full report is included in *Volume II: Annex D*.

Impact Significance

For impacts associated with accidental events it is necessary to consider the risk of an event occurring in assessing impact significance, since if the event does not occur there will be no impact. Risk is defined as the combination of the likelihood of an event occurring and the consequences of that event. Assessing the significance of impacts from accidental events such as oil spills requires consideration of:

- the likelihood that an oil spill event might occur;
- the probability of an oil spill affecting a particular area;
- the sensitivity of the marine/coastal resources that may be affected; and
- the mitigation measures that will be implemented.

In this assessment the potential impacts on sensitive resources and receptors are described, followed by an analysis of the likelihood of spills occurring that might affect these resources and receptors.

7.10.3 Oil Spill Risk Assessment

The scenarios modelled were designed to be indicative of possible spill events that could occur and would lead to three different levels (tiers) of oil spill responses.

Oil Spill Release Frequencies

Oil spill events can be categorised in terms of their frequency of occurrence and their magnitude (*ie* size of spill). These two factors are typically combined to provide a measure of risk.

The likelihood or frequency categories are typically presented as the expected number of spill occurrences over a period of years. For example 1E-02 equates to a likely spill every 100 years of operation and 2E-06 equates to two spills every million years. The severity of an oil spill may be categorised according to the quantity spilled. The severity of oil spills is typically only in terms of the volume of oil released (in barrels of oil to the sea) rather than the impact of such spills on the coast or other sensitive receptors. Small spills are more frequent than large spills and a range of spill sizes, the weighted average volume of these spills and the weighted average frequency of these spills are presented in *Table 7.34*. These have been derived from a range of studies in other oil producing regions in the world, *eg* the Gulf of Mexico and the North Sea.

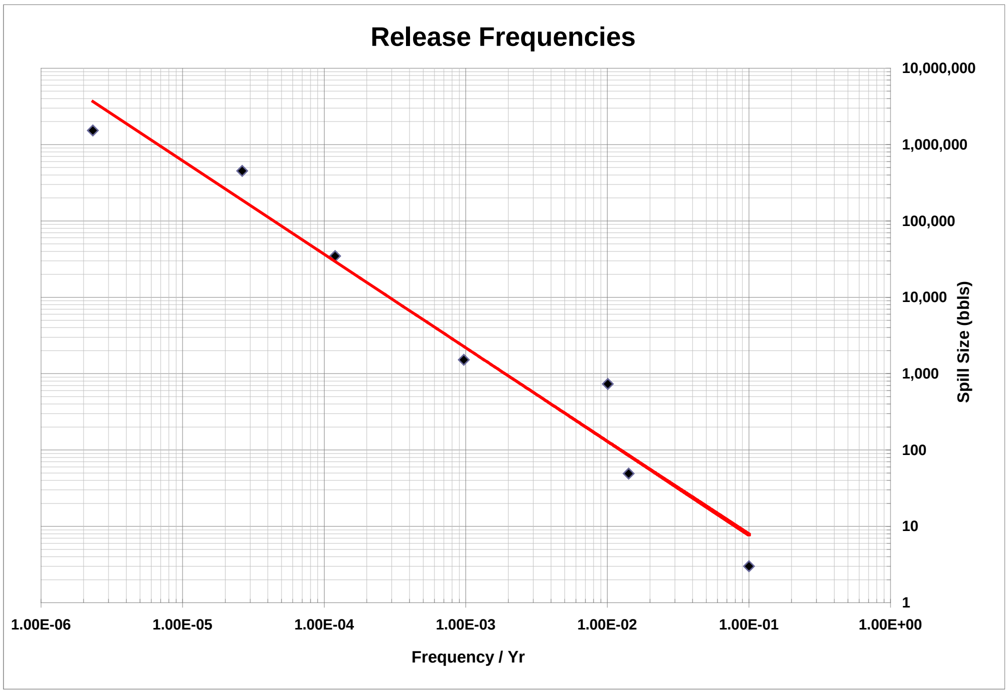
Figure 7.22 illustrates the results on a graph and shows that relatively small spills (*ie* approximately 10 bbl) are the most likely to occur (approximately once every 10 years) whereas progressively larger spills become increasingly unlikely to occur (*ie* a spill between 100 and 1,000 bbl is only predicted to occur every 100 years).

Table 7.34 Weighted Average of Release Sizes and Frequencies

Spill Size Ranges (bbl)	Weighted Avg Size (bbl)	Weighted Avg Frequency
>1,000,000	1,527,249	2.32E-06
100,000 - 1,000,000	451,511	2.63E-05
10,000 - 100,000	34,654	1.19E-04
1,000 - 10,000	1,519	9.68E-04
100 - 1,000	734	1.01E-02
10 – 100	49	1.42E-02

Note: E-1 equates to 10 years / E-2 equates to 100 years etc. Therefore to use 10E-2 as an example this equates to a likelihood of 10 spills every 100 years *ie* there is the likelihood of 1 spill every 10 years.

Figure 7.22 Release Frequencies by Size



Source: IRC 2009

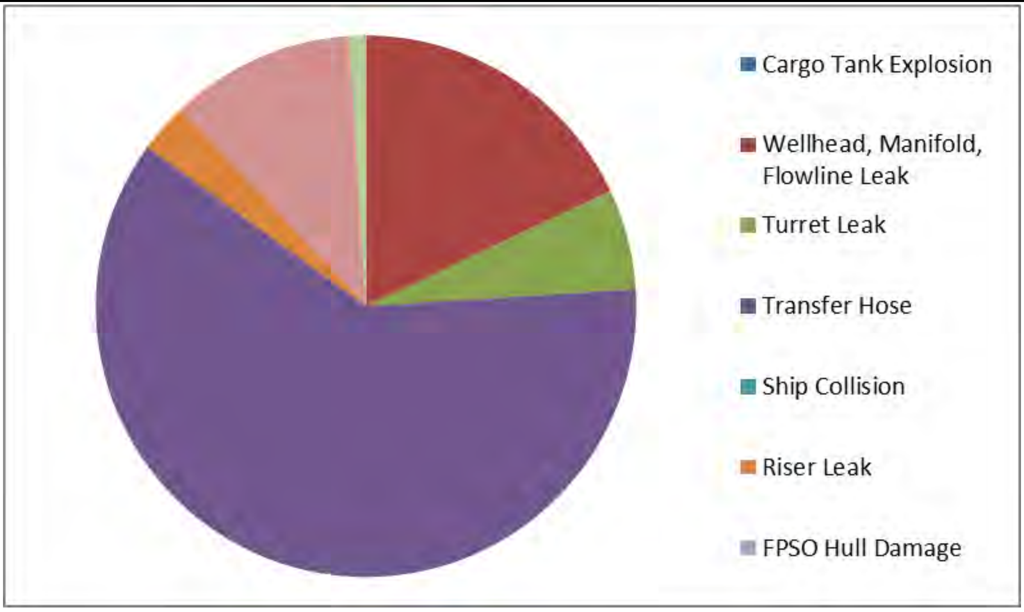
Table 7.35 presents the frequency of spills that can be expected for a range of credible scenarios. This is also illustrated in *Figure 7.23* below which shows that of the spill scenarios examined the most likely source of a spill is from the transfer hose during oil unloading from the FPSO. This is predicted to occur approximately twice every 10 years (2.00E-01). However, this would most likely be a small spill of less than 10 bbl.

Table 7.35 Release Frequencies by Spill Scenario

Release Source	Frequency
Wellhead, Manifold, Flowline Leak	5.81E-02
Turret Leak	1.86E-02
Transfer Hose	2.00E-01
Ship Collision	1.02E-04
Riser Leak	1.06E-02
FPSO Hull Damage	1.33E-04
Bunkering	3.54E-02
Blowout	1.90E-03
Cargo Tank Explosion	8.30E-05

Source: IRC 2009

Figure 7.23 Percentage of Release Frequencies by Release Source



Source: IRC 2009

The major spill events, such as from a ship collision, FPSO hull damage, blowouts and cargo tank explosions are so unlikely to happen they are not shown on *Figure 7.23*. For example spills from a ship collision would be expected once every 10,000 years (*ie* 1.02E-04).

Scenario Selection

A representative range of credible oil spill events were identified for the TEN Project oil spill modelling studies. Although smaller spills are more likely the scenarios include a range of spill sizes including representative worst case large spills.

1. **Riser leak with isolation.** A release from a production riser has been selected as representative of the worst case from the import facilities. It is assumed that a larger riser release will be detected within five minutes and that approximately 3,500 bbl would be released in that time.

2. **Riser leak without isolation.** A riser leak scenario where preventative measures are unable to isolate the leak has also been modelled. The scenario assumes a one hour release at rate of 1,568 kgs^{-1} for the first 20 minutes and 60,000 bbl per day (maximum production rate) for the remaining 40 minutes, giving a total release of 15,500 bbl. All production risers are fitted with a riser base valve which is a 'fail open' valve. This scenario would require both the failure of the riser and simultaneous failure of the riser base valve or control system. In addition, a 60 minute release period is considered a worst case.

3. **Transfer hose release.** This event involved a large release from transfer hose while offloading crude oil due to rupture of the hose (1). The hose rupture has been selected as temporary connections have a greater failure rate than permanent ones. It is assumed that the transfer pumps will be stopped in 30 seconds and approximately 900 bbl would be released in that time.

4. **Bunkering.** This event involved a large hose release during bunkering of MGO to the FPSO due to a rupture of the hose. Both oil offloading and marine oil bunkering were selected so that different fluids are modelled. Historical data on actual events present a total spill size of approximately 1,000 bbl as typical for a spill during bunkering. As there is no information on the release duration, 30 seconds was assumed as for transfer of oil to the tanker.

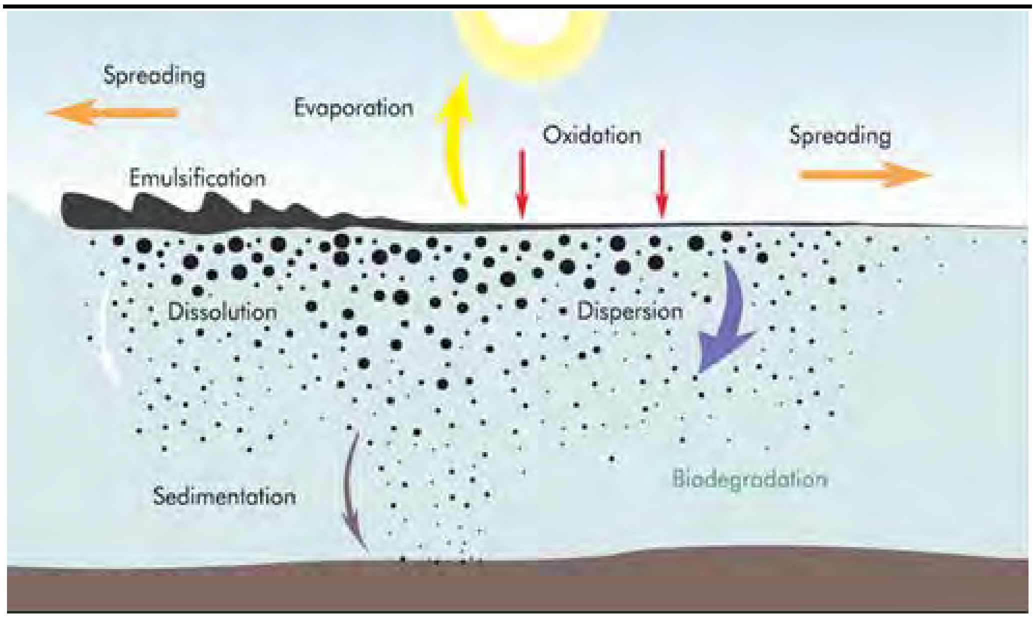
5. **Well blowout.** Although the likelihood of a major well blowout is very low (1.90E-03) this event was selected to represent a major subsea release of crude at a rate 10,000 bpd. The blowout release was assumed to occur over a duration of 60 days which takes into account the duration of drilling a relief well in such an event. This scenario was informed by the Mocondo incident in the Gulf of Mexico in 2009. The total volumes spilled in this event would be approximately 600,000 bbl and has been modelled for two well locations.

(1)The modelling was undertaken based on a spill from an oil offloading buoy (OOB) (see Volume II: Annex D). The design is now for offloading of the FPSO to an offtake tanker using a floating hose, however, the modelled oil spill is representative of a spill from the offloading operation as the failure risk and potential volume of oil loss from the floating hose is the same for both methods, and the location of the former proposed OOB is within 3 km of the FPSO.

7.10.4 *Oil Behaviour*

The physical and chemical change that spilled oil undergoes is collectively known as 'weathering' (*Figure 7.24*). Knowledge of these processes and how they interact to alter the nature and composition of the oil with time is essential in identifying the best oil spill response strategies, choosing appropriate equipment and developing effective contingency plans. A short description of the fate process is provided in *Box 7.2.*

Figure 7.24 Weathering Processes for Oil at Sea



Source: ITOPF 2012

Box 7.2 Oil Weathering Process

Drifting: physical movement of surface oil from one location to another due to the combined effects of water current, tides, waves and wind. Oil on the water surface typically moves at 100% of the current speed and direction and 3% of wind speed and direction.

Spreading: increase in the length and breadth of the oil slick as it spreads and thins on the sea surface.

Evaporation: evaporation of lighter hydrocarbons from the oil to the atmosphere.

Emulsification / mousse formation: Formation of water in oil emulsions, resulting in an increase in oil viscosity. Oils with a high asphaltene content are more likely to form stable emulsions.

Entrainment / dispersion: the formation of oil droplets due to breaking waves, resulting in transport of oil from the sea surface into the water column.

Dissolution: Physical chemical process resulting in oil from the oil slick or from suspended oil droplets dissolving into the water column.

Submergence/sinking/sedimentation: increase in density of oil due to weathering and interaction with suspended sediments or material of biological origin. Deposition of material on the sea floor. Tar balls may be formed, which could roll along the seabed.

Shoreline interaction/stranding: impact of oil on the shoreline where it may strand on the surface, or become buried in layers, or may refloat and move elsewhere. The rate of weathering of stranded oil depends on several factors, in particular the amount of exposure to waves.

Photo oxidation/photolysis: chemical transformation of petroleum hydrocarbons caused by sunlight.

Biodegradation: biological chemical process altering or transforming hydrocarbons through the action of microbes and/or the ingestion by plankton and other organisms.

7.10.5 Oil Spill Modelling

Introduction

The oil spill modelling used to predict the consequences of the various oil spill scenarios in the event that a spill required information on the nature of the oil spilled, the location and duration of the spill, the behaviour of the oil in the marine environment, and its transport from the spill site to other marine and coastal areas. The information used in the model allows the likely fate of various oil spills in the marine environment to be assessed and illustrated. This aids the assessment of potential environmental impacts of an oil spill on sensitive receptors (*eg* coastal habitats).

Oil Spill Scenarios

Six oil spill scenarios were simulated with the aim of assessing the impact of oil on nearby surface water and shorelines from potential MGO (1) and crude oil spills. These scenarios are based on the spill events identified in *Section 7.10.3* above. It should be noted that the spill modelling scenarios were run on the basis that no intervention measures are undertaken.

Four potential surface oil spill scenarios were simulated as summarised in *Table 7.36*. The surface spill scenarios included releases from three different locations and used two different oil types. For the purposes of the modelling study, three of the four spill durations were assumed as instantaneous although they may be of very short duration in reality.

Table 7.36 Surface Spill Modelling Scenarios

#	Spill Site	Oil Type	Spill Type	Spill Duration	Total Spilled Volume (bbl)	Simulation Duration
1	FPSO	Crude	Surface spill w/ isolation	Instantaneous	1,000	21 days
2	FPSO	Crude	Surface spill w/o isolation	1 hour	3,453	21 days
3	OOB	Crude	Transfer hose release	Instantaneous	900	14 days
4	EN-7	MGO	Bunkering	Instantaneous	1,000	14 days

Two subsurface blowout oil spill scenarios were also simulated as summarised in *Table 7.37*. The only difference between the two scenarios is the location and depth of release.

Table 7.37 Subsurface Spill Modelling Scenarios

#	Spill Site	Oil Type	Spill Type	Spill Rate (bbl/day)	Spill Duration	Total Spilled Volume (bbl)	Simulation Duration
5	EN-7	Crude	Subsurface blowout	10,000	60 days	600,000	75 days
6	EN-22	Crude	Subsurface blowout	10,000	60 days	600,000	75 days

Wind

Wind is the primary driving factor used in surface modelling to predict surface spread and transport. Wind data for the TEN Project area was sourced from NOGAPS (see *Chapter 4: Section 4.3*). The wind regime near the spill sites is characterised by south-westerly winds throughout the year. There is some slight variability in the directional trend from month to month with more persistent south-westerly winds in the spring and summer and slightly more variability in the winter months.

(1) MGO is often used as fuel in marine vessels. MGO was selected as a representative worst case fuel type for modelling as it is heavier than diesel (gasoil) and, due to its properties, will take longer to weather in the marine environment.

Currents

Regional currents for the area were obtained from a hindcast analysis using inputs from the HYCOM model (see *Chapter 4: Section 4.5.4*). Average current fields are similar in April and December, with currents typically travelling eastward close to the coastline and westward offshore near the equator. However, there are major differences in the average velocities observed in each of those months, with average currents typically higher in April relative to December.

The vertical profile of currents was needed to evaluate the transport of oil particles through the water column for the subsurface blowout simulations. The vertical profiles of currents were obtained from the HYCOM model outputs. In April, near surface currents are persistent toward the east. This trend tends to dissipate with depth, with currents at 500 m showing a reversal of flow toward the west and currents at 1,000 m split almost equally between west northwest and east southeast. In December, the surface currents, despite having a net flow to the east, exhibit significantly more variability in the directionality of flow.

Seasonality

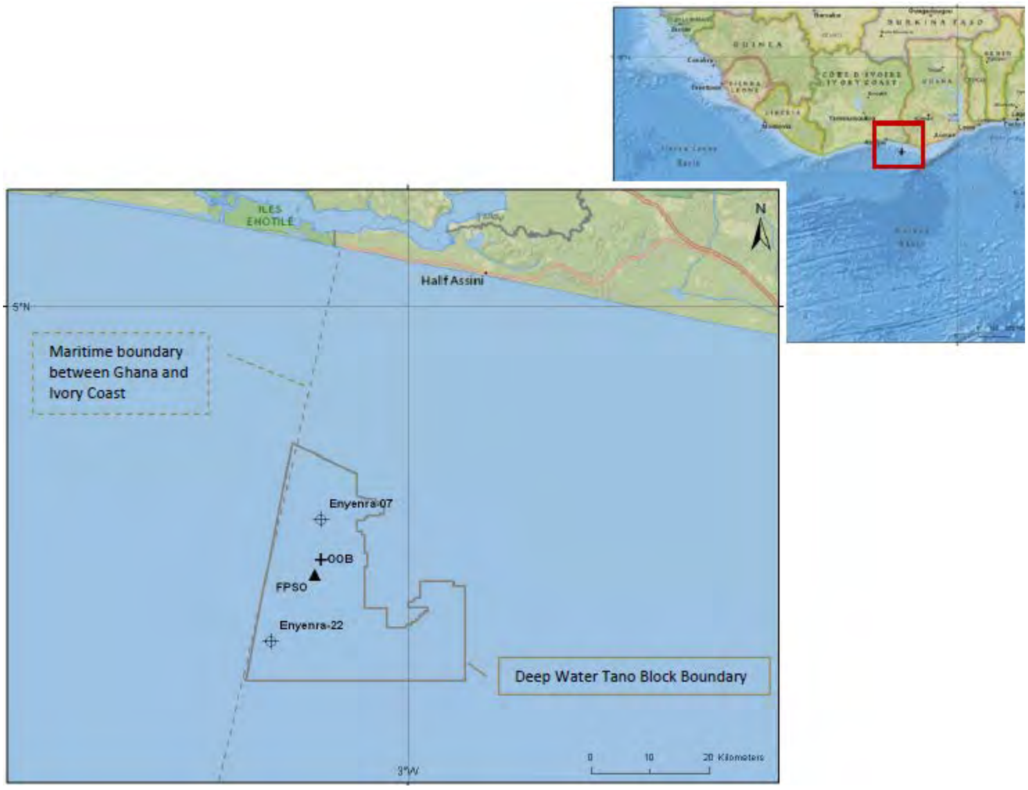
While there are some climatic differences throughout the year, seasonal variability in winds and surface currents are relatively small and, therefore, the potential wind or current driven transport of oil is expected to be relatively similar throughout the year. Therefore, all stochastic oil spill scenarios were run on an annual basis and thus were not specifically run for any seasons.

Spill Location

The modelling studies assumed potential spills from four release sites. As described in *Section 7.4.7*, EN-7 was selected as a nominal well site representing the most northern extremity of the TEN Project area, *ie* nearest to the coast and in shallower water (992 m). EN-22 was selected as a nominal well location representing the southern extremity of the TEN Project area, *ie* furthest from the coast and in deeper water (1,851 m)[(1)]. The transfer hose release was modelled from the former OOB location which is situated less than 3 km from the FPSO, however, given the distance offshore and the scale of the spill, the small change in location will not substantially affect the results of the modelling. The FPSO location was selected for the remaining spill scenarios. The spill locations are shown in *Figure 7.25*.

(1) EN-22 is no longer part of the TEN Project plan.

Figure 7.25 Study Area Showing Location of the FPSO within the TEN Project Area



Source: RPS-ASA 2013

Water Depth

Water depth is an important input for 3D subsurface oil spill modelling. Two representative well locations were selected, namely EN-7 and EN-22 located in a depth of 992 m and 1,851 m respectively as noted above.

Oil Type

The properties of the oils used in the model simulations are provided in *Table 7.38*. These are based on the crude oil (a relatively light oil with an API of 37) expected from the Enyenra field and MGO (heavy diesel) likely to be used for marine vessels. Evaporation characteristics were assumed based on representative oils with a similar density and viscosity at standard test temperatures.

Table 7.38 Summary of Oil Properties

Oil Type	Density (gcm^{-3})	Viscosity (cP)	Surface Tension (dyne cm^{-1})	Maximum Water Content (%)
Enyenra Crude	0.857	21.98 @20^{0}C	27	82
Marine Gas Oil (Heavy Diesel)	0.831	2.760@20^{0}C	27.5	0

7.10.6 *Surface Water Modelling Approach*

The RPS-ASA oil spill modelling system, SIMAP, was used for all surface oil spill simulations. Both stochastic and deterministic modelling was used to analyse surface and shoreline oiling for the different scenarios.

Stochastic simulations provide insight into the probable behaviour of potential oil spills in response to temporally and spatially varying meteorological and oceanographic conditions in the study area. Stochastic analysis provides the following information: the footprint of sea surface areas that might be oiled and the associated probability of oiling as well as the shortest time required for oil to reach any point within the areas predicted to be oiled.

Deterministic model simulations provide a time history of oil weathering over the duration of the simulation, expressed as the percentage of spilled oil on the water surface, on the shoreline, evaporated, and naturally dispersed in the water column.

Stochastic Oil Spill Modelling

Table 7.39 summarises the results of the stochastic analysis of the four surface oil spill scenarios with respect to the probability of oil impacting the shoreline. The percentage of simulations reaching shore indicates the likelihood that any particular spill event will reach nearby coastal areas at some point. The table also provides the maximum and average times for oil to reach the shoreline. It is noted that for scenarios 1 and 2 the model was run for a period of 21 days and 14 days for scenarios 3 and 4 (RPS-ASA 2013).

Table 7.39 Summary of Surface Water Oil Spill Scenario Stochastic Simulations

#	Spill Site	Oil Type	Total Volume Released (bbl)	Simulations Reaching Shore (%)	Volume of Oil Ashore (bbl)		Time to Reach Shore (hours)	
					Max	Avg.	Min.	Avg.
1	FPSO	Crude	3,500	85	337	318	32	129
2	FPSO	Crude	15,500	85.5	1,514	1,086	28	129
3	OOB	Crude	900	83.2	594	564	28	101
4	EN-7	MGO	1,000	78.6	255	119	28	94

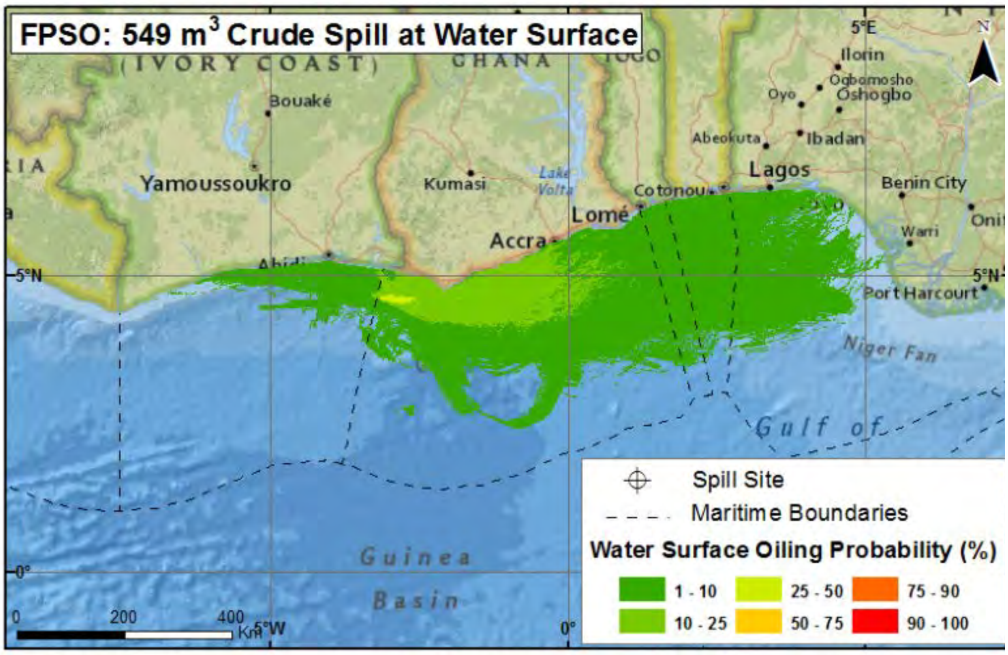
The stochastic model predicts there is approximately an 85% probability that oil will reach the shoreline from either of the riser leak scenarios. There is a difference of four hours between the minimum time it could take oil to reach the shoreline, with 28 hours the least of either scenario. There is a difference in the potential volume of oil which could impact the shoreline owing to the difference in spill volumes; up to 2,150 bbl and 10,400 bbl of oil could impact the shore for scenarios 3 and 4, respectively.

For the near-instantaneous surface spills (scenarios 3 and 4), the stochastic model predicts there is approximately an 80% probability that oil will reach the shoreline. There are slight differences in the probability of oil reaching the shoreline as well as the average time that it could take for the oil to reach the shoreline. In both scenarios the least time that oil could reach the shoreline is 28 hours, however, on average releases from EN-7 (MGO bunkering) would reach shore quicker. There are differences in the potential volume of oil which could impact the shoreline. A maximum volume of 255 bbl of MGO from EN-7 could impact the shoreline compared to up to 594 bbl of crude from the export tanker.

Figure 7.26 illustrates the potential footprint of water surface oiling for scenario 1 (3,500 bbl crude spill from a production riser rupture). The footprint of potential oiling to the water surface (>1% probability) extends about 950 km to the east and 400 km to the west, past the waters of Ghana and into the offshore waters of Benin, Côte d'Ivoire, Nigeria and Togo. The highest probability footprint (>50% probability) is isolated to within about 7 km of the spill location, oriented predominantly toward the east and northeast of the spill location. There is approximately an 85% of oil impacting the coastline. Over 590 km of shoreline has a greater than 1% probability of being oiled, including the shoreline of Ghana, Côte d'Ivoire and Benin; however, no section of coastline has a greater than 15% probability of oiling. Oil could reach the coastline in 1.3 days, with an average time of 5.4 days.

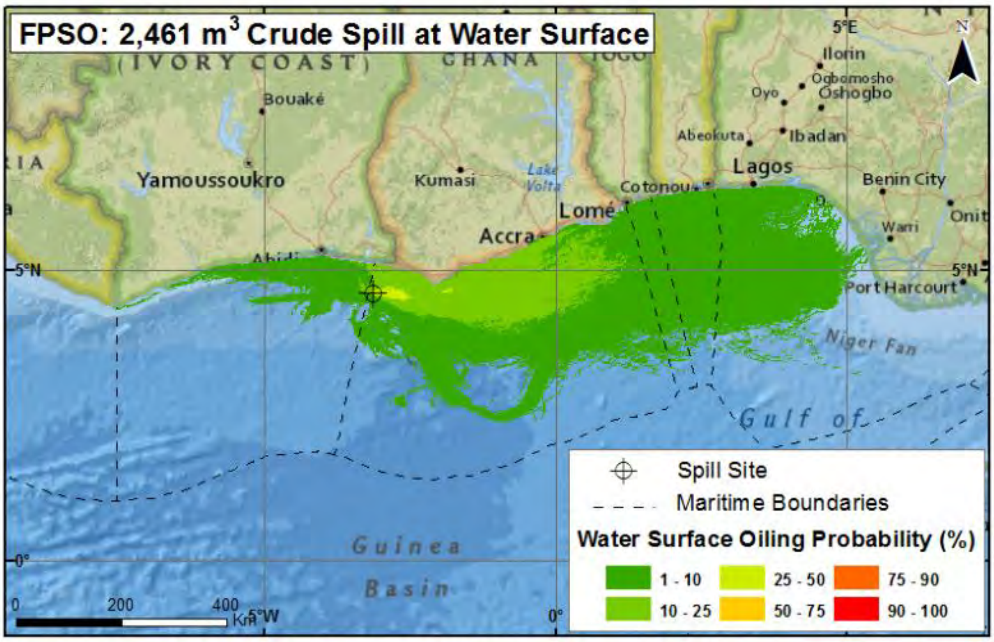
Figure 7.27 illustrates the potential footprint of water surface oiling for scenario 2 (15,500 bbl crude spill from a production riser rupture). The footprint of potential oiling to the water surface (>1% probability) extends about 950 km to the east and 500 km to the west, past the waters of Ghana and into the offshore waters of Benin, Côte d'Ivoire, Nigeria, Togo and Liberia. The footprint with the highest probability (>50%) is isolated to within 10 km of the spill location, oriented predominantly toward the east and northeast. There is approximately 85.5% change that oil will impact the coastline. Over 715 km of shoreline has a greater than 1% chance of being oiled, including the shoreline of Ghana, Côte d'Ivoire, Benin, Togo and Nigeria; however, no section of coastline has a greater than 15.5% probability of oiling. The model predicts that oil could reach the coastline in 1.2 days, with an average time of 5.4 days.

Figure 7.26 Scenario 1 Probability of Water Surface Oiling from 3,500 bbl Crude Spill



Source: RPS-ASA 2013

Figure 7.27 Scenario 2 Probability of Water Surface Oiling from 15,500 bbl Crude Spill

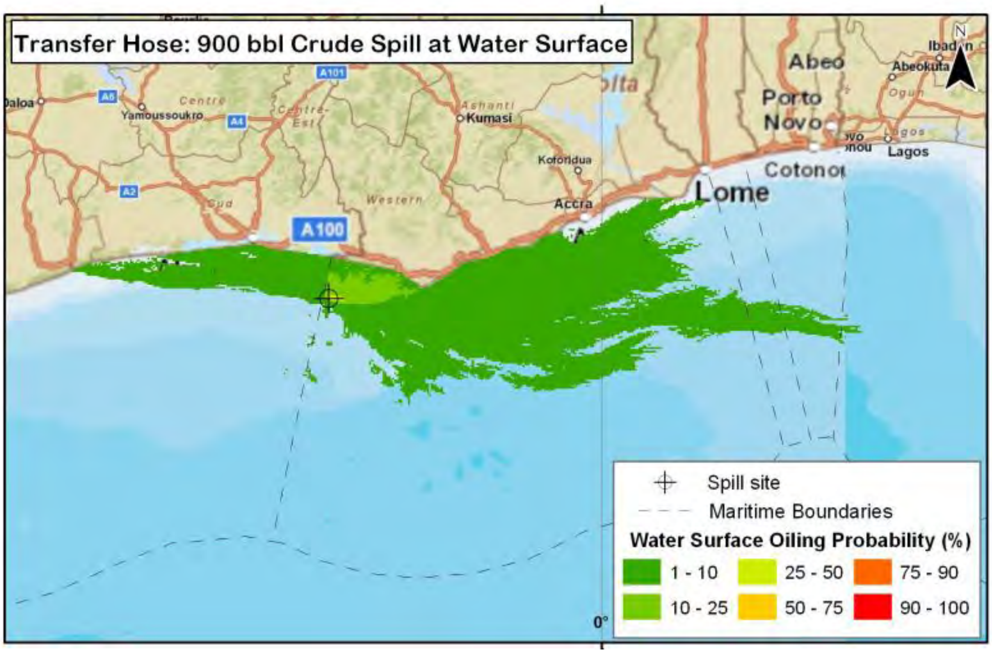


Source: RPS-ASA 2013

Figure 7.28 illustrates the potential footprint of water surface oiling for scenario 3 (900 bbl crude release from transfer hose). The footprint extends predominantly to the east, approximately 675 km past the waters of Ghana and into the offshore waters of Benin, Côte d'Ivoire, Nigeria and Togo. Over 900 km of shoreline has a greater than 1% probability of being oiled, including the shorelines of Ghana and Côte d'Ivoire. Similar to the two scenarios describe above, there is a relatively low probability that oil would reach the shoreline (1 to 25%) under a range of environmental conditions. The shoreline in the region of Axim has the highest probability of shoreline impact. The oil will reach the shoreline of Ghana within 28 hours, with an average time of shoreline impact in approximately 4.2 days.

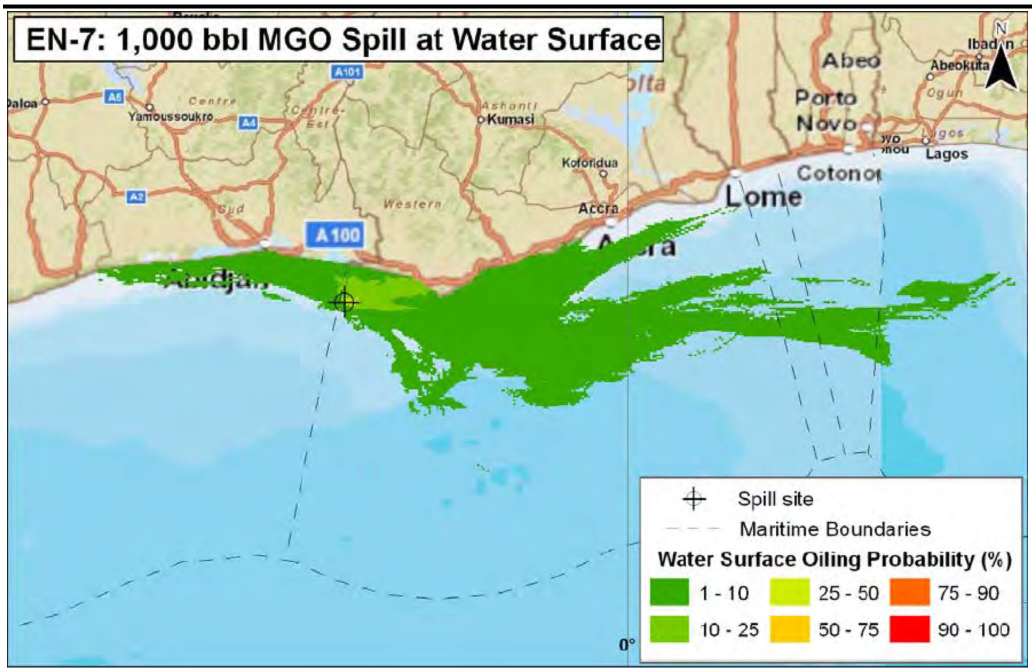
Figure 7.29 illustrates the potential footprint of water surface oiling for scenario 4 (1,000 bbl MGO release during bunkering). The footprint extends predominantly to the east, approximately 800 km into the offshore waters of Benin, Côte d'Ivoire, Nigeria and Togo. Over 900 km of shoreline has a greater than 1% probability of being oiled, including the shoreline of Ghana and Côte d'Ivoire. There is a relatively low probability that oil would reach the shoreline (1 to 25%) under a range of environmental conditions. The shoreline in the region of Axim has the highest probability of shoreline impact. The oil will reach the shoreline of Ghana within 28 hours, with an average time of shoreline impact approximately 4 days.

Figure 7.28 Scenario 3 Probability of Water Surface Oiling from 900 bbl Crude Spill



Source: RPS-ASA 2013

Figure 7.29 Scenario 4 Probability of Water Surface Oiling from 1,000 bbl MGO Spill



Source: RPS-ASA 2013

Deterministic Oil Spill Modelling

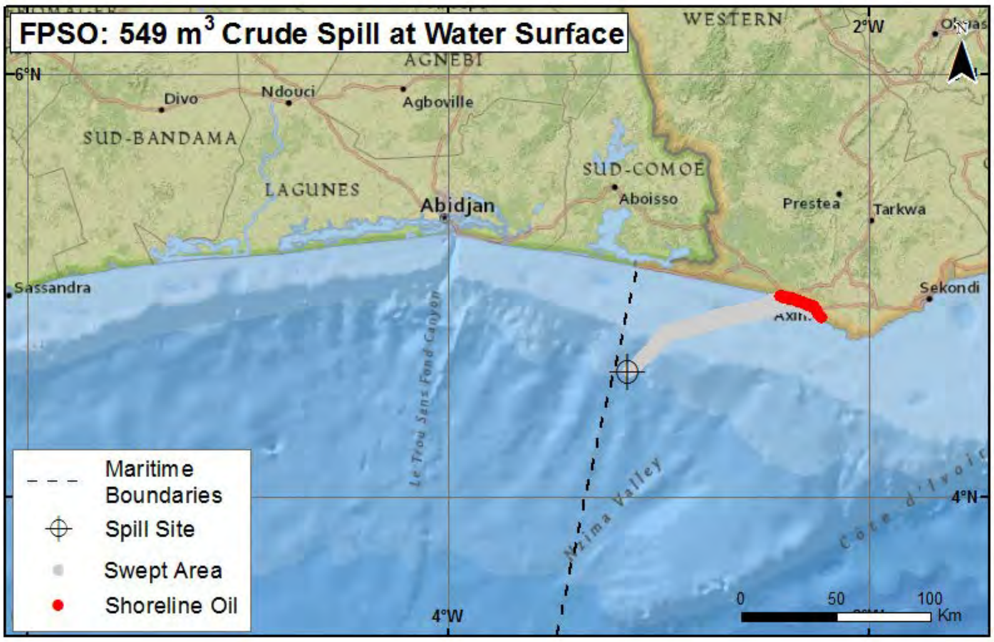
Deterministic modelling was performed to investigate a specific spill trajectory identified in the previous stochastic analysis representing an event that resulted in high shoreline impacts. The trajectory/fate simulation was run using the same variable winds and current forcing used for the corresponding stochastic simulations. The deterministic simulations were based on environmental conditions that would lead to the highest degree of shoreline oiling (*ie* scenario with a large volume of oil reaching the shoreline in the shortest possible time).

Figure 7.30 to *Figure 7.33* illustrate the deterministic simulations for the four surface release oil spill scenarios. The model outputs show the predicted footprint of the spilled oil (in grey) and the shoreline impacted (in red).

Figure 7.30 illustrates that a spill of 3,500 bbl crude resulted in a trajectory of oil to the northeast of the spill location. The slick reaches the shore approximately 45 hours after release. At the end of the simulation (21 days after release), the model predicts that approximately 2,100 bbl of oil will impact 10 km of shoreline between Esiama and Axim, Ghana.

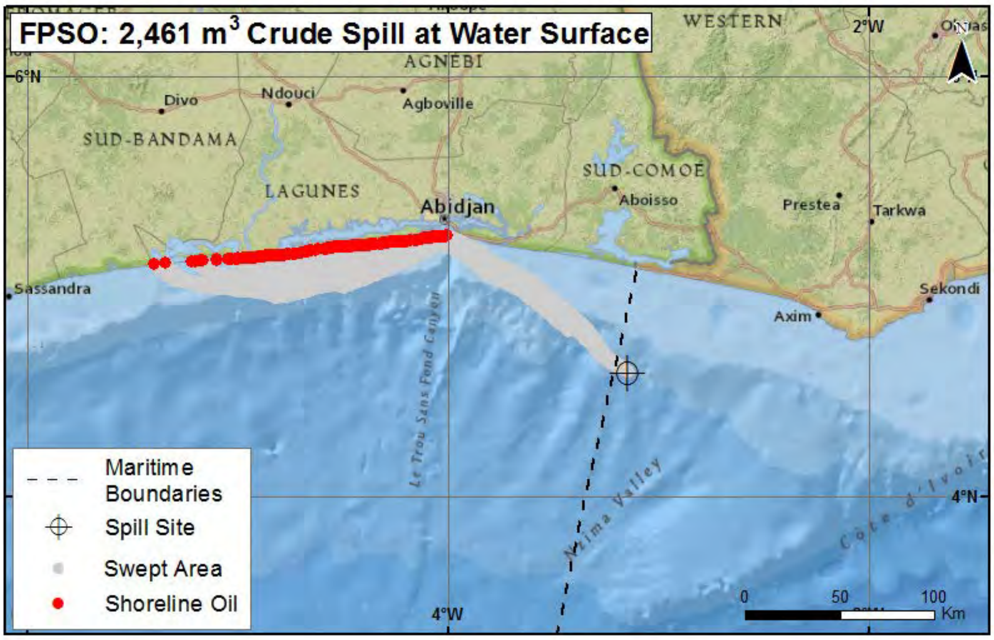
Figure 7.31 illustrates that a spill of 15,500 bbl crude resulted in a trajectory of oil to the northwest from the spill location, over the Ghana-Côte d'Ivoire maritime border. The slick reaches shore approximately 41 hours after release. At the end of the simulation, the model predicts that 9,500 bbl of oil will impact 64 km of shoreline between Abidjan and Grand-Lahou, Côte d'Ivoire.

Figure 7.30 Scenario 1 Trajectory of a Riser Leak Spill of 3,500 bbl Crude



Source: RPS-ASA 2013

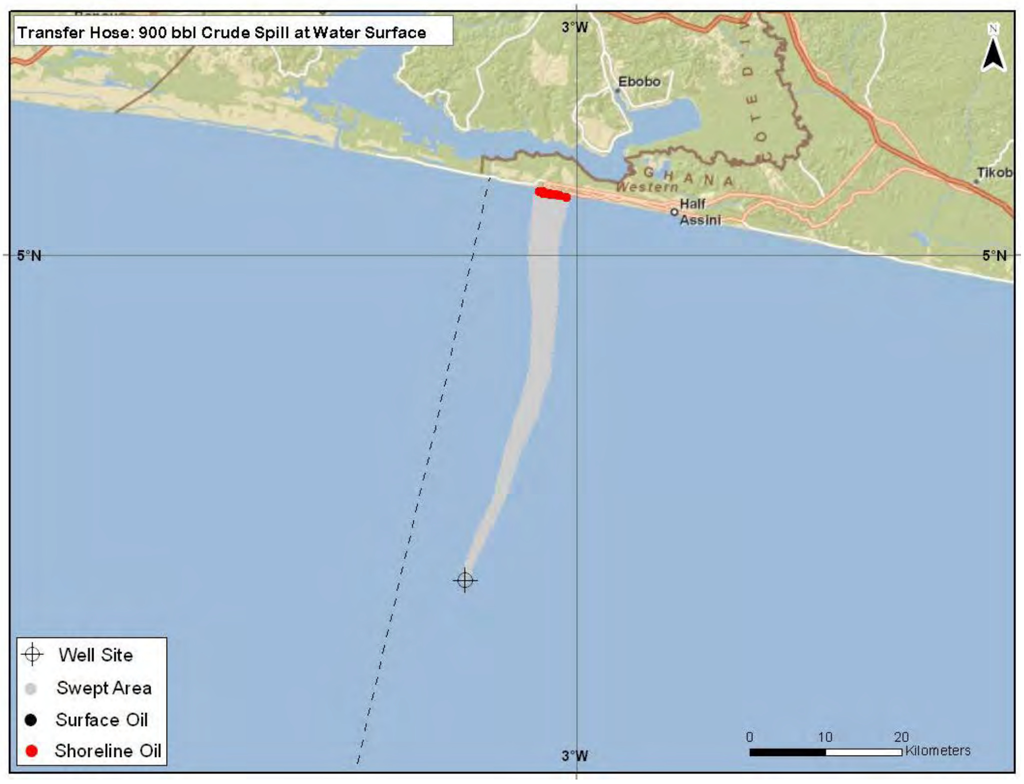
Figure 7.31 Scenario 2 Trajectory of a Riser Leak Spill of 15,000 bbl Crude



Source: RPS-ASA 2013

Figure 7.32 illustrates that a spill of 900 bbl crude resulted in a trajectory of oil to the north-northeast from the spill site, over the Ghana-Côte d'Ivoire maritime border and subsequently transitioning to a north-northeast trajectory due to changes in the wind pattern. The slick reaches the western shore of the Ghana coast approximately 30 hours after being released. The model predicts that approximately 594 bbl of oil will impact 7 km of shoreline between New Town and Half Assini.

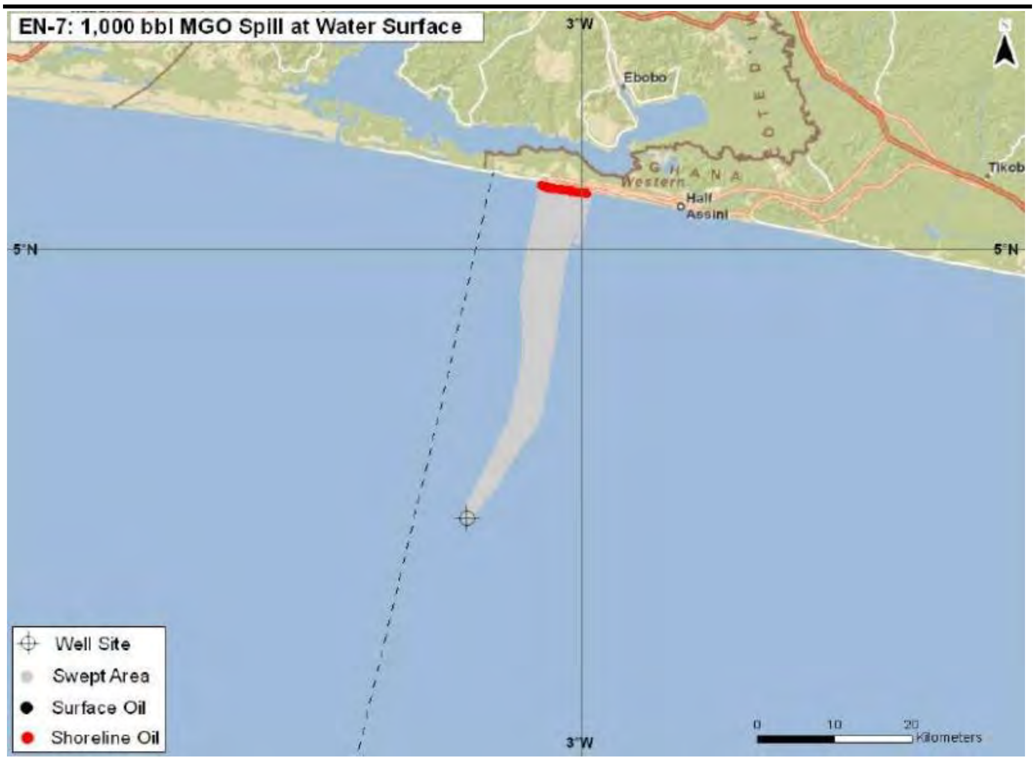
Figure 7.32 Scenario 3 Trajectory of Spill of 900 bbl Crude from Floating Hose



Source: RPS-ASA 2013

Figure 7.33 illustrates that a spill of 1,000 bbl MGO resulted in a trajectory of oil to the north from the spill site, with oil reaching the shore approximately 32 hours after being released. The model predicts that approximately 240 bbl of oil will impact 6 km of shoreline between New Town and Half Assini.

Figure 7.33 Scenario 4 Trajectory of Spill of 1,000 bbl MGO Spill During Bunkering



Source: RPS-ASA 2013

7.10.7 *Subsurface Oil Spill Modelling Approach*

Stochastic and deterministic simulations were performed for two potential subsurface well blowout scenarios. Blowout simulations are typically performed in two phases.

- **Near-field analysis.** Describes the oil/gas plume generated by the blowout that typically evolves vertically due to vertical processes (momentum and relative buoyancy). The near-field results depend on the blowout conditions (flow rate, gas-to-oil ratio and pipe diameter), and less on the environmental conditions (*eg* seasonality). The objective of this first step of the blowout modelling is to characterise the plume mixture (oil, gas and water) discharged from the wellhead blowout. In most cases the near-field region occurs only within a few hundred of meters of the wellhead. The results of the near-field analysis were taken forward for far-field modelling in stochastic and deterministic modes.

- **Far-field analysis.** Describes the long term transport and weathering of the released oil mixture that typically evolves as a horizontal process due to currents and winds. Far-field modelling is highly dependent on the environmental conditions such as winds and currents as the main drifting/driving forces. The 3D model SIMAP was used to assess the fate of oil in the far- field(1). The SIMAP model quantifies the transport and fate of different components of hydrocarbon mixture (dispersed, dissolved *etc*) in space and over time.

Near-field Blowout Plume Modelling

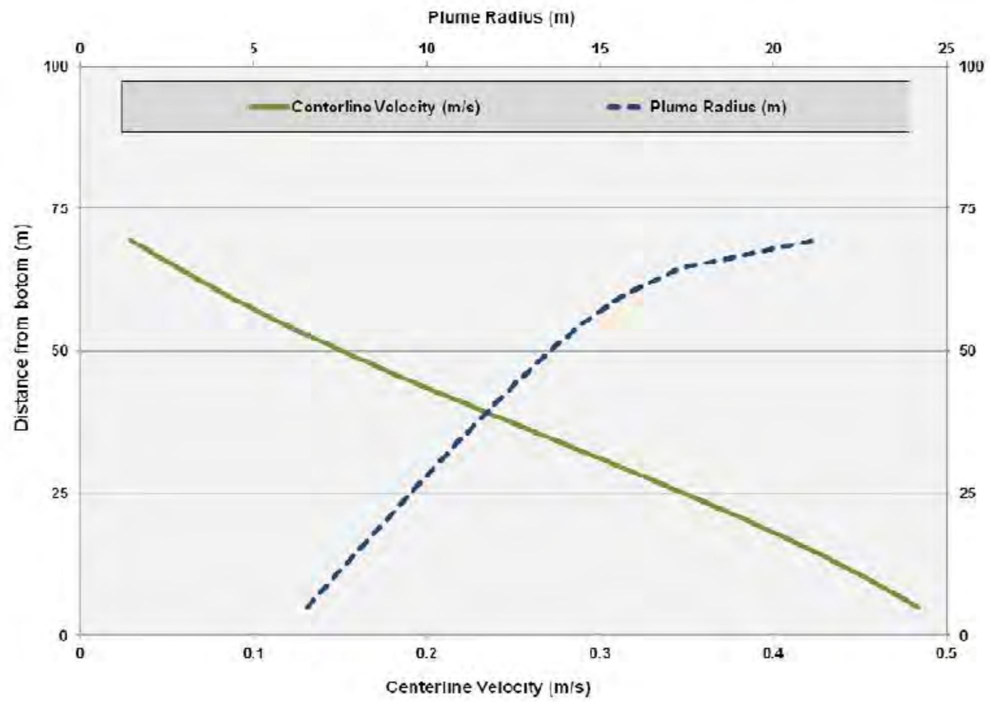
The characterisation of the plume height and radius is important for determining the area for the most effective subsurface collection and dispersant application of oil spills. Near-field modelling was carried out for two subsurface scenarios. *Table 7.40* illustrates the parameters used for near-field subsurface modelling.

Table 7.40 Parameters of Oil Scenarios and Blowout Conditions

#	Spill Site	Oil Type	Total Volume Released (bbl)	Water Depth (m)	Gas to Oil Ratio	Pipe Diameter	Discharge Temp
5	EN-7	Crude	600,000	992	159-210m³ per m³	12.347 in (31.36 cm)	80-110⁰C (average)
6	EN-22	Crude	600,000	1,851			

Figure 7.34 and *Figure 7.35* show the plume radius plotted as a function of the height above the sea floor and plume centreline velocity (*ie* vertical movement of the mixture of gas, oil and water along the centre of the plume) of the blowout as a function of the height above the seafloor.

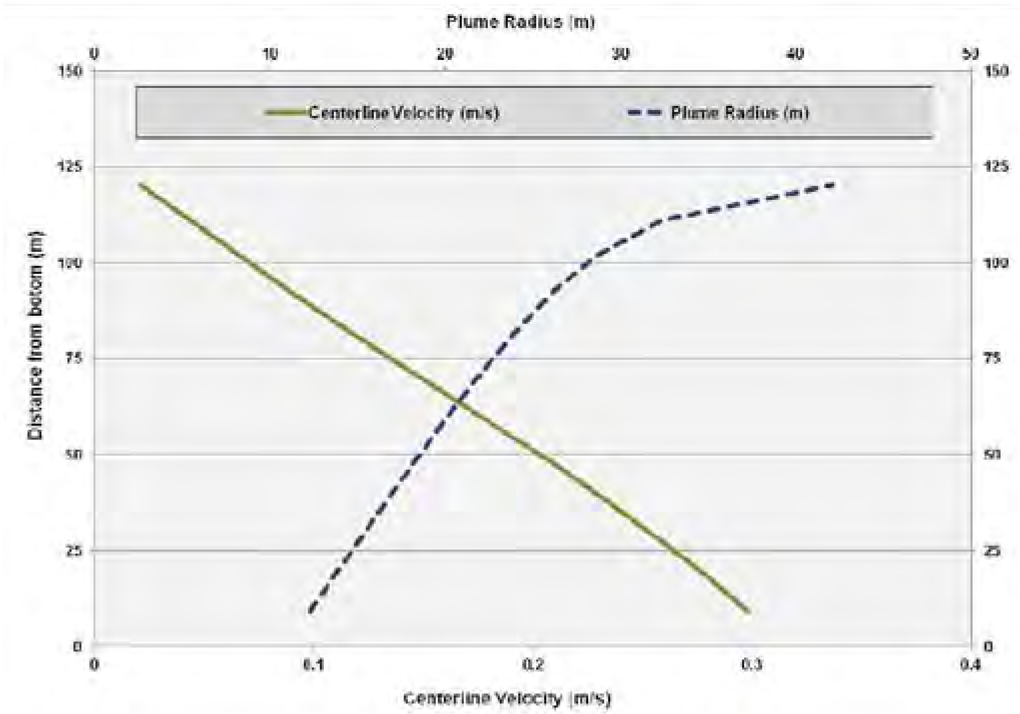
Figure 7.34 Predicted Blowout Plume Centre Line Velocity and Plume Radius Versus Elevation above Release Point at EN-7



Source: RPS-ASA 2013

(1) Defined as the point at which ambient currents dominate the oil transport rather than the near-field blowout plume phase.

Figure 7.35 Predicted Blowout Plume Centre Line Velocity and Plume Radius Versus Elevation above Release Point at EN-22



Source: RPS-ASA 2013

The model shows that the velocity of the plume decreases quickly at heights further from the discharge point as it entrains heavier ambient seawater. The plume diameter increases linearly until approximately 90% of the termination height has been reached, at which point the plume widens more quickly.

At EN-7 (scenario 5), the plume is expected to terminate approximately 69 m above the seafloor and have a radius of about 21 m. At EN-22 (scenario 6), which is much deeper, the plume will extend about 120 m above the well head and will have a radius of 42 m.

For a subsurface blowout the smallest particles (500 microns) would rise to the surface in approximately 20 hours and 38 hours from EN-7 and EN-22 respectively (see *Figure 21* and *Figure 22* in *Volume II: Annex D1*). The largest particles (10,000 microns) would surface within 2 hours and 3.7 hours for subsurface blowouts from EN-07 and EN-22 respectively. Overall the particle size distributions predicted for EN-7 and 22 are similar as the initial conditions (flow rate, pipe opening size) are identical. There are slight differences in the gas pressure as a result of the difference in water depth between the two sites.

Far-field Subsurface Oil Spill Modelling

Subsurface Stochastic Oil Spill Modelling

Table 7.41 summarises the results of the stochastic analysis of each of the subsurface oil spill scenarios with respect to the probability of oil impacting the shoreline. The percentage of simulations reaching shore indicates the likelihood that a particular spill event will reach nearby coastal areas at some point. The table also provides the volume of oil and minimum and average times for oil to reach the shoreline.

Table 7.41 Summary of Far-Field subsurface Oil Spill Stochastic Results

#	Spill Site	Oil Type	Total Volume Released (bbl)	Simulations Reaching Shore (%)	Volume of Oil Ashore (bbl)*		Time to Reach Shore (hours)	
					Max	Avg.	Min.	Avg.
5	EN-7	Crude	600,000	100	223,487	114,149	32	122
6	EN-22	Crude	600,000	100	227,048	133,336	54	195

* After 75 days of simulation, including 60 days well flow

Both of the blowout scenarios resulted in 100% probability of oil reaching some segment of the shoreline due to the proximity of the spill sites to the shoreline, the nature of the winds and currents in this region, and the long duration and volume of the spills. Approximately 230,000 bbl (about 38% of original spilled volume) could reach the shoreline, however, on average much less oil would reach the shoreline from any particular spill event.

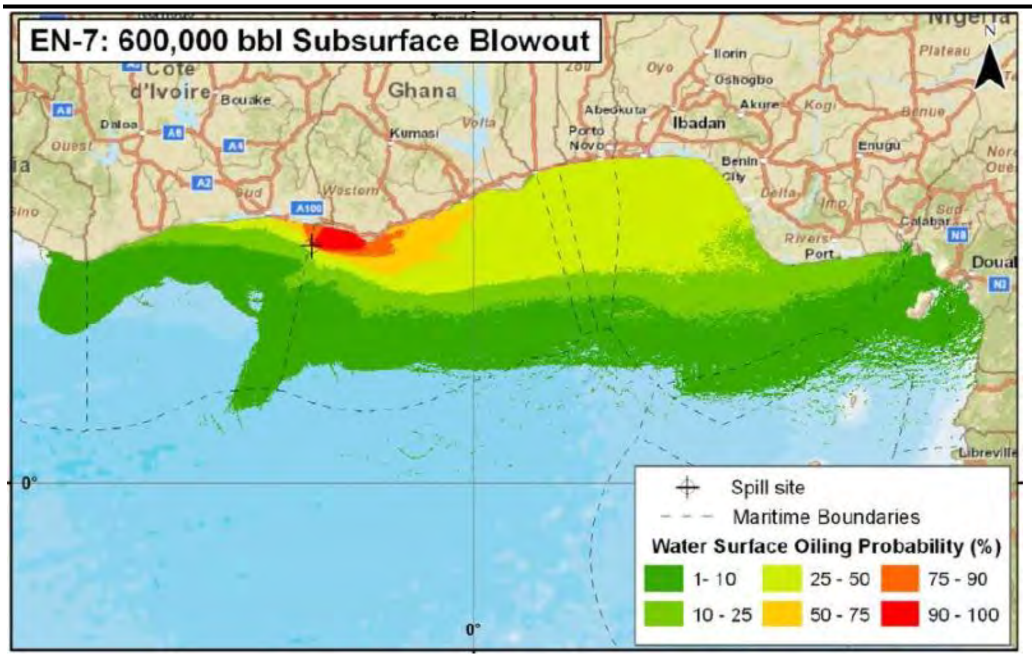
Figure 7.36 illustrates surface water oiling probability contours for a spill of 600,000 bbl well blowout from EN-7. The potential oiling contours extend to the north and east. Persistent south-westerly winds tend to drive floating surface oil toward the northeast, with the average time for oil to reach the shore being 5 days. A maximum of approximately 223,000 bbl of oil (about 37% of the original spilled volume) is expected to impact the shoreline at the end of the 75 day simulation.

There is a high probability that oil would reach the shoreline. The highest probability of shoreline impact (90 to 100%) would occur between Half Assini and Axim. The probability of shoreline impact is greater than 25% along the entire Ghana coastline. The probability of shoreline oiling decreases east of Axim and west of Half Assini. There is a 43% probability of oil reaching the shoreline in the vicinity of Accra. The maximum probability of shoreline oiling in Côte d'Ivoire is 88% and 34% in Togo, Benin and Nigeria. The 10% and 50% probability contours reach up to 1,290 km and 380 km from the spill location, respectively.

Figure 7.37 illustrates surface water oiling probability contours for a spill of 600,000 bbl well blowout at EN-22. Persistent south-westerly winds tend to drive floating surface oil toward the northeast, with oil reaching the shoreline in an average time of 8 days. The maximum volume of oil predicted to wash ashore is expected to be slightly higher at 227,000 bbl (about 38% of the initial spilled volume).

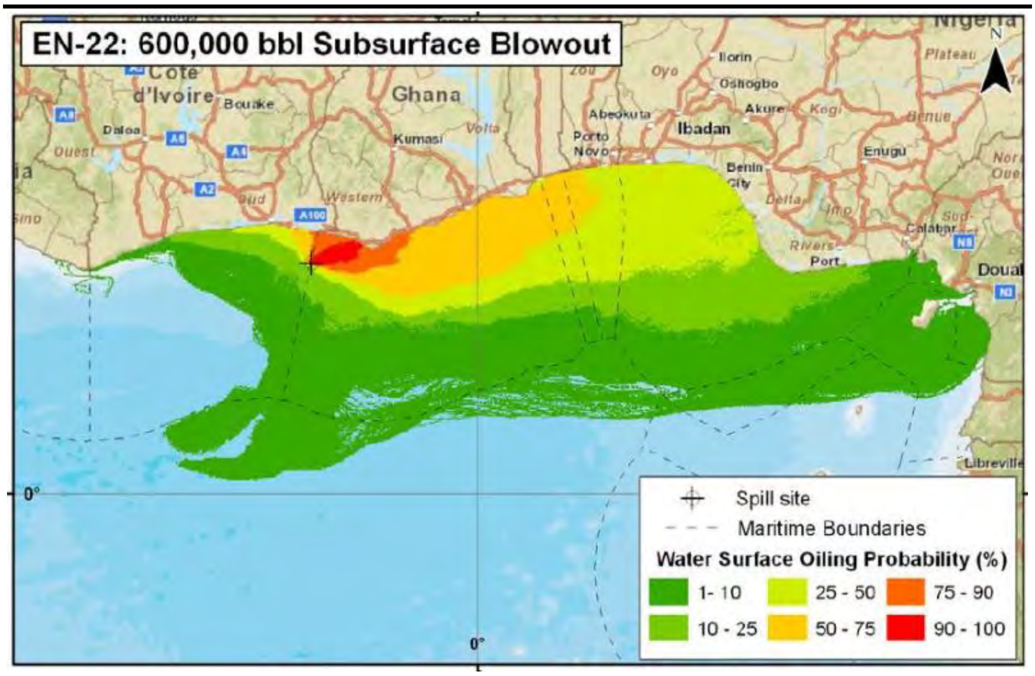
A blowout at EN-22 has a lower probability of oil impacting the shoreline relative to EN-7. While winds are similar at the two sites, EN-22 is located further offshore where easterly currents tend to drive oil from EN-22 further to the east before impacting the shoreline. There is no individual coastal section that has higher than a 90% probability of shoreline oiling. The area with the highest probability of shoreline oiling is located near Axim, with a probability of 90%. The probability of shoreline oiling decreases east and west of Axim. The probability of shoreline impact is greater than 25% along the entire Ghana coastline. There is a 57% probability of oil reaching the shoreline in the vicinity of Accra. The maximum probability of shoreline oiling in Côte d'Ivoire is 79% and 51 to 49% in Togo, Benin and Nigeria. The 10% and 50% probability contours reach up to 1,200 km and 640 km from the spill location, respectively.

Figure 7.36 *Scenario 5 (EN-7) Probabilities of Subsurface Oiling from 600,000 bbl Blowout*



Source: RPS-ASA 2013

Figure 7.37 Scenario 6 (EN-22) Probabilities of Subsurface Oiling from 600,000 bbl Blowout



Source: RPS-ASA 2013

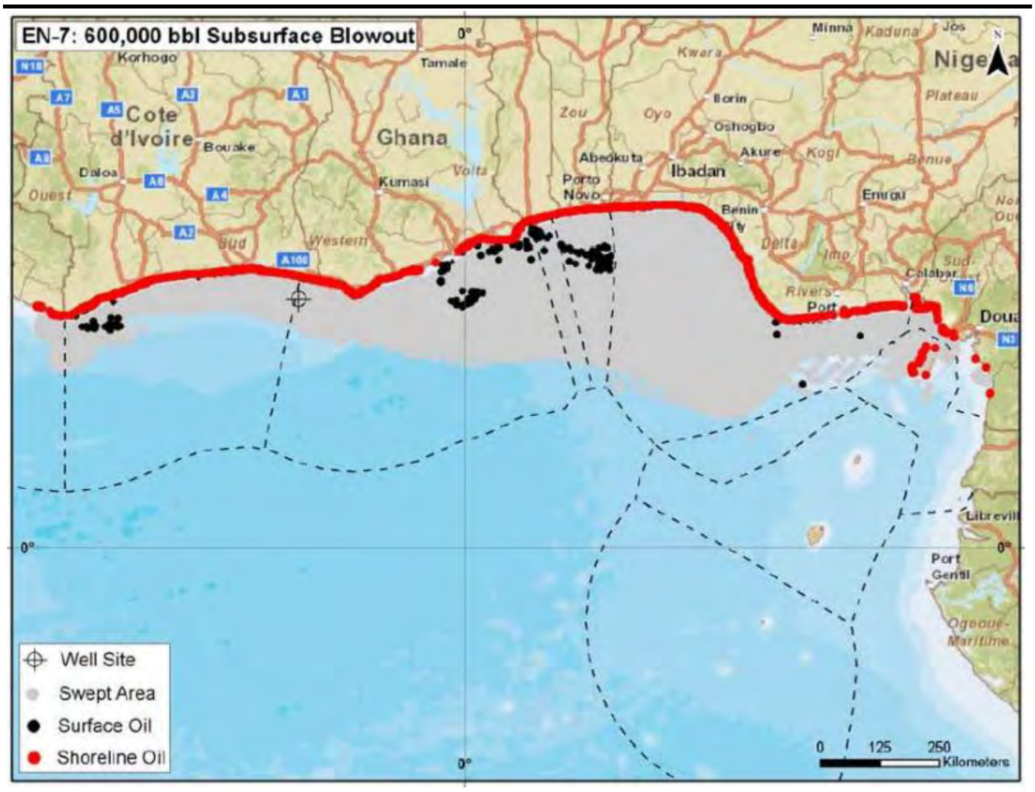
<u>Subsurface Deterministic Oil Spill Modelling</u>

Figure 7.38 and *Figure 7.39* illustrate the deterministic simulations for the subsea surface release oil scenarios. The model outputs show the predicted footprint of the spilled oil (in grey) and the shoreline impacted (in red).

Figure 7.38 illustrates that a subsurface release of 60,000 bbl oil will result in a trajectory of oil in all directions from the spill site. The slick will most typically be driven to the northeast due to the persistent winds and currents and will reach the shorelines of the Côte d'Ivoire and Ghana within 15.5 days. The oil spreads over a large geographic range and by 75 days after the start of the spill, oil impacts most of the shoreline between eastern Liberia and north-western Cameroon. At this time there is about 223,500 bbl of oil along the West African coastline, with over half of that volume expected to be along the Côte d'Ivoire. There is a large transport of oil towards the west, with more than 36,000 bbl of oil impacting the Nigerian shoreline, whilst a large volume of oil remains in the Côte d'Ivoire waters at the end of the simulation.

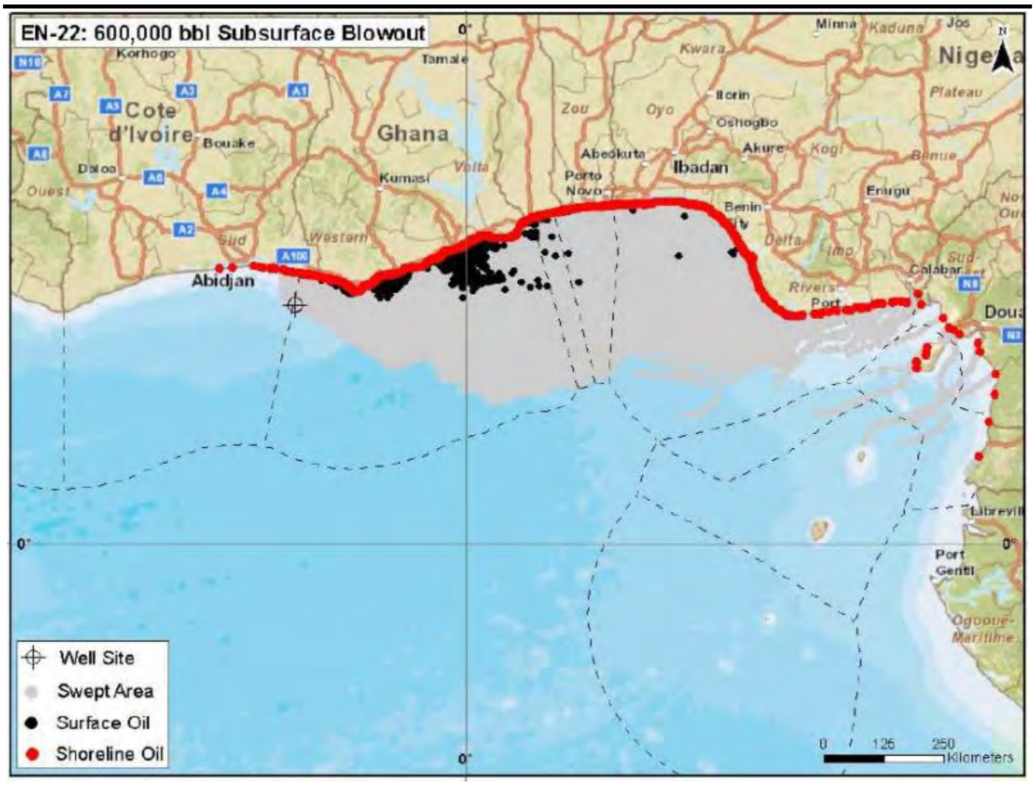
Figure 7.39 illustrates that a subsurface release of 60,000 bbl oil will result in a trajectory of oil in all directions from the spill site. The slick will most typically be driven to the northeast due to the persistent winds and currents and will reach the shoreline of the Côte d'Ivoire within 8.5 days and Ghana less than a day later.

Figure 7.38 Scenario 5 (EN-7) Trajectory of Subsurface Oiling from 600,000 bbl Blowout



Source: RPS-ASA 2013

Figure 7.39 Scenario 6 (EN-22) Trajectory of Subsurface Oiling from 600,000 bbl Blowout



Source: RPS-ASA 2013

The oil spreads over a large geographic range, and by 75 days after the start of the spill, oil impacts most of the shoreline between eastern Côte d'Ivoire and eastern Nigeria. At this time there is about 222,000 bbl of oil along the West African coastline, with over half of that volume expected to be along the Ghana coast. There is a large transport of oil towards the west, with more than 138,000 bbl of oil impacting the shoreline of Ghana, whilst a large volume of oil remained on the Nigerian shore line, mainly due to predominant eastern currents.

7.10.8 *Modelling Conclusions*

The key conclusions from the results of the stochastic and deterministic (trajectory/fate) modelling can be summarised as follows.

Surface Water Oil Spill Modelling

- For the four surface oil spill scenarios, the oil slick could potentially travel in many different directions but most predominantly towards the northeast following predominant winds and favourable easterly currents.

- The potential for shoreline oiling from these scenarios is low (less than 25%). The highest probability of shoreline oiling is around Axim. There are very low probabilities of shoreline oiling in Côte d'Ivoire from these spill scenarios and not probability of shoreline impacts in other countries. The minimum time for oil to reach the shore from these scenarios range between 28 and 32 hours.

- On average, at the end of the 14 day simulations, there could be approximately 12% and 63% of the initial spilled oil remaining on the shoreline for the EN-7 MGO spill and transfer hose spill, respectively. At the end of the 21 day simulations, there could be approximately 60% and 61% of the initial spilled oil on the shoreline for the 3,500 bbl and 15,500 bbl riser leaks, respectively.

Subsurface Water Oil Spill Modelling

<u>Far-field Stochastic Modelling</u>

- The stochastic far-field results of the two blowout scenarios indicate that the predominant transport of the trajectories is towards the east/northeast. A 600,000 bbl spill at EN-7 has a higher probability of reaching the coastline relative to EN-22. The coastline between Half Assini and Axim has the highest probability of shoreline impact of 90 to 100% (from a blowout at EN-07). For a blowout at EN-22, no individual shoreline segment exceeds a 90% probability of being oiled. In both scenarios there is a greater than 50% probability of shoreline impact for the entire coastline of Ghana.

- There are high probabilities of shoreline impact in Côte d'Ivoire of up to 88% and 79% from blowouts at EN-7 and EN-22 respectively. A blowout at EN-7 has a lower probability of impacting shorelines in Togo, Benin and Nigeria (34%) relative to a blowout at EN-22 with probabilities of shoreline impacts in these countries of between 49 and 50%. The scenarios have a probability of 1 to 8% to impact the shoreline in Cameroon, Equatorial Guinea, and São Tome and Principe.

- For a potential blowout at EN-7, oil may reach the coast within an average of 5 days, while a blowout at EN-22 would reach the coast within an average of 8 days. A maximum of approximately 230,000 bbl of oil could be washed ashore from a blowout at EN-7, with slightly more oil expected to wash ashore from a spill at the EN-22 location (270,000 bbl).

Far-field Deterministic Modelling

- A release of oil from EN-7 would result in oiling of surface waters in all countries between Liberia and Cameroon. Under a worst case deterministic scenario, the minimum time for oil to reach the shore was 15.5 days. Approximately 223,500 bbl of oil washed ashore at the end of the 75 day simulation, approximately half of which impacted the shoreline of the Côte d'Ivoire.

- Similarly, a release of oil from EN-22 impacted the shorelines of countries between Côte d'Ivoire and Equatorial Guinea. Under a worst case deterministic scenario, the minimum time for oil to reach the shore was 8.5 days. Approximately 222,000 bbl remained washed ashore at the end of the 75 day simulation, with approximately 138,000 bbl oil impacting the coastline of Ghana.

7.10.9 *Mitigation Measures*

Introduction

Mitigation of oil spill incidents for the TEN Project will be addressed through the implementation of oil spill prevention and oil spill preparedness measures.

The primary mitigation measure for avoiding the impacts of an oil spill is to prevent any such spill taking place in the first place. This is done through both technology applications as well as operational controls. In the event of an oil spill incident, the project will implement a response system to mitigate the consequences of oil spills. These systems will be designed with the capacity to handle even the worst case scenario.

Oil Spill Prevention

TGL has designed the project facilities with a range of inherent measures designed to minimise the risk of potential of oil spills. Oil spill prevention measures that will be implemented as part of the design of the project will include the following.

- Blow-Out Preventers (BOPs) will be permanently installed on the subsea wells during well completions, and a double mechanical barrier system will be used during production and injection operations using the subsea 'Christmas trees' and other barriers.

- A system of wells, subsea flowlines, risers, emergency shutdown systems and FPSO topsides will be designed and operated to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to meet performance standards.

- The FPSO deck and drainage system will be designed to contain spills (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release.

- Specific procedures will be developed for offloading crude onto the export tankers. These will include vetting of tankers involved in offloading, management of offloading activities by trained and experienced personnel, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (including contingencies for any engine failures), and the continuous monitoring and actions to be taken in the event of any non-routine events or equipment failures.

- TGL has chemical permits in place for its dispersant inventory which pre-approve their use (although TGL requires to notify the EPA if it intends to use dispersants). In the event of a spill, dispersants will not be used where there could be a detrimental impact on areas designated by the EPA as environmentally sensitive, such as areas of coral reef including the recently discovered reef in the DWT block.

Spill Preparedness and Response

Despite the prevention measures and management procedures built into the design of the project there is always a risk that an oil spill can occur. In response to such as event TGL has in place the fundamental components of preparedness and response, including an Oil Spill Contingency Plan (OSCP) which sets out the strategy and procedures that will be taken in the event of an oil spill.

The OSCP is based on a tiered response approach. The approach involves categorising potential oil spills as Tier 1, 2 or 3 incidents in terms of their potential severity and the capabilities that need to be in place to respond. This approach is aligned with the International Petroleum Industry Environmental Conservation Association (IPIECA) guidance which advocates a response to oil spills such that the planned response engages resources commensurate with the severity of the spill with the higher the Tier the higher the collateral response required. *Figure 7.40* provides indicative conditions for the establishment of different tiers of response. *Figure 7.41* illustrates the full definition of tiered preparedness and response showing the influence of factors.

Figure 7.40 Conditions for the Establishment of a Tiered Response

CHARACTERISTICS OF A TIER 1 OIL SPILL

- The spill is less than 100 bbls
- The spill does not affect sensitive areas
- There is no threat to the coastal ecosystem
- The response will be immediate
- There is no danger of an oil slick crossing maritime boundaries
- The response is monitoring

CHARACTERISTICS OF A TIER 2 OIL SPILL

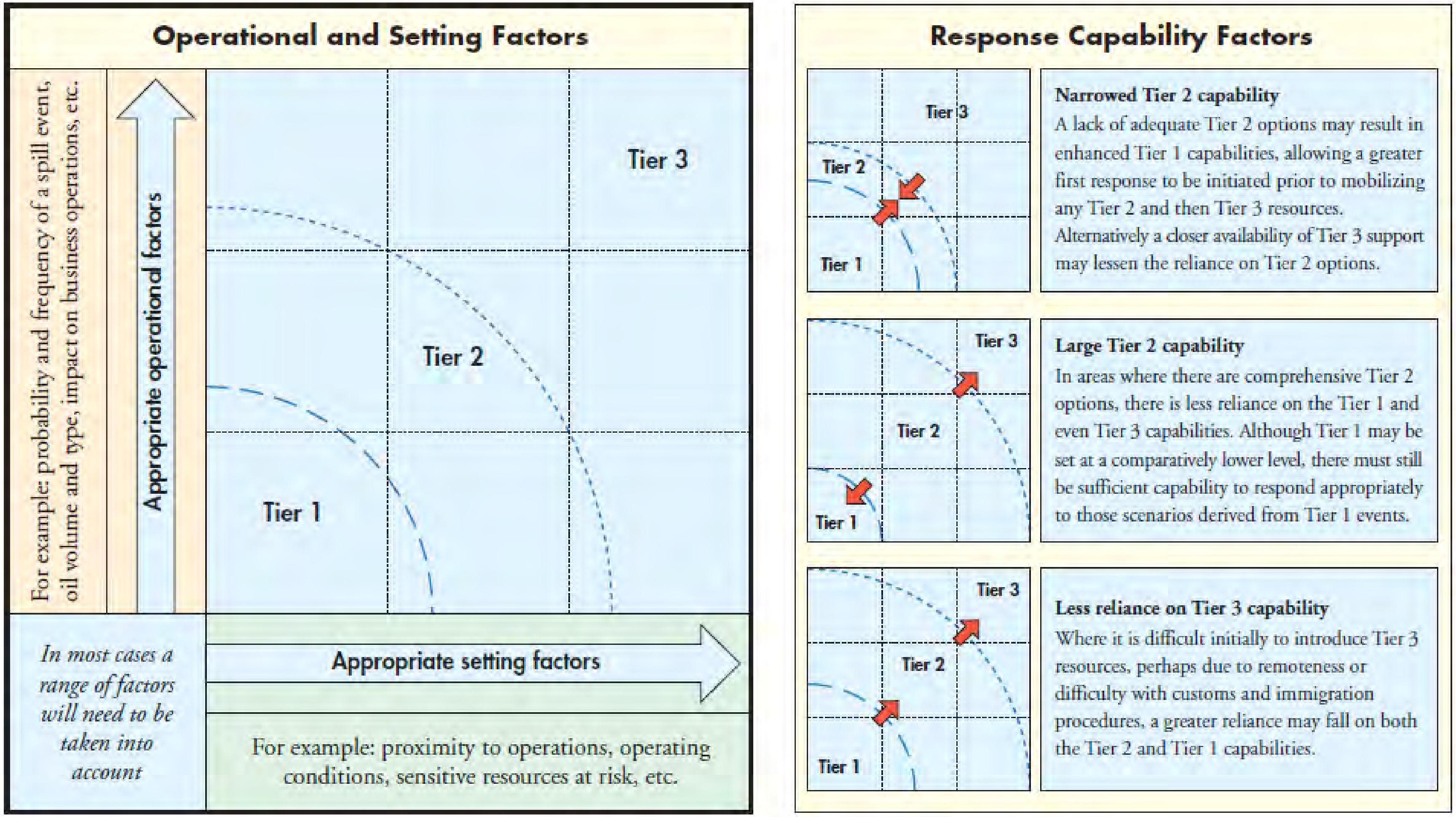
- The spill is between 100 and 1,000 bbl
- There is a possibility of significant pollution
- Tier 1 resources are insufficient
- Alterations are expected to normal operations
- There is continued leakage
- The oil is migrating across maritime boundaries
- Active response strategies are needed
- The oil needs to be isolated

CHARACTERISTICS OF A TIER 3 OIL SPILL

- The spill is more than 1,000 bbl
- There is coastal impact or is imminent
- The incident involved a catastrophic spill
- Tier 2 resources are insufficient
- Sensitive area were affected or are about to be
- The oil is migrating across maritime boundaries
- Intervention is necessary

The definition of oil spills are based on operational factors (*eg* probability and frequency of a spill event, oil volume and type), setting factors (*eg* proximity to operations, sensitive resources) and response capability factors (*ie* adequate resources/capacity to respond).

Figure 7.41 Definition of Tiered Preparedness and Response



Source: IPIECA 2007

Oil Spill Preparedness

TGL's oil spill preparedness is based on a number of key elements that are consistent across all tiers of capability and include the following.

- A management framework which defines the roles and responsibilities of the various stakeholders potentially involved in the range of different oil spill scenarios.
- An OSCP that sets out the elements for response and the processes for managing the integration of local, regional, national and international resources as appropriate.
- Specific response strategies for various areas of operation and in detail for particular areas of high environmental or socio-economic importance.
- On-site oil spill response equipment for small to medium sized spills available at all times.
- Arrangements for the integration of additional support at all tier levels.
- Logistical arrangements to facilitate and support response operations across all tier levels.
- Trained staff in oil spill response both on-site and also at the Tier 2 and Tier 3 levels.
- A programme of simulation exercises to test different aspects of preparedness to build familiarity and promote competence.

<u>Oil Spill Contingency Plan</u>

TGL's has an OSCP in place which covers its current offshore and onshore operations (TGL-EHS-PLN-04-0010). The OSCP will be updated to include the TEN Project phases (see *Chapter 11*, *Section 11.3.4*). The OSCP defines the following components:

- key personnel, roles and responsibilities;
- internal and external notification procedures;
- response strategies and control procedures; and
- internal and external resources.

The OSCP comprises a number of sub-plans including action plans for offshore, onshore and harbour spills, a WMP, response resources, and a risk and regulatory review. The OSCP is complemented by Site Specific Mobilisation Plans that provide guidance for the deployment of shore protection resources if there is a probability of shoreline oiling.

Training and Exercises

TGL has established and maintains an on-going program to train relevant personnel in oil spill response. The programme includes training on oil spill preparedness and response and periodic oil spill preparedness exercises.

The oil spill preparedness and response training includes:

- oil spill monitoring;
- notification procedures;
- strategic solutions;
- safe and effective use of dispersants;
- safe and effective use of offshore booms and ancillaries;
- mobilisation and deployment of onshore booms and ancillaries;
- onshore site management; and
- waste management.

TGL will conduct oil spill response exercises and drills on a regular basis to improve and maintain the skills of staff. The different types of exercise that will be undertaken include:

- OSCP orientation workshops;
- communications drills;
- desktop exercises;
- equipment deployment drills; and
- full-scale incident management exercises.

Response Resources

Response resources will depend on the tier level of the spill. Spill response resources are outlined below.

- **Tier 1 Resources.** TGL has in place a range of spill response equipment to respond to oil spill incidents. Offshore resources are located mainly on the support vessels and include oil containment and recovery equipment as well as dispersant spraying systems. Additional dispersant spraying systems are located on other vessels supporting the FPSO. Onshore resources include containment and recovery equipment, ground clearing equipment and additional stock of dispersant. Further information on TGL's response resources are provided in the following section.

- **Tier 2 Resources.** In addition to Tier 1 resources TGL has access to resources within Ghana that are capable of responding to a Tier 2 spill, including the WACAF (1) aerial dispersant spraying unit. Oil Spill

(1) WACAF - the Global Initiative for West and Central Africa is a partnership between the International Maritime Organization (IMO) and the International Petroleum Industry Environmental Conservation Association (IPIECA) to enhance the capacity of countries to prepare for and respond to marine oil spills.

Response Limited's (OSRL) in-country aerial surveillance and dispersant application aircraft for West and Central Africa is based in Accra.

- **Tier 3 Resources.** TGL is a member of OSRL, a Tier 3 oil spill response contractor based in Southampton, UK. A Tier 3 response service can be delivered from any of one, or a combination of, three response bases in the UK, Bahrain or Singapore. Singapore and the UK have dedicated aircraft and hold equipment in commercial aircraft compatible pallets. OSRL will provide technical advice to TGL on the most appropriate spill response equipment for the specific incident. This equipment would be transported by cargo aircraft to Ghana and then to the site. The EPA, as the national statutory agency and head of the National Oil Spill Response Centre, would have overall responsibility for formulating the response strategies to combat a Tier 3 incident. To support response and clean-up of wildlife, TGL will mobilise the oiled wildlife response group, Sea Alarm, through its membership with OSRL.

TGL Response Resources

TGL have a range of spill response equipment in-country to respond to offshore, harbour and onshore spills. Offshore response resources include offshore boom systems for containment and recovery (*Figure 7.42*), as well as dispersant and spray equipment. Offshore equipment is located mainly on the marine vessels and includes equipment for containment and recovery as well as dispersant sprayers.

Figure 7.42 Offshore Boom Systems

Ro- Boom 1500 deployed offshore

Desmi Helix Skimmer System

Source: TGL 2011

Harbour and onshore response resources are contained in response packages located at the Takoradi Port and Sekondi harbour. The two harbour response packages are identical, each include two rapid response trailers (*Figure 7.43*). One of the trailers (at each location) contains an inflation boom and skimmer package and the second trailer (at each location) contains a fence boom and initial response kit.

Figure 7.43 Harbour Response Packages in Containers

Containers containing response trailers.

Rapid response trailer.

Source: TGL 2011

7.10.10 Impact Assessment

Introduction

The potential environmental impact of an oil spill is related to the likelihood of a spill occurring and the magnitude of the consequence (taking into account sensitivity/value of receptor and size of spill). *Section 7.10.5* to *Section 7.10.8* discussed the potential likelihood of various spill scenarios in terms of the size of the spill and probability of the oil reaching the coastline. The remainder of this section discusses the potential consequence of oil spills in terms of the impact on receptors and their sensitivity to impacts from oil spills.

Description of Potential Impacts

In the event of an oil spill, the marine environment offshore Ghana would be impacted. In the event of a catastrophic spill, the marine environment offshore Liberia, Cote d'Ivoire, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea and São Tome and Principe could be impacted. This section focusses on the potential impact on the marine environment offshore Ghana.

In the event of an oil spill there will be localised impacts to water quality, however, the more significant impacts would be on marine biodiversity, and in particular those species that frequent the sea surface, including seabirds, marine mammals and turtles. Fish species and larger invertebrates in deeper water can be expected to be less exposed to impacts from oil spills as they will tend to avoid the sea surface or leave the impacted area in the event of a spill.

For large spills and assuming the prevailing wind is from the southwest there is a possibility that secondary impacts would be experienced on the coastline if the oil beaches. If oil reached the coastline, impacts could include contamination of sensitive coastal habitats such as mangroves, wetlands, lagoons and turtle nesting beaches and impacts on species that frequent such habitats such as coastal birds and fish. An additional impact of oil reaching the coastline would be the potential impacts on local communities, for example from the damage or even loss of fishing grounds.

This section summarises the potential impacts on the most sensitive receptors that would likely be exposed to impacts from a major oil spill. However, it should be noted that this assumes a 'worst case' spill that reaches the coastline without any intervention (no response measures being implemented).

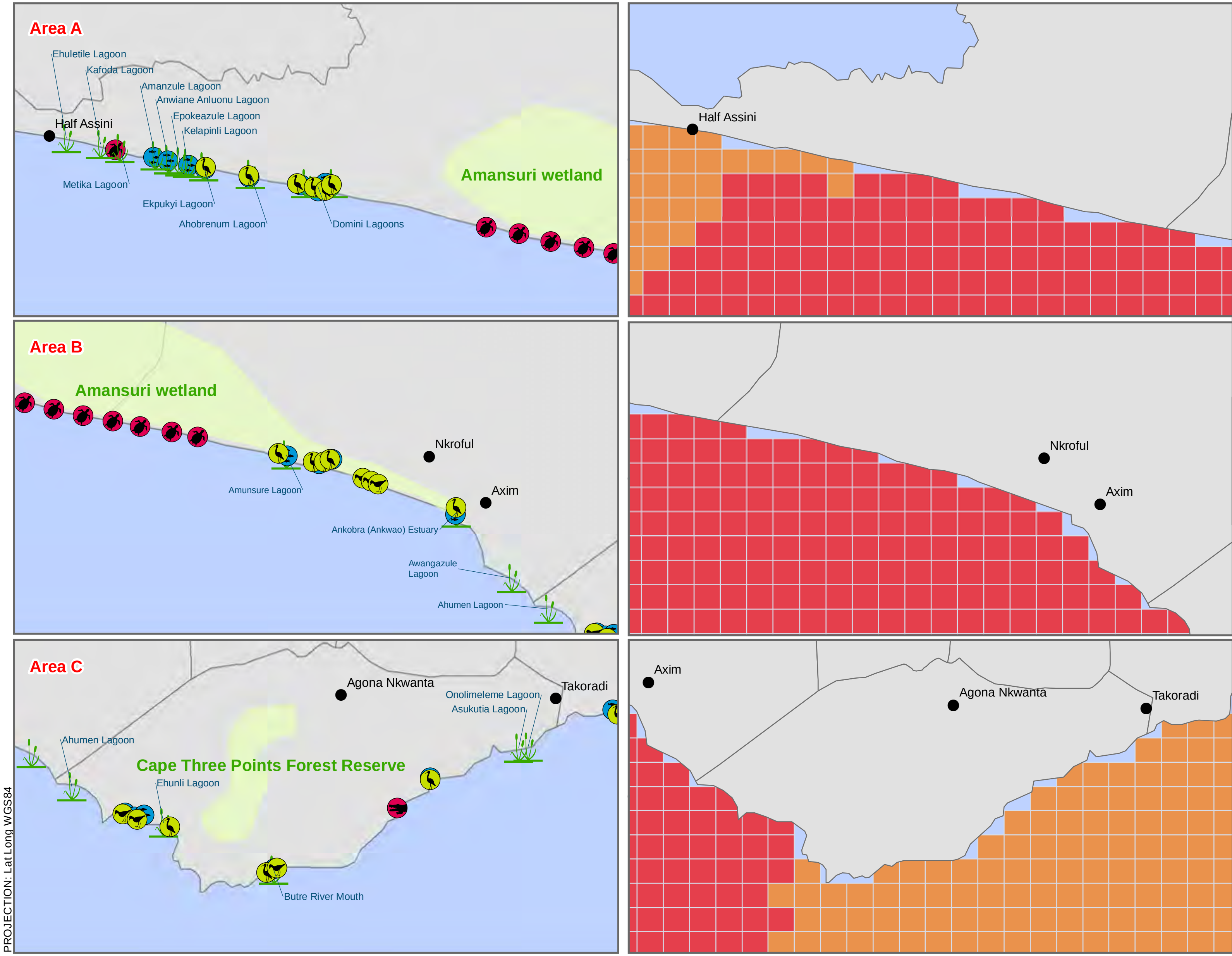
The focus of the discussion relates to the stretch of shoreline west of Cape Three Points (*ie* between Axim and New Town) which the modelling showed had the highest probability of greater than 90% of being oiled in the worst case scenario of a large oil spill from a 600,000 bbl crude blowout at EN-7. It should be noted, however, that there is a relatively high probability (more than 50%) of shoreline oiling of the entire Ghana coastline from a large blowout. Smaller surface water spills will likely impact the same stretch of coastline in the vicinity of Axim, however, the probability of shoreline oiling from these scenarios is much lower than from a large blowout.

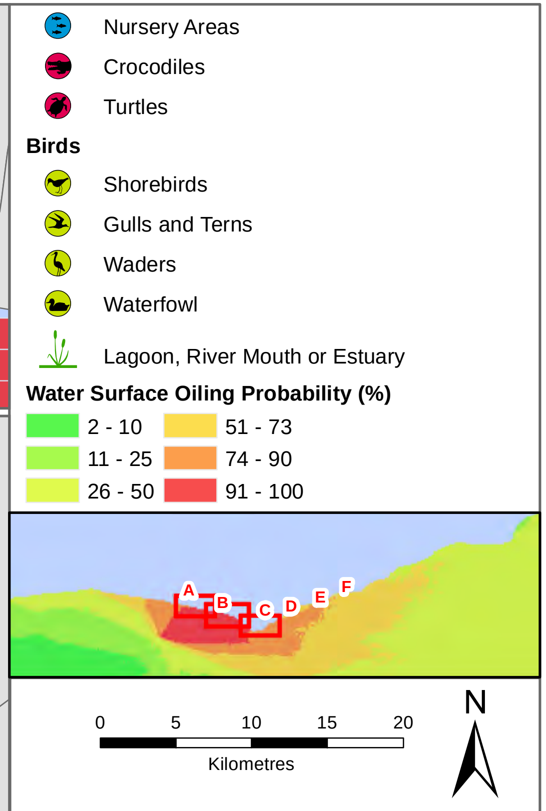
Figure 7.44 to Figure 7.47 show oil spill probability contours in relation to sensitive ecological and human use coastal features along a wider stretch of coastline with a greater than 50% probability of shoreline impact between New Town and Cape Coast.

The following ecological features are shown on the maps: bird areas (including shore birds, gulls and terns, waders and water fowl, designated Important Bird Areas), estuaries, fish nursery areas, lagoons, river mouths, and turtle and crocodile areas. The following sensitive human use features are shown on the maps: aquaculture sites, beach seine sites, historical monuments, landing sites and public/bathing beaches.

Seabirds and Coastal Birds

Ghana's coastal wetlands and lagoons form an ecologically important unit, providing feeding, roosting and nesting sites for thousands of migratory and resident birds. Eight of these coastal wetlands: Keta Lagoon, Songor Lagoon, Sakumo Lagoon, Korle Lagoon, Densu Delta, Muni Lagoon, Elmina Salt Pans and Esiama Beach, qualify as internationally important wetlands under the Ramsar criteria of supporting 20,000 waterfowls or 1% of the population of a waterfowl species. Of these only Esiama Beach falls within the area at most risk of an oil spill which is a sandy beach thought to support over 10,000 birds.





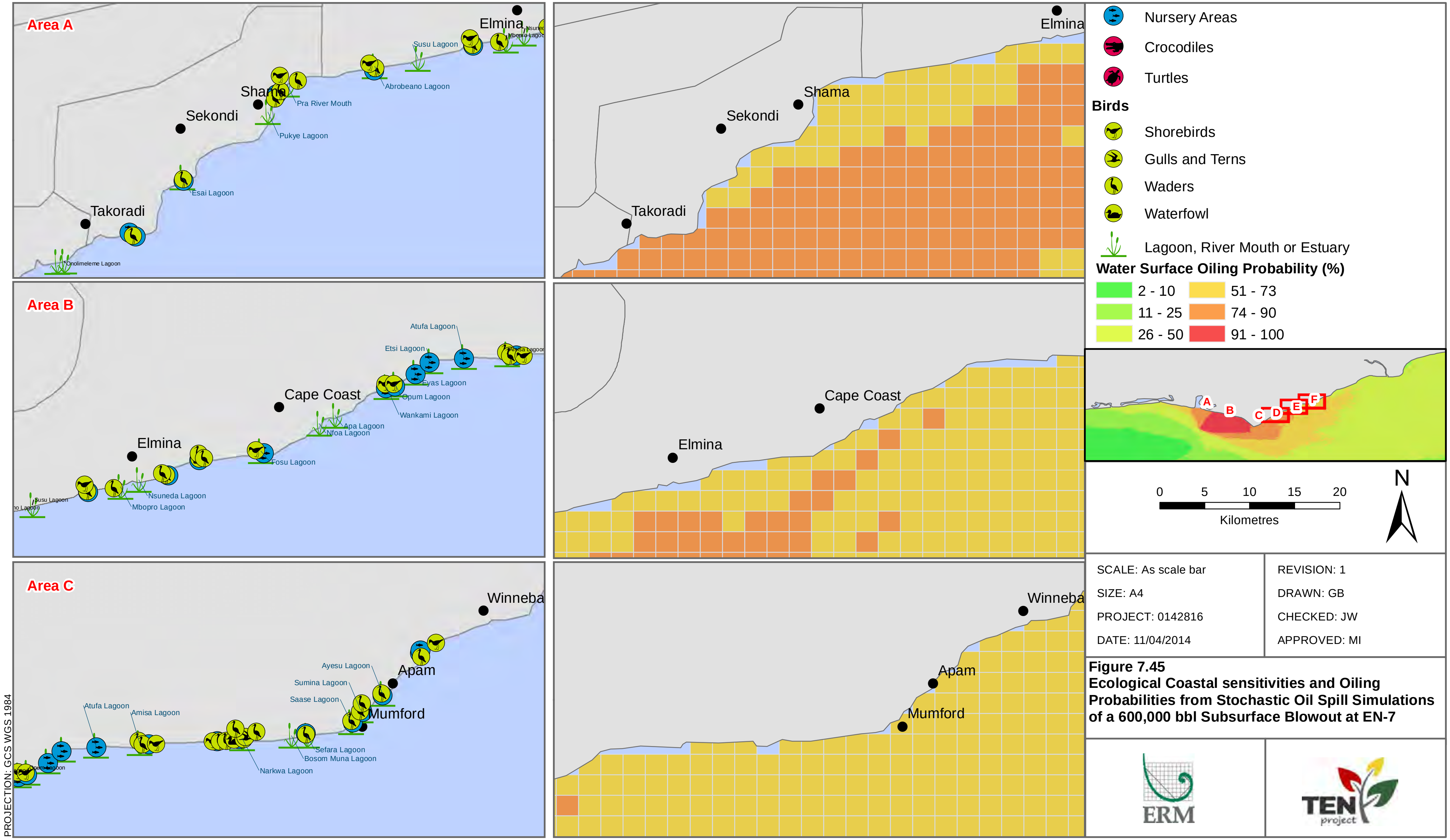
SCALE: As scale bar
SIZE: A4
PROJECT: 0142816
DATE: 11/04/2014

REVISION: 1
DRAWN: GB
CHECKED: JW
APPROVED: MI

Figure 7.44
Ecological Coastal sensitivities and Oiling Probabilities from Stochastic Oil Spill Simulations of a 600,000 bbl Subsurface Blowout at EN-7.

SOURCE: RPS-ASA 2012

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Eco_Oil_A_Rev0.mxd



SOURCE: RPS-ASA 2012

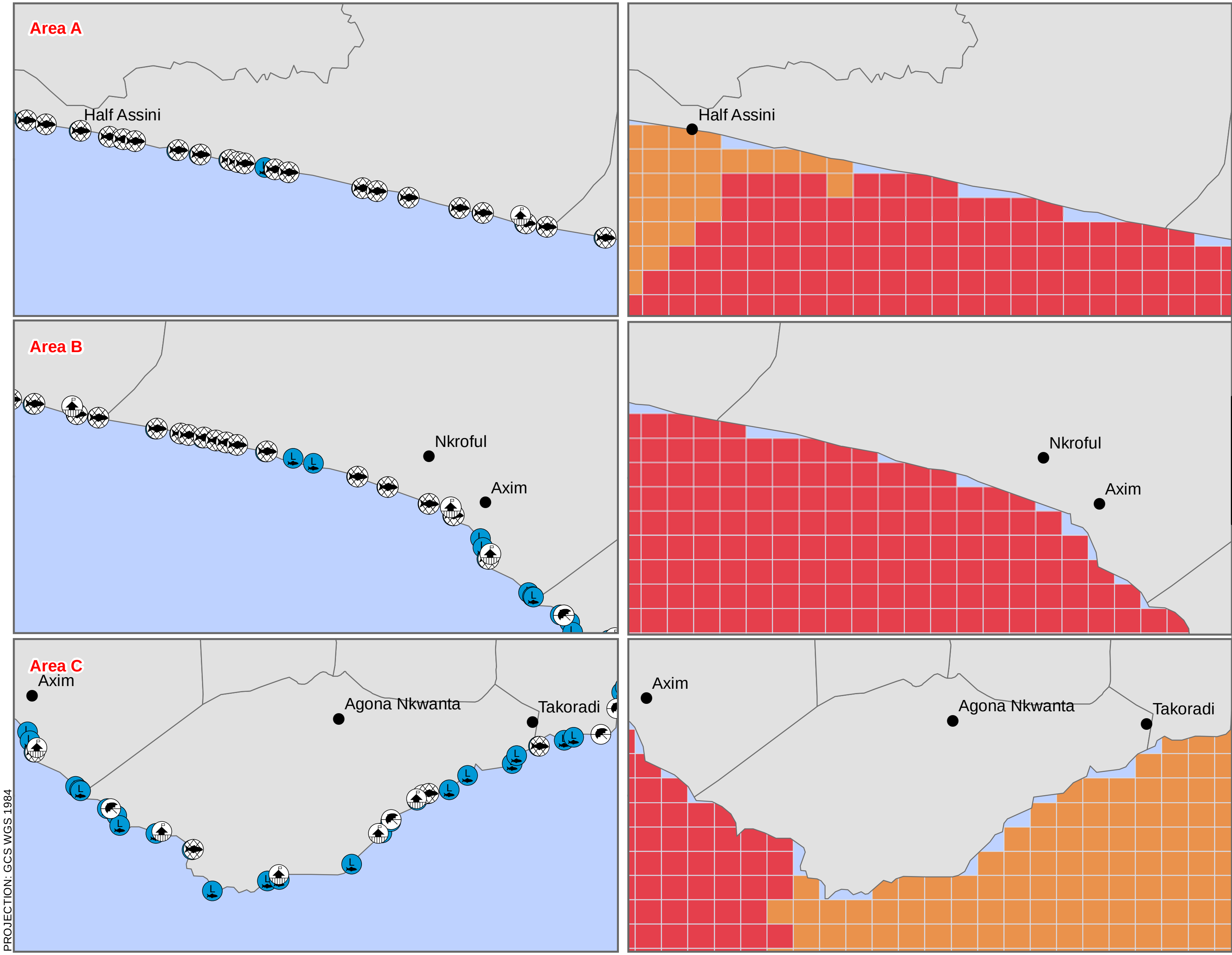
SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 11/04/2014	APPROVED: MI

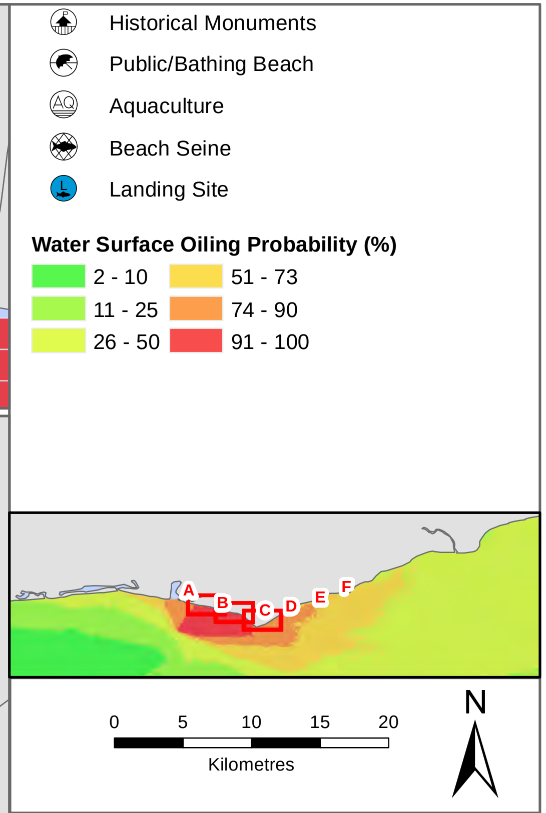
Figure 7.45
Ecological Coastal sensitivities and Oiling Probabilities from Stochastic Oil Spill Simulations of a 600,000 bbl Subsurface Blowout at EN-7

ERM

TEN project

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Eco_Oil_D_Rev0.mxd





SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 11/04/2014	APPROVED: MI

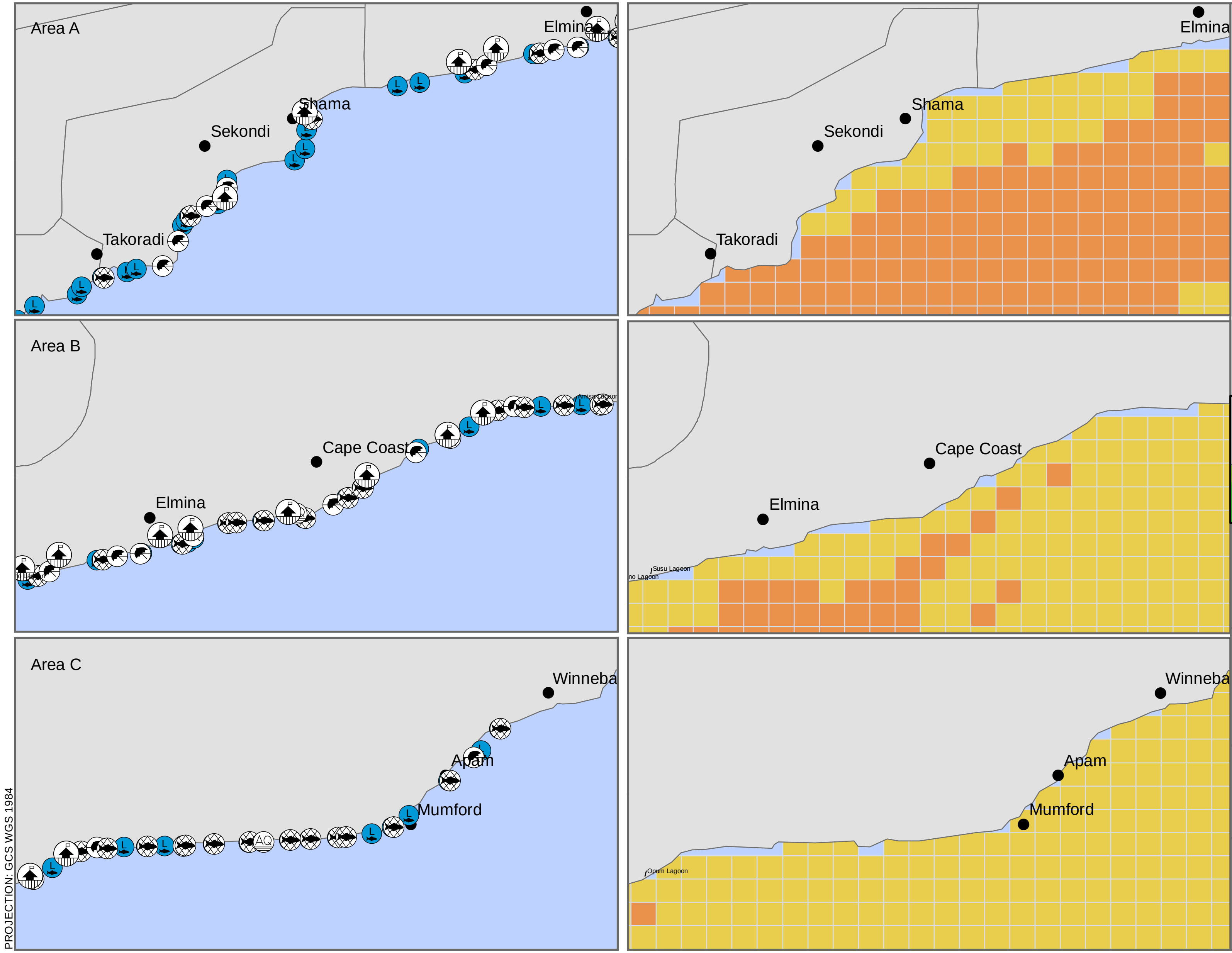
Figure 7.46
Human Use Coastal sensitivities and Oiling Probabilities from Stochastic Oil Spill Simulations of a 600,000 bbl Subsurface Blowout at EN-7

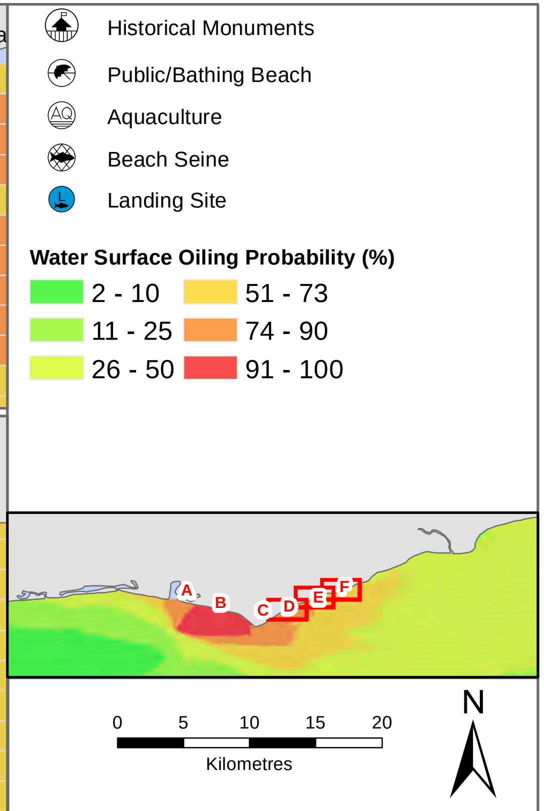
ERM

TEN project

SOURCE: RPS-ASA 2012

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\MAPS\0142816_Human_Oil_A.mxd





SOURCE: RPS-ASA 2012

SCALE: As scale bar	REVISION: 1
SIZE: A4	DRAWN: GB
PROJECT: 0142816	CHECKED: JW
DATE: 11/04/2014	APPROVED: MI

Figure 7.47
Human Use Coastal sensitivities and Oiling Probabilities from Stochastic Oil Spill Simulations of a 600,000 bbl Subsurface Blowout at EN-7

ERM

TEN project

Path: Q:\Team\GIS\Projects\0142816_TGL_TEN_ESIA_GN_MI\OUTPUTS\EIA\Rev 2\Fig7.47_0142816_Human_Oil_D_Rev0.mxd

However, there are several other lagoons and wetlands including Domini Lagoon, Amansuri Lagoon, Ankobra (Ankwao) Estuary and the Ehnuli Lagoon which are important bird feeding and breeding areas and support significant numbers of waterfowl including common tern, egret, common sandpiper, ringed plover and grey plover. As a whole, the stretch of coastline west of Cape Three Points is considered highly sensitive for coastal bird species.

Direct mortality of birds in the event of an oil spill is often the most widely perceived risk. While impacts to birds can occur offshore in the marine environment, the more pronounced impacts are often experienced if oil reaches coastal waters. Spills affecting coastal waters near major bird colonies during the breeding season can be particularly severe since birds are feeding intensively and often dive through the surface oil to feed on fish. Birds are affected by oil pollution in the following three key ways.

- Stains of oil on the plumage may destroy the insulating and water repelling properties which may ultimately cause the death of the bird.

- Toxic effects after the ingestion of oil during preening, ingestion of oiled prey, inhalation of oil fumes or absorption of oil through skin or eggs may also lead to death.

- Indirect effects may result from destruction of bird habitats or food resources.

Coastal birds are most abundant from August to March. Migrant birds begin to arrive at the site in late August and their numbers peak in September-November.

Marine Mammals

The area offshore Ghana is known to support significant marine mammal populations including certain protected and sensitive species such as humpback and fin whales and Atlantic spotted dolphins. While the seasonal distribution of these species is not well understood it is likely that during the months of September and October a number of species of whale and dolphin pass through the offshore area.

Marine mammals are generally less sensitive to oil spills than seabirds as they will tend to detect the area around a surface oil slick and avoid any breaching or feeding behaviours that may bring them into direct contact with oil. However, marine mammals are still sensitive to impacts from oil spills, and in particular from the hydrocarbons and chemicals that evaporate from the oil, particularly in the first few days following a spill event.

Symptoms of acute exposure to volatile hydrocarbons include irritation to the eyes and lungs, lethargy, poor coordination and difficulty with breathing. Individuals may then drown as a result of these symptoms. Studies conducted following the Exxon Valdez tanker oil spill identified direct mortality of marine mammals (primarily seals, with increased pup mortality reported in areas of heavy oil contamination compared to un-oiled areas) resulting from exposure to oil.

Marine Turtles

Marine turtles spend most of their life at sea, but during the breeding season they go ashore and lay their eggs on sandy beaches. The sandy beaches of Ghana support the breeding of the green turtle, the leatherback and the olive ridley turtle. The shoreline west of Three Cape Points is made up of several sandy beaches which provide turtle nesting sites; including the coastline between Domini Lagoon and Amansuri Lagoon and Esiama Beach. The turtles come ashore to nest between August and March. During this period turtles swim to shore and push themselves onto the dry beach where they dig nests, lay dozens of eggs, cover the nests and return to the sea (Armah *et al* 2004).

Turtles are sensitive to the effects of oil spills at all life stages: eggs, post hatchlings, juveniles and adults. Several aspects of sea turtle biology place them at particular risk. These include a lack of avoidance behaviour, indiscriminate feeding around the sea surface and large pre-dive inhalations at the sea surface. Potential direct impacts from oil spills to sea turtles include:

- increased egg mortality and developmental defects;
- direct mortality due to oiling in hatchlings, juveniles and adults; and
- negative impacts to skin, blood, immune systems and salt glands.

In addition, sea turtles are sensitive to potential secondary and longer term impacts, which are generally less obvious than the short term impacts immediately following a spill. These impacts include:

- behavioural effects (*eg* disorientation) resulting from loss of smell sensors;
- contamination of food supply and reduction in available food levels; and
- influences on sea turtle development and behaviour caused by subtle changes in sand temperature colour and when spills impact the shoreline (*eg* because sex determination in turtles is temperature dependent, shifts in sand temperature caused by oiling could potentially change hatchlings sex ratios).

Marine turtles spend most of their life at sea. They visit the beach three to seven times during a nesting period (between August and March), laying about 350 to 500 eggs within a breeding season.

Seafloor Habitats

Offshore seafloor habitats are not often considered in terms of impacts from oil spills unless they are defined as being particular sensitive. An area of coral reef has been identified within the DWT block, immediately east of the TEN Project area. Coral reef may be exposed to oil in one of the following three ways.

- Direct contact when surface oil is deposited on intertidal corals. This is not considered relevant to the DWT reef given its location offshore.

- Rough seas and a light, soluble oil can combine to mix the oil into the water below the surface, where it may impact corals.

- Subsurface oiling can occur when heavy oils weather, or mix with sediment material. This increases the density of oil to the point where it may sink.

Given the water depth at which the DWT reef occurs (400 m), direct contact with oil from a spill within the TEN field is unlikely. However, the risk of contact may be increased if dispersant chemicals are used as part of a spill response. The toxicity of the dispersant and the increased concentration of oil in the water column following dispersion would increase the likelihood of oil impacts on the reef. As such, the use of dispersant chemicals will be prohibited where they may affect this reef habitat.

Coastal Habitats

The modelling work has predicted that in the event of a very large oil spill (*ie* 600,000 bbl) there is a 90 to 100% probability that oil will reach the shoreline between Half Assini and Axim. While it is unlikely that under any scenario oil would beach along this entire stretch of coastline, it is not possible to determine with any accuracy the particular coastal areas that would be likely to be affected by a spill as this would depend on the size of spill, currents, winds and other physical factors at the time. Therefore this section highlights the key sensitive coastal sites and habitats in the region that may be particularly sensitive to impacts from oil spills.

There are six major types of ecosystems along the shores of Ghana (Armah *et al* 2004), including:

- sandy marine shore ecosystems;
- rocky marine shore ecosystems;
- coastal lagoon ecosystems;
- mangrove/tidal forest ecosystems;
- estuarine wetland ecosystems; and
- depression wetland ecosystems.

The stretch of coastline west of Cape Three Points consists mainly of sandy beaches (Esiama Beach), rocky beaches (Axim and Cape Three Points), coastal lagoons (Domini Lagoon, Amansuri Lagoon, Ehnuli Lagoon) and estuarine wetlands (Ankobra estuary). The various sensitivities of each are summarised below.

- Species diversity on sandy beaches is typically low, especially on beaches with coarse sand and steep slopes. On such beaches only one species is normally encountered, the ghost crab (*Ocypoda cursa*) which is active when the tide is low and retires to its burrow on the beach when the tide rises. However, sandy beaches serve as important nesting sites for sea turtles and in some cases (such as Esiama Beach) are important sites for coastal bird species.

- Rocky shores occur as rocky out-cropping alternating with sandy bays. The rocks are substrate for a wide variety of species of macro algae, barnacles and snails. Ecologically, algae mats on rocky shores serve as important micro-habitats for epifauna (*ie* crustacean, macro-invertebrates) and fish.

- The coastal lagoon habitats are particularly important ecosystems. They support mangrove habitats and significant populations of fish, shrimps, crabs and mollusc species; in addition they are important nursery sites for many fish species. Coastal lagoon habitats also support significant numbers of waterfowl species.

- Estuarine areas and wetlands occur at Ankobra (Ankwao) estuary support in excess of 1,000 km^2 of marshland habitat. These areas are generally exposed when the tide is out and are seasonally inundated during the rainy season. They support stands of mangrove and other species typical of swamp forests and act as important nursery habitats for fish and feeding areas for waterfowl species.

In terms of vulnerability to impacts from oil spills, each of the coastal habitats is considered sensitive. However, lagoons and estuarine wetland habitats are considered particularly sensitive as they tend to support more significant numbers of species, including fish nurseries and bird feeding areas. If an oil spill beached in these areas toxic concentrations of oil may develop in the shallow water and due to the long persistence time of the oil effects may be encountered for a long period. If oil enters into an open lagoon or wetland natural removal rates are slow because there is no wave action to remove the oil and oil components tend to adhere to the flat substrate preventing removal by tides.

In lagoons or wetlands that support mangrove stands oil slicks may enter the mangroves when the tide is high and are deposited on the aerial roots and sediment surface as the tide recedes. The oil clogs the pores in the aerial roots and if many roots are oiled, the respiratory system collapses and the trees die.

Fish Stocks

The offshore and coastal waters in Ghana support significant numbers of fish species many of which are targeted by the extensive coastal fishing industry. Most commercial species occur in coastal waters from close inshore to the edge of the continental shelf. Fish species that occur in the coastal lagoons along the Ghanaian coastline are also important as these areas act as vital nursery grounds and assist with sustaining fish stocks in coastal waters.

Typically, adult fish are not considered highly sensitive to impacts from oil spills. Adults are mobile and generally able to detect heavily contaminated areas or areas of low water quality. In open waters, fish have the ability to move away from an area of pollution, and are therefore either unaffected by oil or affected only briefly. Oil contamination in open waters below an oil slick is generally low (only a few ppm or below) (IPIECA 2000) and there is no evidence to suggest that fish are significantly affected by oil in open water.

Fish kills may occur as a result of high exposure to emulsified oil / freshly spilled diesel in shallow waters (such as in lagoons) and oil pollution may clog fish gills causing asphyxiation. At the population level effects can be short lived due to the death of affected individuals and the persistence of healthy individuals unaffected by contamination. Non-lethal negative effects are more usual and fish can be affected in the long term in some circumstances, especially when oil spills into shallow or confined waters. Fish exposed to elevated concentrations of hydrocarbons absorb contaminants though their gills, accumulating it within their internal organs which can lead to long-term, sub-lethal effects. In addition, spilled oil in confined and shallow waters, such as lagoons, poses a threat to fish eggs and larvae which cannot actively avoid oil. Fish eggs and larvae are mostly in the upper planktonic layers, and hence are affected and heavy mortalities often result. Lethal effects on the population as a whole are rare but long-term, sub-lethal effects are possible, particularly if a major spawning area is affected.

In terms of the vulnerability of impacts to fish stocks from an oil spill, while fish in open waters are not particularly sensitive, the species found in coastal lagoons (such as Ehnuli, Amansuri and Domini lagoons) are highly sensitive. These areas are spawning grounds and nursery areas for young and small fish.

Fisheries

The marine fishing fleet can be classified into four main groups: canoes, inshore vessels, deep-sea vessels (industrial trawlers and shrimpers) and tuna vessels. Canoes and inshore fisheries dominate the fishing industry in Ghana, providing about 70% of the total marine fish production in the country. In the area west of Cape Three Points there are marine fishing communities using canoes at almost all coastal settlements, with important centres at Axim, Cape Three Points and Esiama beach.

Coastal lagoons and estuaries are also important sources of fish and shellfish for both subsistence and commercial purposes. Along the coastline west of Cape Three Points several coastal lagoons (*eg* Ehnuli, Amansuri and Domini) provide important local fisheries throughout the year.

In the event of an oil spill that reaches either coastal waters, or beaches within coastal lagoons, fisheries are usually suspended by the regulatory authorities to avoid contamination of fish being lifted through the slick on the surface waters and to prevent gear contamination. Fishing is difficult or impossible in areas directly affected by an oil spill. Vessels and gear will be smeared in oil and the catch might be spoiled. The fishermen might for a period be forced to stop or temporarily move to other fishing grounds nearby free of oil slicks. These fisheries closures will directly affect fishing communities along the coastline by preventing them from maintaining their livelihood during the period of closure, resulting in a reduction in both food and economic resources.

In addition, tainting of fish can impact fisheries affected by oil spills. Tainting of fish will reduce the quality of the fish landed and sold to traders. As a result these fish may fetch a lower price than others unaffected by tainting.

Given the importance of the artisanal fishing industry along the west coast of Ghana, fisheries are considered highly sensitive to impacts resulting from an oil spill that reaches coastal waters. The fishing season is closely influenced by the upwelling phenomenon, which is from January to April (minor upwelling) and July to September (major upwelling).

Tourism and Recreation

The major coastal tourism attraction areas in Ghana are in Keta, Ada, Ningo, Prampram, Tema, Labadi, Accra, Winneba, Kromantse, Cape Coast, Elmina, Brenu-Akyinim, Komenda, Sekondi-Takoradi, Axim and Busua. In this area, there are 28 waterfront hotels with approximately 1,000 beds registered by the Tourist Board of Ghana. Furthermore, there are a similar number of minor resorts and campsites at waterfronts. Along the west coast, Axim would represent the main sensitivity with regard to tourism activities.

In the event of an oil spill beaching at or near tourist areas, direct access to the shore and the options of swimming, fishing or utilising water sport facilities will be hampered or made impossible. Also rumours of an oil spill affecting the coast might result in cancellations of hotel bookings, even in other areas along the coast not directly affected by oil. In the longer term, the perception among tourists of a polluted coastline might adversely impact the tourism industry. At current levels of tourism the area is not considered highly sensitive economically for local communities, however, any oil spills could have a detrimental impact on the area’s reputation and the potential for future economic growth.

Impact Significance

The results of the oil spill modelling study indicated that, for all spill scenarios, the most likely fate of the oil would be for it to be transported to the east of the release point (*ie* towards the Ghana coastline). The shoreline with the highest probability of being oiled is the stretch of coast west of Cape Three Points (between Axim and Half Assini). For a very large spill (*ie* 600,000 bbl) there is a 90 to 100% probability that oil would beach on the stretch of shoreline and greater than 50% probability that the oil would beach along the entire coastline of Ghana. However for smaller spills the probability is much less. It should be noted that this assumes that no oil spill response measures are taken.

There are a number of potentially highly sensitive coastal receptors along the coastline west of Cape Three Points (between Axim and Half Assini) that are most at risk in the event of a spill. These include coastal lagoons and wetland habitats that support significant bird populations and act as fish nursery grounds, turtle nesting sites on sandy beaches and extensive artisanal fishing grounds. These receptors would be adversely impacted in the event of an oil spill that reaches the coastline.

Although highly unlikely, in the event of a very large oil spill (*ie* 600,000 bbl subsurface well blowout), significant impacts could occur. A large spill would likely reach the Ghanaian shoreline and the shorelines of neighbouring countries to the east and west of Ghana, which would result in oil beaching, despite the proposed oil spill response measures proposed by TGL. The stretch of coast most likely to be affected by an oil spill (west of Cape Three Points) is considered highly sensitive to impacts from oil beaching as a result of the ecological sensitivities and extensive fishing activities along that affected area of coastline. If oil beaches these sensitive receptors will be exposed to adverse impacts that will be difficult to mitigate effectively.

While the residual risk of oil spills from the project remains, the overall impact of oil spills is considered to be of *Moderate* significance (but reduced to ALARP levels) on the basis that:

- the most likely spills associated with the project would be small scale (*ie* less than 1,000 bbl) that are unlikely to reach the coast due to the distance offshore and the fact that these can be mitigated via the project oil spill response measures; and
- large oil spills are highly unlikely to occur (*ie* a probability of 1 in 10,000 years).

TGL has in place an oil spill response system which includes Tier 1 oil spill response resources, and a Tier 2 system for cooperation between TGL, other oil and gas operators in Ghana and the Government of Ghana that, if implemented effectively, would reduce the probability of oil reaching the coast and would therefore reduce the impacts significantly. In Tier 2 and 3 spill situations, the response strategy set out in the OSCP is intended to align with the Ghana National Oil Spill Contingency Plan and comply with its requirements. TGL has contracted OSRL for Tier 2 and Tier 3 support.

7.11 CUMULATIVE IMPACTS

7.11.1 *Scope of the Assessment*

An assessment of cumulative impacts requires consideration of other plans or projects that may act cumulatively with the proposed project to cause environmental and social impacts. Cumulative impacts can result from individually slight but collectively significant activities taking place over a period of time. Consideration of other plans or projects in a cumulative impact assessment is usually restricted to those plans or projects occurring at the same time, those that have been consented but not yet completed, or those that are under consideration by the determining authority.

The resources and receptors that may be subject to cumulative impacts include those that have been identified as potentially impacted by the TEN Project at the offshore project location, the onshore logistics bases and the transit routes between these, and coastal areas that could be affected in the event of a large oil spill.

The present, proposed and potential future activities that could give rise to cumulative impacts are addressed in *Section 7.11.2* , *Section 7.11.3* and *Section 7.11.4* respectively. An assessment of potential cumulative impacts is provided in *Section 7.11.5.*

7.11.2 *Present Activities*

Jubilee Phase 1 and Phase 1A Development

The main activity that is likely to result in cumulative impacts with the TEN Project is the Jubilee Field development which started production in late 2010. The Jubilee Unit Area is located approximately 30 km to the east of the TEN Project area and is approximately 110 km^2 in extent. Crude oil is produced through the *Kwame Nkrumah*, a turret-moored FPSO vessel. The FPSO is located in the north of the Jubilee Unit Area (*Chapter 1: Figure 1.1*).

The Phase 1 development comprises 17 wells (nine oil production wells, six water injection wells and two gas injection wells) and at full development, the Jubilee FPSO capacities are:

- oil production: 120,000 bpd;
- gas compression: 160 MMscfd; and
- water injection: 232,000 bpd.

TGL is now undertaking an additional infill and expansion phase to extend production levels at the Jubilee Field. The extension, referred to as the Phase1A development, involves the drilling and completion and tie-in to the existing FPSO *Kwame Nkrumah* of up to five new production wells and three new injection wells and the expansion of the subsea infrastructure. The Jubilee Phase 1A development is expected to extend the Jubilee field production plateau rate of 120,000 bpd by one and a half to two years. Phase 1A development footprint will be limited to within the Jubilee Unit Area. There is no routine flaring from the Jubilee development and produced water is treated and discharged to sea.

The TEN Project will share onshore facilities with the Jubilee development.

Saltpond Oil Production

The Saltpond oil and gas field is approximately 100 km west of Accra and is located 12 km offshore Saltpond town in approximately 27 m of water. Six wells were drilled from a centrally located jack-up rig (Mr Louie) which was later converted into a production unit and the field was put on stream in 1978. The field was shut-in in mid-1985 and was reopened again in 2000. Two wells are currently producing approximately 600 bbls of oil a day which are offloaded to storage vessels and then onto a tug (150,000 barrels capacity) for export to refineries. Gas is flared and the produced water is treated and discharged to sea.

7.11.3 Proposed Activities in the Adjacent Blocks

WCTP Exploration and Appraisal Drilling

On-going exploration and appraisal well drilling in the DWT and WCTP blocks may also results in cumulative impacts with the TEN Project. In the WCTP block, TGL and Partners are undertaking further exploration and appraisal drilling on the Teak, Mahogany, Akasa and Banda discoveries in order to determine possible future development of these fields. Current exploration and appraisal programmes will share onshore support bases with the Jubilee and TEN Project activities.

Other Activities

There are a number of other current operations or regularly performed activities in the general project area that have the potential to cause environmental impacts. These are summarised in *Table 7.42*.

There are other on-going human activities that have the potential to contribute to impacts such as discharge of untreated waste and effluent to the marine environment, waste disposal, and releases of oils and fuels by marine vessels.

Table 7.42 Other Activities within the Project Area

Activity	Description	Location
Artisanal Fishing	Fishing by traditional methods by local fishing communities	Along the coast mostly in nearshore areas and using beaches for fish processing and sale
Commercial Fishing	Fishing by commercial vessels using trawling and line methods	In deeper water areas using main ports (including Takoradi) for berthing
Shipping	Commercial ship traffic	In the Gulf of Guinea and near main ports
Tourism, and Recreation	Tourism, swimming, fishing and boating	In the nearshore areas and along beaches
Dredging	Maintenance dredging of Takoradi port area	Within and near Takoradi port
Manufacturing/ Refining	Oil and gas extraction, processing, and transport, both onshore and offshore	Various locations within the project area
Agriculture	Plantations and agricultural activities	Along coastline
Power Generation	Operation of power plants	At Takoradi power plant
Transport Infrastructure	Construction and maintenance of roadways such as road asphalt widening and new bridge construction	In Takoradi near the port and airport
Real Estate Development	Business and housing construction projects	In Takoradi and along coastline
Environmental Restoration	Shoreline stabilisation work or hydrologic restoration	Along the coastline near land developments

7.11.4 *Potential Future Activities*

The types and nature of reasonably foreseeable future development that may result in cumulative impacts with the TEN Project was gathered through the EIA process from discussions with stakeholders, and through review and experience with similar developments worldwide.

These include:

- future expansion of the TEN and Jubilee developments;
- new offshore oil and gas exploration and production fields and developments;
- onshore oil and gas processing and other industrial development induced by oil and gas availability; and
- development of a dedicated Oil Services Terminal in the Western Region.

Expansion of the TEN and Jubilee Developments

There may be further phases in the development of the TEN and Jubilee fields to increase or extend production capacity. Future phases will depend on information obtained during the drilling programme and actual field performance. It is not known what future development may occur but it is possible that new wells would be drilled and additional subsea infrastructure installed to accommodate larger volumes of oil or an additional FPSO installed within the field.

New Offshore Oil and Gas Exploration and Production

There is significant exploration activity in Ghanaian waters under the oversight by the Government of Ghana (see *Figure 7.48).* The activity currently is focussed on exploration drilling to identify hydrocarbon reserves and to prove production capability.

If the exploration activity is successful then the future development of one or more of the identified reserves is likely to occur. The development could take an approach similar to the Jubilee and TEN Projects (*ie* FPSO) or it could take a different approach (*eg* platform and pipelines to onshore processing facilities). Oil and gas exploration and production is also occurring in Cote d'Ivoire to the west of Ghana, including activity close to the TEN Project (see *Figure 7.49*).

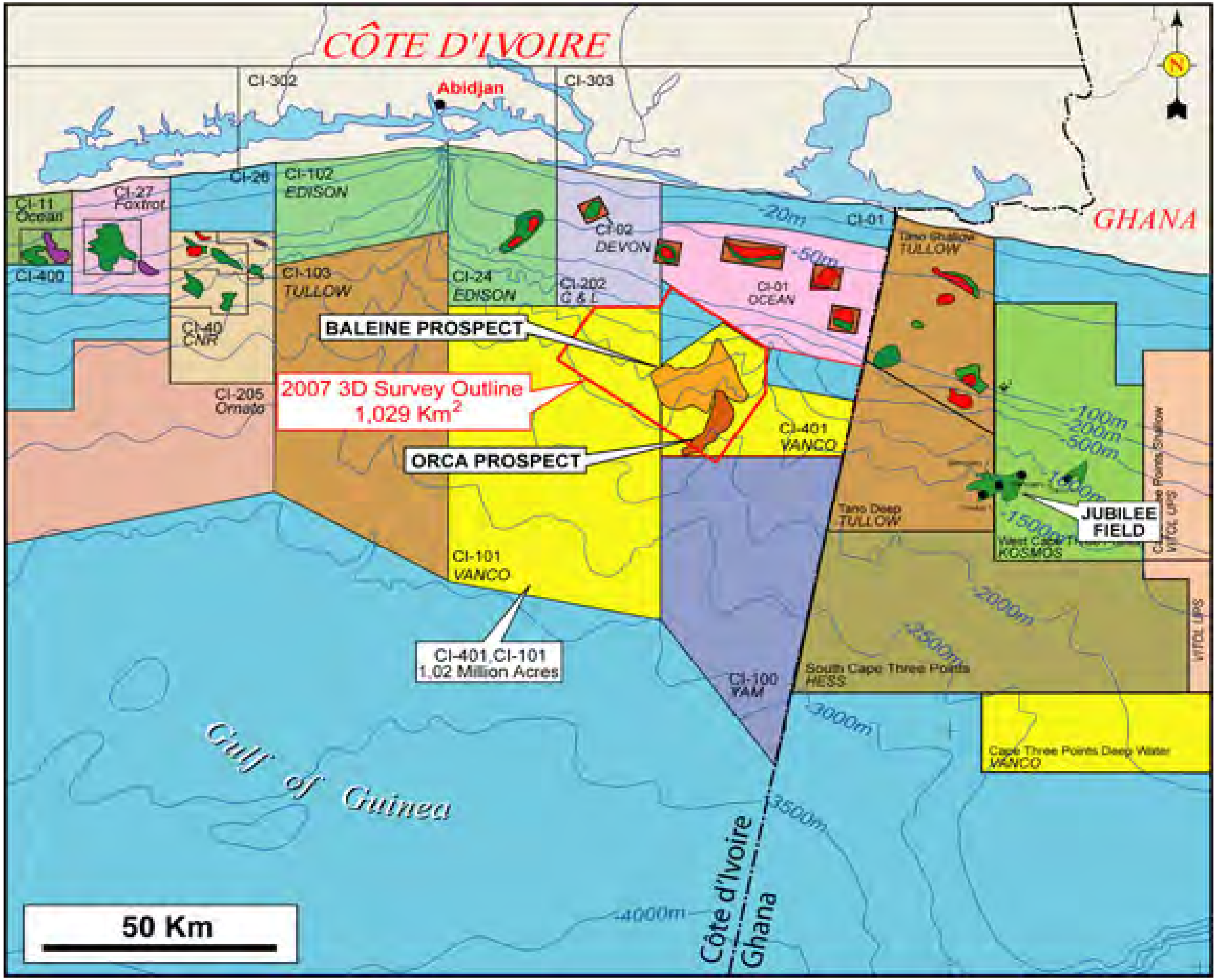
Onshore Oil and Gas Processing and Other Industrial Development

The Government of Ghana is investigating a potential project to transport associated and non-associated gas from Jubilee and TEN by subsea pipeline to an onshore processing facility. There the gas would be processed and treated and further transported for commercial use. Concepts being investigated include using the gas for a power plant located on the coast in the western part of Ghana or to transport the gas to the West African Gas Pipeline system. Future options for a refinery and other industrial plants are also possible.

Figure 7.48 Oil and Gas Licence Areas and Potential Prospects, Offshore Ghana

Source: Vanco Energy 2012

Figure 7.49 Oil and Gas Licence Areas and Potential Prospects, Offshore Côte d'Ivoire



Source: Vanco 2012

Oil Services Terminal in the Western Region

A private developer is proposing to develop an Oil Services Terminal (OST) in the Western Region to provide support services to oil and gas operations offshore Ghana. The OST will also provide infrastructure to oil and gas services companies to offer services to the oil and gas industry in the West African region. The oil services terminal will likely include a:

- logistics supply base (*eg* laydown storage areas, warehousing);
- fabrication yard and spool base (*ie* pipe manufacturing);
- shipyard facilities (*ie* rig repair or modification);
- waste collection and treatment facilities; and
- accommodation for employees of the port users and tenants.

A potential site has been identified in the Western Region near the community of Atuabo. The first phase of the OST would be developed on approximately 0.81 km^2 of an 8 km^2 site. If this proposal is approved then it is anticipated that the port would be operational from mid to late 2014.

7.11.5 Assessment of Cumulative Impacts

The TEN Project is scheduled for a minimum period of 25 years. Short-term impacts include disturbance from noise and vessel movements from the presence of a number of installation and support vessels during well drilling, completions, installation and commissioning and seabed disturbance during installation of seabed infrastructure. Long-term impacts associated with the project include effects associated with on-going emissions to water and air, risk of accidents including oil spills, restrictions on fishing and shipping in the vicinity of the FPSO, waste management and changes to socio-economic conditions through employment and procurement.

Based on the impact assessment from the TEN Project activities discussed in the preceding sections, cumulative impacts from other current and future project activities could potentially impact the following resources and receptors.

- Habitats and species from physical presence of project infrastructure.
- Water and air quality from effluents discharges (including accidental spills) and emissions to air.
- Waste disposal sites from waste arisings.
- Habitats and species and human activities from major oil spills.
- Socio-economic and other human activities from interactions with other users (*eg* fishermen and shipping) and from employment and procurement.

Within the TEN Project area the main potential cumulative impacts will be from the Jubilee field operations, on-going exploration and appraisal drilling and any future phases of the development in the DWT block. In the adjacent licence blocks the main cumulative impacts will be from planned exploration and appraisal drilling and potential future development projects. Cumulative impacts from increases in the level of shipping and helicopter traffic servicing other oil and gas field exploration and development programmes in the area will also occur.

Onshore, the project will interact with other current and future activities at the logistics bases/ports and will result in an increase of activity at Takoradi port and the Air Force base airport and heliport.

Physical Presence

Development drilling is expected to continue for approximately three years during which time there will a single MODU and supply vessels in the field. The FPSO will be present at the offshore location in 2015 for a period of 20 years. There will be safety zones around the FSPO and the MODU and there will be a number of installation and support vessels in the area operating with limited manoeuvrability. The TEN Project will result in additional loss of area for other marine users due to the temporary (around the MODU) and permanent (around FPSO) safety zones. The loss of these offshore deep water areas are not considered to result in a proportional loss of catch for fishermen as the operations will not have a detrimental impact on fish and the individual safety zones are very small in the context of the available offshore fishery area.

The safety zones from TEN (including temporary safety zones around the MODU) and Jubilee will comprise a maximum cumulative area of 2.36 km^2, which is 0.52% in relation to the TEN Project area and 0.001% of the EEZ. The magnitude of this loss of area is small. With effective communications within the project advisory area and enforcement of safety zones no significant cumulative impacts with other vessels are expected.

There will also be vessels travelling to and from Takoradi port and supporting the TEN and Jubilee operations and well as on-going drilling. The use of these shipping lanes and the control of vessel movements close to port by the port authorities will reduce the risk of vessel collisions and potential cumulative impacts are considered to be *not significant*.

For other planned and potential offshore oil and gas developments in Ghanaian waters, the direct physical and indirect ecological impacts will be localised and potential cumulative impacts with the TEN Project are considered to be *not significant.*

Noise impacts from other drilling and production activities are not expected to have significant impacts beyond 6 km from the source and cumulative impacts with Jubilee operations and other oil and gas activities in the Ghana EEZ area are considered to be *not significant.*

Effluent Discharges

Offshore discharges into the marine environmental from oil and gas developments will follow MARPOL requirements and good industry practice and will result in impacts of *Minor* significance. Given the high dilution and dispersion capacity of the deepwater offshore area cumulative impacts from other offshore activities in the vicinity of the TEN Project area are considered to be *not significant.*

There will be impact from the drilling activities due to the disposal of drill cutting onto the seabed in the vicinity of well locations. These impacts are described in *Section 7.4* which concludes that seabed and marine ecology impacts will be localised and of *Minor* significance. Drill cuttings depositions of more than 10 mm thick (a conservative threshold for smothering effects) are not expected to extend beyond approximately 50 m from each well.

Biochemical effects from drill cuttings are not expected to extend beyond 1 km from each well. Therefore, it is unlikely that there will be cumulative impacts from cuttings that are discharged from adjacent wells that are typically located further than 2 km apart. The total cumulative impact of drill cuttings on the seabed from all drilling activities in the DWT and WCTP blocks is not anticipated to exceed *Minor* significance given the level of treatment of cuttings, type of NADF used and nature of the receiving environment.

Effluent discharges at the onshore logistics bases would only occur in the event of spillages and run-off from storage areas and are assessed as being *not significant* with controls in place to ensure oil in water content of discharge waters is within standards. These discharges will act cumulatively with discharges from other activities *ie* port activities, however, the contribution from the TEN and Jubilee developments is assessed as being *not significant* given the scale and likelihood of discharges and the controls in place.

Air Emissions

Emissions to atmosphere from all TEN operations have been quantified and are presented in *Section 7.5*. The air dispersion modelling study included emissions from TEN and Jubilee operations. One of the scenarios modelled assumed that all emission sources were operational and that flaring was undertaken simultaneously at TEN and Jubilee. Such a scenario is highly unlikely and presents a theoretical worst case. The modelling results demonstrated that impacts on air quality will be *not significant* for all pollutants when comparing against the WHO air quality standard, even when considering the worst case.

Emissions of GHG from the TEN Project were assessed as of *Minor* significance. Emissions of GHGs from TEN and Jubilee combined are assessed to be of *Minor* significance. The combined GHG emissions from TEN and Jubilee with future oil and gas developments and power plants will, however, significantly increase the GHG emissions for Ghana.

Waste Management

Volumes of solid and liquid waste requiring onshore land disposal will be higher during the period where drilling activities and installation activities are being undertaken in the TEN Project area. TGL has previously commissioned a review of the waste management options for a number of specific waste streams (ERM 2010). TGL is working with the EPA on these issues and with its waste contractor to provide additional waste treatment services. The waste disposal impacts from the project will act cumulatively with other requirements for non-hazardous and hazardous waste disposal facilities, particularly those from Jubilee and other oil and gas operations. The limitations of current waste disposal facilities have been recognised by the project as a key issue that requires active management by TGL in collaboration with other parties, including the Government of Ghana. The proposed future OST may provide additional waste facilities and capacity for a number of waste streams to treat waste arisings from the oil and gas industry. With the generation of project wastes assessed as being of *Minor* significance and the planned development of waste handling and disposal facilities for wastes from the oil industry, cumulative impacts from other activities are assessed as *Minor.*

Oil Spills

The project undertook a study of fate of oil or fuels if there were an accidental release into the environment (see *Volume II: Annex D*). The modelling simulated releases for both an accidental release of oil from a well blowout during drilling and from fuel spillages and operational spillages at the FPSO.

There is the possibility that there would be cumulative effects from multiple spills occurring over time from a number of different sources. The Jubilee QRA study (IRC 2009) indicated that the probability of major spills), particularly those that could affect the coast, occurring is very low (*eg* 1 in 2,000 years). The probability of two major spills occurring simultaneously would be even smaller.

In the event of a major oil spill from one or more locations a co-ordinated national oil spill response effort will be required. An OSCP has been developed by TGL. Contingencies for smaller scale spills, both offshore and in port and from vessels and the MODU include bunds, barriers and recovery equipment (skimmers and absorbent). TGL's membership of the OSRL provides further access to international scale response capabilities including further trained personnel, equipment and dispersant capabilities.

Taking into account the high sensitivity of coastal resources and receptors and the very low probability of large spills the impact from the TEN Project was assessed as being of *Moderate* significance. Smaller spills with higher probabilities were assessed as being of *Minor* significance. The probability of multiple spills over time remains very low and cumulative impacts from other oil and gas activities are predicted to be *not significant.*

Socio-economics and Human Activities

The TEN Project will provide significant economic benefits to the Government of Ghana and will add to the current oil revenue from the Jubilee development. It is likely that future oil and gas industry developments will increase these benefits and in the longer term, a large scale increase in oil and gas developments in Ghana could lead to cumulative impacts of *Major* significance at the macro-economic scale. Employment and procurement impacts are likely to be more localised, nevertheless they are likely to be positive and significant. At this stage in the development of the industry, cumulative macro-economic and employment impacts from other activities with the TEN Project are considered to be of *Minor* significance.

The perceptions of increased employment opportunities and other benefits as a result of the expansion of oil and gas industry activities and associated businesses will be raised and may increase the current rate of in-migration, particularly to Takoradi. Any influx of people could put a strain on facilities and services, such as health and education, currently available to residents (see *Section 7.9.5*). The majority of oil and gas workers will be based offshore and will make periodic trips to the shore on a work rotation basis. In the short term, many of the workers on the MODU will be foreign nationals who will leave the country during their work break period so their impact to the local socio-economic environment is expected to be minimal. It is expected that the oil industry will meet the needs of its workforce by, for example, providing the required safe water and health services. However, regional development plans will have to provide for additional industries (*eg* power generation) that may develop in the region as a result of the development of the oil and gas industry. At this stage of development the cumulative impacts on onshore facilities and services are assessed as being *not significant.*

During the TEN Project there will be an increase in the number of vessels making port calls, mainly to Takoradi. The overall number and frequency is low and cumulative impacts with normal port management procedures in place are assessed as *not significant*. If the OST is developed near Atuabo, oil and gas operators in Ghana may move their onshore support bases to the dedicated port, which will relief some of the vessel traffic at Takoradi port.

During periods of peak production export tankers will visit the TEN FPSO every 10 to 12 days, increasing the number of tanker movements in the area. The advisory export tanker anchorage/pilotage waiting and boarding area (ATBA) is 3 nmi (5.56 km) radius around the TEN FPSO. Given the Jubilee and TEN FPSOs are located approximately 20 km apart, the ATBAs for both FPSOs will not overlap and it is unlikely that the additional tanker traffic volume will affect other sea users. The cumulative impact from additional tanker traffic is therefore assessed as *not significant*.

Future offshore developments, particularly if these are in coastal waters, are likely to result in localised displacement of fishing activity. While individually *not significant*, if there a large number of offshore installations and associated shipping in areas currently fished then there may be cumulative impacts on some fisheries sectors.

7.11.6 Managing Cumulative Impacts

TGL has the ability to mitigate potential impacts associated with the TEN Project and other operations where it is the designated operator. It has a more limited ability to manage or influence activities by others which may result in cumulative impacts. Management of impacts from a range of different activities will in large part depend on the measures put in place by the government, oil and gas companies and other stakeholders in the coming years. The general approach for mitigating and managing potential cumulative impacts will therefore require coordination of all the relevant industries, the private sector and agencies under the direction of the Government of Ghana.

Strategies that could help manage potential future cumulative impacts are outlined below. TGL, as well as other oil and gas companies and interested parties, could contribute to these studies at various levels as they develop over the next few years. These suggestions are not mandatory requirements for the TEN Project.

- **Strategic Environmental Assessment (SEA).** A government led SEA would enable a comprehensive consideration of potential impacts that may result from the development of the oil and gas sector in Ghana. Such an assessment would ideally feed into the key elements of proactive planning (land use zoning, analysis of infrastructure, waste management, utility and social service needs). The assessment would require greater information on the types of development than is presently available.

- **Build Capacity of Local Administration.** The support provided to regional and district government to build the capacity of its staff would determine the extent to which it is able to plan effectively for future development in the area. Administrative capacity building could include training, provision of equipment and the provision of technical support (*eg* information technology support). TGL has supported certain districts in formulating spatial development plans to guide future development. General capacity building is typically government led (sometimes through donor assistance) but industry can play an active role in developing technical capacity for oil and gas sector oversight.

- **Business Collaboration.** Companies operating in the Western Region and the Government of Ghana should collaborate to agree on common standards and approaches for managing cumulative impacts. This is especially relevant to companies operating in the oil and gas sector. This could be achieved through the establishment of a working group to develop cumulative impact management objectives, standards and measures, and to oversee the monitoring of impact management over time. The extent to which businesses collaborate on such matters as shared infrastructure and local vocational training schemes will be important.

- **Data Gathering and Monitoring.** A structured programme of data gathering and monitoring studies would allow for the proactive management of negative trends that could arise over time. This would require the establishment of a monitoring capability within local government and a set of indicators that would allow the positive and negative impacts associated with change to be tracked. Regional monitoring would need to be government led but industry can play a role in contributing any project related data or supporting the programme through technical assistance.

- **Developing and Enforcing Environmental Management Standards.** Environmental standards need to be reviewed and developed for new and existing industries and collectively applied by the government on all businesses operating in Ghana. This would benefit communities and industry and would influence the severity of impacts on environmental resources and receptors from illegal sources.

- **National Oil Spill Plan.** Collaboration of the oil and gas industry, shipping interests and the Government of Ghana to develop and support an integrated approach to oil spill response including shared resources and expertise and joint training and exercises.

7.11.7 Conclusion

The offshore impacts from the TEN Project are generally localised and cumulative impacts from other current and planned projects are assessed as *Minor*. In the future, emissions of GHG from the TEN Project in combination with the Jubilee development and potential additional offshore oil and gas developments is likely to result in a significant increase in national emissions given the relatively low level of current national emissions.

Onshore, the potential exists for both positive and negative impacts, particularly if Takoradi develops as a base to serve a growing offshore oil and gas industry. The possible future development of an OST outside Takoradi may reduce pressure on existing infrastructure in Takoradi and may provide additional waste treatment capacity. At the national scale, revenues payable to government and employment opportunities from new projects are likely to have a significant positive benefit to the country. Strategic actions by government and industry will be required to manage these impacts if the oil and gas industry develops further in Ghana.

7.12 *Transboundary Impacts*

7.12.1 *Routine Impacts*

The project activities will mostly occur within Ghanaian national waters. The FPSO will be permanently moored at the TEN Project area and the shore support base will be located at Takoradi port. The port of Abidjan in Côte d'Ivoire has served a support role in the past, particular for the supply of offshore drilling chemicals, however, these services are now being established in Ghana. Activities may interact with other national waters and international waters such as during transport of the FPSO and subsea infrastructure to the project location and export of crude oil from the FPSO to offloading destinations.

The following issues with the potential for transboundary impacts have been considered.

- Air dispersion modelling results showed that emissions from the FPSO and MODU would generally dissipate a short distance from the source. Although some emissions may reach the coastline of Côte d'Ivoire, the impact would be *not significant* even for a worst case scenario (see *Section 7.5*).

- Project generated waste will be treated to acceptable levels and discharged or transported to an onshore location in Ghana for treatment and disposal. Any transboundary movement of hazardous waste that cannot be dealt with in Ghana would be subject to controls under the Basel Convention and Bamako Convention. There may be occurrences of marine vessels with ancillary association to the project using non-Ghanaian ports such as Abidjan for service. Control of any discharges, emissions or wastes from these vessels would be governed by MARPOL requirements. The number of such vessels is expected to be low.

- Migratory and mobile marine fauna (*eg* fish, whales, turtles and birds) will pass through the project area. No significant impacts on marine fauna are expected so no transboundary impacts are predicted.

- Foreign registered fishing vessels are reported to use the Ghanaian wasters illegally. Enforcement is likely to increase during the project construction and operation phase due to the presence of project vessels and occasional visits by the Ghanaian Navy. The number of fisherman affected is not expected to be significant.

No significant transboundary impacts are expected to occur as a result of normal operations.

7.12.2 *Transboundary Oil Spills*

Oil spill modelling results showed that small surface releases (approximately 1,000 bbl) have a low probability (less than 10%) of reaching neighbouring countries. However, modelling simulations of a large crude oil spill (approximately 600,000 bbl), showed oil being transported throughout the Gulf of Guinea, with oil making landfall in Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, and Equatorial Guinea. The modelling results are presented in *Section 7.10.8*.

Dealing with transboundary oil spill incidents is not within TGL's remit as they cannot operate in other countries. The Government of Ghana is a signatory to the *International Convention on Oil Pollution Preparedness Response and Cooperation* (OPRC 1990) and has an obligation to fulfil the following requirements in the event of trans-boundary oil spill incidents.

- Report oil spill incidents to the national competent authorities of those countries that could potentially be affected.

- Provide assistance to contracting parties to the Convention in case of oil spill incidents as appropriate as appropriate.

In the event of a large, transboundary oil spill, the Ghana on-scene commander will cooperate with the relevant countries to establish a clear delineation of responsibilities for the response. The national competent authorities of the countries concerned will activate their National OSCPs.

The Government of Ghana is currently working closely with the other contracting parties of the Abidjan Convention to seek and finalise formal arrangements for dealing with trans-boundary oil spill incidents.
Due to the high sensitivity of resources and receptors but the very low probability of large transboundary spills the impact from the TEN Project is assessed as being of *Moderate* significance.

8 MITIGATION AND MANAGEMENT MEASURES

8.1 INTRODUCTION

A key objective of the EIA is to develop and describe practical, commensurate and cost effective mitigation measures that avoid, reduce, control, remedy or compensate for negative impacts and to create or enhance positive impacts such as environmental and social benefits. For the purposes of this EIS the term mitigation measures has been used to include changes to the design, engineering controls and procedures, and operational plans and procedures.

The objectives of mitigation have been established through legal requirements or industry good practice standards (as described in *Chapter 2*). The approach taken to defining mitigation measures is based on a hierarchy of decisions and measures (see *Box 8.1*). The majority of mitigation measures fall within the upper two tiers of the hierarchy and are effectively built into the design of the project.

Box 8.1 Mitigation Hierarchy

THE MITIGATION HIERARCHY FOR PLANNED PROJECT ACTIVITIES
Avoid at Source; Reduce at Source **Avoiding or reducing at source is designing the project so that a feature causing an impact is designed out (*eg* a waste stream is eliminated) or altered (*eg* reduced waste volume).**
Abate on Site **This involves adding something to the design to abate the impact *eg* pollution controls.**
Abate at Receptor **If an impact cannot be avoided, reduced or abated on-site then measures can be implemented off-site (*eg* noise or visual screening at properties).**
Repair or Remedy **Some impacts involve unavoidable damage to a resource, *eg* land disturbance. Repair essentially involves restoration and reinstatement type measures.**
Compensate in Kind **Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss or damage might be appropriate.**

8.2 SUMMARY OF MITIGATION AND MANAGEMENT MEASURES

Table 8.1 provides a summary of environmental and social mitigation measures that have been identified in the description of the project design (*Chapter 2)* and through the impact assessment process (*Chapter 7*). Monitoring requirements associated with the mitigation measures are provided in the provisional Monitoring Plan (see *Chapter 9*). Mitigation measures will be implemented through TGL's EHS Management System and related detailed management plans (see *Chapter 11*).

Table 8.1 Summary of Mitigation Measures with Reference to the Project Stage and Project Plans and Procedures

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Project Footprint				
Section 7.3.2	Impacts from subsea infrastructure.	• The layout of the subsea infrastructure will be designed to avoid seabed features considered to be geo-hazards. This will also protect areas with potentially more diverse habitats and species. • Most in-field subsea flowlines will be laid directly on the seabed and flowline burial using methods such as dredging and jetting will be avoided.	• Design / Planning • Installation	• Basis of Design • TEN ESMP • Decommissioning
Section 7.3.1 Section 7.3.3	Interaction from vessel and helicopter movements and underwater sound with marine mammals, turtles and birds.	• A policy and procedures will be implemented to reduce disturbance to marine and coastal fauna from traffic and operations of drilling vessels, support vessels and helicopters. • Vessels will not be allowed to intentionally approach marine mammals or turtles and, where practicable, will alter course or reduce speed to further limit the potential for disturbance or collision. • Helicopter travel routes will be specified to avoid Important Bird Areas and helicopter pilots will be required to fly at a minimum altitude of 2,300 feet (710 m) when flying over the Amasuri Wetland IBA. • TGL will continue with its current marine mammal observation and monitoring programme at and in the vicinity of the proposed TEN Project area to obtain additional information on marine mammal distributions in the area.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• TEN ESMP • Marine Logistics Procedures • Helicopter Operations Plan
Operational Discharges				
Section 7.4.3	Impacts from operational discharges to the marine environment.	*Ballast Water* • Visiting export tankers and other vessels discharging ballast water will be required to undertake ballast water management measures in accordance with the requirements of the *International Convention for the Control and Management of Ships Ballast Water & Sediments*. This will include exchanging ballast water beyond 200 nm before entering Ghana EEZ. • The TEN FPSO will be equipped with segregated ballast tanks. The primary means of maintaining an even keel, stability and trim will be through management of the distribution of crude oil within the storage tanks, minimising ballast water intake and discharge. • The tanker vetting procedures will include demonstration compliance with the *International Convention for the Control and Management of Ships Ballast Water & Sediments* to minimise the transfer of organisms.	• Design/ Planning • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • TEN ESMP

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.4.4	Impacts from operational discharges to the marine environment.	*Black Water, Grey Water and Food Waste* • Black Water: Compliance with MARPOL. Treat to achieve no floating solids, no discolouration of surrounding water and a residual chlorine content of less than 1 mgl^{-1} prior to discharge. No discharge from vessels within 12 nmi from the nearest land. • Organic food wastes: Compliance with MARPOL. Macerated to pass through a 25 mm mesh and discharged more than 12 nm from land with no floating solids or foam. • Residual concentrations of hypochlorite in discharge waters will be set at 1 mgl^{-1}.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • TEN ESMP • Monitoring Plan
Section 7.4.5	Impacts from operational discharges to the marine environment.	*Completion and Workover Fluids* • TGL will manage the selection and use of each chemical taking into account its concentration, toxicity, bioavailability and bioaccumulation potential, with selection based on the least environmental potential hazard. • Where possible, used fluids will be injected into the formation, flared, or collected in a closed system and shipped to shore for recycling or treatment and disposal. • Only discharge completions and wellbore clean-up fluids to sea after treatment to remove free oil. • Return to the MODU any acidic completion and workover fluids that are used where well fluids will be neutralised by mixing in soda ash, or similar, to attain a pH of 5 to 7 before disposal to sea.	• Planning / Design • Completions • Operation (during workovers)	• Basis of Design • TEN ESMP • Completions Plan • Waste Management Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.4.6	Impacts from operational discharges to the marine environment.	*Deck Drainage and Bilge Water* • The FPSO and MODU deck and drainage system will include coamings around the main decks to contain leaks, spills and contaminated wash-down water to minimise the potential for uncontrolled overboard release. The open drain system will collect oily rainwater drainage from drip pans and drain boxes throughout the topsides, rainwater on FPSO decks, and deluge water from the modules. A closed drain system will collect hazardous fluids from process equipment in hydrocarbon service. If the deck becomes contaminated, oily deck drainage will be contained by absorbents or collected by a pollution pan for recycling and/or disposal. • The FPSO, MODUs and marine vessels will treat oily water (*eg* from open and closed drain systems, bilges and slop tank water) in accordance with the MARPOL Annex I requirements (15 mgl^{-1} oil and grease as a maximum limit) and discharge to sea. • Oil discharge monitors will be used to prevent oil in water content targets being exceeded. Records will be maintained of all discharges and oil content to verify controls in place are working effectively	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • TEN ESMP • Monitoring Plan
Section 7.4.7	Impacts from operational discharges to the marine environment.	*Drill Cuttings and Fluid* • Solid control systems will be used, including dryers, to reduce oil on cuttings to a target which meets the EPA (2010) discharge compliance limit. • TGL is considering other options to reduce oil on cuttings further using TDUs on the MODU and there are on-going feasibility studies to confirm if such equipment can be installed on the MODU alongside other drilling and completion equipment. • Measures will be taken to comply with project effluent guidelines, including use of low toxicity (Group III) NADF, no free oil, and limits on mercury and cadmium concentrations.	• Drilling	• Basis of Design • TEN ESMP • Monitoring Plan
Section 7.4.8	Impacts from operational discharges to the marine environment.	*Hydraulic Discharges from Subsea Equipment* • The hydraulic fluids used will be a water based glycol control fluid which has a low toxicity and bioaccumulation potential and is readily biodegradable.	• Planning/Design • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • TEN ESMP

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.4.9	Impacts from operational discharges to the marine environment.	*Pre-commissioning Pressure Testing Fluids* • Pre-commissioning disposal plan to control the rate of discharge, chemical use and dispersion. Dispersion will be improved by optimising the discharge rate, pressure and direction of the discharge at the release point. • The volume of pre-commissioning water required will be reduced by testing equipment onshore where possible, before it is loaded onto offshore facilities. • Preferential use of low toxicity and readily biodegradable chemicals.	• Commissioning	• Basis of Design • TEN ESMP • Hydrotesting Plan
Section 7.4.10	Impacts from operational discharges to the marine environment.	*Produced Water* • Produced water will be re-injected if technically feasible. The feasibility of reinjection will be demonstrated by the outcome of the PWRI study. • TGL will design the FPSOs produced water treatment system to include a three stage process of a water skim vessel, followed by hydrocyclones and ending with a flotation cell prior to discharge to sea. Dispersion of discharges will be increased using diffusers on the discharge pipe. • TGL will continually monitor produced water and if oil in water (hydrocarbons) exceeds 40 mgl-1 as per EPA (2010), the water will be routed to the off-specification tank for further treatment prior to any discharge. Operations staff will be alerted to any rising trends by alarms at less than 40 mgl-1 in various stages. • TGL will follow EPA (2010) guidance (29 mgl^{-1} maximum 30 day average and 40 mgl^{-1} maximum oil content and no visible sheen).	• Operation	• Basis of Design • TEN ESMP • Monitoring plan • Produced Water Management Procedure

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.4.11	Impacts on the quality of the local physical environment in the vicinity of onshore bases.	• Chemical and fuel storage areas will have appropriate secondary containment (bunds), and procedures for managing the containment systems. Secondary containment design will depend on the type of tanks and nature and volume of the materials being stored. • Impervious concrete surfaces will be in place at all areas of potential chemical and fuel leaks and spills, including below gauges, pumps, sumps and loading /unloading areas. • Storage tanks and components will meet international standards, such as those of the API, for structural design and integrity. • Storage tanks and components will undergo periodic inspection for corrosion and integrity and will be subject to regular maintenance of components such as pipes, seals, connectors and valves. • Fuelling equipment will be inspected daily to ensure all components are in satisfactory condition. • For chemical and fuel storage, handling and transfer areas, TGL will install stormwater channels with subsequent treatment through oil-water separators. • Loading and unloading activities will be conducted by properly trained personnel according to formal procedures to prevent accidental releases and fire and explosion hazards. • Spill control and response plans will be developed in coordination with the landowners (*ie* GPHA Takoradi and Takoradi Air Force base).	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Oil Spill Contingency Plan • Leasing Agreements • Basis of Design • TEN ESMP • Cargo Tanker Transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan
Section 3.6.2	Impacts from operational discharges to the marine environment.	*Produced Sand* • Install sand control in all wells during well completions to prevent produced sand. • Sand monitoring installed for each well. • Any produced sand with residual oil >1% dry weight will be shipped to shore for proper treatment and disposal.	• Planning / Design • Completions • Operation • Decommissioning	• Basis of Design • TEN ESMP • Waste Management Plan
Section 3.8.3	Impacts from operational discharges to the marine environment.	*Naturally Occurring Radioactive Material (NORM)* • TGL will inject scale inhibitor into the wells and process facilities.	• Planning / Design • Operation • Decommissioning	• Basis of Design • TEN ESMP • NORM Management Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Emissions to Atmosphere				
Section 7.5	Impacts on air quality from atmospheric pollutant emissions	*Atmospheric Pollutant Emissions* • TGL will implement a 500 m safety zones around the FPSO and MODU to avoid exposure of transient receptors to excessive air pollution. • The FPSO and MODU, construction/installation and support/supply vessels will comply with MARPOL 73/78 Annex VI standards with regards to air emissions. In addition incineration of certain products on board such as contaminated packaging materials will be prohibited. • TGL will use low-sulphur diesel. • TGL will implement methods for controlling and reducing leaks and fugitive emissions will be implemented in the design, operation and maintenance of the offshore facilities. • TGL will undertake routine inspection and maintenance of engines, generators and other equipment. • Routine flaring will be avoided and non-routine flaring will be kept to minimum to maintain safe conditions or during short-duration activities such as start-up, re-start and maintenance activities. • TGL will install a Vapour Recovery Unit (VRU) to collect the vapours from the gas treatment system's TEG dehydration reboiler unit to mitigate the venting of aromatic hydrocarbon compounds that can be released by these units, pending to the outcome of gas blanketing system BAT assessment.	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • TEN ESMP • Tanker Cargo Transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan
Section 7.6	Impacts on air quality from greenhouse gas emissions.	*Greenhouse Gases* • TGL will develop and implement a project flaring strategy for normal steady state production with a goal to eliminate or minimise flaring. • TGL will develop an operational strategy to monitor, reduce and work to eliminate cold vent volumes. • TGL will establish a targeted maximum abnormal flaring rate of 5% of the monthly average total gas production. • TGL will quantify annually total GHG emissions in order to identify areas of improvement. • BAT assessments will be undertaken to demonstrate that GHG emissions have been reduced to ALARP in relation to power generation, optimisation of energy efficiency, reduction in flaring and reduction in venting.	• Drilling • Design/ Planning • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • TEN ESMP • Tanker Cargo Transfer and Fuel Oil Transfer Procedure • Preventative Maintenance Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Waste Management				
Section 7.7.2 Section 7.7.3	Impacts on marine environment, terrestrial environment, local communities and waste facilities as a result of inappropriate segregation, storage and transport of waste.	*Storage, Segregation and Transport of Waste* • TGL will incorporate TEN into TGL's WMP and manage via the EHSMS. • The TGL WMP will require that facilities operated or controlled by TGL (including contractors based within TGL's shore base facilities) will adopt specific procedures for the management of wastes, including the segregation of non-hazardous and hazardous wastes at source and appropriate containment measure for specific waste types. • Designated areas for the temporary storage and segregation of waste will be available on the FPSO, MODU and supply vessels. The onshore bases at Takoradi Port and the Air Force base will also have designated secure waste reception and temporary storage facilities. • Reduce waste generation and maximise reuse and recycling. • Waste identification and classification. • TGL will use appropriate containers, including skips and bins for specific types of solid or liquid waste. Containers will not be overfilled. • TGL will transport waste in a safe manner, in accordance with the associated MSDS information for spent chemicals and other industry packaging and transport advice. • TGL will ensure that waste is transported using properly maintained, legally compliant and pre-inspected and approved vehicles and vessels that are driven/crewed by appropriately trained operators. • TGL will assess vehicles and vessels to be used for the transport of wastes and approve them to meet minimum standards and TGL vehicle policy. • Waste to be transported by TGL and EPA approved waste contractors only.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• TGL Waste Management Plan • TEN ESMP • Monitoring plan • Transport Management Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.7.4	Impacts on marine environment, terrestrial environment, local communities and waste facilities as a result of inappropriate treatment/disposal.	• EPA approved companies providing waste treatment and disposal services will be selected by review and evaluation in line with international good practice (eg IFC (2007e) EHS Guidelines for Waste Management Facilities). • Periodic audits of third-party waste facilities and sites will be undertaken to ensure wastes are being managed in line with standards and methods agreed in TGL waste contracts. TGL approved waste management services used for Jubilee have been audited by IFC. • Waste tracking procedures as defined in the WMP will be implemented to provide traceability from source of generation to end point. Waste Transfer Notes will be used to track waste consignments from offshore and onshore locations to specific waste contractor locations. • Waste will be treated in accordance with the procedures outlined in the TGL WMP. • Non-hazardous waste will be segregated and recycled where possible. No hazardous waste will be landfilled. • Used oil and slops will be recycled offshore into the production crude stream via the closed drain system on the FPSO to avoid transfer for onshore disposal. • Hazardous waste will be sent to an approved waste contractor for recycling or treatment. • Unused chemicals will be returned to suppliers. • TGL will store small quantities of hazardous waste that currently cannot be treated in Ghana until such time as a suitable management option is identified. • TGL will work with contractors to identify opportunities for further recycling and facilitate the continuous improvement and upgrading of facilities.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• TGL Waste Management Plan • TEN ESMP • Monitoring Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Fisheries Impacts				
Section 7.8.2	Impacts on fisheries	• A Community Liaison Officer (CLO) will be based in each of the six coastal districts to liaise between fishermen and TGL and to provide information to fishing communities regarding TGL's activities and notifying them of the requirements to keep away from the operations for safety reasons. The CLOs will also deal with any claims for gear damage through TGL's grievance mechanism and will monitor interaction with fishermen and other users of the area through the project's grievance procedure. • Notification will be given to mariners of the presence of the FPSO and other marine operations within the TEN Project area. Safety and advisory areas will be marked on nautical charts as cautionary advice to all sea-users. • The safety zone will be monitored with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (*eg* fishermen) when potentially close to the FPSO or MODU (when present). • Development of a code of practice (based on the UN Voluntary Principles of Security and Human Rights) and training for those responsible for maintaining the exclusion zones. • A vessel transit route will be agreed with the GMA and communicated to fishermen and other marine users through the CLOs. • TGL will continue to liaise with the Fisheries Commission to identify opportunities to improve understanding of current fishing activities within the Ghanaian EEZ and to investigate ways to reduce potential conflict between the oil and gas industry and the fishing industry.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Marine Logistics Plan • TEN ESMP • Stakeholder Engagement Plan • Voluntary Principles on Security and Human Rights • Social Investment Framework and Strategy
Socio-Economic and Community Health Impacts				
Section 7.9.2	Increased government revenue	• TGL will follow the Extractive Industries Transparency Initiative (EITTI) principles. • TGL will work with the Government of Ghana to make payments in a transparent and accurate manner, utilising sound financial principles and accounting processes. • Preceding decommissioning, TGL will communicate with the Government of Ghana regarding potential implications to government revenues.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Social Investment Framework and Strategy • Stakeholder Engagement Plan • TEN ESMP

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.9.3	Employment and skills development	*Employment* • TGL will continue to implement local employment and skills development policies for the recruitment, training and development of national staff in its operations (known as 'nationalisation'). • TGL service contracts will transpose these employment and skills development requirements to contractors. • Recruitment practices will be based on ability, objectivity and fairness in line with relevant labour legislation and organisational policies and strategies. • Employment opportunities will be advertised widely (eg in the national or local media). In addition, relevant job opportunities will be specifically communicated to communities in the coastal districts of the Western Region by the CLOs. CLOs will also provide information on job application procedures. • TGL will implement mentoring and job shadowing programmes for national staff of TGL, to enhance the quality of employment and the longevity and sustainability of jobs. *Skills Development* In recognition of the current skills shortage in the Western Region and Ghana, TGL will, through its Social Investment (SI) Framework and Strategy: • Investigate potential partnerships with NGOs and other education organisations to provide support for primary and secondary level education, which may include funding for upgrading of facilities, sponsoring of books, training of teachers or scholarships. • Investigate potential partnerships with NGOs and training organisations to support construction trade skills development programmes considering skills required by the oil industry. • Provide support for education and training at tertiary level eg support to polytechnics and universities in developing curriculums, funding and sponsoring of students which could provide employment in the oil industry or other heavy industries. • Provide apprenticeship programmes for suitable graduates in their operations.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Human Resource Strategy Plan • Social Investment Framework and Strategy • Stakeholder Engagement Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.9.4	Procurement of goods and services	• Contracting and procurement of goods and services will be executed in accordance with the requirements of the DWT Petroleum Agreement, applicable laws and established project procedures and principles. In this regard, TGL will continue to implement its local content strategy which is aimed at building capacity and capability of Ghanaians and Ghanaian businesses to support the long-term development of the oil industry. • A TEN-specific local content plan will be developed that addressed local procurement. • TGL will enter into contracts with companies in Ghana to establish long-term commitments to the business to promote long-term sustainable growth and help new businesses establish. • TGL will carry out contractor vetting and develop contract conditions to ensure the requirement for local content and procurement is passed to contractors, so that goods and services are purchased regionally or nationally where possible, and employment rights and conditions are respected. • TGL will work with and support suppliers in Ghana to help them meet the required standards in areas such as business operations employee rights, training, environment and health and safety, eg through pre-tender workshops and training. • TGL will partner with organisations to develop a programme for strengthening the capacity of Ghanaian businesses to deliver identified goods and services to the industry. • TGL will audit local content through facility visits and interviews to monitor and track the effects of the strategy of maximising local content over the project lifespan from contractors.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Local Content Strategy • TEN Local Content Plan • Social Investment Framework and Strategy
Section 7.9.5	Influx of job-seekers	• TGL will address public expectations about project related job opportunities through a SEP and undertake on-going engagement with the public and communities in the six coastal districts throughout the project life. • TGL will work with government in delivering SI projects that could support infrastructure projects in the coastal districts. TGL will seek feedback from stakeholders on proposed SI programmes and projects prior to implementation.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Social Investment Framework and Strategy • Stakeholder Engagement Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.9.6	Issues with heightened and unmet expectations	• On-going engagement with communities in the six coastal districts as per the SEP and address expectations though these engagements, in collaboration with government. • TGL will develop its SI Framework with consideration of regional and district development plans and priorities. Details of the SI programmes and projects will be subject to further consultation with government agencies and communities in the coastal districts. • TGL will coordinate the planning and implementation of SI programmes and projects so that there is uniformity in their approach. • TGL will implement a grievance procedure to manage and facilitate disputes and grievances. TGL's CLOs will communicate the grievance procedure to communities and facilitate the grievance process. When a grievance has been brought to the attention of TGL staff it will be logged and evaluated, and action/responses recorded. Grievances will be monitored on an on-going basis. • TGL will, through its employment and skills development and local content strategies and plans, build on the capacity and capability of Ghanaians and Ghanaian businesses to support the long-term development of the emerging oil industry.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Social Investment Framework and Strategy • Stakeholder Engagement Plan • Human Resource Strategy Plan • Local Content Strategy • TEN Local Content Plan
Section 7.9.7	Impacts on commercial shipping	• The 500 m safety zones around each installation and the 3 nmi ATBA will be mapped on international nautical charts and formally designated by the GMA and endorsed by the IMO. • TGL and its contractors will notify mariners of the presence of the FPSO and other marine operations within the TEN Project area. • The presence of standby vessels and offloading tugs at the FPSO and MODU locations will reduce the risk of vessel collision with commercial vessels. • Compliance with requirements of SOLAS with regards to communication and navigation equipment and COLREGS with regard to vessel operations.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Marine Logistics Plan • TEN ESMP • Stakeholder Engagement Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.9.8	Impacts from onshore supply base	• TGL will implement its EHS management system at onshore bases to manage environmental and social impacts from onshore activities (*eg* interaction with neighbours, noise abatement, traffic management and waste management). • TGL will implement a grievance procedure and communicate it to surrounding communities and the general public. Social investments as part of the SI strategy will seek to address specific community issues arising from the project activities. • TGL will manage contractor environmental and social performance through contractual mechanisms. • TGL will undertake periodic audits and reviews of shore based operations to review site EHS performance and take corrective actions as required.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• EHS-MS • TEN ESMP • Monitoring plan • Stakeholder Engagement Plan
Section7.9.9	Impacts on Community Health	• TGL will ensure strict compliance with pre-employment screening protocols for all employees (including contractors and subcontractors) which will include testing for TB and other diseases appropriate to the individual's country of origin, vaccinations and voluntary testing for sexually transmitted disease. • Regular health screening will be provided for all employees (including contractors and subcontractors). Adequate referral and support for on-going treatment programmes for workers found to have treatable conditions. Subcontractors will be required to do the same through contractual specifications. • All employees, contractors and subcontractors will be required to follow, and will be trained in, the Worker Code of Conduct which includes guidelines on worker-community interactions, worker-worker interactions and alcohol and drug use. • All employees, contractors and subcontractors will be trained and educated to improve awareness of transmission routes and methods of prevention of sexually transmitted infections, communicable diseases (such as TB) and vector borne diseases, notably malaria, as part of induction. Other diseases will be covered as appropriate. • TGL will develop Emergency Response Plans (ERPs) for the TEN Project taking into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident. • TLG will continue to implement a programme of stakeholder engagement including a grievance mechanism.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• EHS-MS • TEN ESMP • Monitoring plan • Social Investment Framework and Strategy • Stakeholder Engagement Plan • Human Resource Strategy Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Oil Spill Risk				
Section 7.10	Impacts from oil spills on vulnerable components of the ecosystem in offshore and coastal environments (*eg* seabirds, marine mammals, turtles, coastal habitats) and fishing activities and other livelihoods dependent on the coast.	*Oil Spill Prevention Measures* To minimise the risk of potential spills, TGL has designed the project facilities with a range of inherent measures designed to reduce the risk of oil spill. Oil spill prevention measures that will be implemented as part of the design of the project will include the following. • Blow-Out Preventers (BOPs) permanently installed on the subsea wells during well completions, and the use of a double mechanical barrier system during production and injection operations using the subsea Christmas trees and other barriers. • A system of wells, subsea flowlines, risers, emergency shutdown systems and FPSO topsides designed to international process codes and with alarm and shutdown systems to maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to ensure performance standards are met. • The FPSO deck and drainage system will be designed to contain spills (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release. • Specific procedures will be developed for offloading crude from the FPSO onto the shuttle tankers. These will include vetting of tankers involved in offloading, management of offloading activities by trained and experienced personnel, the use of a quality marine fleet to undertake the operation of hose handling and tanker movements (including contingencies for any engine failures), and the continuous monitoring and actions to be taken in the event of any non-routine events or equipment failures.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Basis of Design • Formal Safety Assessment • Emergency Response Plan • Oil Spill Contingency Plan • Preventative Maintenance Plan

EIS Reference	Impact Factor	Mitigation Measures	Project Stage	Project Plan/Procedure (see *Chapter 9*)
Section 7.10	Impacts from oil spills on vulnerable components of the ecosystem in offshore and coastal environments (*eg* seabirds, marine mammals, turtles, coastal habitats) and fishing activities and other livelihoods dependent on the coast.	*Oil Spill Preparedness Measures* TGL will have in place the key elements of oil spill preparedness and response including the following. • Management Framework which defines the roles and responsibilities of the various stakeholders potentially involved in the range of different oil spill scenarios. • Oil Spill Contingency Plan (OSCP) that sets out the elements for response and the processes for managing the integration of local, regional, national and international resources as appropriate. • Specific response strategies for various areas of operation and in detail for particular areas of high environmental or socio-economic importance. • On-site equipment commensurate with the Tier 1 risk available at all times. • Arrangements for the integration of additional support at all tier levels. • Logistical arrangements to facilitate and support response operations across all tier levels. • Trained staff in oil spill response both on-site and also at the Tier 2 and Tier 3 levels. • A programme of simulation exercises to test different aspects of preparedness to build familiarity and ensure competence.	• Drilling • Completions • Installation • Commissioning • Operation • Decommissioning	• Emergency Response Plan • Oil Spill Contingency Plan

9 PROVISIONAL MONITORING PLAN

9.1 INTRODUCTION

The purpose of this chapter is to outline the key monitoring requirements identified through the EIA process to monitor the environmental and social performance of the project.

The TEN monitoring requirements will be integrated into the existing TGL monitoring requirement that were developed for the Jubilee field operations. The TGL monitoring plan will be updated to include the TEN environmental and social monitoring requirements to be implemented by TGL and its contractors. The TGL Monitoring Plan will be updated as significant changes to TGL's environmental aspects/impacts profile occur and as per the TGL Management of Change process (TGJ-PJM-PRC-07-0006-1). The Monitoring Plan will also be reviewed, and re-issued if necessary, in line with the TGL EHS management system review process, which will occur as a minimum on an annual basis. The plan will be implemented prior to first oil (targeted for mid 2016), although certain elements will be in place earlier than this as outlined in *Table 9.1.*

The purpose of the Monitoring Plan is to implement monitoring systems designed to accurately and constantly monitor the project and company's environmental and social aspects/impacts. This environmental and social performance data will be applied to achieve both continual improvement in performance and to avoid or minimise adverse significant environmental and social aspects/impacts by supporting the control and management measures identified in the Environmental and Social Management Plan (ESMP) (*Chapter 11*).

The overall objectives of the Monitoring Plan are as follows.

- To measure the TEN Project's environmental and social performance against regulatory requirements and project standards described in *Chapter 2 (*it should be noted that these monitoring requirements are also maintained in the TGL Commitments and Legal Database*).*

- To verify predictions made in the EIA.

- To verify that mitigation measures are effective and implemented in the manner described in *Chapter 8*.

- To inform future operations and contribute to continuous improvement in the management of environmental and social issues related to the project.

It should be noted that monitoring requirements are also maintained in the TGL Commitments and Legal Database.

Monitoring requirements for the drilling phase, including drill cuttings monitoring, are also addressed within the Monitoring Plan.

9.2 MONITORING APPROACH

Monitoring will be carried out by TGL's EHS, Social Investment and relevant technical departments, and its contractors pursuant to their contractual obligations to undertake inspections, monitoring and reporting. The following four types of inspections and monitoring will be employed.

- **Inspections** planned and conducted on a regular basis to ensure that mitigation measures and commitments are properly maintained and implemented, and that specific management procedures are being following (*eg* practices on waste storage and disposal).

- **Receptor monitoring** undertaken to verify predictions made in the EIA and to confirm that the activities at the site are not resulting in an unacceptable deterioration in the quality of habitats or infrastructure (*eg* monitoring disturbance to affected residents through a grievance mechanism).

- **Compliance monitoring** involving periodic sampling or continuous recording of specific environmental quality indicators or discharge levels to ensure compliance of discharges and emissions with project standards (*eg* produced water discharges and air emissions).

- **Auditing (internal and external)** to assess compliance of the project activities with both regulatory and site management system requirements.

The frequency of inspection, monitoring and audits are listed in *Table 9.1* and are based on project risk management requirements and standard industry practices.

Monitoring results will be presented in regular reports and reviewed at EHS, Social Investment, TEN Partners, Operating Committee and Government management meetings. The results of the inspection and monitoring activities will be reported to TGL on a weekly/monthly basis, or as required. The approach to EHS management, including responsibilities, and checking and corrective actions relating to monitoring activities are outlined in the provisional ESMP for the TEN Project (*Chapter 11*).

In addition to routine reporting, an annual monitoring report, aggregating much of the data produced by the other reporting processes, will be submitted to the Ghana Government and appropriate external stakeholders. The monitoring plan and parameters will be reviewed periodically and, if necessary, will be modified to include any additional parameters necessary to ensure good environmental and social performance. Similarly, the monitoring methods and frequencies will be subject to periodic review by the TEN Partners.

9.3 *PROVISIONAL MONITORING PLAN FOR SPECIFIC MITIGATION MEASURES*

The provisional Monitoring Plan is presented *Table 9.1*. Issues are listed following the format used in the EIA. The provisional Monitoring Plan describes what potential impact is to be measured and the frequency of monitoring and reporting. Specific monitoring parameters and reporting for discharges from the project will be provided in the Monitoring Plan.

Table 9.1 Provisional Monitoring Plan for Specific Mitigation Measures

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Impacts of project activities including vessel movements and underwater sounds on marine mammals and turtles	Monitor sightings of marine mammals, turtles from vessels in the vicinity of the proposed TEN Project. TGL and relevant contractor personnel to be trained to identify marine mammals and turtles in the project area and report sightings on daily basis. Monitoring from both the TEN fields and from the supply vessels when steaming between Takoradi and FPSO.	Continually throughout project life (*ie* during drilling, commissioning, operations and decommissioning) from support vessels attending the FPSO and on regular passage between Takoradi port and the FPSO.
	Appoint experienced marine ecologist to inspect and analyse sighting records.	Annually
	Monitor flight paths to ensure compliance with flight restrictions (route, speed, height) for helicopter and fixed wing operations. Monitor vessel location to ensure compliance with stipulated shipping routes.	Daily, per aircraft and vessel trip
Impacts and subsea infrastructure and drill cuttings on benthic environment	Undertake a scan of the seabed prior to the installation of subsea infrastructure to ensure that is not placed on any significant seabed features. Note: side scan sonar of seafloor already undertaken.	One-off scan of seabed by ROV prior to installation of subsea infrastructure.
	Undertake a scan of the seabed after installation of subsea infrastructure to ensure that is placed correctly and undamaged.	One-off scan of seabed by ROV once flowlines and other subsea equipment have been installed.
	Undertake seabed sampling programme to investigate the impact of drill cuttings discharges and recovery over time. Monitoring to include benthic sampling (macro-fauna fauna abundance and biodiversity, sediment particle size distribution, sediment chemical analysis for metals and hydrocarbon content). Methodology to follow international good practice.	Before drilling commences, at a representative drill site and periodically thereafter. Baseline work undertaken in 2011. Detailed survey programme to be developed.

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Impact of discharges on pelagic marine biodiversity	TPH, PAH and metal (As, Ba, Cd, Cu, Cr, Hg, Pb, Zn) concentration in muscle and liver tissue from fish caught in vicinity of FPSO (at edge of 500 m exclusion zone) to be analysed and compared with international standards and fish caught in two reference sites at a minimum distance of 20km. Up to three pelagic species that are common to the FPSO area to be selected as part of the study.	Once off programme to be undertaken after 12 months of operations.
Pre-commissioning pressure (hydrotest) test fluids	Monitoring and reporting of quantity of chemicals used and discharge volumes.	Daily monitoring and monthly data reporting during commissioning of FPSO.
Chemical use (including discharges of hydraulic fluid from subsea equipment)	For all chemicals used the following monitoring will be undertaken: • Quantity used (kg or l) • Quantity of major chemicals discharged (monitored either by calculation or direct measurement)(kg or l) • Concentration in the discharge (monitored either by calculation or direct measurement) • Discharge depth • Hazard Quotient (HQ) and Offshore Chemical Notification Scheme (ONCS) band categories each chemical will be reported.	Monthly data reporting throughout project.
Reverse osmosis discharge water	Monitor salinity (%) and volume of desalination brine discharged (m^3) and	Daily flowmeter records; Monthly data reporting throughout project.
Well completion and workover fluids	Prior to discharge from the MODU, the following parameters shall be monitored and compared against discharged standards: • volume of discharged fluids (m^3); • oil in water content (mgl^{-1}) – (discharge standard less than 29 mgl^{-1} monthly average; maximum 40 mgl^{-1}); • pH of treated wellbore clean-up fluids (pH 5 or more).	Per batch: oil in water and pH Daily: Volume of discharged fluids Per operation: oil in water content (average) and total volume discharged Data to be reported on a daily basis
Produced water	Monitor total volume of produced water discharged (m^3) and oil content (average and maximum) in produced water discharge (mgl^{-1}) and compare against discharge standards (29 mgl^{-1} maximum monthly average and 40 mgl^{-1} maximum daily average oil content and no visible sheen).	Continuous: oil content (average and maximum)(automatic in-line) Twice daily: oil content (manual sampling) Daily: Total volume of produced water discharged; visual sheen checks

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
	Monitor receiving water quality around the FPSO. Analyse for salinity, pH, temperature, suspended solids, metals (As, Ba, Cd, Cr, Cu, Hg, Pb, Zn), sulphate and hydrocarbons (TPH and PAH).	Annually
FPSO black water (treated sewage), grey water and food waste	Visual observations to check for no floating solids, foam or discolouration of surrounding water.	Daily visual inspections and recording throughout project.
	Monitor compliance of discharge against MARPOL Annex IV discharge standards (residual chlorine content of less than 1 mgl^{-1}	Biannually sampling and analysis throughout project
	Monitor volume of sewerage discharged	Daily monitoring throughout life of project.
	Estimate total quantity of macerated food waste discharged overboard (kg or m^3) based on POB (persons on board)	Daily estimate. Report Monthly
Deck drainage and bilge water from FPSO	Monitor volume (m^3), time and date of discharge, and oil content (mgl^{-1}) in FPSO deck drainage and bilge water discharge (continuous log) and compare against discharge standards (15 ppm oil and grease maximum) including oil content and visual inspection of sea surface.	Continuous: oil in water content (automatic in-line). Daily: volume of water discharged; visual sheen check.
Ballast water from FPSO	Monitor volume (m^3), time and date of discharge, and oil content (mgl^{-1}) in ballast water discharge (continuous log) and compare against discharge standards (15 ppm oil and grease maximum) including oil content and visual inspection of sea surface.	Continuous: oil in water content (automatic in-line). Daily: volume of water discharged; visual sheen check.
Drilling fluids and drill cuttings	Monitor volume (m^3) and type of drilling fluids discharged into the sea, including concentration of oil on cuttings (% by weight on dry cuttings) to compare against discharge standards (no more than 3%).	Daily monitoring during drilling operations.
	Analyse Hg, Cd and As concentration in stock barite.	Composite sample analysed for each new bulk delivery.
	Calculate volume of drill cuttings (m^3) created by each well.	End of well reporting.
Produced Reservoir Sands	Monitor volume (m^3) of reservoir sand (if encountered) discharged and concentration of oil on sand (g/kg) and compare to discharge standards (no more than 10g of oil per kg of dry matter).	As required. Report monthly.

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Offshore Fuel Consumption	FPSO: Gas (MMscf) and marine gas oil (l), use shall be monitored and recorded. MODU and Support Vessels: Marine gas oil (l), use shall be monitored and recorded. Calculation of GHG emissions as per the methodology set out in the API Compendium of Greenhouse Gas Estimation.	Monthly calculation using emission factors. Annual reporting.
Onshore Fuel Consumption	Helicopter: Aviation fuel (l) use shall be monitored and recorded. Fixed Wing: Aviation fuel (l) use shall be monitored and recorded. TGL Vehicles: Diesel (l) and petrol (l) use shall be monitored and recorded. Calculation of GHG emissions as per the methodology set out in the API Compendium of Greenhouse Gas Estimation.	Monthly calculation using emission factors. Annual reporting.
FPSO Fugitive Emissions and venting	Monitor the volume of hydrocarbons used/handled/stored/vented. Calculation of fugitive GHG emissions as per the methodology set out in the API Compendium of Greenhouse Gas Estimation.	Monthly calculation using emission factors. Annual reporting.
Flaring	FPSO and MODU: volumes of gas and hydrocarbons (MMscf) flared shall be monitored and recorded. Calculation of GHG emissions as per the methodology set out in the API Compendium of Greenhouse Gas Estimation.	Monthly calculation using emission factors. Annual reporting.
Impacts to commercial navigation and fisheries from the MODU, FPSO and support vessels.	Continuous monitoring of safety exclusion zone and recording of all vessel interactions between project vessels and other users of the area. Develop and implement a system for inspection and maintenance of navigation, communication and safety equipment. Recording all complaints/ suggestions through the Community Liaison Officer and assign specific remedial actions and responsibilities.	Auditing with Accident Reporting Procedure. Monthly audit of equipment inspection reports. Six monthly review of interaction/grievance records and audit of actions arising throughout project.

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Human resources strategy for creation / transfer of employment opportunities	Monitor employment levels and local staff content against targets for TGL and its contractors.	Quarterly review of HR data and recruitment and organisational development plans.
Stakeholder understanding of the TEN Project	Organise stakeholder consultation and feedback sessions to ensure communities understand the impacts of the project, what actions are on-going and have access to opportunities created by project. Assess community understanding of project.	Quarterly monitoring on-going throughout life of project.
Project Performance Evaluation	Monitor Social Investment project execution targets via assessment meetings attended by beneficiaries and contributors (NGOs, District Assemblies, and TEN Partners).	Quarterly reviews on-going throughout life of project.
Grievance	Monitor levels of complaints through the grievance procedure and track actions taken to resolve complaints	As required in response to complaints and six monthly review of records and audit of actions arising throughout project.
Segregation, storage and transport of wastes	Monitor volumes of hazardous and non-hazardous waste streams generated. Identify for each waste type the quantity of waste recycled or reused, treated, incinerated or sent to landfill	Ongoing throughout life of project. Data collected monthly from waste contractors.
	Inspect waste storage areas on TGL and waste contractor's sites for compliance with project standards. Specifically assess state of containment, bunding, presence of spills, performance of treatment measures, correct segregation, safety systems, transport equipment and systems to ensure that appropriate mitigation and measures are enforced.	Audit of new waste contractors prior to agreeing any formal contracts. Six monthly in first year and thereafter annual audits of facilities that receive project wastes throughout project.
Spills of hazardous materials	FPSO, MODU, and Support Vessels Report and investigate all leaks and spills, including type and quantities of substances spilled and actions a taken.	Ongoing throughout life of project.

10 DECOMMISSIONING AND ABANDONMENT

10.1 INTRODUCTION

At the end of the economic life of the TEN Project the project will be decommissioned to restore the site to a safe condition that minimises potential residual environmental impacts and permits reinstatement of activities such as fishing and unimpeded navigation at the site.

10.2 REGULATIONS AND AUTHORITY

The main current legislation covering oil and gas developments within Ghana is the *Petroleum (Exploration and Production) Law (Act 84 of 1984)*. In relation to decommissioning, operators are required to remove infrastructure no longer required for petroleum production, including the decommissioning and abandonment of all wells at the end of the field's life. The Act further states that all decommissioning works must meet good international practices in comparable circumstances (*ie* similar deepwater FPSO projects).

The Act also requires that a Plan of Development (PoD) for proposed development be submitted and approved by the Petroleum Commission (PC) and the Ministry of Energy prior to field development and that this must include decommissioning requirements. The TEN PoD containing decommissioning requirements has been submitted to the PC.

TGL will adhere to Ghana environmental and marine laws and regulations that are in place at the time of decommissioning including those concerned with environmental protection, pollution prevention, waste disposal and navigational safety at sea. These could include the following:

- *Environmental Assessment Regulations (LI 1652, 1999)*; and
- *Oil in Navigable Waters Act (Act No. 235 of 1964)*.

In addition the requirements of emerging legislation, including the *Petroleum (Exploration and Production) Act* and the *Health Safety and Environment Regulations* for the oil and gas industry will be adhered to.

10.3 INTERNATIONAL CONVENTIONS AND GUIDELINES

There are a number of International Conventions pertaining to the decommissioning of oil and gas projects which cover both the removal of installations (*ie* to remove navigation and fishery hazards) and disposal of wastes (*ie* to prevent pollution).

These are summarised in *Chapter 2* and include the following.

- The UNCLOS, 1982, to which Ghana is a signatory, permits the partial removal of structures provided that IMO criteria are met.

- The IMO Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf in the Exclusive Economic Zone, 1989, stipulate that structures in deep waters can be partially removed as long as there is a minimum of 55 m of clear water for the safety of navigation. Structures weighing less than 4,000 tonnes located in water depths of 100 m or less are required to be removed completely.

- The requirements of the OSPAR Decision 98/3 supersede a number of the 1989 IMO guidelines, requiring that decommissioning will normally remove the whole of the installation with possible exceptions for large structures. Although Ghana is not a signatory to OSPAR, the requirements do provide guidance on good international practices in comparable circumstances as required by the *Petroleum (Exploration and Production) Law.*

- The Basel Convention, 1989 and Bamako Convention, 1998 in relation to the control, movement and disposal of hazardous wastes.

It should be noted that there are currently no international guidelines on the decommissioning of disused pipelines, therefore, good industry practice will be applied at the time of decommissioning.

10.4 APPROVAL PROCESS

TGL will develop a project-specific Decommissioning and Abandonment Plan (DAP) early in the operational life of the project. The plan will be based on national regulations, licence requirements and international standards prevailing at the time. These currently include:

- Government of Ghana, including PC and EPA requirements;
- TEN PoD requirements;
- international laws and conventions to which Ghana is a signatory; and
- industry good practice standards and procedures such as OSPAR decommissioning requirements.

The DAP will include decommissioning methods and procedures for individual components of the TEN facilities and infrastructure and waste management requirements. The plan will address potential environmental and social impacts, as well as health and safety issues identified by a risk assessment. It will also include details on a post-decommissioning survey and monitoring programme (see *Section 10.7.1*).

Planning for decommissioning will be an on-going activity through the life of the TEN Project and will be periodically reviewed.

The DAP will be updated to incorporate:

- any changes in the field development (*eg* additional wells);
- changes to regulatory requirements; and
- new decommissioning techniques developed by the industry.

The GMA and Fisheries Commission will also be consulted by TGL in developing the plan. Any updates over the life of the TEN Project will be provided to these authorities. The final plan will be submitted to the PC, Ministry of Energy and EPA for review and approval two years before closure and prior to commencement of decommissioning activities.

The DAP will be used as the basis for assessing funding requirements to decommission the TEN fields. A decommissioning trust fund will be set up by the TEN Partners with contributions made over an agreed period to cover the full decommissioning costs of the project.

When production at the TEN fields becomes uneconomic and any other opportunities to increase production levels (*eg* introduction of new sources of hydrocarbon production) are not viable, a Cessation of Production (CoP) consent and approval to begin decommissioning will be sought from the PC. The request will include all relevant data required to demonstrate that practical and economic extraction of oil from the field has been achieved.

Once the CoP consent has been received and approval to commence with decommission has been granted, TGL will implement the DAP.

10.5 DECOMMISSIONING METHODS

10.5.1 General Approach

The selection of appropriate decommissioning methods and procedures for individual components of the TEN facilities and infrastructure will take into account a variety of factors including:

- safety;
- environmental impacts;
- technical feasibility,
- complexity and technical risks;
- cost and economics;
- impacts to other sea users; and
- legal compliance.

As stated in *Section 10.4*, the final DAP will be submitted to PC and the Ministry of Energy for review and approval before commencement of decommissioning activities. This will include evaluation of the decommissioning options based on the selection criteria listed above.
At the time of decommissioning, the TEN Project is likely to consist of the following infrastructure:

- FPSO vessel and 9-line mooring line arrangement;
- Oil Offloading Buoy and mooring lines;
- 24 subsea wells (both production and injection wells);
- approximately 100 km of flowlines;
- risers (oil production, water injection, gas export, gas injection/production and gas lift riser);
- manifolds with suction piles; and
- riser bases with suction piles.

The above infrastructure will have a total seafloor footprint of approximately 1 km^2. There may have been subsequent development phases by the time of decommissioning that will increase the footprint. Any scope further development phases would be included in the regularly updated DAP.

TGL will dismantle and remove as much of the infrastructure as practicable given the deep water location, however, as is typical in deep water environments, some infrastructure *eg* flowlines will be flushed, cleaned and then abandoned in place.

10.5.2 Production and Injection Wells

The TEN subsea wells will be decommissioned and abandoned. The purpose of well abandonment is to prevent potential fluid migration after the field has been decommissioned. *Figure 10.1* illustrates a typical decommissioned well, however, well-specific decommissioning requirements will be identified in the DAP. The general well decommissioning and abandonment approach is outlined below.

- Downhole equipment such as tubing in the wells will be removed.

- Residual hydrocarbons in production wells will be displaced with a high density fluid (*ie* weighted brine).

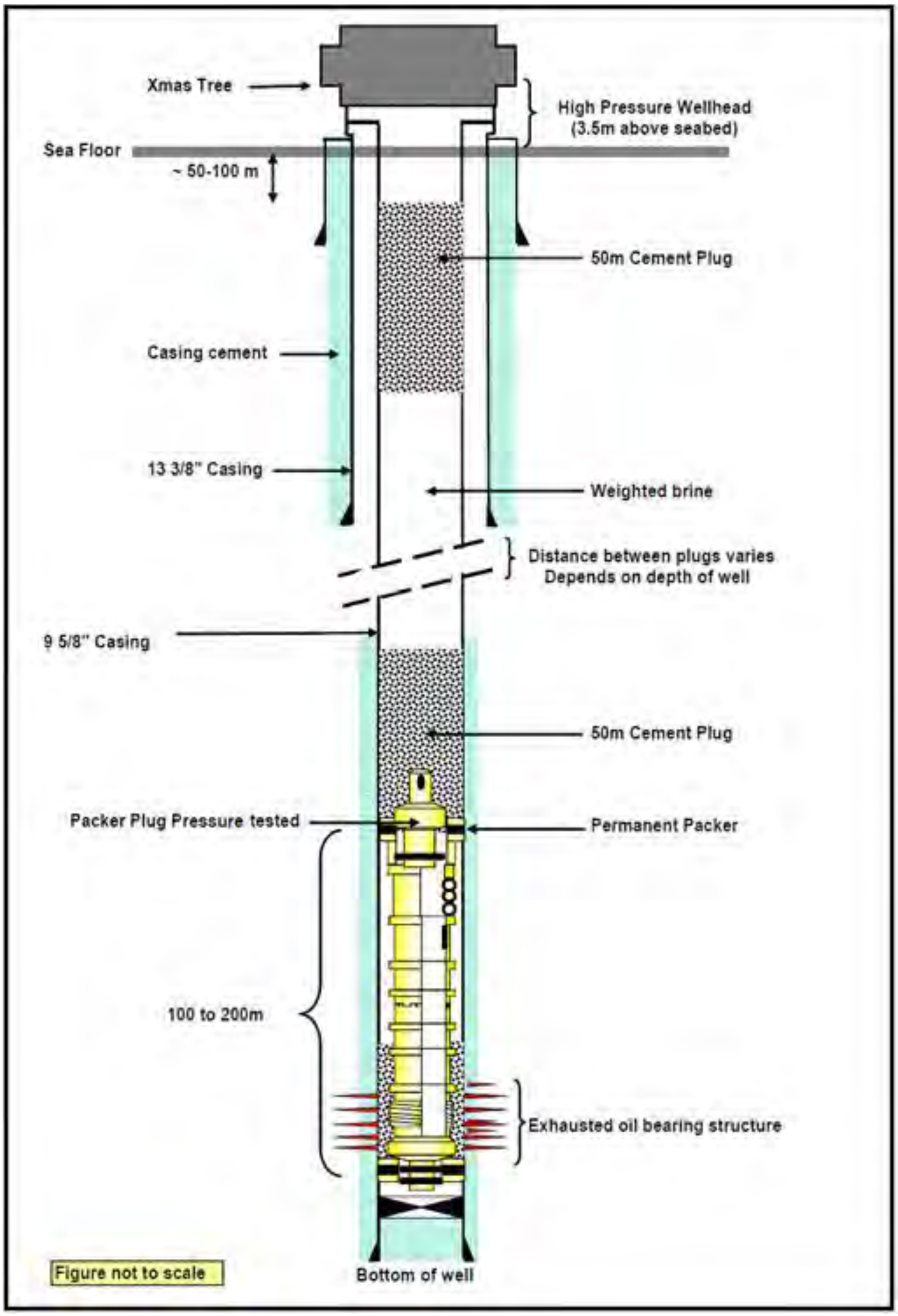
- Wells will be mechanically and/or cement plugged to prevent fluid migration within the wellbore to the overlying formations or seabed.

Each well will be individually abandoned using a drilling vessel or well service vessel depending on requirements. Well abandonment will take approximately 16 days for each well including two days to flush any residual hydrocarbons back to the FPSO.

10.5.3 *Well Heads and Xmas Trees*

Well heads and Xmas trees will be decommissioned by purging the systems of production chemicals and hydrocarbons and abandoned *in situ*.
The wellheads will be in water depths between 1,000 m and 2,000 m and will not pose a hindrance to future fishing or navigation. Well will be plugged, well heads and Xmas trees removed and the casing cut below seabed.

Figure 10.1 Cross-section of Typical Decommissioned Well



Source: TGL 2012

10.5.4 *Subsea Equipment*

Subsea flowlines and manifolds will be purged of hydrocarbons and flushed and abandoned in place, as is typical for deepwater developments. The subsea production and injection risers will be detached from the riser bases, flushed and lowered to the seabed for abandonment. The anoxic conditions at the seabed will reduce further oxidation (rusting) and deterioration of subsea equipment that will be left in place.

Umbilicals will be removed as they are fabricated from various materials including rubber and plastic that are not permitted to be abandoned at sea under UNCLOS 82. The control umbilicals will be flushed and the umbilical risers between the FPSO and the initial subsea termination points will be removed. Infield umbilicals will be hauled to the surface and removed by reel barge.

10.5.5 *FPSO Processing and Storage Facilities*

The decommissioning and removal of the FPSO, including the mooring system, will be completed by the FPSO contractor.

The FPSO production system will be isolated from the decommissioned and abandoned wells and the risers will be disconnected. The topside equipment will be decommissioned at the offshore location and returned to the onshore base for final decommissioning depending on their condition. The processing facilities will be flushed using seawater to displace any residual hydrocarbons and production fluids. The cargo tanks will be flushed by flooding them with seawater and the resulting oily water will be transported to shore for treatment before discharge. Once the production and offloading systems have been confirmed clean, the FPSO will be released from the mooring system. The FPSO's main engine will be re-commissioned so it can sail to a location outside of Ghana.

The lines and chains from the FPSO mooring system will be recovered. The mooring suction piles will be abandoned in place. The piles will protrude approximately 1 m above the seabed in waters approximately 1,000 – 2,000 m deep.

The ultimate decommissioning of the FPSO will depend on its condition at the end of the production life and options available for further use. The FPSO will either be refurbished for use elsewhere or dismantled and components recycled or disposed in accordance with the appropriate local regulations.

10.5.6 *Support Infrastructure*

Onshore facilities at Takoradi Port and Air Force base are currently leased by TGL. These facilities will be handed back to the property owners on completion of the offshore decommissioning activities provided that they will no longer be required for other TGL operations in Ghana. Any improvements to the infrastructure made over the tenure of the project will also be handed over to the owners. Light vehicles, aircraft and support vessels leased to support the project will be demobilised once decommissioning has been finalised.

10.5.7 *Discharges and Waste*

TGL's WMP will be updated to include specific requirements for managing decommissioning waste. Solid hazardous and non-hazardous waste generated during the decommissioning phase will be managed in accordance with TGL's WMP. Although the FPSO contractor will be responsible for decommissioning of the FPSO, TGL will ultimately remain responsible for ensuring that wastes generated from the decommissioning activities are managed in compliance with Ghanaian waste legislation.

Discharges that occur during the decommissioning phase will meet the same discharge criteria that applied to the operational phase of the project. Unused chemicals will be returned to suppliers.

10.6 *POST-DECOMMISSIONING SURVEYS AND REPORTING*

10.6.1 *Post-Decommissioning Surveys*

A post-decommissioning survey and monitoring programme will be developed and implemented by TGL to verify that decommissioning requirements were followed. This programme will include geophysical and environmental surveys.

The geophysical survey will confirm the state of the seabed once all activities have been finalised. A final layout plan will be developed indicating where infrastructure was located and what infrastructure remains on the seabed post decommissioning.

The environmental survey will verify the state of the environment (sediment and water quality) once all decommissioning activities have been completed. The results of the survey will be assessed against data collected during the baseline and operational phase. Unless a particular issue is identified during the surveys, the post-decommissioning sampling programme will only occur once.

10.6.2 *Reporting*

TGL will submit a close-out report to the relevant authorities describing what activities occurred during the decommissioning process and the state of the environment once all activities have ceased.

This report will include:

- the fate of subsea infrastructure, whether recovered or left *in situ*;
- a final layout indicating where subsea infrastructure has been left *in situ;*
- the fate of land-based support facilities (*ie* handover back to owners);
- the fate of the FPSO and infrastructure;
- results of the monitoring programme identifying any issues that may require on-going monitoring; and
- tracking of wastes, including a clear indication of quantity and type treated by each company, whether in Ghana or overseas.

11 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

11.1 OVERVIEW AND SCOPE

11.1.1 Introduction

This chapter describes the provisional Environmental and Social Management Plan (ESMP) for the TEN Project. The elements of this provisional plan will be taken forward and incorporated into a separate TEN Project ESMP that will be used to deliver the project's environmental regulatory compliance objectives and other related commitments.

The TEN Project ESMP is a component of TGL's overall Environmental, Health and Safety Management System (EHSMS). On behalf of the TEN Partners, TGL has been appointed as the TEN Project Operator and is ultimately responsible for the management and supervision of all project activities. The twelve key elements of the EHSMS (see *Section 11.2.3*) will be adopted by TGL throughout the various project stages. These elements will aid TGL achieve consistency in the standards applied across various project components. Contracting parties to TGL will be monitored on their implementation of these key elements in their activities.

This provisional ESMP describes the structure and processes that will be applied to activities to check and monitor compliance and effectiveness of the mitigation measures to which TGL has committed. The TEN Project ESMP will be used to monitor compliance with statutory requirements and corporate environmental and social policies.

With respect to the significant impacts identified by this EIA, the provisional ESMP provides the linkage between each significant impact (see *Chapter 7*), the relevant mitigation measures (see *Chapter 7* and *Chapter 8*) and the monitoring approach (see *Chapter 9*). Through this provisional ESMP significant impacts are referenced to:

- applicable regulatory requirements and other commitments; and
- relevant operational controls (*eg* management best practices, construction and operation specifications, procedures, and work instructions).

11.1.2 Objectives

The objectives of the provisional ESMP are as follows.

- To develop a commitments register to address legal and other requirements.

- To promote environmental and social management and communicate the aims and goals of the ESMP.

- To ensure that all workers, subcontractors and others involved in the project meet legal and other requirements with regard to environmental and social management.

- To incorporate environmental and social management into project design and operating procedures.

- To address concerns and issues raised in the EIA's stakeholder consultation process and those that will likely continue to arise during the project's lifetime.

- To serve as an action plan for managing the significant environmental and social impacts associated with the TEN Project.

- To provide a framework for implementing project environmental and social commitments (*ie* mitigation measures identified in the EIA).

- To prepare and maintain records of project environmental and social performance (*ie* monitoring, audits and non-compliance tracking).

11.1.3 *Scope*

The provisional ESMP is intended to cover those activities described in this EIS. It covers onshore and offshore project activities during drilling, completions, installation, hook-up and commissioning, operations and decommissioning.

The provisional ESMP relates to the significant environmental and social impacts associated with the TEN Project. It should be noted that whilst social mitigation are included within this provisional ESMP, they will also be implemented through a separate set of documentation *eg* the Stakeholder Engagement Plan (SEP) that complement the provisional ESMP. In addition, an 'Issues and Grievances' register will be developed and implemented through CLOs.

The provisional ESMP does not cover activities related to equipment and facility fabrication being done outside of Ghana.

11.2 GENERAL REQUIREMENTS

11.2.1 *Introduction*

Requirements for an ESMP and guidance on scope and application are given in the Ghana environmental regulations. International standards such as those outlined in the IFC's Performance Standards on Environmental and Social Sustainability provide further guidance on the ESMP scope and application. These are summarised below.

11.2.2 *Ghanaian Regulatory Requirements*

Requirements for an ESMP are contained in the *Environmental Assessment Regulations of 1999*. Under Part II, Section 9, a 'provisional environmental management plan' is a required element of an EIS.

In Section 24, the Regulations further require:

(1) The person responsible for an undertaking in respect of which a preliminary environmental report or an environmental impact statement has been approved shall submit to the Agency an environmental management plan in respect of his operations within 18 months of commencement of operations and thereafter every 3 years.

Further:

(3) The environmental management plan shall be a document in such form as shall be determined by the Agency.

(4) The environmental management plan shall set out steps that are intended to be taken to manage any significant environmental impact that may result from the operation of the undertaking.

Consequently, the ESMP considers impacts on the natural environment, the well-being of the people involved in the oil and gas operations (health and safety) and those who the oil and gas operations may affect directly or indirectly (Community issues).

This chapter of the EIS serves to satisfy the requirement for a provisional ESMP. It is henceforth referred to as the 'ESMP'. The ESMP will subsequently be developed into a standalone TEN Project ESMP (as per *Section 24*, Item 1) in the same format as that of the TGL Jubilee Phase 1 Development Environmental and Social Management Plan (TGL-EHSS-PLN-04-0004) and submitted to the EPA for approval.

11.2.3 *TGL Requirements*

TGL has committed to governing the execution of the project following the expectations and operating philosophy of the EHSMS. The 12 key elements of the project EHSMS are presented in *Box 11.1*. The primary document that describes the proposed strategies and systems for managing EHS issues associated with the TEN Project is the EHS Management Plan (00002-TLW-ES-PLN-0001).

During drilling, installation, hook-up and commissioning, environmental and social management will be implemented through the TEN Project ESMP and related documents. From the commencement of operations, the TGL EMS Management Framework (TGL-EHS-PRC-04-0052), certified to the ISO14001:2004 standard, will also be applied to the TEN Project.

Box 11.1 Key Elements of the TGL EHS Management System

1. **Policy & Leadership.** The TEN Partners will establish policy, provide perspective, set expectations and provide the resources for responsible EHS management of the TEN Project.

2. **Risk Management.** Appropriate risk management techniques will be employed throughout the project to protect employees, subcontractors, communities and the environment, and to preserve assets, investor value and the reputation of the TEN Partners. A Safety Case is also being developed for the TEN Project based on UK Offshore Installations (Safety Case) Regulations of 2005. As part of the Safety Case, formal safety assessments (FSAs) are being conducted during the design phase of the project. From these, recommendations are being made for reducing risk both in the design and in the operations phases to 'as low as reasonably practicable' (ALARP).

3. **Facilities Design & Construction.** Sound standards, procedures and management systems will be utilised for facility design, construction, commissioning and startup activities to ensure safety and minimise risk to health and the environment.

4. **Information & Documentation.** Information on the design, configuration and capabilities of processes and facilities and infrastructure, potential environment, health, and safety hazards and legal and regulatory requirements will be documented and maintained, and made readily accessible for review to acceptably manage the risks associated with the development.

5. **Personnel & Competence.** The success of development operations depends on competent people. Effective selection, placement, ongoing assessment and competence of employees and subcontractors executing the development will be ensured. Proven designs will be used and reputable service providers employed.

6. **Operations & Maintenance.** The development will deliver facilities which have effective operating and maintenance procedures and practices in place with reliable safety and control facilities, and competent personnel who consistently execute these procedures and practices. The installation safety case will identify the Safety Critical Elements (SCEs) of the process scheme and ensure that appropriate performance standards for these SCEs are in place and tested at regular intervals; these will be built into the FPSO subcontractors maintenance management system. The strategy is also to keep the topsides in classification society requirements during the operations phase as a further verification step to ensure that the asset is being appropriately maintained by the subcontractor. The FPSO will be classed, as a minimum, by an established classification society. The chosen classification society will use their Guides for Classing which do provide minimum specifications for marine equipment and structures, safety systems, and process areas. The selected FPSO subcontractor has their own well-established maintenance philosophy to meet HSE and operational efficiency targets common to their world-wide operations.

7. **Health & Safety.** The development activities will be conducted in accordance with health and safety standards and practices that are adopted in the international E&P industry. Key Performance Indicators (KPIs) will be established to monitor performance and where possible to benchmark against the rest of the industry.

8. **Environment Protection.** The TEN Partners and their subcontractors will operate in accordance with sound environmental practices and will respect the customary rights, cultural heritage, social values and resource utilisation patterns of the countries where development activities occur. This will include key impact mitigation such as disposal of any produced water in an environmentally acceptable manner to meet prevailing regulatory requirement as a minimum standard, the minimisation of chemical use in all activities, disposal of waste in an appropriate manner, and avoidance of any routine flaring during steady-state production.

9. **Incident Reporting & Investigation.** An incident reporting system will be established to ensure management is notified and that incidents are properly investigated with the goal of preventing recurrence.

10. **Emergency Response.** Emergency Response plans will be developed that reflect the reasonably foreseeable emergency events that could be associated with development activities including oil spill clean-up equipment and resources.

11. **Community Relations & Outreach.** Open and honest communications will be established with the communities impacted by the development to build trust and confidence in the integrity of the Contractors and their parent companies, and their operations. A strong Social Performance framework will be developed and implemented.

12. **Continuous Improvement.** We will establish a process to measure the performance relative to the expectations established in this management system and to ensure that any lessons are learned and communicated to sustain or improve performance as appropriate. Audits include design verification audits, construction site audits (both onshore and offshore), and Pre-start-up Review. EHS is also a core element of the Ready for Operations programme to ensure implementation of the EHS philosophies and objectives.

In the context of accepted international frameworks for quality and environmental management systems the EHSMS process can be summarised as follows (see *Figure 11.1*).

Plan

- Define policies and objectives for environmental and social performance.
- Identify environmental and social impacts and risks of the operations.
- Develop mitigations and operational controls to address impacts and risks.
- Develop a management plan to achieve these objectives.

Do

- Implement management plan.
- Implement mitigations and operational controls.

Check

- Monitor performance against policies and objectives.
- Check that mitigations and operational controls are effective.

Act

- Make corrections to plans, mitigations, or controls in response to performance monitoring or out of control events.

Figure 11.1 Environmental Management Process

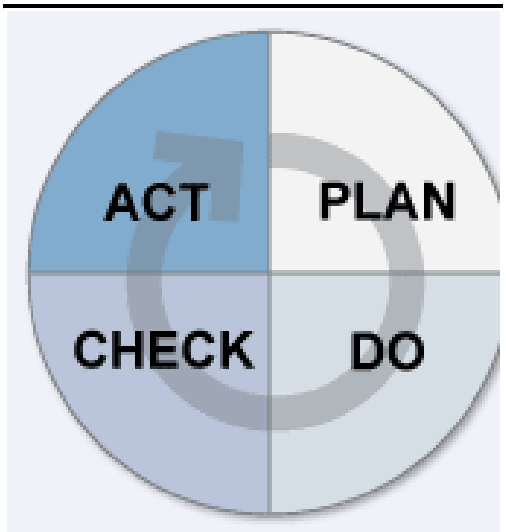


Figure 11.2 and *Figure 11.3* illustrate the hierarchy of EHSMS documentation that is under development for the TEN Project. This will be updated as the various plans and procedures are developed and integrated into the overall EHS and operations management system.

Figure 11.2 EHSMS Documentation Hierarchy: Pre-Operations Phases

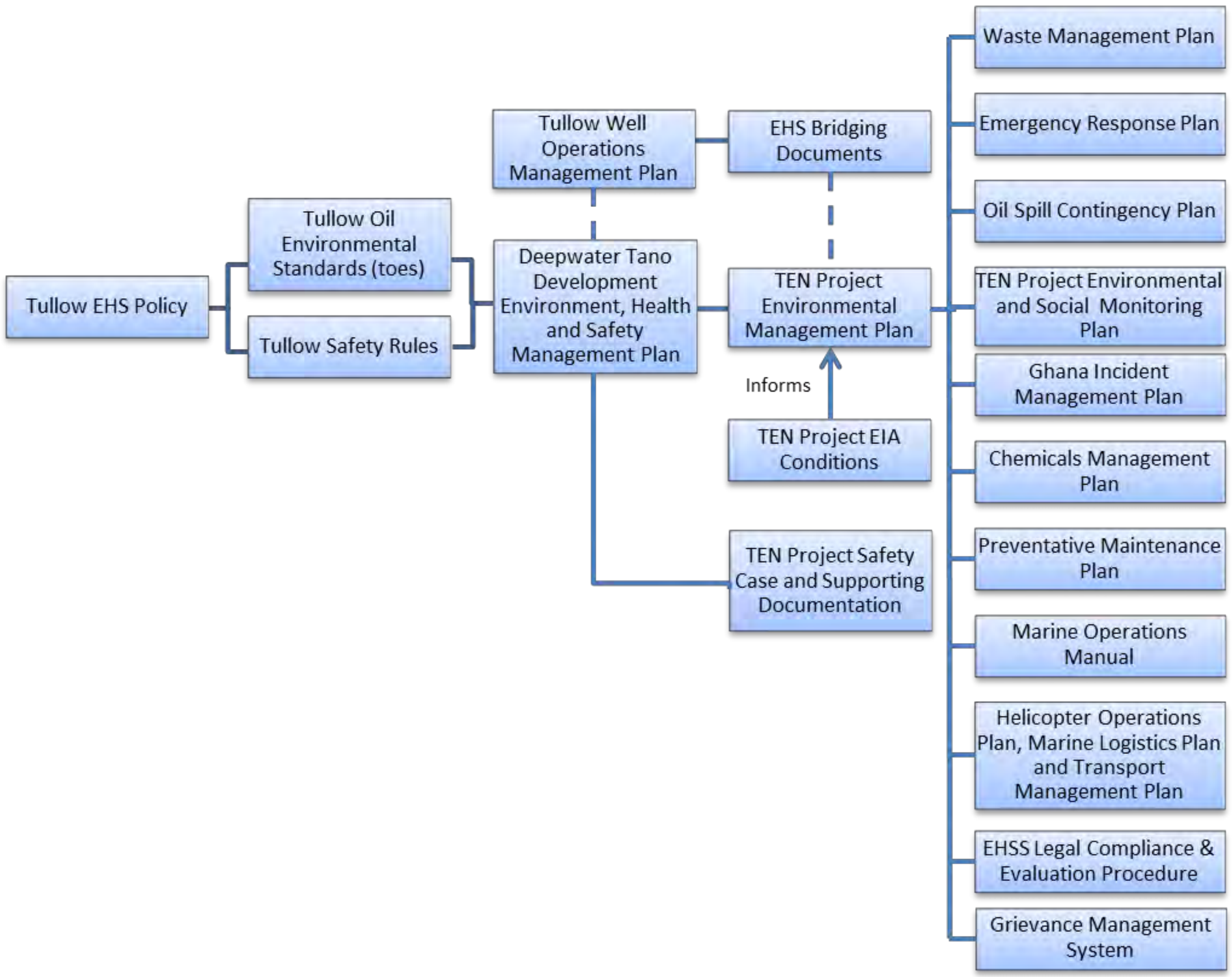
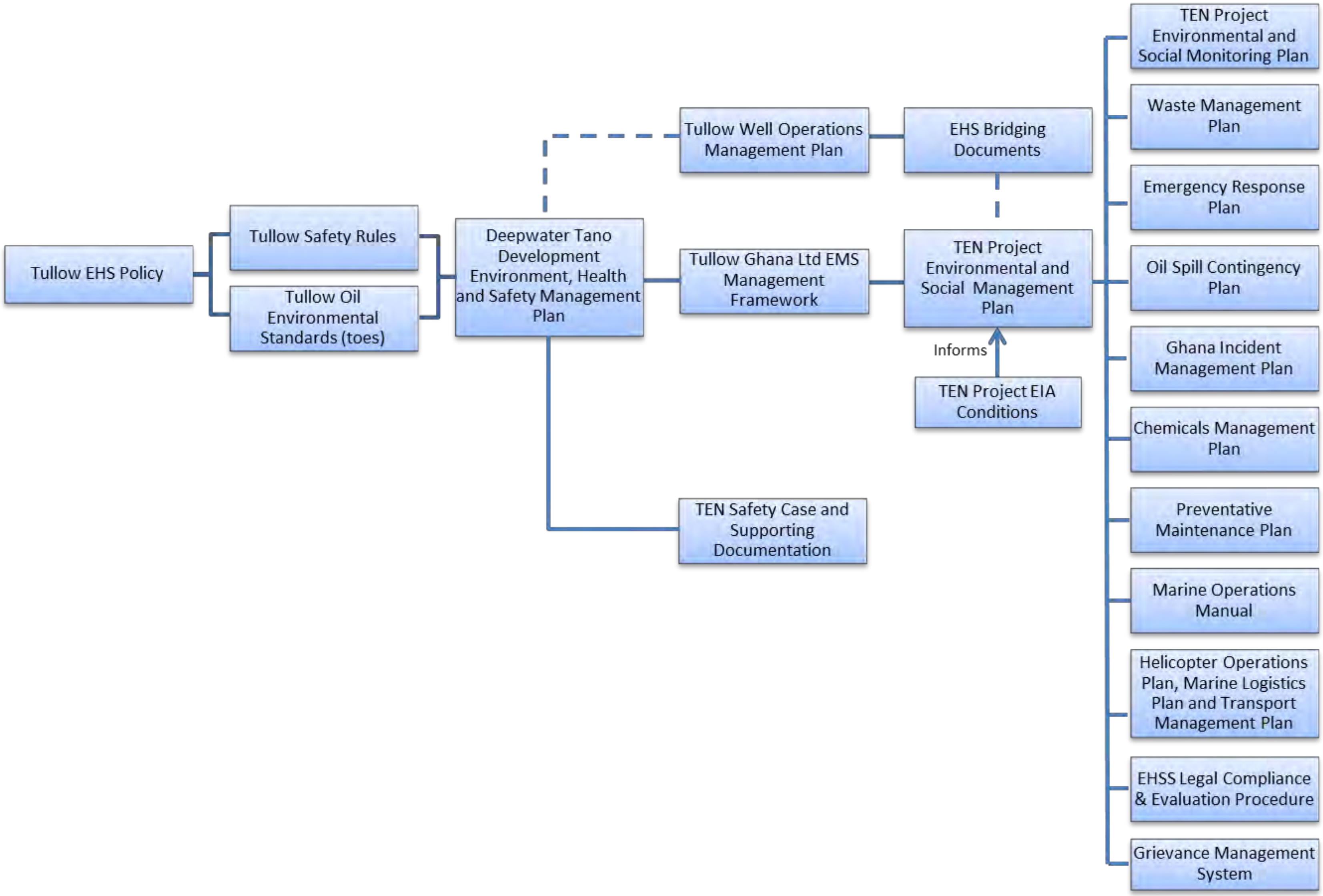


Figure 11.3 EHSMS Documentation Hierarchy: Operations Phase



IFC's Environmental and Social Performance Standard 1 (2012) requires that the environmental and social management system be part of the client's overall management system for the project. It should include the organisational structure, responsibilities, policies, procedures and practices, and resources. Performance Standard 1 underscores the importance of on-going management of environmental and social performance to achieve continuous improvement. The IFC requires that a management system be in place at the level where their investment is utilised. In this case, it is at the level of the project. It requires a plan for implementing the project-specific management programme developed through the environmental and social assessment.

This ESMP is intended to be consistent with the elements and expectations of the project EHSMS. It addresses key elements of the EHSMS including the application of risk management techniques throughout the project to protect the environment and employees, subcontractors and communities. All activities will be subject to an appropriate risk review and assessment, adopting the hierarchy of controls identified in *Chapter 8,* so that risks can be eliminated, mitigated or reduced to ALARP or controlled.

Appropriate plans (including this ESMP), procedures and programs will be implemented during the course of the project to ensure that the key elements of the EHSMS management expectations are met. These will be based on industry best practice and TGL's own company EHS policies and standards, such as the Tullow Oil EHS Policy and Tullow Oil Environmental Standards.

11.3 PLANNING

11.3.1 Impact Assessment

As part of the EHSMS, the project utilises impact assessment as a part of the planning process. Impact assessment has been conducted for drilling activities as well as for the development. The project will continue to use impact assessment as a planning tool for any future development activities including significant changes, additional development phases, expansions, or ancillary projects.

11.3.2 Project Commitments

Through the project development and the EIA process, the project has made commitments to actions to manage or improve environmental and social performance. These commitments are not recommendations; they are binding commitments on the part of the project.

The commitments take a number of forms as summarised in *Box 11.2* with the specific actions intended to address a particular environmental or social issue. The commitments are detailed in tabular form in *Chapter 8*. The commitments are organised by development stage and reference to the EIA, as applicable.

Box 11.2 Types of Commitments

Avoidance
During the planning phases, potential impacts to sensitive resources are identified. Where feasible, locations or processes can be changed during the planning or design phases to avoid impacts to these areas.

Minimisation
Minimisation involves measures to reduce proposed impacts to a resource. Minimisation can include for example, vessels slowing down in the vicinity of marine mammals.

Management
Management commitments include development of plans and procedures for ensuring that measures to protect the environment actually take place and are of the desired standard of practice. Training is another commitment in this category.

Monitoring
Commitments to monitoring are primarily to ensure the above measures are working properly and delivering the desired (and anticipated) results.

Additionality
Additionality involves actions and contributions which are designed to provide a positive benefit. Examples include maximising Ghanaian content in employment, procurement of local goods and services, and dissemination of scientific data.

11.3.3 Management Plans

Provisional Environmental and Social Management Plan

The goal of the provisional ESMP is to ensure full compliance with the project's policies and with mitigation, monitoring and other commitments made in the EIS. It outlines the actions necessary to attain this goal, and describes the means, and designation of responsibility required for compliance and conformance. The provisional ESMP provides the link for implementation of mitigation and monitoring actions described in *Chapter 8* and *Chapter 9*.

Development Environmental and Social Management Plan

TGL will develop a separate TEN Project ESMP which will replace this provisional ESMP. The TEN Project ESMP will be subject to annual review and re-issue, or as required, such as in the event of any significant changes to the project's environmental impacts occur, following the TGL Management of Change process (TGJ-PJM-PRC-07-0006-1). The TEN Project ESMP will be structured as described in *Table 11.1*. The key elements of the TEN Project ESMP will be a series of Environmental and Social Management and Monitoring Tables.

These tables present potential project impacts (*Chapter 7*), the proposed mitigation/management actions (*Chapter 8*) to address them and associated monitoring actions (*Chapter 9*). The tables will be constructed as described in *Table 11.2*. Provisional mitigation and monitoring tables are outlined in *Chapters 8* and *Chapter 9* respectively. These provisional tables include all mitigation and monitoring requirements identified in this EIS and will be further developed and included in the TEN Project ESMP.

The monitoring tables presents specific parameters to be monitored with references provided to plans, procedures and specifications that inform the measurements to be made, monitoring methodologies, frequency and responsible parties. The tables will be constructed as described in *Table 11.3*. Examples of the ESMP tables are provided in *Figure 11.4* and *Figure 11.5*.

Table 11.1 Proposed TEN Project EMP Structure

Section	Contents
1	Introduction
2	Scope
3	Abbreviations and Definitions
4	ESMP Roles and Responsibilities
5	Reference Documents
6	ESMP – Organisation:
6.1	Environmental and Social Impact Mitigation Hierarchy
6.2	EHS and Operational Management Structure
6.3	Contractor EHS Interfacing and Bridging
6.4	Environmental and Social Management and Monitoring Table(s) Construction
6.5	Environmental Reporting Requirements
6.6	Related EHS Management Plans
6.7	Compliance Hierarchy and Framework
6.8	TGL EHS Commitments Database
6.9	EHS Training and Awareness
6.10	Document Organisation
6.11	ESMP and Environmental and Social Monitoring Activity Tables

Table 11.2 Environmental and Social Management Plan Table Construction

Column #	Description
1	Major project activities
2	Corresponding sources of impact
3	Potential consequences (impacts)
4	Specific mitigation measures or management actions
5	EIA reference
6	Applicable mitigation/management timing (project phase)
7	Implementation responsible party
8	Key Performance Indicators (KPIs) and related targets
9	Reference to project plan(s), procedures, specifications, standards

Table 11.3 Environmental Monitoring Table Construction

Column #	Description
1	Major project activities
2	EIA reference
3	Monitoring processes
4	Responsible party
5	Analysis methodology reference
6	Analysis frequency
7	Legal/compliance limit reference

11.3.4 Related Management Plans

The EHSMS also comprises a number of related detailed management plans and procedures that lay out the specifications for compliance with specific environmental and social elements and describes the plans and processes required for carrying out the necessary activities. Project management plans are outlined in *Table 11.4* with information on how these relate to the activities and impacts being discussed in the EIS, including reference to who has lead responsibility.

11.3.5 Subcontractor Environmental and Social Management Plans

The project will engage contractors to carry out various project activities. The contractors are responsible for performing all work:

- in compliance with relevant national and international EHS legislation and regulations, and with other requirements to which the project subscribes;
- in conformance with the TEN Project ESMP and the overall EHSMS; and
- in accordance with contractual technical and quality specifications.

As such the TEN Project ESMP and related EHSMS are the overarching contractual documents to which subcontractor environmental and social management documentation will be bridged to. Each subcontractor will be required to develop its own specific management plans demonstrating how they intend to comply with the stipulated requirements. Subcontractor plans will be reviewed and approved by TGL.

Figure 11.4 Example TEN Project ESMP Table (Extract from Existing Jubilee ESMP)

Ref #	Project Activity	Impact Source/ Environmental Aspect	Impact /Aspect Consequence	Impact/Aspect Mitigation or Management Action	EIA Reference	Timing/Project Phase	Responsible Party	KPIs and Related Targets	Applicable Document Reference(s)
SECTION #1: PROJECT FOOTPRINT......									
1.01	Jubilee Field/FPSO commissioning and operational activities	Disposal of solid waste materials to the sea (kitchen waste, sewage etc.)	- impacts on marine fauna as a result of marine debris settling through the water column Settling of waste on seabed Entanglement of macro fauna in inorganic waste	Development of Waste Management Plans to minimise the chance of accidentally losing items overboard Compliance with MARPOL 73/78 Annex V – requirements for discharging waste to the ocean Macerate organic waste to achieve particle size < 25 mm No inorganic waste to be discharged	Sect. 5.2.1	All project phases	IPT (Design Engineering Team), MODEC (OIM) and TGL Operations Manager	< 25 mm maximum particle size No inorganic waste to be discharged and no floating solids	Waste Management Plan (WMP) EMP
1.02	Jubilee Field/FPSO commissioning and operational activities	Installation, operation and maintenance of the FPSO operational subsea infrastructure structure (wells, christmas trees, manifolds, umbilicals, risers et al) and associated sea bed/sea surface activities	- short-term disturbance of the seabed (e.g. from sediment suspension) with secondary impacts on the benthic and demersal community e.g. smothering - permanent habitat and associated	Pre installation side scan sonar and ROV surveys will determine if there are significant seabed features that should be avoided where possible, such as channels. The layout of the subsea infrastructure will be designed to avoid seabed	Sect. 5.2.2	Drilling, design, planning. engineering, Installation and HUC	IPT (Design Engineering Team), TGL Operations Manager	EIA (recorded baseline conditions)	Project BoD Project Geophysical and Geotechnical Report(s) EMP

Source: Jubilee Phase 1 Development EMP

Figure 11.5 Example TEN Project ESMP Monitoring Table (Extract from Existing Jubilee ESMP)

Ref #	Project Activity	EIA Reference	In-situ Monitoring or Sampling Methodology	Responsible Party	Analysis Methodology Reference	Analysis Frequency	Legal Limit and/or Compliance Reference
SECTION #1: PROJECT FOOTPRINT RELATED......							
1.01	FPSO construction, commissioning and operational activities (discharge of solid kitchen/sewage waste)	Sect. 5.2.1	Observation	Environment Team	N.A.	Per batch (daily)	MARPOL max. particle size < 25 mm pre-discharge No floating solids/foam post-discharge
1.02	FPSO construction, commissioning and operational activities (presence of subsea operational systems)	Sect. 5.2.2	Grab sampling (various) – sea bed, water column and surface water	Environment Team	Various	Annually	EIA (recorded baseline conditions)
1.03	Drilling process and associated activities (discharge of NADF/cuttings)	Annex B.	Grab sampling (batch)	Environment Team	1. WBDF/NADF bio-toxicity analysis 2. Barium Sulphate (barite) assay 3. Oil on cuttings 4. Volume (m^3) discharged	1. Batch 2. Batch 3. Daily 4. Daily	IFC/EIA 1. Lowest toxicity alternative (group III) – limitations on Hg/Cd concentrations 2. Lowest toxicity alternative 3. < 5% (weighted average)
SECTION #2: OPERATIONAL DISCHARGES.....							
2.01	FPSO construction, commissioning and operational activities (Black water discharge)	Sect. 5.3.3	Grab sampling	Environment Team		Weekly	MARPOL/EIA: No floating solids; No discolouration of surrounding waters
2.02	FPSO construction, commissioning and operational activities (Deck drainage and bilge water	Sect. 5.3.4	In-line sampler	Environment Team	Oil in water concentration	Daily	15 mg/dm^3 oil/grease maximum limit

Source: Jubilee Phase 1 Development EMP

Thus the TEN Project ESMP will be implemented and controlled using the management systems of both TGL and appointed contractors, with the former being the controlling instrument. The company/contractor management systems (plus any related 'bridging' documentation):

- provide the framework that regulates the EHS activities both on location and at the shore/beach support bases;
- define responsibilities and reporting relationships for expediting, mitigation and monitoring actions detailed in the ESMP; and
- specify the mechanisms for inspecting and auditing to ensure that the agreed actions are implemented.

It should also be noted that contractors must also provide documentation detailing their plans for:

- ensuring compliance with the EPA environmental permit conditions;
- local content;
- logistics; and
- managing and expediting community relations.

Contractors will be required to self-monitor against their plan and the contractor's compliance with the plan will be routinely monitored by TGL directly or by third-parties. Contractors will be required to submit regular reports of monitoring activities for review by TGL. An external assurance process will be conducted on an annual basis, the results of which will be disclosed at completion of the process.

Table 11.4 TEN ESMP Hierarchy of Key Plans

Plan Name	Includes	Plan Owner
TEN Project ESMP	Overarching plan linking all the other plans to the project EHSMS	EHS Manager
TEN Project Environmental Monitoring Plan	Seabed monitoring, routine effluent and discharge monitoring and Marine Mammal Observation Programme	EHS Manager
Waste Management Plan	Project-related waste handling procedures for hazardous and non-hazardous solid wastes. Including chemical handling procedure and drilled cuttings and fluid disposal methods and procedures.	EHS Manager
Emergency Response Plan	Accident and Incident Investigation and EHS Statistics Reporting Procedure and supporting training manual. Investigation process to determine accident root cause and feedback for process improvement or prevention.	EHS Manager
Oil Spill Contingency Plan	Spill preventative measures and spill response procedure	EHS Manager
Helicopter Operations Plan, Marine Logistics Plan and Transport Management Plan	Transport risk assessment, water transport routes, overland routes, air routes, transport rules	Supply Chain Manager / Base and Logistics Manager
Preventative Maintenance Plan	Maintenance procedures and description of the maintenance management system.	Production Operations Manager
Marine Operations Plan	Tanker Vetting Procedure, Cargo Transfer Procedure & Fuel Oil Transfer Procedure. Ballast Water Management Procedure.	Asset Manager
Social Performance Plan	Social Performance and Social Investment Programme	Corporate Affairs Manager/Social Performance Manager
Stakeholder Engagement Plan	Addressing interactions with community and other stakeholders, and the grievance procedure.	Corporate Affairs Manager/Social Performance Manager
Local Content Plan	To define a strategy/plan that maximises Ghanaian goods and services on the project.	Contracts and Procurement Manager
Human Resources Strategy and Plans	Local hiring, training and procurement programme and procedures.	Human Resources Manager
Security Management Plan	Training of security near FPSO in Voluntary Principles on Security and Human Rights	EHS Manager/ Security Manager

11.4 IMPLEMENTATION

11.4.1 *Environmental and Social Management Organisation*

TGL is committed to provide resources essential to the implementation and control of the ESMP. Resources include the appropriate human resources and specialised skills. As a contractual requirement, contractors are required to provide sufficient resources to manage the EHS aspects of their work. This includes providing adequate resources to monitor compliance of their subcontractors.

On behalf of the TEN Partners, TGL has been appointed as the TEN Project Operator and is ultimately responsible for the management and supervision of all project activities. TGL has a Safety, Sustainability and External Affairs (SSEA) department which has responsibility for both EHS and Social Performance with dedicated staff, competent on the basis of appropriate education, training and experience. The TGL structure for EHS management, relevant to the TEN Project is illustrated in *Figures 11.6* and *11.7* and further information is provided in *Table 11.5.*

The TGL SSEA department will be headquartered in Accra, where staff overseeing commissioning and operations will be located. Staff will also be located in Takoradi to facilitate EHS and social performance oversight of site activities as well as to allow direct interface and access for stakeholders in the Western Region. These functions will manage the successful implementation of the ESMP and the continuation of the stakeholder consultation process. During commissioning and operations, EHS staff will also be located offshore.

Supervision of contractor activities will be conducted by the relevant TGL technical team. This will be accomplished through management controls over strategic project aspects and interaction with contractor staff where project activities take place. *Figure 11.8* provides an indication of the expected interfaces between TGL and the key subcontractors throughout the project.

Figure 11.6 *TGL EHS Organisation*

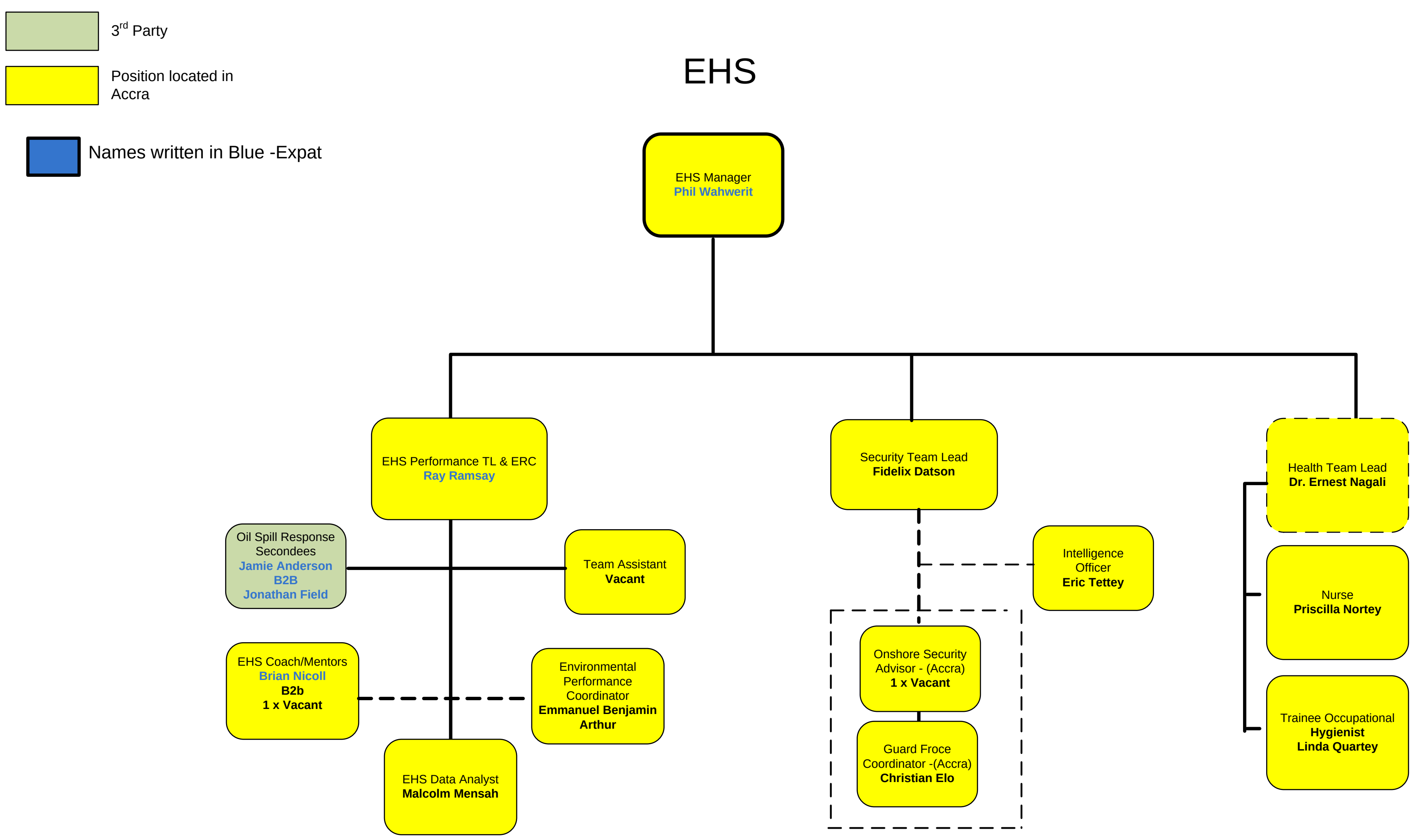


Figure 11.7 TGL EHS Organisation (continued)

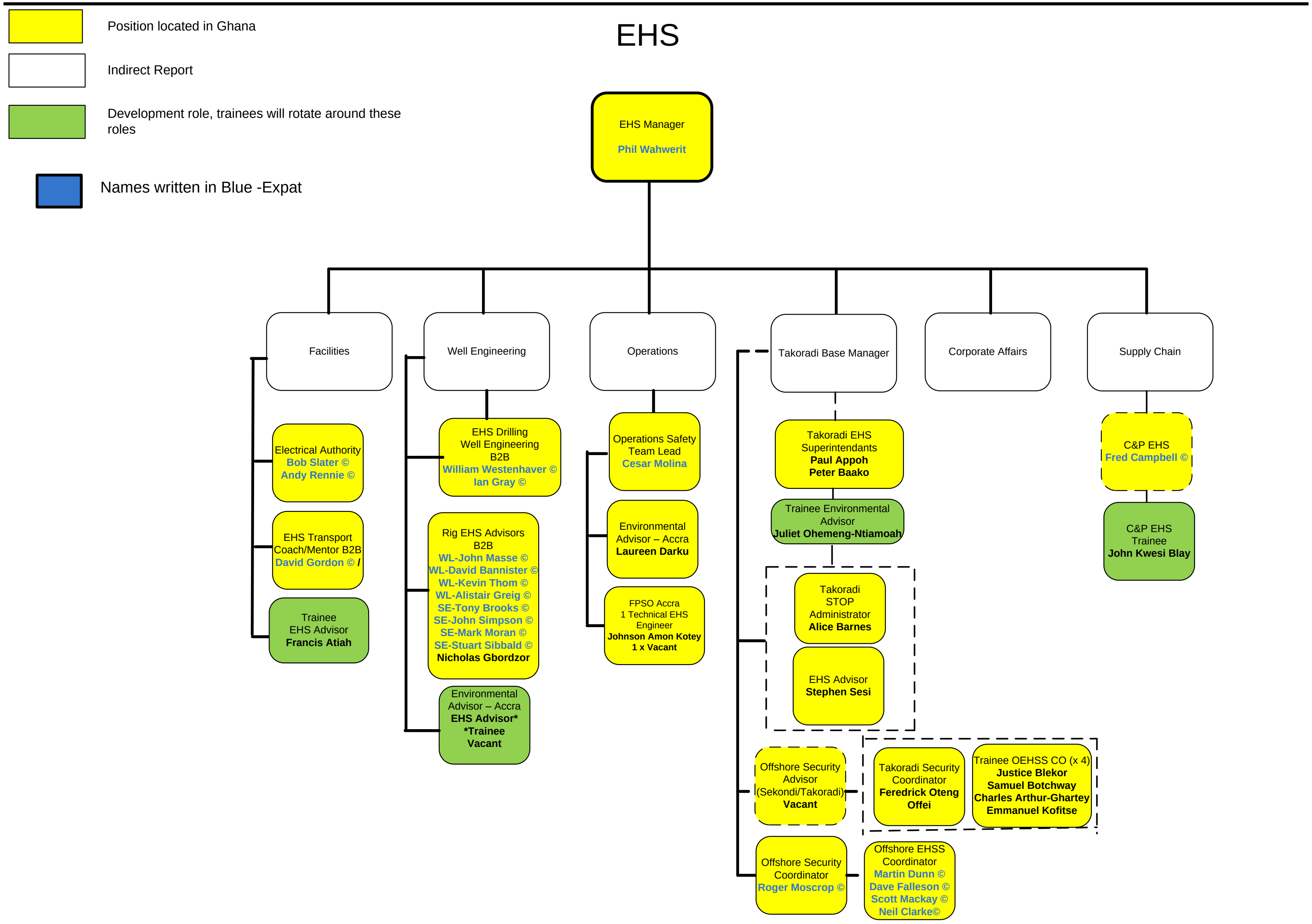
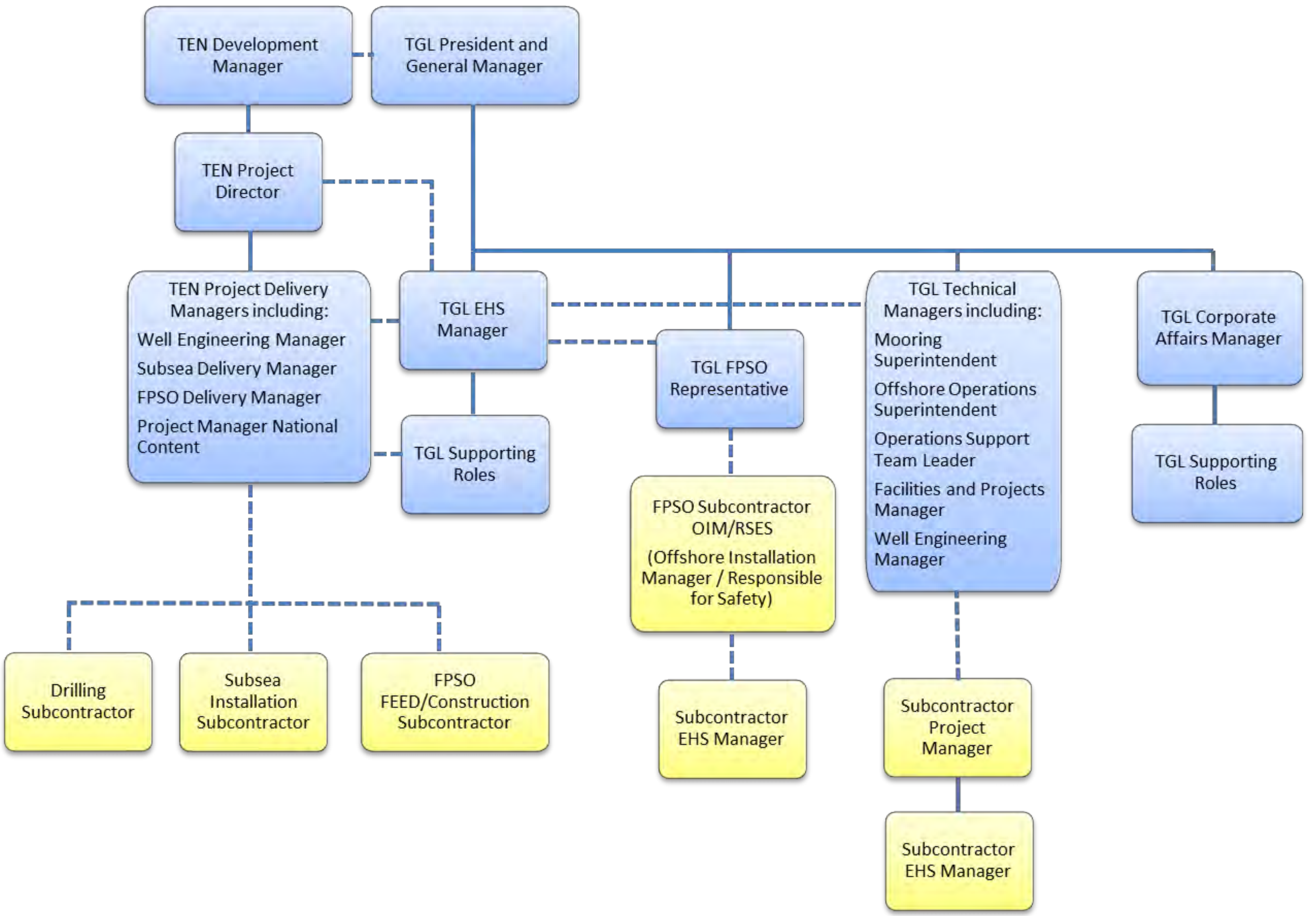


Table 11.5 Environmental and Social Management Organisation Roles and Responsibilities

Position	Responsibility
TEN Project Team	
EHS Manager	• Oversee and coordinate all activities pertaining to the EHS aspects of the project. • Ensure delivery asset EHS and operational targets. • Ensure that the project and subcontractors operate in accordance with applicable regulatory environment, health and safety requirements and plans. • Responsible for the execution of Emergency Response Plan execution including Oil Spill Contingency Planning aspects therein. • Ensure effective communication with all stakeholders. • Provide the necessary resources (financial, manpower *etc*) to successfully implement and complete the proposed EHS management controls and initiatives.
EHS Performance Team Leader	• Provide on-going oversight of the implementation of the proposed environmental and social protection and management measures • Assist with technical input into the proposed project EHS management controls and initiatives including project related oil spill response requirements.
Technical Managers including: Production Operations Manager Project & Facilities Manager Well Engineering Manager	• Technical aspects of the project including subcontractor supervision.
Environmental Performance Coordinator	• Support the ESMP at the operational level. • Perform monitoring and data collection and analysis duties were directed. • Liaise with FPSO and shore base operational management and personnel to ensure that duties and commitments in support of this ESMP are expedited efficiently and in a timely manner.
Corporate Affairs Manager /Social Performance Manager	• Liaise with government regulators and other stakeholders including the public on the project's behalf. • Responsible for the implementation of the Social Performance strategy and stakeholder engagement plan including grievance procedure. • Employment/deployment of Community Liaison Officers.
Subcontractor	
Project Manager	• Responsible for subcontractor technical performance and EHS compliance.
EHS Manager	• Ensure that environment, health and safety regulatory requirements are met and that EMP requirements are properly implemented and in a timely manner • Ensure that all EHS reporting requirements stipulated by TGL, and all/any EHS bridging requirements are met in a timely manner. • Ensure TGL's participation in all FPSO EHS related meetings.

Figure 11.8 *EHS Organisation Key Contractor Relationships*



11.4.2 *Training and Awareness*

TGL will identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environment or social conditions. The project recognises that it is important that employees at each relevant function and level are aware of the project's environmental and social policy; potential impacts of their activities; and roles and responsibilities in achieving conformance with the policy and procedures.

Training and awareness (raising) therefore forms a key element of both EHS/operational control and the expediting of this provisional ESMP. Key staff will, therefore, be appropriately trained in key areas of EHS management and operational control with core skills and competencies being validated on an on-going basis.

The identification of training and awareness requirements and expediting of the identified training/awareness events will be the responsibility of the TGL Human Resources (HR) department with input from relevant departments (including the FPSO management). Similarly, the key FPSO contractor will also implement a similar training and awareness programme strategy for FPSO operational and management personnel.

A training and awareness gap analysis will be performed for each key member of staff and a training and awareness matrix will be constituted as a method of managing and expediting the identified requirements. These requirements shall also be reviewed for efficacy on an on-going basis.

Training will include awareness and competency with respect to:

- environmental and social impacts that could potentially arise from project activities;
- necessity of conforming to the requirements of the EIA and ESMP, in order to avoid or reduce those impacts; and
- roles and responsibilities to achieve that conformity, including with regard to change management and emergency response.

Specific environmental and social impact and EHS related training will be offered to improve the environmental and social performance of the company and affiliates. Examples of training events which will be undertaken include:

- EHS induction programme for all incoming personnel including visitors;
- OSCP (oil spill contingency plan) training courses;
- offshore marine mammal observation courses;
- EIA/ESMP training; and
- Community Oil Spill Awareness training

Subcontractors engaged during the pre-Operations phase of the development will be responsible for the training and awareness of their staff. As a minimum it is expected that this will cover the environmental and social setting within which the work is carried out; the potential environmental and social impacts of their work activities; the management and mitigation measures to address these; and the existence of, and importance of complying with, the TEN Project ESMP.

11.4.3 Communication

TGL will maintain a formal procedure for communications with the regulatory authorities through its Stakeholder Engagement Plan (SEP) which will be applicable to all TGL's operations in Ghana. The Corporate Affairs Manager is responsible for communication of EHS issues to and from regulatory authorities. This is coordinated with the project's Communications and External Relations Manager. The Project Director will be kept informed of such communications. Pertinent information arising from such interactions will be communicated to subcontractors through the EHS Manager.

Whereas it is anticipated that the subcontractor EHS staff may interact with representatives from regulatory authorities on an informal, day-to-day basis regarding routine matters, the EHS Manager shall be the point of contact for formal communications. The EHS Manager will be responsible for communicating any pertinent information arising from such discussions to appropriate subcontractor through the technical department.

Meetings will be held, as required, between the TGL SSEA department and the appropriate regulatory agency and community representatives to review EHS performance, areas of concern and emerging issues. Dealings will be transparent and stakeholders will have access to personnel and information to address concerns raised. The entire project organisation will be open to Ghana Government review and audit.

The Corporate Affairs/Social Performance Manager is responsible for communications with the public and with public stakeholder organisations (see *Section 11.8*). Communications and community relations will follow formal written procedures to document these communications.

With regard to EHS issues, the Corporate Affairs Manager/Social Performance Manager is responsible for facilitating dissemination of information necessary to mitigate impacts through coordinating public notifications (*eg* meetings, media announcements, written postings) and through stakeholder interaction.

The project will maintain a written register of stakeholder interactions in line with the SEP to effectively track communications so that commitments made to follow up actions can be tracked and implemented. This includes grievances that are tracked through the formal grievance procedure (see *Section 11.9*) which will be administered by the Social Performance Manager.

11.4.4 *Documentation*

TGL will control EHS documentation, including management plans; associated procedures; and checklists, forms and reports, through a formal procedure. The document control procedure will describe the processes that the project will employ for official communication of both hardcopy and electronic documents. In addition, it will describe the requirement for electronic filing and posting and for assignment of a document tracking and control numbers (including revision codes).

During operations, the EHS Manager will be responsible for maintaining a master listing of applicable EHS documents and making sure that this list is communicated to the appropriate parties. The EHS Manager will be responsible for providing notice to the affected parties of changes or revisions to documents, for issuing revised copies and for checking that the information is communicated within that party's organisation appropriately. During the pre-operations phase of the TEN Project, this role will be undertaken by the TEN Project Document Control Team.

Subcontractors will be required to develop a system for maintaining and controlling their own EHS documentation and describe these systems in their respective EHS plans.

11.4.5 *Operational Control Procedures*

Each potentially significant impact identified in the EIA will have an operational control associated with it that specifies appropriate procedures, work instructions, best management practices, roles, responsibilities, authorities, monitoring, measurement and record keeping for avoiding or reducing impacts. Operational controls are monitored for compliance and effectiveness on a regular basis through a monitoring and auditing procedure described in the TEN Project ESMP.

Operational control procedures will be reviewed and, where appropriate, amended to include instructions for planning and minimising impacts, or to at least reference relevant documents that address impact avoidance and mitigation. To be comprehensive, suitable, adequate, and effective, the EHSMS will ensure that operational controls for avoiding and minimising impacts are properly maintained for the project's life-cycle.

11.4.6 *Emergency Preparedness and Response*

TGL has developed plans and procedures to identify the potential for and response to environmental accidents and health and safety emergency situations and for preventing and mitigating potentially adverse environmental and social impacts that may be associated with them.

These include the following plans.

- Oil Spill Contingency Plan (TGL-EHS-PLN-04-0010).
- Civil Crisis Plan (TGL-EHS-PLN-04-0001).
- Ghana Incident Management Plan (TGL-EHS-PLN-04-0003).
- Business Continuity Plan (Currently Unreferenced).

Emergency preparedness and response will be reviewed by TGL at least annually and after any accidents or emergencies to ensure that lessons learnt inform continuous improvement. Emergency exercises will be undertaken regularly to confirm the adequacy of response strategies. Investigations of accidents or incidents will follow formal documented procedures.

11.4.7 Management of Change

Changes in the project may occur due to unanticipated situations. Adaptive changes may also occur during the course of final design, commissioning or even operations. The TGL Management of Change process (TGJ-PJM-PRC-07-0006-1) will be used to manage changes including, but not limited to:

- facility, plant and equipment modification;
- design change and design development;
- procedural and activity changes; and
- organisational and operational change.

The objective of the procedure is to ensure that the impact of changes on health and safety of personnel, plant and equipment and the environment are identified and assessed prior to changes being implemented. The management of change procedure will ensure that the following requirements are met.

- Proposed changes have a sound technical, safety, environmental, and commercial justification.

- Changes are reviewed by competent personnel and the impact of changes is reflected in documentation, including operating procedures and drawings.

- Hazards resulting from changes that alter the conditions assessed in the EIA have been identified and assessed and the impact(s) of changes do not adversely affect the management of health, safety or the environment.

- Changes are communicated to personnel who are provided with the necessary skills, via training, to effectively implement changes.

- The appropriate person is designated responsibility for the change.

11.5 *CHECKING AND CORRECTIVE ACTION*

11.5.1 *Introduction*

Checking includes inspections, monitoring and audits to confirm proper implementation of EHS systems as well as effectiveness of mitigations. Corrective actions include response to out-of-control situations, non-compliances, and non-conformances. Actions also include those intended to improve performance.

11.5.2 *Inspection*

EHS inspections will be conducted by subcontractors on a daily basis. The results of the inspection and monitoring activities will be reported to TGL on a weekly basis or more frequently if requested by the EHS Manager or the technical managers responsible for operational activity. Examples include daily operations and drilling reports which will feedback on any incidents and the status of pro-active EHS work and activities.

11.5.3 *Monitoring*

Monitoring will be conducted to ensure compliance with regulatory requirements as well as to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts.

With respect to the impacts identified in the EIA, TGL has developed a programme to monitor the effectiveness of the mitigation measures (*Chapter 9*). The programme describes what effect is to be measured and the frequency.

In conjunction with monitoring of the effectiveness of specific mitigation measures, TGL has developed a programme to monitor for compliance with relevant regulatory standards. This programme also ensures that subcontractors are meeting contractual obligations with respect to work practices and design specifications. Monitoring is carried out by the TGL EHS department and/or by subcontractors under contractual obligations. Provisional monitoring tables including parameters to be measured along with the frequency of monitoring are provided in *Chapter 9*.

11.5.4 *Auditing*

Beyond the routine inspection and monitoring activities conducted, audits will be carried out internally by both TGL and its Partners (including the Government of Ghana) to ensure compliance with regulatory requirements as well as their own EHS standards and policies. Audits to be conducted will also cover the subcontractor self-reported monitoring and inspection activities. The audit shall be performed by qualified staff, in line with the EHSS Audit Process (TGL-EHS-PRC-04-0040), and the results will be communicated to the TEN Asset Managers and related executive management.

The audit programme will include a review of compliance with the requirements of the EIA and of this provisional ESMP and include, at minimum, the following:

- completeness of EHS documentation, including planning documents and inspection records;
- conformance with monitoring requirements;
- efficacy of activities to address any non-conformance with monitoring requirements; and
- training activities and record keeping.

There will be a cycle of audits into specific areas of the project such as waste management, and effectiveness of local content plans and discharge controls. The frequency of audits will be risk based and will vary with the stage of the project (more frequent in the early stages of the project) and will depend on the results of previous audits. Audits will be scheduled on using the Integrated EHSS Audit Plan (TGL-EHS-PLN-04-0013).

11.5.5 Corrective Action

Identifying potential impacts, hazards and risks is an important part of the EHSMS approach. Equally important is the investigation of 'near miss' or accidents/incidents so that valuable lessons and information can be learnt and used to prevent similar or more serious occurrences in the future.

The Incident Investigation and EHS Statistics Reporting Procedure (T-EHS-PRO-0008) supported by the Incident Investigation Training Manual (T-EHS-GUD-0003) will be used for investigating cause and identifying corrective actions in response to accidents or environmental or social non-compliances. TGL will also implement a formal system of non-conformance reports to record non-conformance issues identified during audits or inspections.

TGL's Action Tracking Database will be used to ensure coordinated action between TGL and its Partners, and also all subcontractors, and to ensure that all corrective actions are addressed in a timely manner and closed-out. The TGL EHS Manager will be responsible for keeping records of corrective actions and for overseeing the modification of environmental or social protection procedures and/or training programs to avoid repetition of non-conformances and non-compliances.

11.5.6 Reporting

Throughout the project, TGL will keep regulatory authorities informed of the project performance with respect to EHS matters by way of written status reports and face-to-face meetings. TGL will prepare a monthly report on environmental performance and submit it to Ghana EPA. Copies may be made available to other interested authorities upon agreement with Ghana EPA. For social performance activities, TGL will submit quarterly reports to the six District Assemblies and the Regional Coordinating Council in Takoradi.

TGL will release corporate annual reports on environmental and social performance which will be available to the public via Tullow Oil's website. The content will be determined with consideration of national requirements and lender requirements.

In addition to regular reporting, official notification shall be made to the government for any of the following:

- significant modifications to the ESMP;
- significant design, routing or implementation changes;
- results of environmental monitoring;
- community incidents; and
- safety incidents or accidents.

TGL will make accessible to government authorities, or provide upon request appropriate documentation of EHS related activities, including internal inspection records, training records, and reports. External monitoring reports will also be publicly disclosed annually.

Subcontractors are also required to provide EHS performance reporting to TGL on a regular basis through weekly and monthly reports. This will be used as input to the above.

11.6 COST ESTIMATES AND SCHEDULES

Cost estimates and schedules for implementing the core environmental and social management plans will be included in the final TEN Project ESMP that will be submitted to the EPA for approval. The management plans that are required during the FPSO production operations phase will be submitted to the EPA for approval as they are developed during 2014 and 2015 as part of the production operations permitting process.

11.7 COMMUNITY DEVELOPMENT

TGL, as Operator, has developed a Social Performance framework, comprising the following components:

- Vision, Values, Strategy;
- Strategic Focus Areas;
- Planning;

- Implementation;
- Communication and Consultation; and
- Monitoring and Evaluation.

Key elements of the Social Performance framework are outlined below.

11.7.1 *Vision, Values and Strategy*

The vision is for the development of the oil and gas business in Ghana in a way that is both profitable and delivers sustainable growth in the long term. Its vision is to be the leading exploration and production partnership in Ghana, committed to supporting the socio-economic development of Ghana for the life of the project.

Its Social Performance values are as follows.

- To respect the people of Ghana and its socio-cultural diversity.
- To contribute to and support local communities.
- To ensure environmental sustainability.
- To value and foster long-term relationships.
- To be transparent in our activities and reporting.

The core elements of its social performance approach are as follows.

- Adopt a precautionary, long-term sustainable approach.
- Promote an effective community-inclusive approach in planning and execution of our social performance programme and projects.
- Partner effectively with local communities, Traditional Authorities, District Assemblies, NGOs and Development Partners.
- Use internationally recognised practices to manage potential impacts on the environment.
- Invest in people and resource governance.

11.7.2 *Strategic Focus Areas*

The TEN Project Social Investment (SI) focusses on the following four key areas.

- **Health:** to promote and foster wellbeing of the impacted communities.

- **Education and Capacity Building:** to improve the educational standards, especially in vocational training.

- **Environment:** to maintain efficient resource governance to ensure sustainability of the limited resources at the community level.

- **Enterprise Development:** to encourage diverse programs and initiatives that will create jobs, skills and enterprises

11.7.3 Planning and Implementation

Planning for SI programmes and projects delivery will involve the following three distinct stages.

- Project Identification.
- Preparation and design.
- Appraisal and selection.

Each stage will follow a transparent and open process designed to deliver best socio-economic value to stakeholder communities. SI programme implementation will address planning, budget preparation, project execution, monitoring and evaluation.

11.7.4 Consultation and Communication

Effective SI programmes/projects will take account of the socio-cultural, administrative and indigenous governance systems in the affected communities. Historically, local communities have managed their land and resources through their chieftaincies.

11.7.5 Monitoring and Evaluation

Monitoring and evaluation of the SI programme and project delivery will be a continuous activity which allows TGL to identify possible changes required in subsequent stages in the SI programme implementation process. This will allow TGL to correct any deviations that may have arisen between what was intended and what has actually been delivered by a specific project, and it will be part of the learning process in engaging Ghana in delivering the SI programmes.

The monitoring and evaluation process will allow the project to assess the effectiveness of SI activities and their economic, social, health and environmental impacts in the target population.

11.8 *ON-GOING STAKEHOLDER ENGAGEMENT*

TGL will develop an SEP including stakeholder consultation strategies to provide on-going engagement through project implementation to decommissioning. Building relationships with local community stakeholders allows for effective project information sharing that can identify further opportunities to deliver local economic benefits, and facilitates the management of disputes and grievances.

On-going engagement will be led by TGL, on behalf of all of the TEN Partners, and specific strategies will be developed for individual stakeholder groups to elicit feedback. Mitigation measures will be monitored and adjusted as required to address government and community concerns. The SI investment programme will be implemented and communicated to multi-stakeholders as per the plan. The TGL Social Performance team will be resourced to ensure that commitments are met and improvements are made as the project progresses through its lifecycle.

On-going engagement will include the following.

- **National, Regional and Local Government.** Engagement with Government departments and other key stakeholders will continue during this phase to ensure that all key regulators at a national, regional and local level are engaged and participate in the implementation of the project.

- **NGOs.** Interaction will involve coordination with NGOs to ensure the implementation of mitigation strategies as required and to maintain transparency post disclosure of the EIS.

- **Local Communities.** TGL's CLOs will meet community representatives at local level in areas potentially affected by the project. The purpose of these meetings would be to provide project updates, answer questions about the planned operations and elicit feedback on local concerns and issues. The grievances procedure would also be communicated.

- **Economically Affected Parties.** Any directly affected parties *eg* fishermen and local businesses will be consulted during the project and on-going consultations will be maintained by the CLO.

11.9 *GRIEVANCE PROCEDURE*

Grievances may be verbal or written and are usually either specific claims for damages/injury or complaints or suggestions about the way that the project is being implemented. When a grievance has been brought to the attention of the project team it will be logged and evaluated. It will not be possible, or in some cases desirable, to address all grievances to the satisfaction of the stakeholders, however, in each case the decision made and the reason for the decision will be communicated to the relevant stakeholders and recorded. *Box 11.3* outlines the main components of the grievance procedure.

Box 11.3 Summary of the Grievance Procedure

Receipt of Complaints
Complaints received verbally or in writing will be recorded by the Community Liaison Officer who will inform the Community Relations Coordinator based in Takoradi. The Community Relations Coordinator is responsible for ensuring that appropriate actions are taken in response to any complaints.

Grievance Register
The Grievance Register will contain a record of each complaint, the actions taken and the persons responsible for specific action. Key dates to be logged include:

- date the complaint was reported;
- date information on proposed corrective action sent to complainant (if appropriate);
- the date the complaint was closed out; and
- date response was sent to complainant.

Tracking the number of grievances and their nature also allows the project team to evaluate how the project is affecting the communities and how to amend or explain activities that are causing most complaints or claims. Tracking by date identifies grievances that are not being addressed in a timely manner. Tracking by responsible party allows the project team to follow up on progress on specific issues.

Grievances/complaints will be logged separately from compensation claims.

Project Response
Response to complaints must be in writing, though a verbal response will also be provided where appropriate under the circumstances (*eg* to restore the relationship or where the complainant cannot read). Complaints will be responded to, though not necessarily resolved, within a reasonable period (*eg* one week) of being received. This may be a summary of what is planned and when it is likely to be implemented. Further correspondence should be given once the complaint is closed.

Monitoring Complaints
The project team will:

- provide a weekly report to management detailing the number and status of complaints and any outstanding issues to be addressed; and
- provide monthly reports, including analysis of the type of complaints, levels of complaints, and actions to reduce complaints.

12 *SUMMARY AND CONCLUSIONS*

12.1 *EIA PROCESS*

This EIA for the proposed TEN Project was undertaken in accordance with the *Ghanaian Environmental Assessment Regulations (LI 1652, 1999)* and Tullow Oil Environmental Standards (***toes***). An EIA is mandatory for an oil and gas field development and the scope of this EIA includes drilling, installation, commissioning, operation and decommissioning project phases.

A Scoping process was undertaken between August 2011 and January 2012 during which a range of stakeholders with a national or regional interest in the project were consulted. The scoping process culminated in the approval and disclosure of the Scoping Report and Terms of Reference.

Baseline and quantitative studies were undertaken to inform the impact assessment. Baseline studies included a marine EBS, a fisheries study, marine fauna observations and an underwater noise study. As part of the baseline studies, community-level consultations were undertaken involving 34 communities in the six coastal districts of the Western Region and over 2,800 people participated in the consultation meetings. Issues and concerns that were raised during the scoping and community consultations were considered in identifying key impacts that needed to be addressed in the EIA. Quantitative studies were also carried out involving numerical modelling of emissions to atmosphere, drilling and produced water discharges and transport and fate of potential oil spills.

Potential impacts were assessed as being significant or not significant. The assessment of impacts took into account mitigation measures that have been built into the project design. Additional mitigation measures were identified to reduce the severity of identified impacts to the extent that was practicable. Impacts that were assessed as significant were rated as being of *Minor*, *Moderate* or *Major* significance. The assessment took into account the magnitude of impacts, and sensitivity, importance or value of the affected resource or receptor. The degree of significance attributed to residual impacts were related to the weight the EIA team considers should be given to them by the authorities in making decisions on the proposed TEN Project and developing conditions for approval.

12.2 *SUMMARY OF IMPACTS AND MITIGATION*

Table 12.1 presents a summary of the assessment of impacts showing the magnitude of the potential impacts and the sensitivity or value of the receptors and resources that may be impacted. Key mitigation measures are outlined and the significance of the residual impacts given.

12.3 *OVERALL CONCLUSION*

The findings of the EIA presented in *Chapter 7* indicate that there are no issues of *Major* significance that could not be mitigated such that the proposed project was not acceptable from an environmental and socio-economic perspective. The significance of all impacts could be reduced to *Moderate* or *Minor* significance through design, use of control technology and operational management controls.

The only *Moderate* significance residual impacts could result from a potential large oil spill. A large oil spill may also result in transboundary impacts. The risk of a large oil spill is very low and the probability of the impact will be reduced to 'as low as is reasonably practicable' levels through preventative measures. TGL will have the necessary preparedness and response facilities in place in the event of an oil spill.

The EIA also identified a number of positive impacts. Increased government revenue was assessed as having the potential benefit of *Moderate* significance. Other positive impacts of *Minor* significance are employment and skills development and procurement of goods and services. These positive impacts could be enhanced through measures identified in *Chapter 8*.

Granting of environmental authorisation for the TEN Project by the EPA will be contingent on a series of conditions. These are likely to include the implementation of the safeguard measures described in the EIA and a programme of monitoring for potential environmental and social impacts.

Table 12.1 Summary of Impacts and Mitigation

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
1.	**Physical Footprint (physical presence and noise)**					
1.1	Subsea infrastructure	Physical impact on the seabed and benthic communities through placement / presence of subsea infrastructure.	**Small** - long term but localised impact to the seabed and benthic communities.	**Low** - generally featureless benthic habitat and homogeneous benthic fauna.	• The layout will be designed to avoid seabed features considered to be geo-hazards, protecting areas with potentially more diverse habitats and species. • Flowline burial using methods such as dredging and jetting will be avoided.	**Minor**
1.2	Underwater noise	Impacts on marine fauna (cetaceans, turtles, fish, birds *etc*) due to underwater sound	**Low** – localised effect on marine fauna from continuous or near continuous low energy underwater sound.	**Medium** – low to high ecological value of marine species. Species and individuals differ in sound threshold level and sensitivity to sound characteristics. Mobile species can avoid adverse sound levels.	• Policy and procedures for traffic and operations to minimise disturbance to marine mammals. • Marine mammal observation and monitoring programme.	**Minor**
2.	**Operational Discharges**					
2.1	Ballast water	Discharge of ballast waters (from export tankers and other vessels) can impact on water quality and marine fauna. Risk of introduction of invasive species.	**Low** – occasional discharges of ballast water may have a localised effect on water quality. Risk of introducing invasive species considered negligible.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• FPSO will be designed with segregated ballast tanks. • Ballast water management measures in accordance with international convention.	**Not significant**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
2.2	Black water (sewage), grey water (washing) and macerated food waste	Discharges from project vessels may impact on water quality with secondary effects on marine fauna.	**Low** – discharge of small volumes of treated black water, grey water and food waste is expected to have a localised impact.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• Compliance with MARPOL requirements and good industry practice.	**Minor**
2.3	Completion and workover fluids	Completion fluids and occasional discharge of workover fluids from the MODU.	**Low** – discharges of treated completion and workover fluid will be occasional and short-term.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• Chemical selection based on the least environmental potential hazard. • Where possible, used fluids will be not be discharged to sea. • Wellbore clean-up fluids will only be discharged after treatment. • Acidic completion and workover fluids will be returned to MODU and neutralised.	**Minor**
2.4	Deck drainage and bilge water	Discharges from project vessel contaminated with traces of hydrocarbons can affect water quality with secondary impacts on marine fauna.	**Low** – frequent but localised impact of small volumes.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• FPSO and MODU deck and drainage system will include coamings. • FPSO and MODU will have open and closed drain systems. The close drained system allows treatment of potentially contaminated water before discharge. • Compliance with MARPOL requirements and good industry practice.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
2.5	Drill cuttings and fluids	Discharges of drill cuttings and fluids to the marine environment increasing total suspended sediment concentration in water and accumulation on the seabed.	**Small** – water column impacts will be temporary and localise. Seabed impacts will be limited to a small area around each well and benthic communities my recover in the medium term.	**Low** - generally featureless benthic habitat and homogeneous benthic fauna.	• Use of solid control systems, including dryers, to reduce oil on cuttings to a target which meets the EPA (2010) discharge compliance limit. • Consider other options to reduce oil on cuttings further using Thermal Desorption Units on the MODU if feasibility studies confirm that installation on MODU is possible. • Use of low toxicity (Group III) NADF, no free oil, and limits on mercury and cadmium concentrations.	**Minor**
2.6	Hydraulic discharges from subsea equipment	Hydraulic fluid from daily subsea valve activation can impact on water quality.	**Low** – occasional discharges of small volumes of hydraulic fluids will have a short-term, localised effect on water quality.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• Control fluid with low toxicity and bioaccumulation potential and is readily biodegradable.	**Not significant**
2.7	Pre-commissioning and line flushing fluids	Chemicals associated with pre-commissioning operations can have a detrimental impact on water quality and marine fauna.	**Low** –discharges of relatively low toxicity effluent will disperse rapidly and will only be discharged during installation and commissioning. Larger volumes may lead to at most temporary, small, localised effects to benthic communities.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• Optimised dispersion. • Testing equipment onshore	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
2.8	Produced water	Produced water discharges will contain some level of hydrocarbons and can impact on water quality.	**Low** – relatively large volumes of produced water discharges will have a localised effect on water quality.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• Three stage treatment process. • Continuous monitoring. • Discharge into the sea such that the 30 day average will not exceed 29 mgl^{-1}.	**Minor**
2.9	Cooling water	Discharges will create a temperature differential with the surface water.	**Low** – excess temperature will be local to the source of discharge as discharge disperses rapidly.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• No mitigation required.	**Not significant**
2.10	Brine discharge	Discharges will create a salinity differential with the surface water.	**Low** – small volumes of brine will dilute rapidly and have a localised effect on water quality.	**Medium** – good existing water quality, water depth, distance offshore and hydrography in area provides a high level of dilution and dispersion.	• No mitigation required.	**Not significant**
2.11	Onshore base - potential leaks and spillages	Potential leaks or accidental releases from tanks, pipes, hoses and pumps, including during loading and unloading from the shore base can impact on soil and groundwater quality.	**Low** – any leaks and accidental releases will have a localised effect, potentially in the long term.	**Medium** – contamination of surface or ground water at onshore facilities could impact on coastal ecosystems and nearby communities.	• Secondary containment (bunds). • Impervious concrete surfaces. • Storage tanks and components will meet international standards. • Periodic inspection for corrosion and integrity of storage containers. Regular maintenance of components. • Fuelling equipment will be inspected daily. • Stormwater collection channels with oil-water separators. • Properly trained personnel with to formal procedures. • Spill control and response plans.	**Not significant**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
3.	**Emissions to Atmosphere**					
3.1	Air pollutants	Project activities will emit varying amounts of primary atmospheric pollutants with the potential to impact air quality.	**Low to High** – no air quality standards exceeded at any onshore locations. Significant quantities of SOx and NOx will be emitted resulting in a localised and short term impact on air quality.	**N/a** - Impacts were assessed against air quality guidelines and standards.	• Compliance with MARPOL 73/78 Annex VI for emissions. • Safety zones will be implemented around the FPSO and MODU. • Use of low-sulphur diesel fuel. • Controlling and reducing leaks and fugitive emissions. • Routine flaring will be avoided and non-routine flaring will be kept to minimum. • Routine inspection and maintenance of engines, generators, and other equipment. • A Vapour Recovery Unit (VRU) on TEG dehydration reboiler unit.	**Not significant**
3.2	Greenhouse Gas (GHG) emissions	Project activities will emit varying amounts of GHGs (*eg* carbon dioxide and methane) believed to contribute to global climate change.	**Low**- emissions from a single installation are relatively small in the context of the industry but significant in the context of relatively low national emissions in Ghana.	**High** - Emissions that can contribute to climate change are significant at an international scale.	• Develop and implement a flaring strategy with goal to eliminate or minimise flaring. • Operational strategy to monitor and reduce cold vent volumes. • Maximum abnormal flaring rate of 5% of monthly gas production. • Quantify annual GHG emissions and benchmark). • Assessment of options to reduce GHG emissions with regards to efficiency of power generation, optimisation of overall energy efficiency, reduction in flaring and reduction in venting.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
4.	**Waste Management**					
4.1	Segregation and storage	Non-hazardous and hazardous wastes will be generated that will require to be transported and disposed of in a manner protective of the natural and human environment.	**Low to Medium** – impact could occur at a regional level and in the long term but volumes of wastes will be small. Limited currently available facilities for waste handling and disposal.	**Medium to High** – depending on the sensitivity/ vulnerability of soils and groundwater resources at disposal sites and the proximity and access of communities to the disposal site.	• Operational controls. • Incorporate TEN into TGL Waste Management Plan. • Designated secure waste reception and temporary storage facilities. • Reduce waste generation and maximise reuse and recycling.	**Not significant**
4.2	Transport				• Safe transport in accordance with MSDS information. • Transport using well maintained, legally complaint and pre-inspected and approved vehicles or vessels with trained operations. • Appropriate containers will be used. • Use of TGL and EPA approved waste contractors.	**Not significant**
4.3	Treatment and disposal				• EPA approved waste management companies by review and evaluation in line with international good practice. • Periodic audits of third-party waste facilities and sites. • Waste tracking procedures as defined in the TGLWMP. • Treat and dispose waste in accordance with the TGLWMP. • No hazardous waste to landfill. • Store small quantities of waste which currently cannot be treated in Ghana.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
5.	**Fisheries Impacts**					
5.1	Vessel presence on local fish populations	Pelagic species will likely be attracted to vessels and floating objects. Safety zones may provide protection from fishing pressure.	**Low Positive** – long-term but very localised impact on pelagic species.	**Low** – sensitivity of pelagic fish populations to presence of infrastructure.	• Community Liaison Officers (CLOs) in six coastal districts to provide information to fishermen about TGL activities and notify them of requirement to keep away from safety zones. • Code of practice and training for those responsible for maintaining safety zones. • CLOs to deal with any claims for gear damage through TGL's grievance mechanism. • Safety and advisory zones to be marked on nautical charts and notify mariners of FPSO presence and other marine operations. Zones will be monitored with assistance from other agencies. • Vessel transit route will be agreed with the GMA and communicated to fishermen. • Work with the Fisheries Commission to improve understanding of fishing activities in Ghana EEZ and investigate ways to reduce potential conflict between oil and gas and fisheries industries.	**Not significant**
5.2	Fisheries	Impacts on the offshore fishing industry through loss of access to due to vessel presence and safety zones.	**Small** – given the number of vessels likely to fish in offshore deep water and only a small proportion of fishing grounds will be affected.	**Medium** – TEN is not an important or exclusive fishing ground, however, tuna fishing is likely to occur in the project area and coastal fishermen are likely to visit the field attracted by fish around the structures.		**Minor**
5.3		Fish will not be available to the fishery while beneath the FPSO and within the safety zones.	**Small** - only a small proportion of the potential fishing grounds will be affected.			**Minor**
5.4		Disturbance to fishing activities and damage to fishing gear by support vessels.	**Small** – given the typically fishing methods and the likelihood of interaction between fishing equipment and project vessels.			**Not significant**
6.	**Socio-Economic Impacts**					
6.1	Increased government revenue	The revenues through oil sales, taxes and royalties will be a valuable source of finance for the government with potential to facilitate investment in the country's socio-economic development.	**Medium** – given the potential value of revenue and long duration (*ie* 20 years).	**High** – Ghana is a developing economy and therefore the need for additional revenue is high to support socio-economic development repay national debt.	• Follow Extractive Industries Transparency Initiative principles. • Potential implications to government revenues will be communicated before decommissioning.	**Moderate positive**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
6.2	Employment and skills development	Direct employment by the project and indirect employment through contractors and suppliers will have a positive impact on those people employed, their families and their local communities.	**Small** - in general, the oil industry is not a large employer. Employment and training could have a positive direct effect at the local level in the long term.	**Medium** – a large proportion of the population are not formally employed. Additional employment opportunities would benefit families and local communities from wages and other benefits.	*Employment* • Implement local employment and skills development policies for recruitment, training and development of national staff. • Employment and development requirements to be transposed to contractors. • Recruitment practices based on ability, objectivity and fairness. • Advertise employment opportunities widely and in coastal districts through CLOs. • On-the-job training programmes. *Skills Development* • Support educational and training organisations through Social Investment Framework and Strategy.	**Minor positive**
6.3		Skills drawdown from other sectors and unmet expectations due to low numbers of staff required.	**Small** - in general, the oil industry is not a large employer.	**Low** – available skilled resources can meet the anticipated short term demand and training will allow longer term demand to be met.	• No mitigation required.	**Not significant**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
6.4	Procurement of goods and services	Procurement of goods and services is likely to be positive through stimulating small and medium sized business development, including investment in people (jobs and training) and generation of profits.	**Low** - the project is not reliant on local goods and services but will use those available within existing capacity.	**Medium** - direct benefits to businesses at a regional level.	• Contracting and procurement in accordance with requirements of DWT Petroleum Agreement. • Implement local content strategy to build capacity of Ghanaians and Ghanaian businesses to support the oil industry. • Project local content plan to guide local procurement • Long term contracts with Ghanaian companies. • Support suppliers in Ghana to help them meet required standards. • Partner with organisations to develop a programme for strengthening capacity of Ghanaian businesses to devolved goods and services to the industry. • Monitor effects of strategy of maximising local content.	**Minor positive**
6.5	Influx of job-seekers	In-migration of job seekers resulting in an increased cost of living, negative social effects, road traffic and informal settlements.	**Small** – influx will be localised and relatively small in scale as compared to the extent of migration already experienced in the region.	**Medium** – local communities are sensitive to changes in social norm and infrastructure is already under strain.	• Stakeholder engagement plan and on-going consultation to manage stakeholder expectations about job opportunities. • Work with government and support infrastructure projects in the coastal districts through Social investment framework.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
6.6	Issues with heightened and unmet expectations	Stakeholders have high expectations in terms of economic benefits, infrastructure development and general improvement in living conditions. Dissatisfaction related to unmet expectations linked to the Jubilee project.	**Medium** – heightened expectations are primarily localised to communities of Western districts but may persist in the long term depending on how issues are being resolved.	**Low/Medium** - stakeholders have a high ability to adapt to unmet expectations.	• On-going engagement with communities in the six coastal districts. • Social Investment Framework with consideration of regional and district development plans and priorities. • Coordinate the planning and implementation of Social Investment programmes and projects to ensure uniformity. • Grievance procedure to manage and facilitate disputes and grievances. • Build the capacity and capability of Ghanaians to support the long-term development of the emerging oil industry.	**Minor**
6.7	Commercial shipping	Interaction with existing commercial shipping as a result of additional vessel movements associated with the project.	**Low** – limited additional vessel movements are anticipated.	**Medium** - larger commercial ships will be able to detect and avoid offshore facilities and vessels.	• Use of established shipping zones, navigation and communication equipment and standby vessels will reduce risk of vessel collisions. • Safety zones and the ATBA will be mapped on international nautical charts and communicated to mariners. • Compliance with requirements of SOLAS and COLREGS.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
6.8	Onshore base	Potential strain on capacity of the public utilities and impact on use of shared services by local communities.	**Medium** – local impacts in the short to medium term.	**Low** – shore bases to be located within existing industrial port area and airport.	• EHS policies and procedures to manage environmental and social impacts from onshore activities. • A grievance procedure to be implemented and made known to the surrounding communities and the general public. • Contractor environmental and social performance will be managed through contractual mechanisms. • Periodic audits and reviews of shore based operations.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
6.9	Community Health	Impacts to the health and wellbeing of local communities due to worker-community interactions resulting in increased transmission of STIs and communicable diseases; traffic movements resulting in the potential for accidents and injury; and increased pressure and possible drawdown on health care resources.	**Small-** local impacts in short term	**Medium to High** –limited existing community health facilities exist	• Pre-employment screening for all employees (including contractors and subcontractors) including testing for diseases appropriate to the individual's country of origin, vaccinations and voluntary testing for sexually transmitted disease. • Health screening for all employees (including contractors and subcontractors) and referral and support for on-going treatment programmes for treatable conditions. • Training Worker Code of Conduct, including guidelines on worker-community interactions, worker-worker interactions and alcohol and drug use. • Training in awareness of transmission routes and methods of prevention of sexually transmitted infections, communicable diseases and vector borne diseases. • Emergency Response Plans to take into account access to health care, major incidences, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident.	**Minor**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
7.	**Oil Spill Risk**					
7.1	Major oil spill	Impacts to marine and coastal habitats and species (seabird, coastal birds, marine mammals, marine turtles, fish), and economic activities such as fisheries and tourism.	**Medium** – this is a precautionary rating as the magnitude of impacts from accidental events takes into account the likelihood of an event occurring. Major spill events, such as blowouts are highly unlikely to occur. In the event of an incident the extent of impacts would be directly related to the duration and volume of the oil release.	**High –** Marine and coastal habitats and species are of high value and sensitivity both ecologically and commercially. Particularly sensitive coastal receptors include coastal lagoons and wetland, turtle nesting beaches and artisanal fishing grounds.	• Oil spill prevention equipment, measures and procedures. • Specific procedures for offloading crude from the FPSO onto the shuttle tankers. • Oil Spill Contingency Plan (OSCP) which contains detailed procedures that will be followed in the event of a Tier 2 and 3 oil spill.	**Moderate**
8.	**Cumulative and Transboundary Impacts**					
8.1	Cumulative impacts	Cumulative impacts can result from individually slight but collectively significant activities taking place over a period of time.	**Medium** – cumulative impacts could occur at a regional or even national scale and in the medium to long term.	**Medium** – difficulty of managing cumulative impacts and potential impacts to significant biophysical and socio-economic resources.	No project specific mitigation. Strategies that could help manage potential future cumulative impacts include the following. • Government-led Strategic Environmental Assessment (SEA). • Build capacity of local administration to plan effectively for future development in the area. • Collaboration and agreed standards. • Programme of data gathering and monitoring studies led by government. • Collectively applied environmental standards. • Integrated approach to oil spill response.	**Not significant**

#	Issue	Impact Summary	Magnitude (S/M/L)	Value/Sensitivity (L/M/H)	Key Mitigation Measures	Impacts Significance
8.2	Transboundary impacts	Oil spills could extend across international boundaries. Emissions to atmosphere will have no significant transboundary impacts.	**Medium** – the magnitude of any transboundary impacts would be low in the offshore environment. Small scale oil spills have low probability of being transboundary; large oil spills will have an effect throughout the Gulf of Guinea.	**Low/high** – Marine and coastal habitats and species are of high value and sensitivity and may be impacted by a large spill.	• As per major oil spill risk.	**Moderate**

REFERENCES

Adamec D and O'Brien J J (1978). *The seasonal upwelling in the Gulf of Guinea due to remote forcing*. J Phys Oceanog 8: 1050-1060.

Aggery-Fynn (2007). *The fishery of Balistes capriscus (Balistidae) in Ghana and possible reasons for its collapse*. PhD Thesis. Centre for Tropical Marine Ecology, University of Bremen.

Ahanta West District Assembly (2012). *Ahanta West District profile*.

Alder J and Sumaila U (2004). *Western Africa: a fish basket of Europe past and present*. Journal of Environment and Development 13 (2):156-178.

Amiteye B T (2002). *Distribution and ecology of nesting sea turtles in Ghana.* Unpublished Thesis University of Ghana.

Anderson D M, P Andersen, V M Bricelj, JJ Cullen, and J E J. Rensel. (2001). *Monitoring and management strategies for harmful algal blooms in coastal waters*. APEC #201-MR-01.1, *Asia Pacific Economic Program, Singapore and Intergovernmental Oceanographic Commission Technical Series No. 59*, Paris.

Arhinful, D. K. (2009) *Health Facilities Survey in GHANA*.

Armah A K, Darpaah G A, Wiafe G, Adomako J K, Quartey S Q, Abotchie C, Ansah F and Fiagbedzi S (1997). *Traditional and modern perspectives of marine turtle conservation in Ghana Biodiversity Conservation: traditional knowledge and modern concepts* (eds. Amlalo DS, Atsiatorme LD and Fiati C), p. 80-87: EPA/MAB/UNESCO.

Armah A K, Biney C, Dahl S O and Povlsen E (2004). *Environmental Sensitivity Map for the Coastal Areas of Ghana Volume II – Coastal Environment*. UNOPS/UNDP, Accra. 80p.

Atta-Mills J, Alder J, Sumaila UR (2004). *The decline of a regional fishing nation: The case of Ghana and West Africa*. Natural Resources Forum, 29 (2004) 13-21.

Aquatera (2012). *BPEO for the management of drilling discharges from the TEN project.* P442 July 2012 (Rev 4). Prepared for TGL.

Asumadu K (2003). *Reform of Ghana's Land Tenure System.* Accessed January 2014 at http://www.ghanaweb.com/GhanaHomePage/features/artikel.php-?ID=36246

Billes A, Formia A Tiwari A M Fretey J (2003). *Sea turtle conservation along the Atlantic coast of Africa*. Marine Turtle Newsletter 100:33-37.

Birdlife (2009). http://www.birdlife.org/news/news/2009/10/migratory_bird_decline_project.html

BirdLife International (2012) *Amansuri Wetland*. Available from: http://www.birdlife.org/datazone/sitefactsheet.php?id=6341

Boere G C & Stroud D A (2006). The flyway concept: what it is and what it isn't. Waterbirds around the world. Eds. Boere G C, Galbraith C A & Stroud D A. The Stationery Office, Edinburgh, UK. pp. 40-47.

Brainerd, T (1991) *The Sardinella Fishery off the Coast of West Africa: The Case Of A Common Property Resource*. Paper presented at the Second Annual Conference of the International Association for the Study of Common Property (IASCP) September 26-29 1991, University of Manitoba, Winnipeg, Canada.

Brandsma, M.G. and J.P. Smith (1999) *Offshore Operators Committee Mud and Produced Water Discharge Model – Report and User Guide*. Exxon Production Research Company, December 1999.

Cadenat J (1959). *Rapport sur les petits cétacés ouest*-Africains. Résultats des recherches entreprises sur ces animaux jusqu'au mois de mars 1959. Bull. IFAN 21 A(4): 1367-1409.

Castro J J, Santiago J A and Santana-Ortega AT (2002). *A general theory on fish aggregation to floating objects: an alternative to the meeting point hypothesis*. Reviews in Fish Biology and Fisheries 11: 255–277.

CECAF (2003). *Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources.* Conakry, Guinea, 19–29 September 2003.

Collette BB and Nauen CE (1983). *FAO Species Catalogue*. Vol. 2. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. FOA Rome.

Collins T, Ngouessono S and Rosenbaum H C (2004). *A note on recent surveys for Atlantic humpback dolphins, Sousa teuszii (Kükenthal, 1892 in: the coastal waters of Gabon.* Paper SC/56/SM23 presented to International Whaling Commission Annual meeting.

CSA International Inc (CSA) (2011a). *Tweneboa, Enyenra and Ntomme Final Environmental Baseline Survey*. Prepared for Tullow Ghana Ltd.

CSA International Inc (CSA) (2011b). *Jubilee Field Drill Cuttings Study.* Prepared for Tullow Ghana Ltd.

Davis R A, Richardson W J, Thiele L, Dietz R, Johansen P (1990). *State of the Arctic Environment- Report on Underwater Noise.* Finnish Initiative on Protection of the Arctic Env.

Debrah J S (2000). *Taxonomy, exploitation and conservation of dolphins in the marine waters of Ghana Master of Philosophy thesis.* Department of Oceanography and Fisheries University of Ghana 86pp. (unpublished).

Department of Environment, Food and Rural Affairs (2009) *Local Air Quality Management Technical Guidance* TG(09).
Duinker P N, Beanlands G E. (1986). *The significance of environmental impacts: an exploration of the concept*. Journal of Environmental Management. 1986; 10(1): 1-10.

E&P Forum/UNEP (1997) *Environmental Management in Oil and Gas Exploration and Production. An Overview of Issues and Management Approaches*. UNEP IE/PAC Technical Report 37. E&P Forum Report 2.72/254. ISBN 92-807-1639-5

Energy and Biodiversity Initiative (EBI) (2003) *Integrating Biodiversity into Oil & Gas Development.*

Elgood J H, Heigham J B, Moore A M, Nason A M, Sharland R E and Skinner NJ (1994). *The birds of Nigeria (2nd edition) British Ornithologists' Union Check-list No. 4.* British Ornithologists' Union Tring.

Ellembelle District Assembly (2012). *Ellembelle District Profile*.

Energy Institute (2012). *Guidelines for the Identification and Management of Environmentally Critical Elements*.

ERM (2009) *Ghana Jubilee Field Phase I Development. Environmental Impact Statement*. Prepared for Tullow Ghana Limited in November 2009.

USEPA (1995) *AP-42 Compilation of Air Pollutant Emission Factors*. Available from http://www.epa.gov/ttnchie1/ap42/

EPA (2010) *Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development*. Available from: www.epa.gov.gh

ERM (2010). *Assessment of Waste Treatment and Disposal Options for Priority Waste Streams*. Prepared for TGL.

ERM (2011) *Tullow Ghana Offshore Operations: Fish and Fisheries Study*. Prepared for Tullow Ghana Limited.

Etsey Y K A (2009). *Mid-Term conference on educational quality in Ghana and outcomes*: *Learning Achievement and the Cycle of Poverty across urban and rural districts in Ghana*. Institute of Africa Studies University of Ghana.

European Commission (2006) *Integrated Pollution Prevention and Control Reference Document on Best Available Techniques: Large Combustion Plants*. July 2006; p. 376.

Evans P G H and Nice H (1996). *Review of the effects of underwater sound generated by seismic surveys on cetaceans*. SeaWatch Foundation, Oxford. (Report commissioned by UKOOA.)

Fanger E W and Longhurst A R (1968) *Recurrent group analysis of species assemblage of demersal fish in the Gulf of Guinea*. Journal of the Fisheries Research Board of Canada 25(7): 1045-1121.

FAO (2010). *Country reports presented at the FAO FishCode-STF/CECAF/FCWC Subregional Workshop on the Improvement of Fishery Information and Data Collection Systems in the West Central Gulf of Guinea Region*. Accra, Ghana, 26–28 June 2007. *FAO Fisheries and Aquaculture Report.* No. 921, Suppl. 113p.

FAO (2011) *FAO FishFinder* [online]. FAO Fisheries and Aquaculture Department [online]. Rome. Available at http://www.fao.org/fishery/fishfinder/about/en [Accessed August 2011].

Félix F and Van Waerebeek K (2005). *Whale mortality from ship strikes in Ecuador and West Africa.* LAJAM 4(1): 55-60.

Finegold C, Gordon A, Mills D, Curtis L, Pulis A (2010). *Western Region Fisheries Sector Review*, WorldFish Center. USAID Integrated Coastal and Fisheries Governance Initiative for the Western Region, Ghana. 84pp.

Fisheries Committee for the West Central Gulf of Guinea (FCWC) (2012). *General Information on Ghana related to Fisheries.* Accessed at www.fcwc-fish.org

Flegg J (2004). *Time to Fly.* Exploring Bird Migration. BTO, Thetford.

Fontaine B, Janicot S and Roucou P (1999). *Coupled ocean-atmosphere surface variability and its climate in the tropical Atlantic region.* Climate Dynamics 15: 451-473.

Fretey J (2001). *Biogeography and conservation of marines turtles of the Altlantic coast of Africa* / Biogéographi*e et conservation des tortues marines de la cote Atlantique de l'Afrique.* CMS Technical Série Publication No. 6: 209-207.

Froese R and Pauly D, Editors (2010). *FishBase version 09/2010* [online] Available at www.fishbase.org [Accessed July 2011].

Fugro Survey Limited (Fugro) (2013) *Pipeline Routes Survey TEN Development Project*. Geophysical Survey and Geotechnical Results. Volume 1 of 3. FSLTD Report No. 120075.65V1.0

Gardline Environmental Ltd (2011a). *Deep Water Tano Project Reconnaissance Geophysical/Geotechnical Surveys.* Survey report prepared for Tullow Ghana Ltd.

Gardline Environmental Ltd (2011b). *Marine Mammal and Turtle Observation Report – 8 to 18 August 2011.* Project 8391. Prepared for Tullow Ghana Ltd.

Gardline Environmental Ltd (2011c). *Measurement and assessment of underwater noise from FPSO operation and offloading for the Jubilee Field, Ghana*. Project 8391. Prepared for Tullow Ghana Ltd.

Gardline Environmental Ltd (2012). *Marine Mammal and Turtle Observation Report - 8 March to 31 December 2011.* Project 8391. Prepared for Tullow Ghana Ltd.

GESAMP (1993). *Impact of Oil and Related Chemicals and Wastes on the Marine Environment*. IMO/FAO/UNESCO/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution.

Ghana Aids Commission (2012). *Ghana country AIDS progress report: Reporting period January 2010 – December 2011*. Accessed from http://www.unaids.org/en/dataanalysis/monitoringcountryprogress/progressreports/2012countries/ce_GH_Narrative_Report[1].pdf

Ghana Ports and Harbours Authority (GPHA) (2012). Official Website. Available at http://ghanaports.gov.gh/GPHA/fishing/index.html [Accessed May 2012].

Ghana Health Service (GHS) (2009) *Sekondi-Takoradi Metro Mid-Year Report*.

Ghana Statistical Service (GSS) (2005). *2000 Population and Housing Census: Analysis of District Data and Implications for Planning – Western Region.* Republic of Ghana.

Ghana Statistical Service (GSS) (2012). *2010 Population and Housing Census: Provisional National and Regional Statistics*. Republic of Ghana.

Holthuis L B (1991). FAO species catalogue. Vol 13. *Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date.* FAO fisheries Synopsis. 125 (13):292 p. http://www.seaaroundus.org/default.htm.

ICCAT (2009). Report for Biennial Period 2008-9. Part II – Vo. 3 p70 Bannerman, P *Annual Report of Ghana*. Available at http://www.iccat.int/Documents/BienRep/REP_TRILINGUAL_08-09_II_3.pdf [Accessed December 2010].

ICCAT (2010). *Report of the Standing Committee on Research and Statistics* Available at http://www.iccat.int [Accessed January 2011].

International Finance Corporation (IFC) (2010). Handbook for Preparing a Resettlement Action Plan.

International Petroleum Industry Environment Conservation Association (2000). IPIECA report series Vol II - *A guide to contingency planning for oil spills on water*. Available at http://www.ipieca.org/activities/oilspill/downloads/publications/reports/english/Vol2_ContPlanning.pdf.

International Petroleum Industry Environmental Conservation Association (IPIECA) (2007) Guide to Tiered Preparedness and Response. IPIECA report series Vol XIV. Available at: www.ipieca.org/system/files/publications/TieredResponse.pdf

Institute of Marine Research (IMR) (2009). *Marine Environmental Survey of Bottom Sediments in Ghana*. NORAD – FAO Project GCP/INT/003/NOR

Institute of Marine Research (IMR) (2012). *Marine Environmental Survey of Bottom Sediments in Ghana*. Preliminary Results - elected physical and chemical compounds from the eastern coast May 2011. NORAD – FAO Project GCP/INT/003/NOR. Bruise Reports 'Dr Fridtjof Nansen' EAF-N/2011/4.

Integrated Marine Management (IMM) (2003). *Ghana: Post-Harvest Fisheries Overview by Ghana Directorate of Fisheries*. Available at http://www.ex.ac.uk/imm/Ghana_Pov_PH.htm[Accessed November 2011].

International Finance Corporation (2007e). *Environmental, Health and Safety Guidelines for Waste Management Facilities*.

International Finance Corporation (IFC) (2007a) *General EHS Guidelines*.

International Finance Corporation (IFC) (2007b) *EHS Guidelines for Offshore Oil and Gas Development*.

International Finance Corporation (IFC) (2007c) *EHS Guidelines for Shipping*.

International Finance Corporation (IFC) (2007d) *EHS Guidelines for Crude Oil and Petroleum Product Terminals*.

International Finance Corporation (IFC) (2007e) *EHS Guidelines for Operational Health and Safety.*

International Finance Corporation (IFC) (2008) *EHS Guidelines for Thermal Power Plants.*

International Labour Organisation (ILO) (2007) *Ghana Child Labour Data Country Brief*. Ghana Child Labour Survey, 2001.

IRC Risk and Safety LLC (2009). *Environmental Releases Summary*. Report number RS-TN-09-033-001 Rev 0.

Itano D, Holland K, Dagorn L, Grubbs D, and Papastamatiou Y (2004). *Monitoring movement patterns, residence times and feeding ecology of tuna, billfish and oceanic sharks within a network anchored FAD*. 17th Meeting of the Standing Committee on Tuna and Billfish. Majuro, Marshall Islands. BIO-2.

ITOPF (2012). *Behaviour of oil at sea*. Accessed at http://www.itopf.com/marine-spills/fate/weathering-process/
Jomoro District Assembly (JDA) (2009). *Jomoro District Profile.*

Jones R and Henderson EW (1987). *The dynamics of energy in marine food chains* S Afr J Mar Sci 5: 447-466.

Koranteng K A (2002a). *Fish Species Assemblages on the Continental Shelf and Upper Slope off Ghana*. The Gulf of Guinea Large Marine Ecosystem. Eds. J M McGade, P Cury, K A Koranteng and N J Hardman-Mountford. Elsevier Science B V.

Koranteng K A (2002b). *Status of Demersal Fishery Resources on the Inner Continental Shelf of Ghan*a. The Gulf of Guinea Large Marine Ecosystem. Eds. J M McGade, P Cury, K A Koranteng and N J Hardman-Mountford. Elsevier.

Kwadjosse J (2009). *The Law Of The Sea: Impacts On The Conservation And Management Of Fisheries Resources Of Developing Coastal States – The Ghana Case Study*. The United Nations -Nippon Foundation of Japan Fellowship Programme 2008-09. University of Edinburgh Law School and the Division of Ocean Affairs and the Law of the Sea (DOALOS), UN, New York.

Lakes Environmental (2012) MM5 meteorological data (2007-2011) supplied to ERM, for FPSO location, 6th March 2012.

Last, KS, Hendrick, VJ, Beveridge, CM and Davies, AJ (2011). *Measuring the effects of suspended particulate matter and smothering on the behaviour, growth and survival of key species found in areas associated with aggregate dredging*. Marine Aggregate Levy Sustainability Fund (MALSF). MEPF Project No. 08/P76.

Longhurst A R (1962). *A review of the oceanography of the Gulf of Guinea.* Bulletin IFAN (Series A), 24: 633-6663.

Longhurst A R and Pauly D (1987). *Ecology of tropical oceans*. Academic Press. San Diego 407p.

Madsen P T, Hofl B K, Nielsen B K and Wahlberg M (2002). *Male sperm whale behavior during exposures to distant seismic survey pulses*, 24 pp., http//wwwiagc.org/public/Gom/Madsen_revised.pdf.

Malme C I, Miles P R, Clark, Tyack P and Bird J E (1985). Investigations on the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Report No. 5366 submitted to the Minerals Management Service, U.S. Department of the Interior, NTIS PB86-174174, Government Printing Press, Washington, DC. In Committee on Characterizing Biologically Significant Marine Mammal Behavior, National Research Council (2005). *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*, The National Academies Press.

Marine Fisheries Research Department (MFRD) (2011a). *Fishing Vessel Data to 2009*. Email communication from P Bannerman, Director of MFRD, July 2011.

Marine Fisheries Research Department (MFRD) (2011b). *Catch Landing Data, Western Region. 2007-2010.* Email communication from P Bannerman, Director of MFRD, July 2011.

Marquette C M, Koranteng K A, Overa R and Bortel-Doku Aryeetey E (2002). *Small-scale Fisheries, Population Dynamics and Resource Use in Africa: The Case of Moree, Ghana.* Ambio Vol. 31, No.4 pp 324-336.

Martos A R *et al. The "Guinea 90" Survey.* CECAF/ECAF SERIES 91/52. 295p.

McCauley R D, Fewtrell J, Duncan A J, Jenner C, Jenner M N, Penrose J D, Prince R I T, Adhitya A, Murdoch J and McCabe K (2000). *Marine seismic surveys: Analysis and propagation of airgun signals and effects of airgun exposure on humpback whales, sea turtles, fishes and squid.* Report produced for the Australian Petroleum Production Exploration Association. 198 pp.

McCauley RD (1994). Seismic surveys. pp 19-122 in Swann J M, Neff J M, Young, PC (eds). *Environmental implications of offshore oil and gas development in Australia – the findings of an independent scientific review.* APEA, Sydney, Australia, 695 p.

Mensah M A and Koranteng K A (1988). *A review of the oceanography and fisheries resources in the coastal waters of Ghana 1981-1986*. Marine Fisheries Research Report No. 8 Fisheries Department.

Merle J and Arnault S (1985). *Seasonal variability of the tropical South Atlantic and linkages to the Pacific Geophysical Research Letters* 13: 1039-1092.

Ministry of Energy (2010). *Energy Sector Strategy and Development Plan.* Republic of Ghana.

Ministry of Food and Agriculture, Ghana (MoFA) (2004). *Information on Fisheries in Ghana.*

Nakamura I (1985). FAO Species Catalogue. Vol. 5. *Billfishes of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes and swordfishes known to date*. FAO Fish. Synop. 125(5):65 p.

National Fisheries Association of Ghana (NAFAG) (2007). *National Fisheries Association of Ghana* (accessed in May 2009 at: http://www.nafagfish.org/aboutus.htm).

Nelson P A (2009). *Marine fish assemblages associated with fish aggregating devices: effects of fish removal, FAD size, fouling communities, and prior recruits* - FADs *Fishery Bulletin* accessed on 4 June 2009 at http://findarticles.com/p/articles/mi_m0FDG/is_4_101/ai_111201177/.

Noble Denton (2008). Offshore Ghana MetOcean data report Report No: L22898/NDC/IGA 45pp.

Nordenfjeldske Development Services (NFDS) (2009). *Identification of potential aquaculture and fish processing investment projects and partners in selected countries in Africa*. Available at http://www.norad.no/en/Tools+and+publications/Publications/Publication+page?key=125664 [Accessed July 2011].

Nunno F K E (2009). *When trash fish is treasure: The case of Ghana in West Africa.* Fisheries Research 96 (2009) 167–172.

Nzema East District Assembly (2012). *Nzema East District Profile*.

Ofori-Danson P K, Van Waerebeek K and Debrah S (2003). A survey for the conservation of dolphins in Ghanaian coastal waters. *J. Ghana Sci. Assoc.* 5(2): 45-54.

OGP (2009). *Guidelines for Waste Management with Special Focus on Areas with Limited Infrastructure*. Oil & Gas Producers Report No. 413. September 2008 (rev1.1, updated March 2009).

Perrin W F and Van Waerebeek K (2007). *The small-cetacean fauna of the west coast of Africa and Macaronesia: diversity and distribution.* UNEP/CMS-WATCH-Inf.6 CMS Bonn.

Quaatey S (1997). *Synthesis of recent evaluations undertaken on the major fish stocks in Ghanaian waters: A Working Document for the Eleventh Session of the Committee for Eastern Central Atlantic Fisheries (CECAF) Working Party on Resource Evaluation* Accra, Ghana. 35pp.

Rankin S and Evans W E (1998). *Effect of Low Frequency Seismic Exploration Signals on the Cetaceans of the Gulf of Mexico*. The World Marine Mammal Science Conference 20-24 January 1998. Abstracts p110.

Rice DW (1998). *Marine Mammals of the World*. Systematics and Distribution Special Publication 4, The Society for Marine Mammalogy 231pp.

Richardson W J, Greene C R, Malme C I and Thompson D H (1995). *Marine mammals and noise* Academic Press, San Diego, CA. 576 pp.

Roper C F E, M J Sweeney & C E Nauen (1984). FAO Species Catalogue. Vol. 3. *Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries*. FAO Fish. Synop., (125)Vol. 3:277p.

Røstad A, Kaartvedt S, Klevjer T A and Melle W (2006). *Fish are attracted to vessels*. ICES Journal of Marine Science 63: 1431 - 1437.

RPS ASA (2012) *Oil Spill, Drilling Discharge and Produced Water Modelling, TEN Development, Offshore Ghana*. Final Report. Prepared on behalf of ERM UK.

RPS ASA (2013) *Oil Spill, Produced Water, Cooling Water, and Brine Modelling, TEN Development, Offshore Ghana.* Final Report. Prepared on behalf of ERM UK.

Salomons, W. and U. Förstner (1984) *Metals in the Hydrocycle*. Springer-Verlag, New York, N.Y. 349 pp.

Sarpong D B, Quaatey S, Harvey S (2005). *The Economic And Social Contribution Of Fisheries To Gross Domestic Product And Rural Development In Ghana.* Final Report of the Sustainable Fisheries Livelihoods Programme (SFLP) GCP/INT/735/UK Pilot Project 1 "Improvement of The Policies And Institutions For Co-Management In Inland Waters, FAO. Available at: ftp://ftp.fao.org/fi/document/sflp/SFLP_publications/English/Contribution_peche_Ghana_june05.pdf [Accessed December 2010].

Schepers F J and Marteijn E C L (eds) (1993). *Coastal waterbirds in Gabon, winter 1992*: Foundation Working Group International Wader and Waterfowl Research WIWO-report 41 Zeist The Netherlands 293 pp.

Sea Around Us Project (2008). *Sea Around Us Project: Fisheries and Biodiversity*. Fisheries Centre, University of British Columbia, Vancouver.

Sekondi-Takoradi District Assembly (2012). *STMA District Profile*.

Shama District Assembly (2012). *Shama District Profile*.

Southall, B L Bowles, A E Ellison, W T Finneran, J J Gentry, R L, Greene, C R Kastak, D Ketten, D R Miller, J H Nachtigall P E Richardson, W J Thomas, J A and Tyack, P L, (2007). *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations*. Aquatic Mammals, 33, 1-521.

TDI Brooks (2008). *Jubilee field Ghana Environmental Baseline Survey Report* Technical Report # 08-2161 Texas, USA.

Troadec J P and Garcia S (eds) (1980). *The Fish Resources of the Eastern Central Atlantic. Part One; The Resources of the Gulf of Guinea from Angola to Mauritania*. FAO Fish. Tech. Rep. 186 (1). 166p.

Tullow Ghana Limited (TGL) (2010). Waste Management Plan. Document No. TGL-EHS-PLN-04-0008. 30 June 2010.

UNESCO (2012) Ghana. Available from: http://whc.unesco.org/en/statesparties/gh/

Van Waerebeek K (1997). *Long-beaked and short-beaked common dolphins sympatric off central-west Africa* Paper SC/49/SM46 presented to the Scientific Committee of the International Whaling Commission. 5pp.

Van Waerebeek K, Baker A N, Félix F, Gedamke J, Iñiguez M, Sanino G P, Secchi, E, Sutaria D, van Helden A, and Wang Y (2007). *Vessel collisions with* *small cetaceans worldwide and with large whales in the Southern Hemisphere*, an initial assessment. LAJAM 6(1): 43-69.

Van Waerebeek K, Barnett L, Camara A, Cham A, Diallo M, Djiba A, Jallow AO, Ndiaye E, Samba Ould Billal AO and Bamy IL (2004). *Distribution, status and biology of the Atlantic humpback dolphin Sousa teuszii* (Kükenthal, 1892) Aq. Mamm. 30(1): 56-83.

Van Waerebeek K, Ofori-Danson P K and Debrah J (2009). *The Cetaceans of Ghana: a Validated Faunal Checklist.* West African Journal of Applied Ecology Vol 15.

Vanco (2012) Vanco Energy Company website. Accessed at http://www.vancoenergy.com.htm/

Weir C R (2007). *The distribution and seasonal occurrence of cetaceans off northern Angola.* J. Cet. Res. Manag. 9(3): 225–239.

West Africa Pipeline Company (WAPC) (2004). *Environmental Impact Assessment for the West Africa Gas Pipeline Project*.

Whitehead P J P (1985). FAO Species catalogue Vol. 7. *Clupeoid fishes of the world. (Suborder CLUPEOIDEI) An annotated and illustrated catalogue of the herrings, sardines, pilchards, sprats, anchovies and wolf-herrings. Part 1. Chirocentridae, Clupeidae and Pristigasteridae.* FAO Fish. Synop., (125)Vol.7 Pt.

WHO (2005) *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide Global update 2005: Summary of risk assessment*. Report WHO/SDE/PHE/OEH/06.02

Wiafe G (2002). *Spatial and temporal dynamics of plankton communities in the Gulf of Guinea ecosystem*. PhD Thesis, University of Ghana (Ghana), 200 pp.

Williams F (1968). *Report on the Guinean Trawling Survey. Publication of Scientific Technical Research Committee*. OAU Vol. I & II.

World Bank (2011). *Changes in Country classification*. http://data.worldbank.org/news/2010-GNI-income-classifications

World Bank (2012a). *Global Economic Prospects: Managing growth in a volatile world*. Washington DC.

World Bank (2012b). *Country Data profile: Ghana, 2010*. Accessed at http://devdata.worldbank.org/AAG/gha_aag.pdf
World Bank (2012c). Tourist numbers by arrival http://data.worldbank.org/indicator/ST.INT.ARVL

World Resource Institute (2003). *Climate and Atmosphere – Ghana* accessed at http://earthtrends.wri.org/pdf_library/country_profiles/cli_cou_288.pdf.

Attachment I

Consultation Report

CONTENTS

1 CONSULTATION REPORT 1-1

1.1 INTRODUCTION 1-1
1.2 BACKGROUND 1-1
1.3 FISHERIES CONSULTATIONS 1-2
1.4 SCOPING CONSULTATIONS 1-4
1.5 EIA CONSULTATIONS 1-18
1.6 COMMENTS ON DRAFT EIA 1-29

1 *CONSULTATION REPORT*

1.1 *INTRODUCTION*

This consultation report describes the consultation activities that were undertaken as part of the EIA for the TEN Project. The report concentrates on the EIA community-level consultations undertaken but also provides an overview of the previous fisheries consultations in April 2011 and scoping consultations in November 2011. It includes details of the approach used to consult communities and the key issues and concerns raised during the consultations. The report includes the following appendices:

- *Appendix 1:* Fisheries Consultation Attendance Sheets and Photos.
- *Appendix 2*: Background Information Document (BID).
- *Appendix 3:* Summary of Issues from Scoping Consultations.
- *Appendix 4*: Community Consultation Presentation.
- *Appendix 5*: Community Consultation Attendance Sheets and Photos.

1.2 *BACKGROUND*

A round of consultation meetings were undertaken in April 2011 with stakeholders in the fishing industry as part of the fisheries baseline study. Stakeholders were selected to include:

- those responsible for regulating and managing the fishing industry;
- representatives from the various fishing communities present in the coastal districts; and
- those involved in ancillary operations such as fish processing.

Representatives of the fishing communities were identified through discussions with the Chief Fishermen in the main fishing communities in the Western Region. In addition, consultations were held with relevant NGOs and research organisations.

During the EIA scoping phase, a round of stakeholder consultation meetings was undertaken in November 2011. The scoping consultations targeted national, regional and district authorities, traditional leadership, NGOs, the media, international organisations and fisher association. A second round of consultations was undertaken in March and June 2012 during the main EIA phase. The aim of these consultations was to gather baseline information on the socio-economic conditions in the coastal districts of the Western Region, to provide information about the proposed TEN Project at a community level and provide an opportunity for these stakeholders to express their concerns directly to the TGL and EIA team.

1.3 *Fisheries Consultations*

Fisheries consultations were undertaken from 6 to 16 April 2011. The consultations focussed on stakeholders with an interest in the fishing sector, in particular artisanal fisheries. Each meeting followed a standard agenda to guide the discussion. Questionnaires were used for meetings with the Chief Fishermen to gather specific fisheries information for each community to inform the baseline study. A total of 45 consultation meetings were held (*Table 1.1*). *Figure 1.1* and *Figure 1.2*, illustrate the locations of the meetings. A photo record an attendance sheets are provided in *Appendix 1*.

Figure 1.1 Location of Consultations – Jomoro, Ellembelle and Nzema East

Figure 1.2 Location of Consultations – Ahanta West, STM and Shama

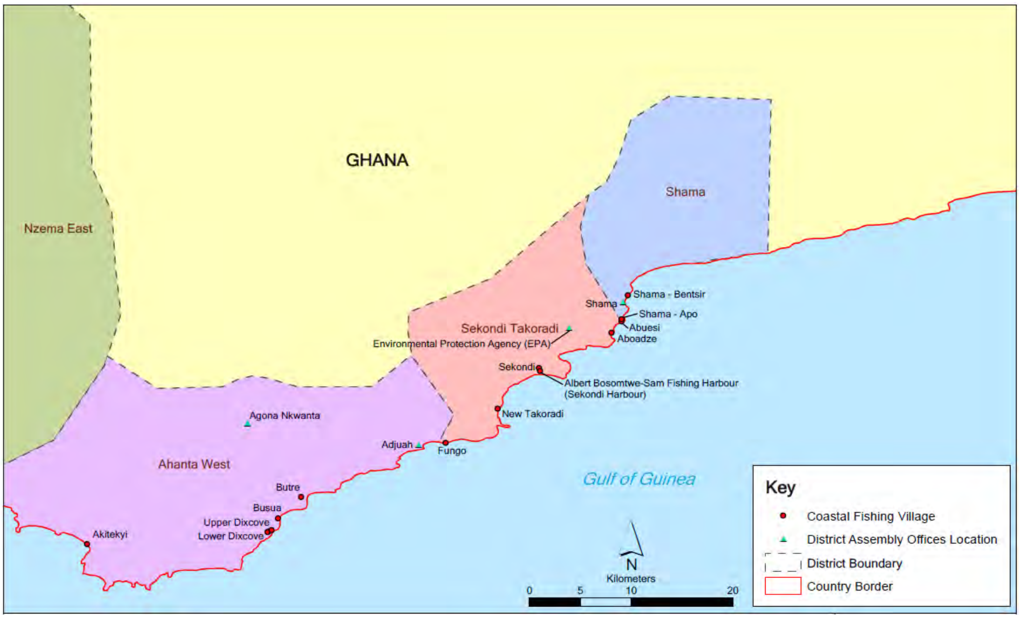


Table 1.1 Details of Fisheries Consultation Meetings, April 2011

Stakeholder Category	Organisation (Representatives from) *	District	Meeting Date
Government	Marine Fisheries Research Division (MFRD)	Accra	Wed 6 Apr
Government	Fisheries Commission	Accra	Fri 8 Apr
Government	Regional Minister	Shama	Tue 12 Apr
Government	Shama District Assembly	Shama	Tue 12 Apr
Government	Environmental Protection Agency (EPA)	Shama	Tue 12 Apr
Government	Ahanta West District Assembly	Ahanta West	Wed 13 Apr
Government	Ellembelle District Assembly	Ellembelle	Fri 15 Apr
Fisher Association	Ghana Tuna Association	Tema	Wed 6 Apr
Fisher Association	Ghana Inshore Fishermen Association, Tema	Tema	Wed 6 Apr
Fisher Association	National Fisheries Association of Ghana (NAFAG)	Accra	Thu 7 Apr
Fisher Association	Ghana National Canoe Fishermen Council (GNCFC)	Accra	Thu 7 Apr
Fisher Association	Ghana Industrial Trawlers Association	Accra	Thu 7 Apr
Fisher Association	Ghana National Association of Farmers and Fisheries (GNAFF)	Accra	Thu 7 Apr
Fisher Association	Ghana Inshore Fisheries Association, Sekondi	Sekondi & Takoradi	Mon 11 Apr
Fisheries Management Body	International Convention For the Conservation of Atlantic Tuna (ICCAT)	Accra	Wed 6 Apr
Fisheries Management Body	Guinea Current Large Marine Ecosystem (GCLME)	Accra	Thu 7 Apr
Fisheries Management Body	Fisheries Committee for the Eastern Central Atlantic (CECAF) (FAO)	Accra	Fri 8 Apr
Traditional Leadership	CF for New Takoradi	Sekondi & Takoradi	Mon 11 Apr
Traditional Leadership	CF for Sekondi	Sekondi & Takoradi	Mon 11 Apr
Traditional Leadership	CF for Aboadze	Shama	Tue 12 Apr
Traditional Leadership	CF for Abuesi	Shama	Tue 12 Apr
Traditional Leadership	CF for Adjuah	Shama	Tue 12 Apr
Traditional Leadership	CF for Fungo	Shama	Tue 12 Apr
Traditional Leadership	CF for Shama - Apo	Shama	Tue 12 Apr
Traditional Leadership	CF for Shama - Bentsir	Shama	Tue 12 Apr
Traditional Leadership	CF of Lower Dixcove 1	Ahanta West	Wed 13 Apr
Traditional Leadership	CF of Lower Dixcove 2	Ahanta West	Wed 13 Apr
Traditional Leadership	CF of Upper Dixcove	Ahanta West	Wed 13 Apr
Traditional Leadership	CF of Akitekyi	Ahanta West	Wed 13 Apr
Traditional Leadership	CF of Busua	Ahanta West	Wed 13 Apr
Traditional Leadership	CF of Butre	Ahanta West	Wed 13 Apr
Traditional Leadership	CF of Upper Axim	Nzema East	Thu 14 Apr
Traditional Leadership	CF of Lower Axim	Nzema East	Thu 14 Apr
Traditional Leadership	CF of Essiama	Ellembelle	Thu 14 Apr
Traditional Leadership	Fishermen Council (Axim)	Nzema East	Thu 14 Apr
Traditional Leadership	CF of Half Assini 1	Jomoro	Thu 14 Apr
Traditional Leadership	CF of Half Assini 2	Jomoro	Thu 14 Apr
Traditional Leadership	CF of Effasu & CF of Newtown**	Jomoro	Thu 14 Apr
Traditional Leadership	CF of Mangyea	Jomoro	Thu 14 Apr
Traditional Leadership	CF of Ahobre	Ellembelle	Fri 15 Apr
Traditional Leadership	CF of Ekpu	Ellembelle	Fri 15 Apr
Traditional Leadership	CF of Eikwe	Ellembelle	Fri 15 Apr
Academic	Department Oceanography and Fisheries, University of Ghana, Legon	Accra	Thu 7 Apr
Non-Governmental Organisation	Friends of the Nation	Sekondi & Takoradi	Mon 16 Apr
Non-Profit Organisation	Ricerca e Cooperazione	Accra	Mon 16 Apr

* CF = Chief Fisherman. Chief Fishermen are mainly fishermen themselves, or retired fishermen as well as serving a leadership role.
** CF of Newtown was visiting CF of Effasu en route to a meeting, so both were consulted simultaneously

1.4 SCOPING CONSULTATIONS

Scoping consultations included stakeholder meetings and disclosure of the Scoping Report.

1.4.1 *Scoping Consultation Meetings*

Scoping consultation meetings were undertaken from 17 to 30 November 2011. Meetings focussed on those stakeholders with a national and regional level interest in the project. A total of 26 meetings were held with 28 stakeholder groups.

A Background Information Document (BID) was compiled which provided information about the project and potential issues (see *Appendix 2*). The BID was written in a non-technical language with illustrations for communication with a wide range of stakeholders. Copies of the BID were handed out to stakeholders during scoping consultation meetings.

Outputs from the scoping consultation meetings were fed into to the Scoping Report and informed the rest of the EIA process.

1.4.2 *Disclosure of the Scoping Report*

A Scoping Report was produced which included records of scoping consultation meetings and a summary of issues raised. A summary of issues raised during Scoping consultations is included in *Appendix 3*. The draft Scoping Report was submitted to the EPA for review and the EPA approved it in April 2012.

The final Scoping Report was disclosed subsequent to the EPA's approval. An advertisement announcing the EIA and availability of the Scoping Report for comment was published in the Daily Graphic on 25 April 2012 (*Figure 1.3*). Copies of the Scoping Report were placed at central locations for public review. The copies were placed at the following locations:

- EPA library, Accra;
- Tullow Offices, Accra;
- Tullow Offices, Takoradi; and
- Sekondi Public Library.

1.4.3 *Project Website*

A website was created with up-to-date information on the TEN Project and the EIA process. Copies of the Scoping Report and BID were available for download from the website.

The URL for the website is www.erm.com/ten.

Figure 1.3 Notice in the Daily Graphic - 25 April 2012

Notice of Environmental Impact Assessment (EIA)

TULLOW

ERM

Further exploration and appraisal drilling in the Deep Water Tano (DWT) block offshore Ghana during 2009 and 2010 resulted in the discovery of the Tweneboa, Enyenra (originally named Owo) and Ntomme (T.E.N.) oil and gas fields. The fields are located approximately 60 km offshore and 30 km to the west of the existing Jubilee Field. Tullow Ghana Limited and partners are proposing to develop the T.E.N. fields.

> *Notice is given of a Public Consultation Process (dates to be further communicated) & the intention to apply for Environmental Authorisation in terms of the Environmental Assessment Regulations (1999). Oil and gas field development is an undertaking for which an Environmental Impact Assessment (EIA) is mandatory.*
> EPA ref: CU/51/77

Tullow is the designated operator for the DWT block and will lead the project design, execution, and operation phases of the proposed development. The T.E.N. development will consist of oil and gas production wells, water injection wells and gas injection wells. Production will be gathered through subsea manifolds and conveyed by subsea flow lines to a Floating Production Storage and Offloading vessel (FPSO) which will be moored in the area of the T.E.N. fields. Subsea equipment installation is planned throughout 2014 and the target for first production is 2015.

Authorisation is required from the Ghana Environmental Protection Authority (EPA) based on the outcome of an EIA. Tullow has commissioned Environmental Resources Management (ERM) in collaboration with Accra-based consultants ESL Consulting and SRC Consulting to undertake the EIA for the T.E.N. development. An EIA will be prepared and submitted for approval by the EPA in 2012.

Copies of all relevant documents can be obtained from Tullow or ESL or downloaded from www.erm.com/TEN. Additionally, copies will be made available for consultation at the EPA Library in Accra (Head Office) and in Sekondi (Western Regional Office). If you have any comments, please submit them to Tullow or ESL on or before 25 May 2012.

Contacts:	**EPA**	**Tullow Ghana Limited**	**ESL Consulting**
Address:	P. O. Box M-326 Accra	P O Box CT 386 Cantonments, Accra	P.O. Box LG 239 Legon, Accra
Contact:	Executive Director	Dr Glenn Bestall	Mr AK Armah
Tel:	021 664697/8	0302 742200	024 477 1707
Fax:	021 662690	0302 742300	021 514 614
Email:	support@epaghana.org	glenn.bestall@tullowoil.com	akarmah@yahoo.com

1.4.4 *Key Issues Raised by Stakeholders during Scoping Phase*

Table 1.2 presents the key issues raised by stakeholders during the scoping phase, including a list of the organisations that raised the issues.

Table 1.2 Key Issues during Scoping Consultations

#	Issue	Organisation
1.	**Interaction with Fishers and Fishery**	
1.1	Tension created between fishermen and Ghana navy / security personnel due to fishing in and around safety zone as fishermen	• Environmental Protection Agency (EPA), Accra • Ellembelle District Assembly (EDA) • Ghana Navy • Marine Fisheries Research division (MFRD) • Ghana National Canoe Fishermen Council (GNCFC) • National Fisheries Association of Ghana (NAFAG) • Friends of the Earth / Coastal Resources Centre • Nzema East Municipal Assembly (NEMA) • Guinea Current Large Marine Ecosystem (GCLME) • Ghana Maritime Authority (GMA) • Coastal Resources Centre – Ghana • Fisheries Commission • Western Region Fisheries Commission (WRFC) • Shama District Assembly (SDA)
1.2	Effect of project on reduction in fish catch rates	• Ahanta West District Assembly (AWDA)
1.3	Seaweed substance in waters and coming on shore and hindering fishing activities. What can be done to remove it?	• Environmental Protection Agency, Sekondi • Ahanta West District Assembly (AWDA) • Chief Fishermen of Western Region (CFWR) • Jomoro District Assembly (JDA)
1.4	More frequent consultation of fishermen may help relieve some tensions about the safety zone as well as direct dealings with fishermen not those with higher authority	• Environmental Protection Agency (EPA), Sekondi • Chief Fishermen of Western Region (CFWR) • Ghana National Canoe Fishermen Council (GNCFC) • Fisheries Commission
1.5	Demarcation of safety zone to ward off fishermen	• Jomoro District Assembly (JDA) • Ghana National Canoe Fishermen Council (GNCFC)
1.6	FPSO prevents fish from following natural annual migrations from west to east	• National Fisheries Association of Ghana (NAFAG)
1.8	How does TGL intend to handle the notion held by fishermen that the FPSO attracts all the fish thus depriving them of catch	• Sekondi Takoradi Metropolitan Assembly (STMA) • Friends of the Nation

#	Issue	Organisation
1.9	Need for comprehensive Fisheries Impact Assessment for T.E.N.	• Fisheries Commission • Marine Fisheries Research division (MFRD) • Chief Fishermen of Western Region (CFWR) • Ellembelle District Assembly (EDA) • Western Region Fisheries Commission (WRFC)
1.10	Suggestions that developments in aqua / mariculture may help fish stocks to recover	• Guinea Current Large Marine Ecosystem (GCLME) • Fisheries Commission
1.11	Suggestion that an independent cost-benefit analysis of the oil industry and fisheries sector should be undertaken	• Wassa Association of People Affected by Mining (WACAM)
1.12	Thinning out of fishermen will not work immediately as they will just return	• Fisheries Commission
1.13	Concern that increased oil and gas support vessel movement will destroy fishing nets	• Western Region Fisheries Commission (WRFC)
2.	**Consultation / Communication / Disclosure**	
2.1	Not all community members consulted for Jubilee Phase 1 EIA, hope for T.E.N. EIA to include all stakeholders	• Ahanta West District Assembly (AWDA)
2.2	Public hearings should be made mandatory	• Ahanta West District Assembly (AWDA) • Jomoro District Assembly (JDA)
2.3	Hard copy of EIAs (including T.E.N.) requested to assembly when completed	• Ahanta West District Assembly (AWDA)
2.4	How will stakeholder comments be addressed?	• Friends of the Earth / Coastal Resources Centre
2.5	Suggest that a simplified version of EIA document devoid of technical expressions is prepared and given to the people. Summaries and key findings document would be useful	• Friends of the Earth / Coastal Resources Centre
2.6	Complaint desk – Concerns that the TGL it is sited at Nkroful which is a long way for fishermen to travel. Complaint desk enables a two-way communication flow.	• Chief Fishermen of Western Region (CFWR) • Friends of the Earth / Coastal Resources Centre
2.7	Request for a sustainable dialogue between operators and local communities to respond to issues and for communication of information.	• Friends of the Earth / Coastal Resources Centre
2.8	The T.E.N. development BID was not received early enough. Some stakeholders were not consulted as a consequence.	• Nzema East Municipal Assembly (NEMA)
2.9	The BID should include some information on planned prevention measures and contingency plans	• Ricerca e Cooperazione
2.10	Communication with fishermen through NAFAG more effective than through central government	• National Fisheries Association of Ghana (NAFAG)

#	Issue	Organisation
2.11	EIA should consider lessons learnt from Macondo deepwater oil spill in the Gulf of Mexico	• Wildlife department, Forestry Commission • Friends of the Earth / Coastal Resources Centre
2.12	Advice stating that TGL should help to manage the expectations of locals	• Sekondi Takoradi Metropolitan Assembly (STMA)
2.13	Wider stakeholder consultations should be undertaken. Would more be undertaken?	• Wassa Association of People Affected by Mining • Ellembelle District Assembly (EDA)
2.14	EPA should have been part of the consultations	• Ellembelle District Assembly (EDA)
2.15	Request that the EIA team consult with the Ghana Museums and Monuments board and Tourism Board	• Ricerca e Cooperazione
2.16	T.E.N development should not be executed without the full involvement and consideration of the plights of fishermen	• Fisheries Commission
2.17	What would happen if the EPA rejects the EIA?	• Western Region House of Chiefs (WRHC)
2.18	Requested more interaction between fishermen, government and oil and gas companies to disclose information about ongoing activities and discuss other issues	• Western Region Fisheries Commission (WRFC)
2.20	Lack of interaction between TGL and the Fisheries Commission. Requests for ongoing consultation with the Commission.	• Western Region Fisheries Commission (WRFC)
2.21	Confusion over the need for an EIA when and EIA had been done for the Jubilee Field which is geographically similar	• Shama District Assembly (SDA)
2.22	Have any waste management companies been contacted in the EIA process?	• Shama District Assembly (SDA)
3.	**CSR and Commitments**	
3.1	Concerns that TGL had not fulfilled promises made in Jubilee EIA. Requests that TGL honour their promises	• Nzema East Municipal Assembly (NEMA) • Chief Fishermen of Western Region (CFWR) • Friends of the Earth / Coastal Resources Centre
3.2	Boreholes which were constructed in the coastal districts - not functional	• Ahanta West District Assembly (AWDA)
3.3	Why has Tullow not appointed a Fisheries Liaison Officers(s)?	• Friends of the Earth / Coastal Resources Centre • Western Region Fisheries Commission (WRFC)
3.4	People of the Western Region do not experience any benefits from the industry which causes discontent	• Fisheries Commission • Ricerca e Cooperazione • District assemblies
3.5	Why are Tullow implementing CSR projects in other Districts and not our District?	• Nzema East District Assembly (NEDA) • Ahanta West District Assembly (AWDA)

#	Issue	Organisation
3.6	Call for coordination between Tullow and respective District Assemblies on implementation of CSR projects	• Friends of the Earth / Coastal Resources Centre
4.	**Education and Training**	
4.1	Concern about the training of youths. Why do they not get the jobs promised? Qualifications offered by training institutions not recognised.	• Ahanta West District Assembly (AWDA) • Ellembelle District Assembly (EDA) • Jomoro District Assembly (JDA)
4.2	TGL to roll out capacity building programmes including workshops and seminars for assembly members to improve skills so that they can engage for effectively.	• Ahanta West District Assembly (AWDA)
4.3	Need for scholarships to be given to children of fishermen in the district to educate children. Scholarships should be sent to education office to select the right beneficiaries.	• Ellembelle District Assembly (EDA) • Chief Fishermen of Western Region (CFWR) • Jomoro District Assembly (JDA) • Shama District Assembly (SDA)
4.4	Communities should be educated in the decline of fish stocks and made aware that it is not because of the oil industry to avoid future conflict	• Friends of the Earth / Coastal Resources Centre
4.5	Training of youth should not just be in the oil and gas sector as there are no enough job in the oil and gas sector	• Nzema East Municipal Assembly (NEMA)
4.6	Concerns about education with scholarships, social security etc	• Nzema East Municipal Assembly (NEMA)
4.7	Education of fishers would help with enforcement of safety zone as fishermen would be aware of the hazards associated with their activities around the FPSO and disperse some of the issues.	• Ghana Navy (GN) • National Fisheries Association of Ghana (NAFAG) • Ghana National Canoe Fishermen Council (GNCFC)
4.8	Suggestions for some form of financial aid be injected into the adult education programme already in place by the Ministry of Education	• Ellembelle District Assembly (EDA)
4.9	Providing youth with better education and opportunities could help with alternative livelihoods to fishing	• Marine Fisheries Research division (MFRD) • Ghana Maritime Authority (GMA)
4.10	Raising awareness and consultation with the fishermen would help disperse some of the issues	• Guinea Current Large Marine Ecosystem (GCLME) • Friends of the Earth / Coastal Resources Centre • Fisheries commission
4.11	Investment in education of technical skills may make local people more employable	• Ricerca e Cooperazione
4.12	Chiefs need to be consulted in the selection of youth to be trained	• Western Region House of Chiefs (WRHC)
5.	**Employment**	
5.1	Concerns over employment and TGL employing people from outside the region and/or Country	• Jomoro District Assembly (JDA) • Ricerca e Cooperazione

#	Issue	Organisation
5.2	Preference should be given to employing people from the Western Region.	• District Assemblies
5.3	Suggested that Tullow manage expectation of people in terms of employment as few job opportunities exist the oil industry	• Ellembelle District Assembly (EDA)
6.	**Waste Disposal / Discharges at sea**	
6.1	Concerns over what happens to drill cuttings and mud during well development. TGL should consider cleaned drill cuttings for alternative uses.	• Chief Fishermen of Western Region (CFWR) • Ghana Maritime Authority (GMA) • Shama District Assembly (SDA)
6.2	Concerns about how waste is transported from the FPSO for disposal	• Ellembelle District Assembly (EDA) • Sekondi Takoradi Metropolitan Assembly (STMA)
6.3	Concerns about discharges at sea and consequently the impacts on marine biodiversity	• Nzema East Municipal Assembly (NEMA) • Jomoro District Assembly (JDA) • Western Region Fisheries Commission (WRFC) • Shama District Assembly (SDA)
6.4	Concerns about ballast water discharge and the effect of micro-organisms and on marine biodiversity. Needs to be addressed in EIA	• National Fisheries Association of Ghana (NAFAG) • Guinea Current Large Marine Ecosystem (GCLME) • Friends of the Earth / Coastal Resources Centre • Chief Fishermen of Western Region (CFWR) • Ghana Wildlife Society (GWS)
6.5	Does GPHA monitor ballast water discharge of vessels queuing in anchorage?	• Ghana Ports and Harbours Authority (GPHA)
6.6	Concerns about the effects of the disposal of water produced during operation on marine biodiversity	• Ellembelle District Assembly (EDA)
6.7	Request that waste management practices comply with international standards	• Sekondi Takoradi Metropolitan Assembly (STMA)
6.8	Concern about the management of oil waste in the Jubilee and T.E.N. development and how TGL monitor vessels	• Environmental Protection Agency (EPA) • Sekondi Takoradi Metropolitan Assembly (STMA)
6.9	Concerns about waste management and capacity of waste disposal contractors need to be enhanced to deal with waste from the T.E.N. or involving more waste disposal contractors involved	• Environmental Protection Agency (EPA) • Ghana Ports and Harbours Authority (GPHA) • Guinea Current Large Marine Ecosystem (GCLME) • Sekondi Takoradi Metropolitan Assembly (STMA)
6.10	No mention in T.E.N. BID about expected volumes of wastes produced daily	• Ricerca e Cooperazione
6.11	Request that EIA team consider waste management issues due to limited facilities available in Western Region	• Ricerca e Cooperazione

#	Issue	Organisation
6.12	Waste management companies need to work in conformity with international standards	• Shama District Assembly (SDA)
7.	**Air Emissions**	
7.1	How will air emissions be mitigated to prevent associated health issues?	• Jomoro District Assembly (JDA)
7.2	How far may the air emissions reach?	• Western Region House of Chiefs (WRHC)
7.3	Concerns of the effects of air emissions on birds? Mitigation measures need to be looked at	• Ghana Wildlife Society (GWS)
7.4	Concern that air emissions is causing health problems such as rashes and swelling of eyes.	• Jomoro District Assembly (JDA) • Nzema East District Assembly (NEDA) • Chief Fishermen of Western Region (CFWR) • Shama District Assembly (SDA)
8.	**Oil Spills – Contingency Plans**	
8.1	Ghana Navy play a role in National Oil Spill and Contingency Plan (NOSCP) in regards to coordination of operation in the event of a spill and make their vessels available.	• Ghana Navy (GN)
8.2	Concerns on how the EPA would make sure mitigation measures are binding on operator so that they would not be able to spill.	• Ellembelle District Assembly (EDA)
8.3	Concerns over the impact of a potential oil spill on marine and coastal fauna especially with regard to coastal RAMSAR sites.	• Wildlife department, Forestry Commission
8.4	Need for a comprehensive contingency plan for oil spills which clearly details different roles	• Ghana Ports and Harbours Authority (GPHA) • Environmental Protection Agency (EPA) • Chief Fishermen of Western Region (CFWR)
8.5	Oil spills and their impacts, should be adequately addressed in the EIA	• Guinea Current Large Marine Ecosystem (GCLME) • Ricerca e Cooperazione
8.6	Concerns about the effect of potential oil spill on fishermen	• Ghana National Canoe Fishermen Council (GNCFC) • Guinea Current Large Marine Ecosystem (GCLME)
8.7	Suggestions that a percentage of oil revenue reserved as part of an oil and gas fund to assist the fishery in this event.	• Ghana National Canoe Fishermen Council (GNCFC)
8.8	Although the project is located offshore coastal sites could be impacted in the event on an oil spill.	• Ricerca e Cooperazione
8.9	How far would a potential oil spill reach?	• Western Region House of Chiefs (WRHC)

#	Issue	Organisation
8.10	What is the capacity of TGL to respond to oil spill hazards?	• Chief Fishermen of Western Region (CFWR) • Shama District Assembly (SDA)
9.	**Compensation**	
9.1	Compensation to fishermen from TGL in the worst case scenario oil spill.	• Chief Fishermen of Western Region (CFWR) • Jomoro District Assembly (JDA)
9.2	There is no contingency plan for managing emergencies such as oil spills, fires etc	• Sekondi Takoradi Metropolitan Assembly (STMA)
9.3	Some NGOs and all fishermen in the region demanding for a clear compensation package for fishermen and local communities	• Friends of the Earth / Coastal Resources Centre • Environmental Protection Agency (EPA) • Marine Fisheries Research division (MFRD)
9.4	Local people are losing land to GNPC without proper compensation	• Wassa Association of People Affected by Mining (WACAM)
9.5	Effects of air emissions on people. What will be done for them in terms of compensation?	• Ellembelle District Assembly (EDA)
10	**Production and revenue**	
10.1	Production capacity of T.E.N. development	• Marine Fisheries Research division (MFRD) • Ahanta West District Assembly (AWDA) • Western Region House of Chiefs (WRHC)
10.2	Would the district assembly also benefit directly for the tax revenue generated to the government	• Jomoro District Assembly (JDA)
11.	**Impacts and Mitigation**	
11.1	Mitigation measures should be explicitly provided in the EIA and linked to implementation timeframes	• Friends of the Earth / Coastal Resources Centre • Ellembelle District Assembly (EDA)
11.2	Mitigations must be separate from CSR	• Friends of the Earth / Coastal Resources Centre
11.3	Have TGL done any environmental monitoring since their operation started?	• Jomoro District Assembly (JDA)
11.4	Will Tullow implement an Environmental, Health and Safety Plan?	• Guinea Current Large Marine Ecosystem (GCLME)
11.5	TGL to maintain and deal with service providers who have environmental approval / permits	• Environmental Protection Agency (EPA)
11.6	Noise impacts should be considered	• Shama District Assembly (SDA) • Western Region House of Chiefs (WRHC)
11.7	Concerns over the age of the data usually used in the EIA. Implementation of independent environmental assessment and monitoring	• Ghana Wildlife Society (GWS)
11.8	Suggestions that oil companies work in collaboration with the government to institute a program to build the capacity for effective offshore monitoring	• Ghana Wildlife Society (GWS)

#	Issue	Organisation
11.9	How does the EPA monitor limits of emissions and waste from FPSO operations?	• Ellembelle District Assembly (EDA)
12.	**Alternative Livelihoods**	
12.1	Establishment of art and craft centre to train fishermen and fishmongers in artefacts production	• Chief Fishermen of Western Region (CFWR)
12.2	Suggestions of alternative livelihoods for fishermen	• Ghana Maritime Authority (GMA) • Nzema East Municipal Assembly (NEMA)
12.3	EIA to address issues regarding capacity building for youth and adult alternative livelihood program	• Nzema East Municipal Assembly (NEMA)
12.4	Farmers may be tempted to go into other businesses therefore less food would be grown	• Ellembelle District Assembly (EDA) • Nzema East Municipal Assembly (NEMA)
12.5	Alternative livelihoods need to be addressed in the EIA	• Shama District Assembly (SDA)
13	**Cumulative Impacts**	
13.1	Concern about the cumulative impacts of the project, other oil and gas activities, future activities and operational activities (eg Port)	• Friends of the Earth / Coastal Resources Centre • Ellembelle District Assembly (EDA) • Guinea Current Large Marine Ecosystem (GCLME)
13.2	Ghanaians are concerned that oil activities could result in a similar situation to Nigeria	• Marine Fisheries Research Division (MFRD)
13.3	Concerns about future developments and the cumulative impact on fishermen	• Ghana National Canoe Fishermen Council (GNCFC)
14.	**Incremental Development and Increased Pressure on Infrastructure**	
14.1	GTB should have a say in regulating development in the Region to prevent developments in unsuitable locations	• Ghana Tourist Board (GTB)
14.2	Concerns that the oil and gas industry is putting pressure on social services and amenities, port and port services and that the new project will increase pressure.	• Friends of the Earth / Coastal Resources Centre • Ghana Tourist Board (GTB) • Ghana Ports and Harbours Authority (GPHA)
14.3	Increase in vehicle movements causing congestion	• Ghana Tourist Board (GTB) • Sekondi Takoradi Metropolitan Assembly (STMA) • Western Region House of Chiefs (WRHC)
14.4	High demand for short term accommodation	• Ghana Tourist Board (GTB)
14.5	Rapid deterioration of roads due to the increase in heavy duty vehicular movement	• Sekondi Takoradi Metropolitan Assembly (STMA) • Western Region House of Chiefs (WRHC)
14.6	Plans to expand Takoradi port to enhance port capacity and operations	• Ghana Ports and Harbours Authority (GPHA)

#	Issue	Organisation
14.7	Plans to redesign road network leading to and from the port and for a new railway system	• Ghana Ports and Harbours Authority (GPHA)
14.8	The development of the oil industry is attracting further development to the Western Region	• Ricerca e Cooperazione
14.9	Lack of developmental plans and controls poses a threat to the natural and cultural heritage of the region	• Ricerca e Cooperazione
14.10	TGL should integrate its activities in the local economy to avoid inflating local prices	• Ricerca e Cooperazione
15.	**Socio-economic effects**	
15.1	Negative social impacts associated with an influx of people into the region	• Environmental Protection Agency (EPA) • Western Region House of Chiefs (WRHC)
15.2	Socio-economic issues should be incorporated in the EIA	• Guinea Current Large Marine Ecosystem (GCLME)
15.3	Development in the region has resulted in significant inflation of rental prices amongst others	• Ricerca e Cooperazione • Ghana Tourist Board (GTB) • Ricerca e Cooperazione • Western Region House of Chiefs (WRHC)
15.4	Need for an assessment of positive and negative impacts that are directly related to the evolving oil and gas sector within the past 2-3 years	• Coastal Resources Centre (CRC)– Ghana • Ricerca e Cooperazione
15.5	Security issues from influx of people to the region eg higher crime rates	• Nzema East Municipal Assembly (NEMA)
15.6	Suggestions that health issues should be investigated and measures put in place to address issues	• Ellembelle District Assembly (EDA)
16.	**Flaring**	
16.1	Concerns about the absence of a gas infrastructure – flaring would still go on	• Nzema East Municipal Assembly (NEMA) • Ellembelle District Assembly (EDA)
16.2	Is flaring currently occurring at the Jubilee? To what extent? Is it allowed in international circles?	• Ellembelle District Assembly (EDA) • Sekondi Takoradi Metropolitan Assembly (STMA)
16.3	Will there be flaring in the T.E.N. development	• Environmental Protection Agency (EPA) • Marine Fisheries Research division (MFRD)
17.	**Emergencies and health Infrastructure**	
17.1	Hospitals in every district should be upgraded and well equipped to handle accidents and fire victims in the case of emergencies	• Nzema East Municipal Assembly (NEMA) • Jomoro District Assembly (JDA) • Ellembelle District Assembly (EDA) • Sekondi Takoradi Metropolitan Assembly (STMA)
17.2	What would be the extent of the likelihood of an accident?	• Western Region House of Chiefs (WRHC)

#	Issue	Organisation
18.	**Jubilee field**	
18.1	EPA has not done much to disseminate monitoring information regarding the Jubilee and should have	• Nzema East Municipal Assembly (NEMA)
18.2	Advice to TGL to strengthen local content policy	• Nzema East Municipal Assembly (NEMA)
18.3	Complaint about Jubilee operators not consulting with GTB about licensing for vehicles	• Ghana Tourist Board (GTB)
18.4	Are any challenges in the Jubilee production not known to the public?	• Sekondi Takoradi Metropolitan Assembly (STMA)
18.5	Initial Jubilee report was too bulky and many communities members could not read or could not understand technicalities	• Jomoro District Assembly (JDA)
19.	**Navigation and safety**	
19.1	EIA must address: • Presence of small vessels destroying fishing nets; • Increased risk on sea due to presence of oil companies • Standby rescue equipment made available	• Chief Fishermen of Western Region (CFWR)
19.2	Concerns in the increase in vessel movements and the potential for accidents with artisanal fishing boats	• Chief Fishermen of Western Region (CFWR)
19.3	Concerns over safety risks from piracy instances in Togo and oil bunkering at Exo Terra	• Friends of the Earth / Coastal Resources Centre • Ghana Ports and Harbours Authority (GPHA) • Environmental Protection Agency (EPA)
19.4	Concerns for safety of staff in rough conditions when inspecting oil shuttle tankers	• Ghana Maritime Authority (GMA)
20.	**Transboundary Issues**	
	Transboundary issues to be well addressed in EIA	• Nzema East Municipal Assembly (NEMA) • Guinea Current Large Marine Ecosystem (GCLME)
	Any maritime boundary disputes will be dealt with by the boundary working group in Ghana before any issues arise	• Ghana Navy (GN)
	Will Transboundary issues be considered in the EIA?	• Guinea Current Large Marine Ecosystem (GCLME)
21.	**Sea level rise and Coastal Erosion**	•
21.1	Opinion that oil production would result in sea level rise and exacerbate the coastal erosion problem in the district	• Jomoro District Assembly (JDA) • Ellembelle District Assembly (EDA) • Shama District Assembly (SDA)
22.	**Tullow operations**	
22.1	Possibility of TGL extending its operation into downstream oil activities?	• Ellembelle District Assembly (EDA)

#	Issue	Organisation
22.2	Why the T.E.N. names were given to the new fields as they do not portray anything from the region	• Western Region House of Chiefs (WRHC)
22.3	Concern with the fact that people keep stating the oil find was in the western region but thoughts were that it was not exclusive	• Ghana Wildlife Society (GWS)
23	**Decommissioning**	
23.1	Any decommissioning plans for the T.E.N development	• Ellembelle District Assembly (EDA)
24.	**International Conventions**	
24.1	Indications that the Government of Ghana will likely ratify 2 conventions (Control and management of ballast water and removal of wrecks)	• Ghana Maritime Authority (GMA)
25.	**Positive Impacts**	
	Further oil field development will result in more revenue and if a fund is set up more will be available for fishermen	• Ghana National Canoe Fishermen Council (GNCFC)
26.	**Fauna and Flora**	
26.1	Concerns over wildlife hunting by expatriates in the Western Region	• Wildlife department, Forestry Commission
26.2	Suggestions that the EIA should consider impacts of lighting on migratory birds and turtles	• Wildlife department, Forestry Commission
26.3	Concern about safety of marine fauna for consumption	• Nzema East Municipal Assembly (NEMA) • Ghana Wildlife Society (GWS)
26.4	Suggestions that the EIA considers the impact of helicopter transit on important bird habitats	• Wildlife department, Forestry Commission
26.5	Suggestions that marine mammal sightings should be recorded during the project. Is there information on cetacean migration routes?	• Wildlife department, Forestry Commission
26.6	Concerns on the effect of oil activities on marine mammals in Ghanaian waters	• Ghana Wildlife Society (GWS)
26.7	Will old baseline information be used for the project?	• Friends of the Earth / Coastal Resources Centre
26.8	Suggestions that Tullow consider beneficiating biodiversity conservation initiatives	• Wildlife department, Forestry Commission
26.9	Concerns that oil and gas activities have influenced marine mammal stranding in Ghana	• Wildlife department, Forestry Commission • Environmental Protection Agency (EPA) • Ghana Wildlife Society (GWS)
26.10	Guidelines for biodiversity offsets are being developed for Ghana	• Wildlife department, Forestry Commission

#	Issue	Organisation
26.11	Algal bloom and sea weed on some beaches causing them to be unsuitable for leisure activities	• Ghana Tourist Board (GTB)
26.11	Nansen fish biomass survey is routinely conducted to monitor fish stocks	• Guinea Current Large Marine Ecosystem (GCLME)
26.12	Issue of independent monitoring of the effect of oil activities on marine biodiversity. Findings should be made available to the general public	• Ghana Wildlife Society (GWS)
26.13	Concerns over the introduction of invasive species from vessels other than in ballast water (eg Indian Myna bird)	• Ghana Wildlife Society (GWS) • Western Region Fisheries Commission (WRFC)
26.14	What will the effects of the Jubilee operations on marine biodiversity be?	• Western Region House of Chiefs (WRHC)
26.15	Concerns on the lack of information on marine biodiversity and the impact of oil activities (especially on birds)	• Ghana Wildlife Society (GWS)
27.	**Cultural Heritage**	
27.1	Western Region has a rich cultural heritage, requests that the EIA considers potential impacts on these sites	• Ricerca e Cooperazione
27.2	Incremental development has negative impacts on cultural world heritage sites.	• Ricerca e Cooperazione • Ghana Tourism Board (GTB)

1.5 EIA CONSULTATIONS

Stakeholder consultations during the EIA included community meetings, Focus group Discussions (FGD) and Key Informant Interviews (KII) in selected communities. This section provides a description of the consultation methods, activities and results.

1.5.1 *Selection of Communities*

The consultations focussed on the six coastal districts in the Western Region, namely Jomoro, Ellembelle, Nzema East, Ahanta West, Sekondi Takoradi Metropolis (STM) and Shama. There are 102 coastal communities within these districts. A representative number of communities were selected for the consultations based on a set of criteria agreed by TGL and the EIA team. The key criteria that were used are outlined below.

- Size of population (small, medium and large per district).
- Dependence on fishing activities as primary livelihood source.
- Traditional/ institutional status of the community within the district.
- Probability of shoreline oiling in the unlikely event of an oil spill.
- Level of vulnerability (*eg* number of female-headed households).
- Access to infrastructure and services and employment/ income-generating opportunities.

Based on these criteria, the communities selected for consultation are presented in *Table 1.2.* A total of 34 communities were selected, comprising approximately 30% of the total number communities in the districts. *Figure 1.4* shows the location of the communities visited during the consultation process.

1.5.2 *Consultation and Data Gathering Methods*

The following consultation and data gathering methods were used.

- Community meetings to disseminate project information and to record issues and concerns.

- Focus Group Discussions (FGD) to gather socio-economic baseline data.

- Key Informant Interviews (KII) to ground truth the information gathered in FGDs and to collect specific information related to education and health.

- Ad hoc meetings to gather further information outside the formal forums.

- General observations to ground truth data gathered.

Table 1.3 provides further information about the selected methods.

Table 1.3 Communities Selected for Consultation

District	Selected Communities	Reason for Selection
Shama	Shama Apo Shama Benstir Aboadze	• District has very few coastal communities; most of which are located very close together (less than 1 km). • Selection was based on coastal fishing population and geographical spread of towns. • High dependency on fishing making the communities vulnerable in case of an oil spill. • High number of immigrants from Ivory Coast found in Aboazde.
STM	Bakakyir Ngyeresia New Takoradi Sekondi European Town (Sekondi)	• District where project onshore bases are located. • District has the highest population density. • The villages were selected based on coastal fishing population and geographical spread of towns. • High dependency on fishing making the communities vulnerable in case of an oil spill.
Ahanta West	Busua Butre Cape Three Points Dixcove Princess Akatakyir Princess Town	• The coastal fishing population and geographical spread of towns were the primary criteria. • The district capital, Nkwanta, is not in the coastal zone therefore was not included. The Traditional Head of district resides in Busua. • High dependency on fishing making the communities vulnerable in case of an oil spill. • Vulnerable and isolated community of Butre.
Nzema East	Upper and Lower Axim	• Most of the settlements lie very close together and are located at or around Axim, the district capital. The Traditional Head of district resides in Axim. • High dependency on fishing making the communities vulnerable in case of an oil spill.
Ellembele	Ankobra Essiama Atuabo Azelenloune Engyambra Enokyi	• Selection was based on coastal fishing/urban population, ecological sensitivity, and geographical spread. • The district capital, Nkroful, is not near the coast therefore was not included. The Traditional Head of district resides in Atuabo. • High dependency on fishing making the communities vulnerable in case of an oil spill.
Jomoro	Effasu Ahobre Bonyere Half Assini New Town Beyin (Benyilin, Ngelekazo, Elloin, Ekebaku, Kegeni and Keyian)*	• Closest district to the TEN Project area (60km to Half Assini the district capital). • The coastal fishing population and geographical spread of towns were the primary criteria. • High dependency on fishing making the communities vulnerable in case of an oil spill. • The traditional head of district resides in Beyin.

*The Paramount Chief invited community members from surrounding villages to attend the Beyin community consultation meetings.

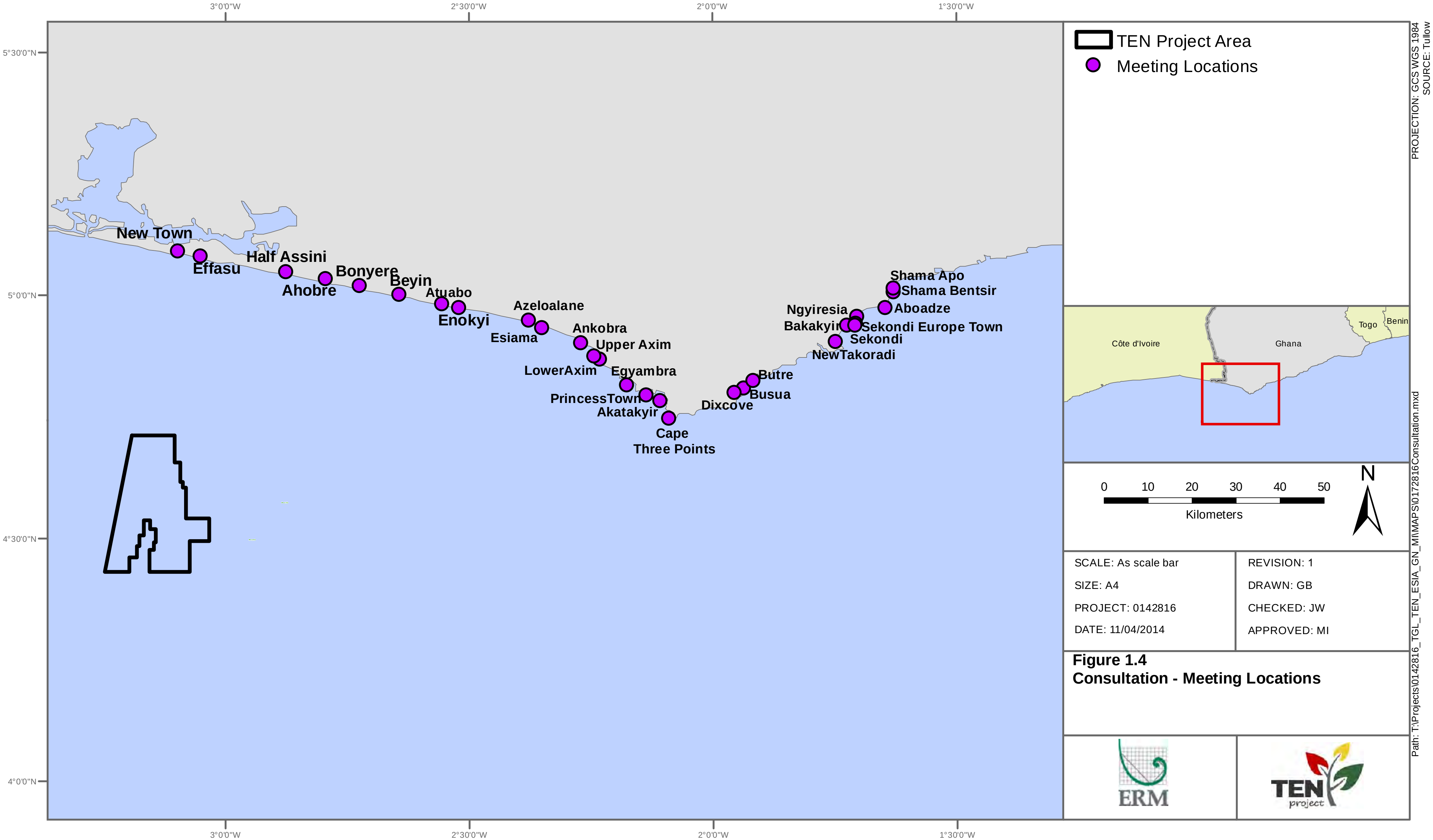


Figure 1.4
Consultation - Meeting Locations

Table 1.4 Data Gathering Tools Used

Data Collection Tool	Objective of Consultation	Justification for Methodology	Target Audience
Community Meeting (specifically selected community)	• Share information about the proposed project. • Provide opportunity for stakeholders to raise issues and concerns about the proposed project. • Provide responses to project related questions. • Record stakeholder comments and concerns for consideration in the EIA.	• To reach as many people as possible. • Recommended by EPA and other stakeholders during the Scoping phase. • Provides the communities the opportunity to speak to TGL representatives directly.	As many community members as possible.
Focus Group Discussion (FGD)	• Provide information about the project. • Allow community members to raise issues and concerns related to the project. • Allow issues to be verified, tested and solutions developed. • Gather socio-economic baseline information about the community.	• Smaller forum encourages participation of all present stakeholders without intimidation or fear (especially people who will not normally speak out in large gatherings). • Allows for the gathering of socio-economic baseline data and recording of further issues and concerns for inclusion into the EIA. • Allows for wider consultation and debate related to selected issues and topics. • Allows issues to be questioned and verified.	• Men and Leaders (in-depth knowledge of the socio-economic characteristics of the community). • Women (in depth knowledge of household characteristics in the community). • Fishermen (potentially most affected by the project). • 10 to 15 participants was the ideal number for FGDs. Note: Due to the level of interest in the communities there were times when these meetings far exceeded this number. The team were pleased with the level of interest and chose to continue with the high number of participants.

Data Collection Tool	Objective of Consultation	Justification for Methodology	Target Audience
Key Informant Interviews (KIIs)	• Provide information about the project activities. • Allow key informants to raise issues and concerns about the project. • Gather key socio-economic baseline information about the community (specifically health and education related). • Verify some of the information provided by the communities.	• Collection of socio-economic baseline data, and gain an understanding of education and health context and challenges. • Allows for follow up on issues and unexpected information. • Interviews by invitation only, so it is easier to predict and prepare for the types of issues that are likely to be raised. • Allows issues to be questioned and verified.	• Education: Head teachers and/ selection of subject teachers. They usually reside in the communities; have an in-depth knowledge of education system in the country and particular community and livelihoods activities of the community. • Health clinics, centers and hospitals: Director or head of administration. They usually reside in the communities; have an in-depth knowledge of health system in the country and particular community and livelihoods activities of the community.
Ad hoc Discussions with Community Members	• Opportunity to cross-check information about community concerns and socio-economic baseline information gathered in other forums. • Respond to observations made while in the communities.	• Gather additional socio-economic baseline information, as well as issues and concerns of those who may not have attended meetings or those who were unable to talk in the large community meeting forum. • Verification of socio-economic baseline information.	• Any and all community members (including traditional healers, shopkeepers, builders, artisans and others).
Observation	• Opportunity to gather socio-economic information related to general social infrastructure in the community. • Opportunity to make observations about the communities' social interactions.	• Verification of socio-economic baseline information.	• N/A

1.5.3 *Consultation Schedule and Records*

Community consultations were undertaken from 20 to 30 March 2012. Consultation meetings were delayed in Jomoro District due to raised levels of tension related to the relocation of the gas processing facility at Donmunlini. Consultations were undertaken in Jomoro from 19 to 25 June 2012. In total, 27 [(1)] community meetings, 66 FGDs and 33 KIIs were held. *Table 1.4* provides a list of the communities that visited and the meetings held in each community.

The consultation team comprised two teams, each including a consultant from ERM, two consultants from ESL or SRC and a representative from TGL's Corporate Social Responsibility team. Where possible, TGL Community Liaison Officers accompanied the teams.

At each community meeting, a presentation was given to communicate information about the proposed TEN Project to community members. Participants were provided an opportunity to ask questions and/or raise any issues or concerns. A copy of the presentation is included in *Appendix 4*. Copies of the BID were handed out to stakeholders during the consultation meetings. Over 1,000 BIDs were distributed. At each FGD, a brief overview of the project was provided, however, the meetings were primarily used for data gathering. At each KII, information on education and health was obtained.

Participants attending community meetings were requested to complete attendance registers. Copies of the attendance registers obtained are provided in *Appendix 5*. Where possible, attendance registers were completed during FGDs, however, this was not always possible. A photo record of the meetings is also provided in *Appendix 5*.

(1) The number of community meetings (27) is less than the number of communities (34) as some smaller communities were invited to attend a combined community meeting at a central village.

Table 1.5 Details of Consultation Meetings Undertaken

Community	Date of Meeting	Type of Meeting	Number of Attendees
Ankobra	20/03/2012	Community Meeting	74
		FGD: Men and Leaders	-
		FGD: Fishermen	31
		FGD: Women	73
		KII Education	5
		KII Health	-
Busua	21/3/2012	Community Meeting	64
		FGD: Men and Leaders	-
		FGD: Fishermen	8
		FGD Women	19
		KII Education	1
		KII Health	-
Essiama	21/3/2012	Community Meeting	40
		FGD: Men and Leaders	11
		FGD: Fishermen	21
		FGD: Women	257
		KII Education	1
		KII Health	1
Cape Three Points	22/03/2012	Community Meeting	93
		FGD: Men and Leaders	42
		FGD: Fishermen	
		FGD: Women	40
		KII Education	1
		KII Health	-
Azulenloanu	22/03/2012	Community Meeting	37
		FGD: Men and Leaders	9
		FGD: Fishermen	14
		FGD: Women	15
		KII Education	1
		KII Health	-
Akatakyir	23/03/2012	Community Meeting	44
		FGD: Men and Leaders	-
		FGD: Fishermen	13
		FGD: Women	12
		KII education	2
		KII Health	
Lower Axim	23/03/2012	Community Meeting	42
		FGD: Men and Leaders	-
		FGD: Fishermen	38
		FGD: Women	31
		KII Education	2
		KII Health	4
Princess Town	23/03/2012	Community Meeting	44
		FGD: Men and Leaders	13
		FGD: Fishermen	18
		FGD: Women	10
		KII Education	3
		KII Health	9
Egyambra	24/03/2012	Community Meeting	128
		FGD: Men and Leaders	10
		FGD: Fishermen	11
		FGD: Women	17
		KII Education	5
		KII Health	1

Community	Date of Meeting	Type of Meeting	Number of Attendees
Upper Axim	24/03/2012	Community Meeting	38
		FGD: Men and Leaders	
		FGD: Fishermen	24
		FGD: Women	-
		KII Education	-
		KII Health	-
Aboadze	26/03/2012	Community Meeting	60
		FGD: Men and Leaders	-
		FGD: Fishermen	15
		FGD: Women	26
		FGD: Youth	24
		KII Education	1
		KII Health	1
Shama Apo & Benstir	26/03/2012	Community Meeting (Apo and Benstir)	79
		FGD: Leaders and Men	8
Shama Benstir	26/03/2012	FGD: Fishermen	32
Shama Apo	26/03/2012	FGD: Fishermen	18
		FGD: Women	11
		KII Education	3
		KII Health	1
Butre	27/03/2012	Community Meeting	31
		FGD: Men and Leaders	-
		FGD: Fishermen	11
		FGD: Women	-
		KII Education	1
		KII Health	-
Dixcove	27/03/2012	Community Meeting	70
		FGD: Men and Leaders	-
		FGD: Fishermen	8
		FGD: Women	8
		KII Education	2
		KII Health	2
Sekondi	27/03/2012	Community Meeting	-
		FGD: Men and Leaders	-
		FGD: Fishermen	-
		FGD: Women (Sekondi Harbor)	24
		KII Education	1
		KII Health	3
		KII Sekondi Harbor Master	1
Sekondi (European Town)	27/03/2012	Community Meeting	16
		FGD: Men and Leaders	-
		FGD: Fishermen	-
		FGD: Women	-
		KII Education	3
		KII Health	1
New Takoradi	28/03/2012	FGD: Men and Leaders	5
		FGD: Women	7
		KII Education	3
		KII Health	1
Ngyeresia	28/03/2012	Community Meeting	55
		FGD: Men and Leaders	10
		FGD: Fishermen	
		FGD: Women	16
		KII Education	1
		KII Health	1

Community	Date of Meeting	Type of Meeting	Number of Attendees
New Takoradi	29/03/2012	Community Meeting	61
		FGD: Fishermen	13
Bakakyir	29/03/2012	Community Meeting	40
		FGD: Men and Leaders	17
		FGD: Fishermen	13
		FGD: Women	16
		KII Education	3
		KII Health	1
Anochie	30/03/2012	Community Meeting	7
		Leaders and Men	27
		FGD: Men and Leaders	-
		FGD: Women	-
		KII Education	1
		KII Health	1
Atuabo	30/03/2012	Community Meeting	96
		FGD: Men and Leaders	5
		FGD Fishermen	11
		FGD: Women	88
		KII: Education	1
		KII: Health	1
Effasu	19/06/2012	Community Meeting	62
		FGD: Men and Leaders	-
		FGD Fishermen	-
		FGD: Women	-
		KII: Education	-
		KII: Health	-
Ahobre	20/06/2012	Community Meeting	116
		FGD: Men and Leaders	-
		FGD Fishermen	-
		FGD: Women	-
		FGD: Youth	
		KII: Education	-
		KII: Health	-
Bonyere	21/06/2012	Community Meeting	118
		FGD: Men and Leaders	-
		FGD Fishermen	-
		FGD: Women	-
		FGD: Youth	
		KII: Education	
		KII: Health	
Half Assini	22/06/2012	Community Meeting	52
		FGD: Men and Leaders	--
		FGD Fishermen	-
		FGD: Women	-
		KII: Education	-
		KII: Health	
New Town	23/06/2012	Community Meeting	73
		FGD: Men and Leaders	-
		FGD Fishermen	-
		FGD: Women	-
		KII: Education	--
		KII: Health	

Community	Date of Meeting	Type of Meeting	Number of Attendees
Beyin, including	25/06/2012	Community Meeting	78
Benyilin*			18
Ngelekaz*			8
Elloin*			6
Ekebaku*			2
Kegeni*			1
Keyian*			1
		FGD: Men and Leaders	-
		FGD Fishermen	-
		FGD: Women	-
		KII: Education	-
		KII: Health	-
Total Number of Recorded Attendees			**2,815**

Note: Attendance registers were taken for all community meetings. It was not always possible to gather attendance registers in the FGDs, no attendance registers were taken for KIIs.
*The Paramount Chief invited people from other surrounding communities to attend the Beyin community consultations.

1.5.4 *Issues and Concerns Raised during Community Consultations*

Issues and concerns raised at meetings (community meetings, FGDs and KIIs) were recorded and included in an issues register which is attached in *Appendix 6*. Some of the recurring issues and concerns that were raised are outlined below.

- Communities perceive a lack of community benefits and lack of employment opportunities from the oil and gas industry.
- Communities believe that TGL has not fulfilled all its promises/ commitments.
- Communities expect the oil and gas industry to improve infrastructure (*ie* schools, medical facilities, roads and electricity) and support small businesses (*eg* flexi loans especially for women).
- Communities believe that the oil and gas operations have caused a decline in fishing resources.
- Communities expect the oil and gas industry to support alternative livelihoods.
- Fishermen are concerned about exclusion from the safety zone. They also claimed that they are harassed by the Navy, that their fishing gear is confiscated by the Navy and that their fishing gear is damaged by support vessels.
- Communities were concerned about the effect of seaweed blooms on fishing activities and hold the perception that the oil and gas operations are a contributing factor.

Over 450 individual issues that were raised during the consultations were analysed. *Table 1.5* provides a breakdown of issues raised during community consultations and a summary is shown in *Figure 1.5*.

Figure 1.5 shows that the highest proportion of issues related to environmental impacts (20%), excluding oil spills. Fishing and fisheries issues comprised 17% while issues relating to perceived lack of benefits comprised 14%. Issues relating to infrastructure development comprised 11% and poverty related issues comprised 12%.

Figure 1.5 ***Summary of Issues Raised During Consultations (Percentage)***

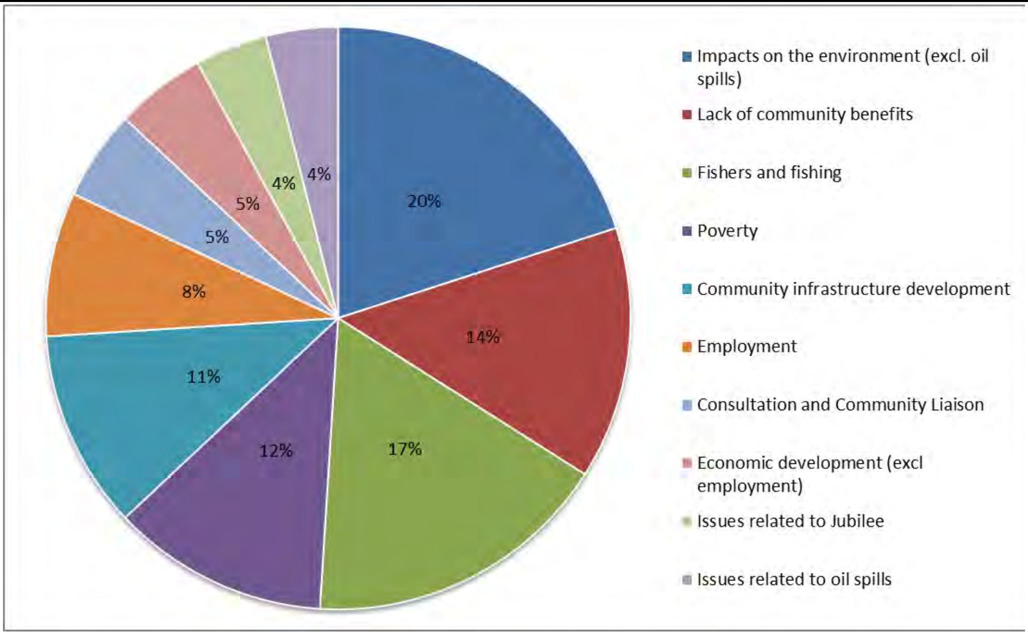


Figure 1.6 provides a further breakdown of issues relating to perceived environmental impacts. More than half of the environmental issues related to the increase in seaweed and algal blooms (55%). General issues relating to environmental impacts comprised 20%. Other issues included concern regarding impacts to air quality and health effects, environmental effects of discharge of ballast water and impacts on farming.

Figure 1.7 provides a breakdown of issues relating to fisheries. The highest proportion (29%) of issues related to exclusion of fishermen from the exclusion zone. Issues relating to the decline in fisheries resources comprised 25%. Other issues included harassment of fishermen by the Navy, confiscation of fishing gear by the Navy, damage of fishing gear by support vessels and general challenges facing fishermen in Ghana.

Figure 1.6 Summary of Issues Relating to Environmental Impacts (Percentage)

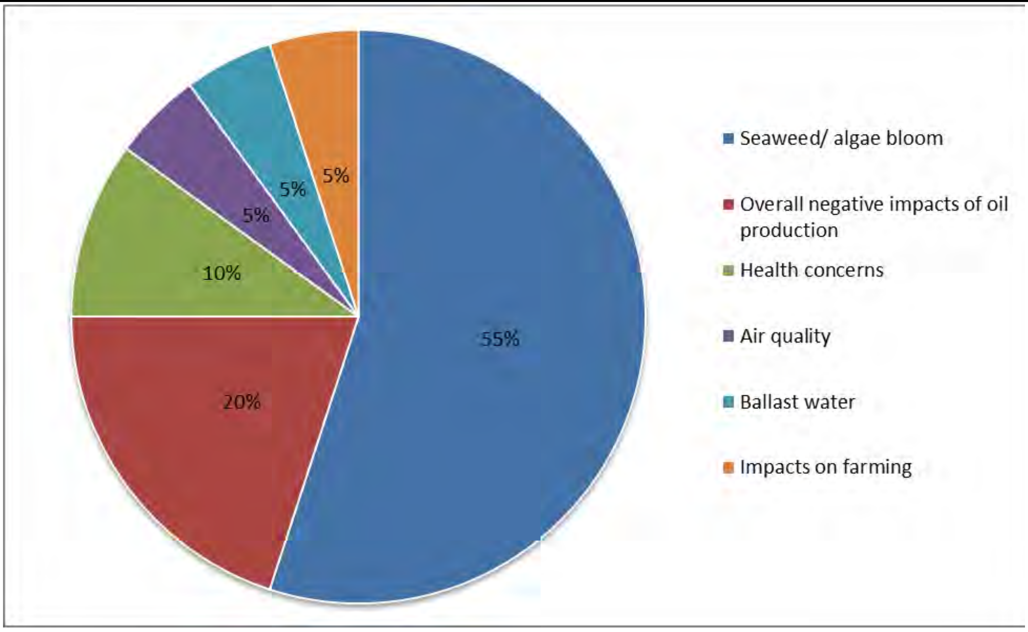
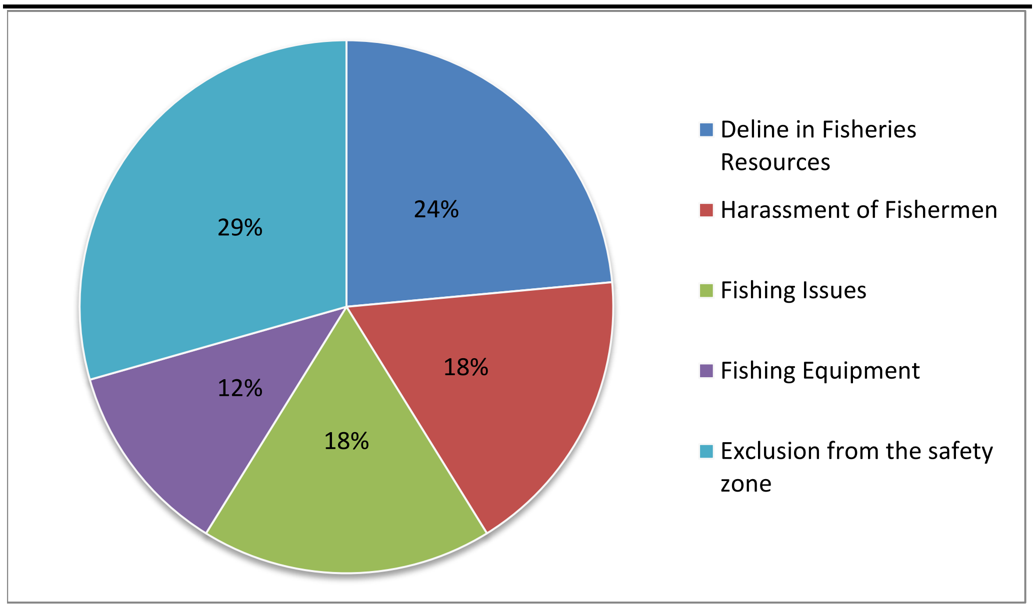


Figure 1.7 Summary of Issues Relating to Fisheries (Percentage)



1.6 COMMENTS ON DRAFT EIA

The EPA comments on the Draft EIA were received 13 December 2013. *Table 1.7* presents the EPA comments alongside a reference of where they have been addressed in the final submission.

Table 1.6 Issues Raised by Category

Main Categories	Sub-Categories	Description	%	Total %
Impacts on the environment (excl. oil spills)	Seaweed/ algae bloom	Perception that the seaweed/ algae bloom is as a result of the TGL activities. The algae damages fishing nets.	11	**20**
	Negative impacts of oil production	Concerns related to the overall potential impacts of the oil production activities to the environment, including issues of tar balls and re-injection of gas into the wells.	4	
	Health concerns	Issues related to the impacts of the project to human health including issues that the oil and gas activities have caused the cough which many people in the areas suffer from.	2	
	Air quality	Issues related to the impacts on air quality primarily due to the flaring of gas.	1	
	Ballast water	Issues related to the impacts of discharges of ballast water into the Ghanaian waters.	1	
	Impacts on farming	Issues related to the oil production activities having affected farming activities in the general coastal districts.	1	
Lack of community benefits	Community benefits	Issues related to a lack of community benefits for the project affected communities since the start of oil production.	9	**14**
	TGL Scholarships	Issues related to the limited number of scholarships provided by TGL as well as the exclusion of children of school going age from the scholarship scheme.	5	
Fishers and fishing	Fisheries Resources	The oil and gas activities have caused a decline fish catch and certain fish species have disappeared.	4	**17**
	Harassment of Fishermen	Fishermen who fish close to the safety zone have been assaulted by the naval personnel.	3	
	Fishing issues	FPSO reduces fishing grounds, fishermen should be allowed to fish in the safety zone, oil activities have decreased the fish catch. Concerns over the possible collapse of the fishing industry due to the oil and gas activities.	3	
	Fishing equipment	Naval personnel seize and/ or destroy fishing nets and other equipment.	2	
	Implementation of safety zone	Issues related to the restriction of fishers from fishing near the FPSO, complaints about the FPSO reducing fishing grounds, and others.	5	
Poverty	Poverty and general suffering	Issues not directly related to the project *eg* how people are suffering because they do not have jobs or alternative livelihoods. Oil and gas has caused the failure of crops.	12	**12**

Main Categories	Sub-Categories	Description	%	Total %
Community infrastructure development	Requests	Community requests to TGL *eg*, out board motors, cold rooms, construction of senior high schools roads, and others. The TGL scholarship should be given to pupils at SSH.	8	**11**
	General suggestions	Suggestions/ mitigation measures for some of the communities' issues *eg*, allow fishing near the FPSO at certain times of the day. Concern that the local infrastructure will not handle the influx of job seekers moving into the Districts in search of employment opportunities.	4	
Employment		Lack of employment opportunities for the local communities and Ghanaian nationals in TGL projects.	8	**8**
Consultation and Community Liaison	EIA consultations	Issues relating to stakeholders not seeing the value in continuously being engaged for the oil and gas activities.	2	**5**
	Issues related to the EPA	EPA not following up with the communities after the Jubilee EIA and absence from the TEN meetings.	1	
	Lack of continued consultation	Issues related to TGL's lack of continued engagement of communities post EIA phase as with the Jubilee Project.	1	
	Issues related to CLOs	Issues related to lack of availability of the CLOs in their offices.	1	
Economic development (excl. employment)	Compensation	Issues related to communities wanting TGL to compensate them for the loss of livelihoods as they believe that the oil production activities have resulted in a reduction in access to fishing grounds and in the decline in fisheries.	2	**5**
	Alternative livelihoods	Requests/ suggestions by communities related to TGL making provisions for alternative livelihoods activities for the coastal communities.	2	
	Support for small businesses and fishermen	Request/ suggestion that TGL should provide people with flexi loans or offer small businesses financial support. Issues related to fishermen not being able to pay out their loans and generally being in debt.	1	
Issues related to Jubilee		Issues as they relate to the lack of community benefits, employment opportunities and potential negative impact on the marine ecology.	4	**4**
Oil spills	Oil spill risks	Potential impacts of oil spills and TGL's readiness to deal with an oil spillage.	4	**4**

Table 1.7 Responses to EPA Comments on Draft EIS

EPA Comments on Draft EIS	Response
Legal and Institutional Framework.	
The Environmental Assessment Regulations 1999, LI 1652 should be quoted correctly and not LI 652 as indicated in the report. The Environmental Assessment Regulations, 1999 has not been amended (Ref. 1.4, Pages 1-7, 2-7, 3-3).	Relevant sections have been updated
The TEN project falls under Regulation 3 and Schedule 2 of LI 1652 and also schedule I because the Wetland Regulations is linked to Regulation 24 and schedule I LI 1652.	Section 1.5.2, page 1-9 and section 2.3.2, page 2-8 have been updated
The Ghana National Petroleum Corporation Act (Act 64) should be changed to Ghana National Petroleum Corporation Law, 1983 (P.N.D.C.L. 64).	Section 2.3.4, page 2-10 has been updated
To make it easier and for ease of reference provide a summary table with the following headings; Laws, applicable sections and then its application to the project.	Section 2.9, page 2-38 has been added
There should be thorough editing made to the some institutional names to reflect the current changes (Eg. Ref. 2.2 Government Administration, Pages 2-1, MEST to MESTI)	Section 2.2 has been updated as well as other chapters where relevant
By virtue of the Petroleum Commission Act, 20I I (Act 821), the Petroleum Commission and not GNPC is responsible for regulating Ghana's hydrocarbon resources. This section refers to the commission without citing the law that sets it up. The purpose for which the commission was set up is not adequately captured viz. regulate and manage the optional utilization of petroleum resources and coordinate the policies in relation to them (Ref. 2.2.2 Ministry of Energy, Pages 2-3)	Section 2.2.2, page 2-3 has been updated
Incorporate the Fees and Charges (Amendment) instrument, 20 I I LI 1986 in the report (Ref. 2.3.2 Environmental Legislation, Page 2-6)	Section 2.3.2, page 2-9 has been updated
This section makes no mention of the Petroleum Commission Act. This should be corrected. The regulatory role of GNPC is what the PC has been set up to do (Ref. 2.3.4. Petroleum Legislation, Page 2-10)	Section 2.3.4, page 2-10 has been updated
The National Environmental Policy has been revised and launched in 2012 (Ref. 2.3.8 Environmental Strategies , Policies and Plans, Page 2-15)	Section 2.3.8, page 2-16 has been updated
This section should incorporate the various laws the commission is working on eg: the Petroleum Exploration & Production Bill (Ref. 2.3.1 0. Legislation under Preparation, Page 2-1 B)	Section 2.3.10, page 2-19 has been updated

EPA Comments on Draft EIS	Response
Project Description	
What would be done with the suspended solids that would be left after the filtration process (Ref. Page 3-28, Seawater)	Section 3.4.1, page 3-29 has been updated
Provide the volumes of cuttings and mud per well (Ref. Page 3.51-52 Drilling Process Description)	Section 3.8.3, page 3-73 has been updated
Provide specific onshore disposal points to facilitate effective monitoring (Ref. Page 3-72)	Section 3.8.5, page 3-82 has been updated
Baseline Environmental Information	
Increasing oxygen with increasing depth is unusual; the reverse is what is expected. Any reason for this phenomenon or occurrence? (Ref. page 4-10 Fig 4.9)	Section 4.5.1, page 4-12 has been updated
Results indicated that there were high TPH 42ug/g in the development area as against the transect 36ug/g. Similarly there was high PAHs 504ng/g in the development area as against the transect route 346 ng/g. There was no comparison of such results to that of the Jubilee Field EBS 2010 as done for the water quality. Any reason or explanation for that? (Ref. Page 4-24: Sediment Quality, Hydrocarbons).	Section 4.7.2, page 4-27 has been updated
The various metal concentrations in sediments of the development area showed high barium levels than the other metals. This however showed a decreased level along the shallower gas pipeline transect route. It was then inferred that this is typical of sediment found in near well sites where barium -related discharges have occurred. This is not the case with respect to the TEN development area. Any explanations? (Ref. Page 4-27, Table 4.6)	Section 4.7.2, page 4-28 has been updated
Marine mammals have been extensively discussed with respect to families and species as well as those endangered on the IUCN's red data list. However, there were no discussions on the possible causes of dead whale beaching in the western part of the country in recent times. A discussion of this topic in the EIS as a current baseline for the TEN Project would be appropriate (Ref. Page 42-46, Marine Mammals).	Section 4.8.3, page 4-49 has been updated
There has been discovery of a live coral reef in the Tano Basin by EPA and Institute of Marine Research Norway. This information was disclosed to the public by EPA in April this year. However, there was no allusion or discussion made about its location, potential impacts (if any), preservation and protection, etc in the EIS.	Section 4.6, page 4-21 and Section 7.10.9, page 7-140 have been updated
There are 22 districts in the Western Region instead of 14 as indicated in the report (Ref. 5.3.2 Administrative Structures)	Section 6.3.1, page 6.4 has been updated
The structure of the chapter (6) proposed to discuss the land tenure system and land use in the six coastal districts but the body of the chapter did not discuss that, the final report should include that (Ref. 6.1, Page 6-1)	Section 6.5.1, page 6-10 has been added

EPA Comments on Draft EIS	Response
Nzema East District should read Nzema East Municipality (Ref. 6.1, Page 6-1)	Section 6.1, page 6-1 has been updated
Use the current Western Region Map (Ref. Figure 6.1, Page 6-2)	Figure 6.1, page 6-2 has been updated
Sefwi-Wiawso is a Municipality not a district (Ref. Table 6.2)	Table 6.2, page 6-5 has been updated
The Ghana Living Standards Survey has current data (2012) which could have been used instead of using data for 2010 (Ref. 6.5.4, Page 6-14)	The most current available data from the Ghana Living Standards Survey have been used
There are 216 Metropolitan, Municipal and District Assemblies in Ghana and not 170 as indicated in the report (Ref. 6.3.1 Formal Structures, Page 6-4)	Section 6.3.1, page 6.4 has been updated
Service sector repeated with different percentages (Ref. 6.5.1 Last Paragraph, Page 6-9)	Section 6.6.1, page 6-12 has been updated
Ellembelle District - Mining is also an economic activity in the District. Currently, Adamus Resources Limited a gold mining firm is operating in the District. The report did not provide information on the activity (Ref. 6.5.2 Regional Economy, Page 6-12)	Section 6.6.3, page 6-15 has been updated
Information on Doctor to patient ratio as well as Nurse to patient ratio was not provided for the districts. It is critical and needs to be provided. Information on the number of Ambulances that are available to the National Ambulance Service in the region was also not provided. This information is necessary especially in times of an emergency. The capacities of Accident and Emergency centres and the calibre of staffing must also be provided (Ref. 6.7.1 Healthcare Facilities, Page 6-26)	Section 7.9.9, pages 7-113 to 7-115 and Section 8.2, page 8-14 have been added.
Environmental Assessment	
Since there is no baseline data for SO_2, NOx, NO_2, CO, PM_{10} and $PM_{2.5}$ for the onshore communities within the receptor grid, explain how the modelling was conducted indicating the estimated pollution levels used (Ref. 7.5.1 0 Baseline and Receptors, Page 7-64)	Section 4.4, page 4-10 and Section 7.5.10, page 7-69 have been updated.
Note that the EPA 24-hr air quality guideline for PM_{10} is 70 µg/m³ for all areas and not 150/260 µg/m³ as indicated. The EPA 24-hr air quality guideline for NOx as NO_2 is 150 µg/m³ for industrial and 60 µg/m³ for residential and that for 1 hr is 400 µg/m³ for industrial and 200 µg/m³ for residential. The Agency has no guidelines for annual averages for NO_2 (Ref. Table 7.17 Air Quality Guidelines, Page 7-63)	Table 7.21, page 7-68 and Tables 7.25 – 7.27 have been updated
Include volatile organic compounds (VOC) as one of the parameters of interest for the modelling (Ref. A 1 .3 Pollutants of Interest, Page A3)	Section 7.5.3, page 7-61 presents the rationale for the parameters modelled

EPA Comments on Draft EIS	Response
Health and Safety impacts assessment was inadequate (Ref. Page 3.9). The key impacts assessed did not include Occupational Health and Safety (OHS) impacts/issues (Ref. Page 7-1)	Section 7.9.9, page 7-114 has been added. Occupational health and safety is addressed further in Chapter 11.
There are in-country treatment facilities that can handle different waste streams. The first and second paragraph should be cross checked since there is a company that handles hazardous waste. This information should be checked and clarified (Ref. 7.7.4, Page 7 -86)	Section 3.8.5, page 3-83 and section 7.7.4, page 7-90 have been updated
Impact assessment of this section failed to mention the possibility of vessels colliding with marine mammals though was mentioned in the mitigation measures. A bit of assessment in this area will be useful to bring clarity to the issue of whale beaching (Ref. Impact Assessment, Page. 7- 21)	Section 7.3.1, page 7-10 has been updated
The mitigation measures on this page should come after the impact assessment. Modelling of produced water at 20 mgl concentration and that of 40 mgl should be reconciled (Ref. 7.4.2, Page 7-26 last paragraph and 7.4.1 0, 7-49)	Section 7.2 presents the assessment methodology. Section 7.4.2 page 7-26 has been updated
How would the discharge of the ballast water by the foreign ships be controlled? (Ref. 7.43 Ballast Water, Page 7-26)	Section 7.43, page 7-27 has been updated
"Stakeholders will be able to adapt to varying degrees, thus the impact is assessed as being of MINOR significance." Report VOL I. Consultation report suggests otherwise. This impact cannot be assessed as being minor (Ref. Page 7-105 paragraph 4).	Section 7.9.6, page 7-109 has been updated
What are the specific remedial actions put in place to avoid adverse impacts on areas with diverse habitats (Ref. 7.3.2, Page 7-11)	Section 7.3.2, page 7-12 and Section 7.109, page 7-140 have been updated.
The report should identify and access potential health and safety impacts of the activity (operation) and propose corresponding mitigation and management measures accordingly (Ref. Chapter 7)	Section 7.9.9, page 7-113 has been updated
Cumulative impact assessment has not been addressed satisfactory. There is the need to do a thorough assessment covering the development of this current (TEN), existing jubilee infrastructure on shipping, fishing, environmental receptors and other uses of the sea. The project should also consider scenarios of future developments of additional fields within the western basin.	Section 7.11.5, page 7-167 has been updated

EPA Comments on Draft EIS	Response
Monitoring Plan	
The report indicated that a detailed environmental and social monitoring plan will be developed for the TEN Project and implemented by Tullow and its contractors. This plan will be modified and updated as the project develops and in response to the outcomes of monitoring activities and in discussion with stakeholders as new issues arise. It is important to give an indication of the timeframe for this activity to show some commitment. A detailed monitoring plan must be provided as part of the report.	Section 11.6, page 11-27 addresses schedule for future deliverables
Provisional EMP	
The provisional EMP should include the following individual plans and submitted to the Agency; • Cost estimates of the various mitigation measures • Timeframes for submission of the following planned activities: Pre-commissioning disposal plan, Spill control and response plan, Project waste management plan Health, Safety and Environmental (HSE) Manuel Environmental Monitoring Plan Corporate Social Responsibility Plan, Decommissioning Plan	Section 11.6, page 11-27 addresses schedule for future deliverables
General Comments	
Introduction says Subsea equipment installation is planned throughout 2014 and first oil production in early 2016, however, in the summary, subsea equipment installation is planned throughout 2015. There is the need to clarify and harmonise timelines.	Non-Technical Summary, Section 4.1.1, page XII and EIS Section 3.2.2, page 3-2 have been updated
It is indicated that there is limited information available for fish resources including marine mammals and fisheries activities offshore Ghana, in particular in the deepwater areas where the main oil and gas activities are being undertaken. Appropriate research programmes should be initiated with relevant stakeholder institutions and communicated to the Agency in order to collect relevant data since it will be difficult to assess the impact on these species if there is no comprehensive baseline to compare with.	Section 11.6, page 11-27 addresses schedule for future deliverables
Though the report mentioned the stakeholder institutions consulted, the consultation report focused on the outcome of communities consulted. It will be useful to provide a summary of concerns raised by key stakeholder institutions in the consultation report. Otherwise letters from the institutions should be attached to the report.	Attachment A has been updated
Explain the implications of the levels of arsenic, chromium, copper and nickel (above the TEL) for the marine environment and any potential changes that will result from your project and its impacts on the marine environment. Indicating how this informed the choice of mitigation measures for metal pollution.	Section 4.7.2, page 4-28 has been updated
An extensive Baseline study was conducted by Institute of Marine Research in Norway and Environmental Protection Agency, Ghana and other stakeholders in 2009, 2010 and 2012, along the entire coastline. This information must be accessed and relevant portions incorporated in the report.	Section 4.6, pages 4-21 to 4-23 have been updated

EPA Comments on Draft EIS	Response
Include Ghana Civil Aviation Authority to the MDAs under Ministry of Transport and Ghana Air Force under the Ministry of Defence	Section 2.2, page 2-1 and Section 2.2.3, page 2-5 have been updated
All figures and diagrams should be presented on A3 sheets. Eg. Fig 3.13 on Page 3-32.	Where relevant A3 figures have been used
It is recommended that since the FPSO is not aligned with any flag, Tullow Ghana Ltd should consider registering the FPSO in Ghana.	Section 2.4.1, page 2-19 and Section 3.4.1, page 3-15 have been updated
Health, Safety and Environmental (HSE) Manual: The HSE manual should be submitted to EPA for review with GMA and the PC.	Section 11.6, page 11-27 addresses schedule for future deliverables

Appendix 1

Fisheries Consultation Photo Record

Figure 1.1 Consultation Photos 1


New Takoradi Chief Fisherman


Sekondi Chief Fisherman


Aboadze Chief Fisherman


Abuesi Chief Fisherman


Adjuah Chief Fisherman


Fungo Chief Fisherman


Shama Apo Chief Fisherman


Shama Bentsir Chief Fisherman


Akitekyi Chief Fisherman


Busua Chief Fisherman


Butre Chief Fisherman


Lower Dixcove Chief Fisherman

Figure 1.2 Consultation Photos 2


Lower Dixcove Chief Fisherman 2


Upper Axim Chief Fisherman


Lower Axim Chief Fisherman


Effasu Chief Fisherman & Newtown Chief Fisherman


Half Assini Chief Fisherman 1


Half Assini Chief Fisherman 2


Mangyea Chief Fisherman


Eikwe Chief Fisherman


Regional Minister


Jomoro District Assembly


Shama District Assembly


Embellele District Assembly

Figure 1.3 Consultation Photos 3

Ghana Tuna Association

Ghana Inshore Fisherman Association, Tema

Ghana National Association of Famers and Fisherman

Ghana Inshore Fishermen Association, Sekondi

Marine Fisheries Research Division (MFRD) & International Commission for the Conservation of of Atlantic Tuna (ICCAT)

Fisheries Commission

Guinea Current Large Marine Ecosystem

Regional Fisheries Directorate

Ghana National Canoe Fishermen Council

Appendix 2

Background Information Document

Tweneboa, Enyenra and Ntomme (T.E.N.) development

Tullow Ghana Limited (TGL) has interests in two oil concession blocks offshore Ghana, namely Deepwater Tano (DWT) and West Cape Three Points. In 2009 to 2010, TGL and its Partners (Kosmos Energy LLC, Anadarko Petroleum Corporation, Ghana National Petroleum Company and Sabre Oil and Gas) developed the Jubilee oil field located approximately 60 km offshore Ghana (Figure 1). Oil production started in December 2010 through the *Kwame Nkrumah* Floating Production Storage and Offloading (FPSO) vessel (Figure 2).

Further exploration and appraisal drilling in the DWT block during 2009 and 2010 resulted in the discovery of the Tweneboa, Enyenra (originally named Owo) and Ntomme (T.E.N.) fields. The fields are located approximately 30km to the west of the Jubilee Field (see Figure 3).

TGL is now proposing to develop the T.E.N. fields. The proposed project is referred to as the T.E.N. development. TGL is the designated operator for the DWT block and will lead the project design, execution, and operation phases of the proposed development.

The aim of this document is to provide background information about the project and the EIA process and to invite comment on any issues or concerns you may have.

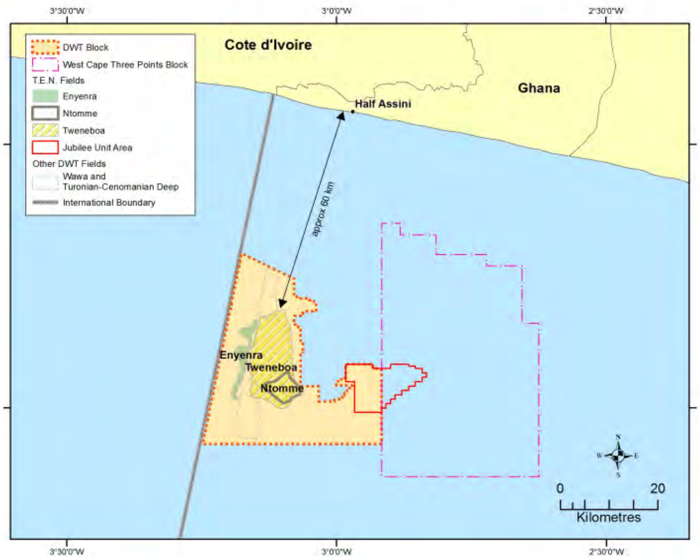


Figure 1: Locality map

Figure 2: *Kwame Nkrumah* FPSO offshore Ghana

Environmental Impact Assessment (EIA)

Under the Ghana Environmental Assessment Regulations of 1999 (LI 1652) an EIA is required to be submitted by the applicant in support of oil production projects.

TGL has commissioned Environmental Resources Management, UK (ERM) in collaboration with two Accra-based companies, namely ESL and SRC , to undertake the EIA for the T.E.N. development.

The EIA will describe the project, assess the likely positive and negative environmental and social impacts of the project and describe the plans to be put in place to manage these impacts. The EIA, along with comments received from stakeholders will be submitted to the Environmental Protection Agency (EPA) who will decide whether or not to authorise the proposed project.

Field Development and Production

Following discovery of the T.E.N. hydrocarbon (oil and gas) fields, the TGL engineering team have been working on the initial design of hydrocarbon production operations and facilities to bring the hydrocarbons to the surface. The development of the field requires drilling a series of wells and the installation of subsea equipment.

Production Facility

Hydrocarbons from the T.E.N. field will be produced through a customised ship, called a Floating Production, Storage and Offloading (FPSO) vessel. The FPSO will be permanently moored in the DWT block. Hydrocarbons from the wells will be transferred to the FPSO through a number of risers (pipes) attached to wellheads on the seabed.

Offloading System

The hydrocarbons from the wells will be processed and stored on board the FPSO. Shuttle tankers will offload the oil from a separate offloading buoy moored to the north of the FPSO and will take the oil to refineries across the world where petrol and other products are made. A gas pipeline will connect the T.E.N. FPSO to the *Kwame Nkrumah* for the purposes of start-up and commissioning and in the future for gas export to shore via the *Kwame Nkrumah*.

Support Operations

Support vessels (eg crew change and supply boats) and helicopters will be required to support drilling operations. FPSO operations will also require daily visits from a support vessel to bring supplies and tugs will be required to help in the weekly tanker offloading operations. Twice daily helicopter support will also be required for crew transfers. The onshore support base is proposed to be at the existing Port of Takoradi and heliport facilities at Takoradi naval base.

Safety Zone

As required for all offshore installations there will be a temporary safety zone around the drilling vessel during well drilling and a permanent safety zone around the FPSO and oil offloading buoy with no access to unauthorised vessels. It is likely that this will cover an area within a 1,000 m of the FPSO and offloading buoy.

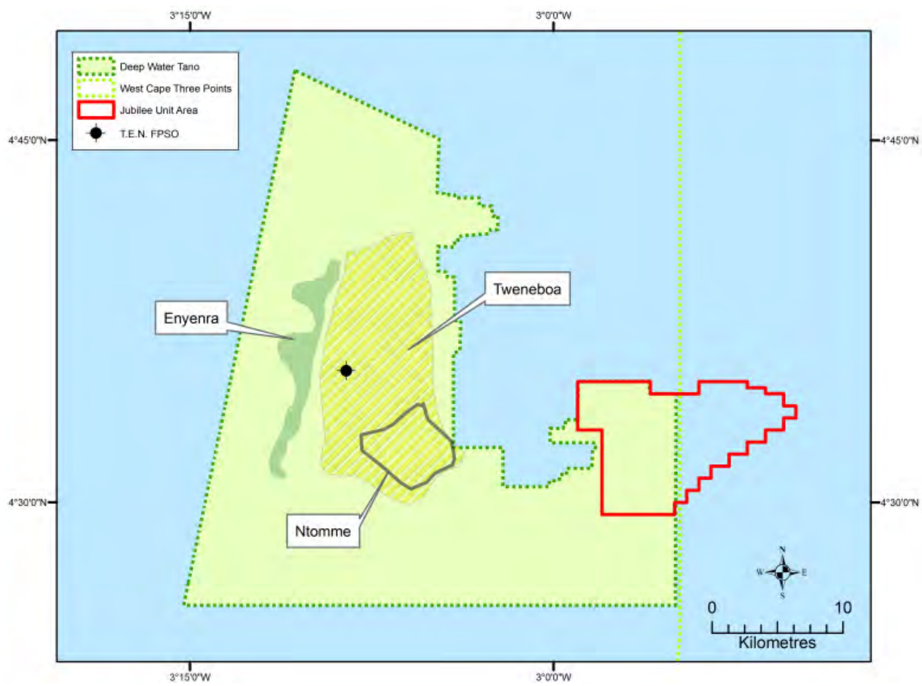


Figure 3: Map showing T.E.N. fields and proposed FPSO location.

Key Issues Identified to Date

Impacts to Water

- Discharge of cuttings to sea in accordance with EPA limits during well drilling.
- Disposal of excess water from the wells into the sea (produced water).
- Discharges (cooling water, ballast water, sewage and deck drainage) to the sea and impacts on water quality.

Impacts to Atmosphere

- Emissions from flaring during well testing and completion operations.
- Exhaust emissions from support vessels and helicopters and from power generation from gas turbines on the T.E.N. FPSO.
- Emissions from gas flaring during commissioning, maintenance shutdowns and emergencies.

Waste Management

- Disposal of solid waste from the T.E.N. FPSO and support vessels.
- Use and disposal of process chemicals.

Biodiversity

- Seabed 'footprint' of subsea infrastructure resulting in seabed disturbance and impacts on benthic communities.
- Disturbance from vessel movements, helicopter operations, noise and light to birds, sea mammals, turtles and fish.

Socio-economics

- Tax revenues payable to the government and effects on the development.
- Creation of direct and indirect employment opportunities.
- Influx of people seeking employment and business opportunity.
- Exclusion of commercial and recreational vessels and fishermen from safety zone around the FPSO and tankers.
- Potential impacts on fish resources due to presence of structures and vessel and discharges and secondary impacts on commercial fisheries.
- Potential damage to fishing nets and increased risk of shipping collisions along supply vessel transit routes.
- Effects of increased use of supply base and heliport on existing users and residents.

Accidental Events

Accidental events could include oil spills and fires which could have impacts to:

- marine and coastal resources and associated socio-economic effects; and
- transboundary effects (*eg* Cote d'Ivoire).

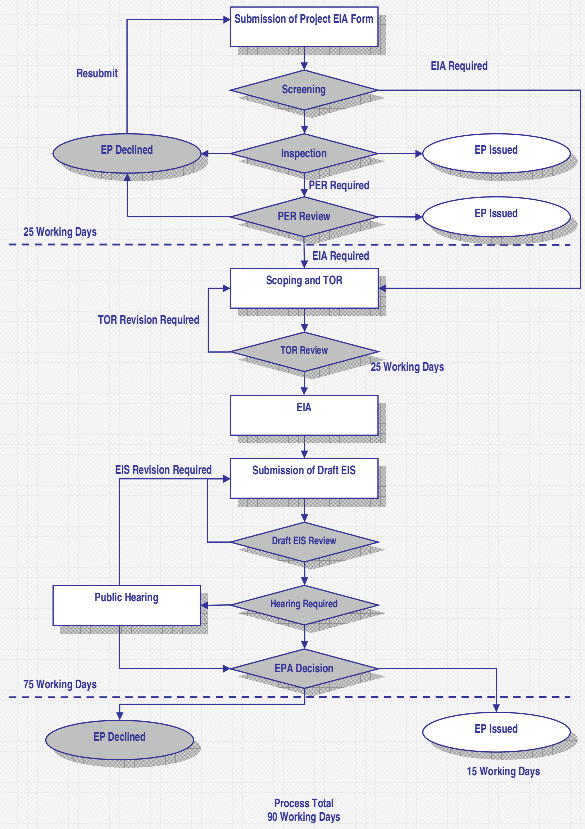
Cumulative Impacts

The EIA will consider cumulative impacts of existing projects, the proposed project and planned future projects.

The EIA Process

The EIA process has the following main steps:

- Register EIA with the EPA.
- Initial scoping consultation with key stakeholders.
- Compile and submit Scoping Report to EPA.
- Advertise and make Scoping Report available to stakeholders for comment.
- Stakeholder consultation meetings to discuss proposals and obtain comment.
- Collate baseline information
- Compile draft EIA report and Environmental Management Plan (EMP)
- Advertise and make draft EIA report available to stakeholders
- EPA to call for Public Hearings.
- Compile final EIA report and EMP and submit to EPA for decision-making



EP = Environmental Permit

EIA Contacts

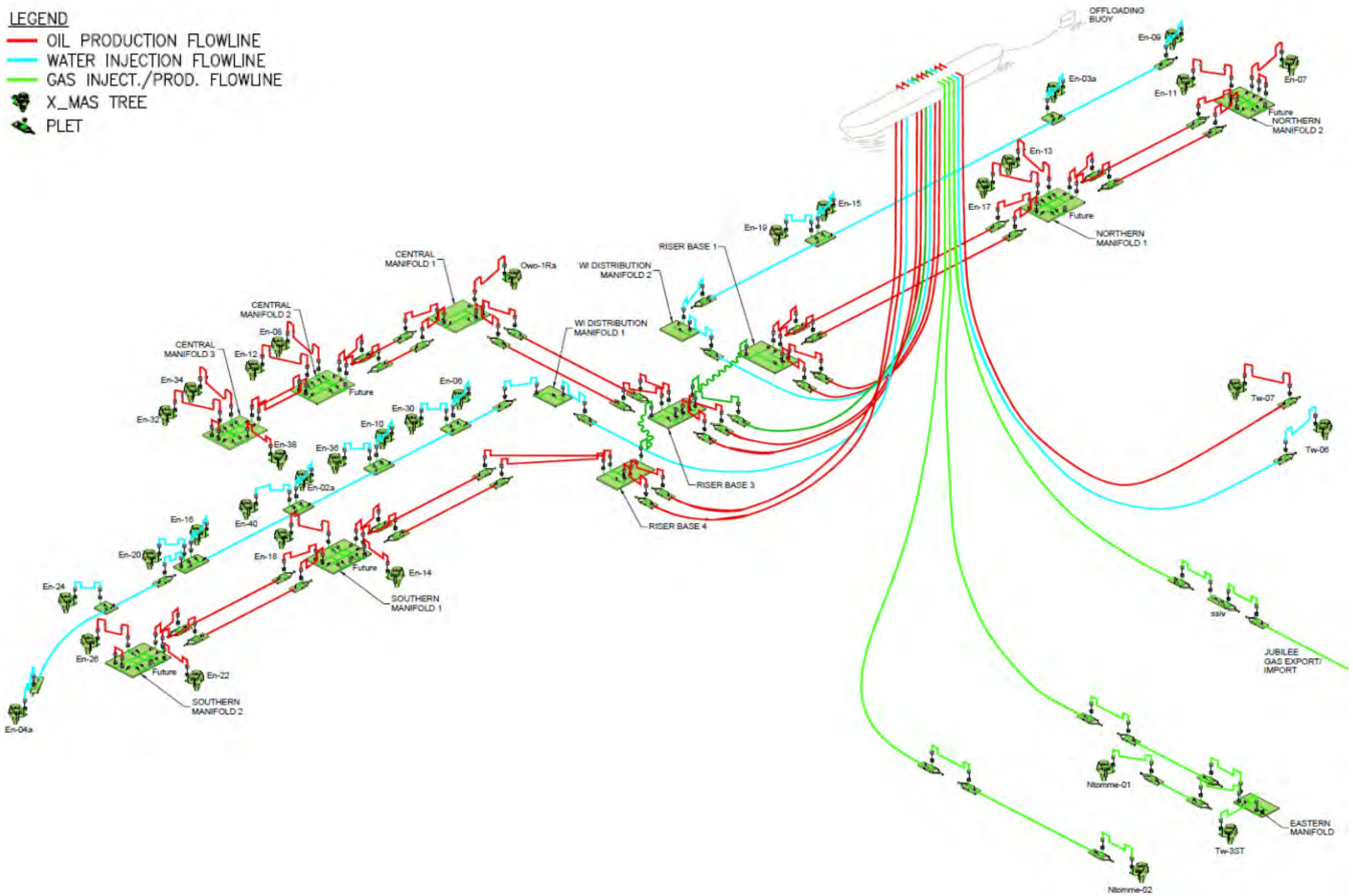
Tullow Ghana Limited
Tel: 030 274 2200
Email:
glenn.bestall@tullowoil.com
Address: Tullow Ghana Limited
P O Box CT 386
Cantonments, Accra

SRC Consulting
Tel: +233 24409 9446
Email: a.adunyarko@yahoo.com
Address
Private Mail Bag CT 361
Cantonments, Accra, Ghana

ESL Consulting
Tel: 021 514614
Fax: 021 520298
Email: ghana_esl@yahoo.com
Address: ESL Consulting
PO Box LG 239, Legon, Accra, Ghana

Environmental Resources Management

Tel: +27 21 702 9100
Email:
Kerryn.McKuneDesai@erm.com
Address: ERM, Block A, Silverwood House,
Steenberg Office Park Steenberg, 7945,
Cape Town, South Africa



Subsea infrastructure layout

Typical offshore drilling vessel

Example of a spread moored FPSO

Subsea installation operations

Typical offloading operations

Shore base at Takoradi port — one of the onshore support units available for the T.E.N. development

Appendix 3

Issues from Scoping Consultations

1 ISSUES FROM SCOPING CONSULTATIONS

A summary of comments raised during the Scoping consultations are provided in *Table 1.1*.

Table 1.1 Summary of Issues from Scoping Consultations

Consultation / Disclosure

- Suggestion for additional TGL communication at local level (*ie* with communities in the Western Region) also prior to Public Hearings. EPA also suggested they may need to take part in these consultations. Concern was expressed that communication with leadership is not always conveyed to fishermen and members of communities.
- Suggestion for TGL to communicate findings of the EIA to communities (*eg* disclose non-technical summary) in a simple, understandable format to help communities understand the implications of the project.
- Requirement for adequate time to review Scoping and EIA Report.
- Indications that Public hearings will be required for the project.

Jubilee Commitments

- Have the Jubilee EIA mitigation measures been implemented?
- A fisheries liaison person has not been appointed as required by the Jubilee EIA.
- Concern that CSR efforts are not aligned with District development plans (*eg* drilling of boreholes which deviated from district development priorities).
- Lack of ongoing consultation at a local level with community members.

Incremental Development and Increased Pressure on Infrastructure

- Uncontrolled development in Western Region with impacts on natural and heritage resources.
- Increased traffic in Takoradi and effects of HGVs on road integrity.
- Increased pressure on port facilities due to increased oil and gas operations.
- Concern over availability of water for more projects and industrial development in the Region.

Interaction with Fisheries

- Perceived impact of oil and gas activities on fishermen's livelihood through:
  - decline in fish stocks from pollution or 'attracting' fish to offshore installations; and
  - restriction of fishing in safety zone.
- Conflict with fishermen due to enforcement of safety zone and confiscation of fishing gear.
- Damage to fishing nets from support vessels.
- Alternative livelihoods (*eg* aquaculture) for fishermen due to declining fish stock and perception that oil and gas activities are worsening the situation.
- Request that Fisheries Impact Assessment be undertaken to address fisheries issues.

Cumulative Impacts

- Effect of additional restriction of fishing in safety zones due to additional oil and gas operations.
- Cumulative impact of new project with current and other ongoing oil and gas activities on air quality, water quality and marine ecology.
- Cumulative impact of expanding oil and gas industry with other industries on protected areas, land use and water requirements.

Secondary Socio-economic Effects

- Influx of foreigners for work in Takoradi.
- Influx of people to seek work opportunities, sometimes leading to unemployment.
- Increase in crime rates due to unemployment.
- Increase in undesired social behaviour (*eg* prostitution).
- Increased cost of living and housing in Western Region. For example, workers in oil industry pay higher rent therefore landlords evict current tenants.
- Increased demand for hotel accommodation and conferencing facilities in Takoradi (positive).

Increase Risk of Oil Spill and Compensation

- Concern over oil spill risk and limited response capabilities.
- Compensation for coastal communities (especially fishermen) in case of an oil spill. It was said that currently there is no local compensation plan (*eg* inventory of fishermen and vessel, catch rates *etc*) if an oil spill happens.
- Coordination with other stakeholders on oil spill response, *eg* fishermen and port operators need to know what to do in case of a spill.

Employment and Income

- Expectation of employment in oil industry (despite few opportunities available).
- Requirement for preference to employ people from coastal districts rather than employing people from elsewhere in Ghana.
- Expectations to receive royalties for coastal districts as these districts are located closest to the oil fields.

Education and Training

- Concern over institutions providing training that is not recognised by oil industry.
- Requests for scholarships (for children of fishermen and youth from Region in general).
- Technical training so that youth can be employed in oil industry.
- Concern that too many people will be trained and not enough jobs.

Communication and Managing Expectations

- Requirement for Tullow presence in coastal districts. For example, people from remote communities feel they cannot communicate with TGL regarding concerns or to obtain information.
- Need for ongoing communication with communities about Tullow operations.
- Communities want to understand what is happening at the oil field as they cannot see it from land.
- Need for CLOs in communities with whom community members can communicate. Request that a dedicated Fisheries Liaison is appointed.
- Requirement to receive Jubilee monitoring results to District Assemblies (*eg* compliance of discharges and waste management with standards).

Transboundary Impacts

- Impacts that could affect Cote d'Ivoire from discharges and potential oil spills due to proximity to maritime boundary.
- Security issues and dispute over maritime boundary for oil resources.

Discharges to Sea

- Impacts to water quality, marine fauna and human health due to discharges to sea.
- Ballast water discharge and potential biological contamination. There is concern that ballast water will have an effect on fish and pollute the marine environment.
- Algal bloom (green-green) in water and on beach (believed oil operations are causing this).
- Perceived risk of sea level rise due to produced water and oil and gas infrastructure and subsequent coastal erosion.

Air Emissions

- Effect of emissions on air quality and impacts to human health.
- Perceived effect of flaring on human health. Belief that flaring is causing a skin rash and swelling of eyes.

Accidental Events

- Concern over capability to respond to large scale emergency event (*eg* fire).
- Requirement to upgrade health facilities and emergency services in Western Region to respond to emergency event.

Waste Disposal

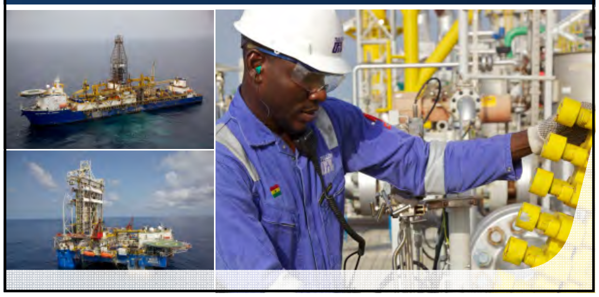
- Lack of facilities for receiving increased waste volumes.
- Concern over contamination of land due to disposal of hazardous waste.

Appendix 4

Community Consultation Presentation

Tweneboa, Enyenra, Ntomme
T.E.N. Development Project

Environmental Impact Assessment (EIA)



Project Overview: Background

- Jubilee development started oil production in December 2010.
- Continued exploration and appraisal drilling in the Deepwater Tano (DWT) block during 2009 and 2010.
- Discovery of the Tweneboa, Enyenra (originally named Owo) and Ntomme (T.E.N.) oil and gas fields.
- Located approximately 60 km offshore and 30 km west of the Jubilee development.
- Second oil field development offshore Ghana: T.E.N. development.
- FPSO construction is planned for 2012 and first oil by 2015.

AdJ1

Introduction

Government of Ghana/GNPC

Operator - Tullow Ghana Ltd

Other DWT Partners

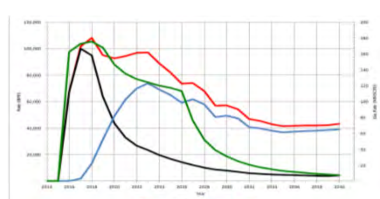
EIA Consultants

Project Location

Purpose of the Meeting

- Share information about the proposed T.E.N. project.
- Provide opportunity for stakeholders to raise concerns / questions about the proposed project.
- Provide responses to project related questions.
- Record stakeholder comments and concerns for consideration in the EIA.

Project Overview: Base Case Production



- Expected peak oil production rate of 100,000 barrels per day by 2018.
- Total oil recovery of approximately 216 million barrels is expected by 2040.
- Gas production rate of 176 million standard cubic feet per day expected by 2017.

Project Phases

1. Drilling

2. Subsea Installation

3. FPSO Installation

4. Commissioning and Production

5. Decommissioning

Project Overview: FPSO

- A Floating Production, Storage and Offloading (FPSO) vessel is a specialised oil production vessel.
- The FPSO will receive and process hydrocarbons (oil and gas), and store and export crude oil.
- An FPSO can be a conversion of an oil tanker or a vessel built specially for the application.
- The FPSO will be spread-moored with a separate Oil Offloading Buoy (OOB).
- The T.E.N. FPSO will be designed for a maximum production capacity of 127,000 barrels of oil per day.
- A 500 m radius safety zone will be implement around the FPSO and other offshore installations as well as a 5 km radius marine avoidance advisory zone.

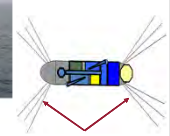
Project Overview: Drilling and Subsea Installation

- Drilling and completion of wells. The base case development will comprise of approximately 33 wells, namely:
  - 15 oil production;
  - 15 water injection;
  - 1 gas production; and
  - 2 gas injection wells.
- Installation of subsea equipment. Subsea (underwater) equipment will include:
  - subsea manifolds;
  - production and injection trees (one per well); and
  - riser bases, jumpers, risers, flowlines, umbilicals; and import/export pipeline.

Project Overview: Example FPSO and OOB

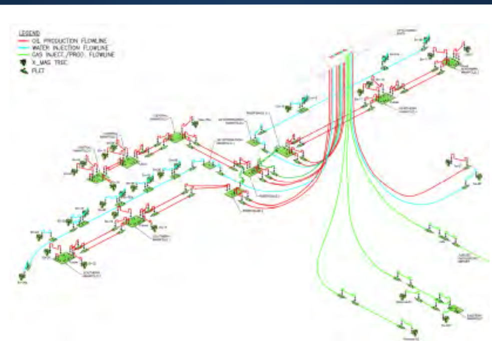
FPSO

OOB



Spread Mooring

Project overview: Subsea Equipment



Project Overview: Production

Production fluid from the wells will be transferred to the FPSO through a series of specialised flowlines (pipes) and subsea equipment to the FPSO.

On the FPSO the produced fluid will be stablalised and separated into oil, gas and water streams.

- **Crude oil:** stored in the cargo tanks of the FPSO and offloaded via the OOB.
- **Associated and produced gas:** used as fuel for power generation on the FPSO, re-injected into gas reservoirs (to maintain reservoir pressure), used for gas lift or exported to the Jubilee field.
- **Produced water:** re-injected or discharged to sea. Before discharge, TGL will treat/clean the produced water to international standards and EPA guidelines.

Temporary flaring will be undertaken during commissioning, upset conditions and maintenance.

Project Overview: Offloading Operations

- During peak production, crude oil stored on the FPSO will be transferred to an export tanker every 10 days.
- Crude oil will be offloaded to an export tanker via a remote Oil Offloading Buoy (OOB).
- The OOB will be situated approximately 2 km from the FPSO.
- Each offloading operation will take approximately 20hrs.
- Approximately one million barrels of oil will be offloaded onto a tanker.

Project Overview: Support Services

- Shore bases at Takoradi
- Supply boats operate out of Takoradi Port
- Helicopter flights from Air Force base

Project Overview: Offloading Operations

Decommissioning

- The T.E.N. development will be decommissioned at the end of its economic life (25 years from first oil).
- Decommissioning will involve dismantling production and transportation facilities and restoration of the area in accordance with license requirements and/or regulations.
- Where required, equipment that could possibly interfere with marine or fishing activities will be removed.
- TGL will comply with any decommissioning conditions in the T.E.N. production permit and submit a decommissioning plan as part of the Field Development Plan.

An example of an Export Oil Tanker

EIA Process – Where are we?

- EIA Scoping
- Specialist Studies ← WE ARE HERE
- Impact Assessment
- Public Consultation
- Final Report and Management Plans

Consultation

Issues Identified to Date

Topic	Associated Issues
Water	• Discharge of rock cuttings to sea during drilling. • Disposal of excess water from the wells into the sea . • Discharges (cooling water, ballast water, sewage and deck drainage).
Atmospheric (Air pollution)	• Emissions from flaring during well testing, completion operations commissioning, maintenance shutdowns and from process vents • Exhaust emissions from support vessels and helicopters and from power generation from gas turbines on the T.E.N. FPSO
Waste	• Disposal of solid waste from the FPSO and support vessels • Use and disposal of process chemicals
Biodiversity	• Seabed 'footprint' of subsea infrastructure resulting in seabed disturbance and impacts on benthic communities • Disturbance from vessel movements, helicopter operations, noise and light to birds, sea mammals, turtles and fish

Questions and Answers

Issues Identified to Date (...continued)

Topic	Associated Issues
Accidental Events	Oil spills and fires which could have impacts to marine and coastal resources and associated socio-economic effects.
Social	Positive: • Tax revenues • Direct and indirect employment (300)
	Negative: • Influx of job seekers • Increased strain on infrastructure • No access to safety zone / advisory zone • Fisheries resources • Damage to fishing nets • Support operations
Cumulative Impacts	Combined effects of Impacts from T.E.N. and other existing and planned projects.

EIA Process – Where are we?

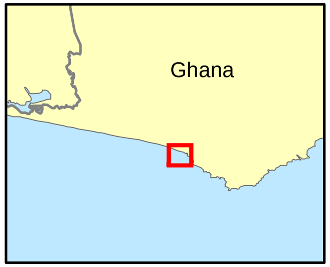
Activity	Timing	
	Start	Finish
EPA Review of Scoping Report	February 2012	March 2012
Disclosure of Scoping Report	-	March 2012
Baseline and Specialist Studies	March 2012	May 2012
Compile Draft EIS	June 2012	July 2012
Submission of Draft EIS	-	August 2012
EPA review of Daft EIS	August 2012	September 2012
Disclosure of EIS and Public Hearings	September 2012	October 2012
Decision on Final EIS	-	November 2012

Appendix 5

Community Consultation Attendance Sheets and Photos

KEY:

● Meeting Location



N
W E
S

0 1
Kilometre

TITLE:
ANKOBRA COMMUNITY
20 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 50,000
DRAWING: Ankobra.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: VILLAGE/COMMUNITY MEETING Meeting location: ANKOBRA Date: 28/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Paul K. Asare	G.E.S	Headmaster	0246367283		[signature]
Mr. Andrews Nyamekeh	G.E.S	Headmaster	0246670819		[signature]
Mary Kainyah	G.E.S	Teacher	0541157716		[signature]
Francis Ea. Amihere	Pensioner	S.M.C. Chairman	0204985296		[signature]
Laudina Debrah	G.E.S	Asist Headteacher	0245214639	laudina.efua@gmail.com	[signature]
Mandosi Blay	Fishing		0200168942		[signature]
Egya Blay	Fishing				E.B
Joseph K. Arthur	Fishing		0240907261		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: VILLAGE/COMMUNITY MEETING Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Thomas Aheto	Tailor		0249758759		[signature]
Enoch Sofetth	Fishing		0240156838		E.S
Francis Kokyle	Fishing		020613E344		F.K
Robert Kaku	Zoil		0246752549		R.K
Joseph Kabilah	Businessman		0246339159		[signature]
Nana Kwame-na Amos	Trader	Ex-Odikro			N.K.A
Paul E Amoah	Pensioner (CG.ES)	Accountant.	0245162109		[signature]
Samuel A. Arthur	Tall		0241307257		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: VILLAGE/COMMUNITY MEETING Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Thomas Kabah	Sea man	Able Seaman	0241664427		Thos.
DAVID ZOLKU	Zoil		0242946907		[illegible]
Rosina Cudjoe	—	—	—	—	R.C
Mawu Dawu Kpo	Zoil		~~02~~08612058		N.D
Promise Gyasah	Suncia		0248647953		[illegible]
Blay Kwesi	farmer		0254842892		[illegible]
Adu Mensah	Petty Trader		—	—	A.M
Sisto Ayyaho	Zoil	—	—	—	S.A.

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: VILLAGE/COMMUNITY MEETING Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Paulina Biney	Fish Monger		0275463722		P. B
Ernest Nyamekeh	Fishing	—	—	—	E. N.
John. K. Mensah	Businessman	—	0242556070		J. K. M.
Simon Srobie	Fishing	—	0242232991		S. S
Kojo Daben	Sup soil		0240-596928		[illegible]
Giffy Kwofie	2oil	—	0 —	—	G. K
John Dadzie	Fishing	—	—	—	J. D
Joyce Ewoonure	—	—	~~0~~0202825612		J. E

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: VILLAGE/COMMUNITY Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Christiana Ofori	Fish Monga	—	0249616638	—	C.O.
Joyce Baido	Zoil	—	0246515259	—	J.B
Mary Ayem	Petty Trader	—	—	—	M.A
Rebecca Tameyeh	Zoil	—	~~0246~~ 0248 6485	—	R.T
Dorothy Mankey	Petty Trader	—	0248254888	—	D.Y
David Cudjoe	Student	—	0247999683		[illegible]
Nicholas Blay	Student	—	0240529561		[illegible]
Patrick Asiedu	Presenter	Anlobra FM.	0246496065		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joseph Gyimah	Farmar		0247832215		[signature]
Gifty Cobbinah	Fish Monger		0200195475		[signature]
Sarah Wilson	Zoil	—	—	—	S.W
Richard Zoiku	Zoil	—	—	—	R.Z
FRANCIS	QUACOE		0242713375		[signature]
Mary	Kudjoe	—	—	—	R/T
Planet	Fisherman	—	0241540328	—	[signature]
Agatha Morkeh	Businesswoman	—	—	—	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Agatha Arthur	Businesswoman	–	–	–	[illegible]
Gifty Ezu	Zoomlion	–	0543022963	–	[illegible]
Cynthia Nwi	Petty Trader	–	0244084566	–	C.N -
Dogbey Samuel	Fishing	–	0547765434		[illegible]
Dogbey Lucas	Fishing		0547765454		[illegible]
Francis Kainyah	Kapinta	–	020109586		[illegible]
Joseph Asiem	Famer		~~02~~ –		J.A
John McCarthy	Fishing		0542170426	–	J.M

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Isaac M. Codjoe	Electrician	Farmer	0544766113		
Augustine Kaku	Electrician	–	0547664896		
Benjamin Yankey	Businessman	–	0244084568		
Bright Quarm	–	–	0257141049		B. Q
Richmond Dadzie	Fishing	–	0546480659	–	R.D
Samuel Quayson	Fishing	–	0541577713	–	S. Q
Peter Avemegah	Fishing	–	0547766433	–	P. A
Safohene Amolele	Fishing	–	0241614114	–	S. A.

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Gloria Obeng	Student		0541158492		Gloria
Patience Aveteh	Fish Mongar		—	—	P.A
Joseph Baidoo	Famer	—	054285925	—	J.B
Peter Baidoo	Fishing	—	—	—	B.P
Moses Kwaw	Driver	—	0241310918	—	M.K
Peter Ackah	Fishing	—	0272542385	—	P.A
Kofi Asanco	Dispery Ass.		0244923530		[illegible]
Lucky	Trader		0246297299		Lucky

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Nkrumah	Former	Chief	0247808983		[signature]
Rita Gyimah	Trader		0246905286		RiG

GPS Coordinates:

5

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: FISHERMEN Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joseph K Arthur	Fisherman		0240907261		[signature]
Joseph K Blay	✓		0251842892 or 0543842892		[signature]
T.A Cabenla	✓		0241664427		[signature]
Samuel Kwesi	✓		0541157713		[signature]
Sofolene Arnole	✓		0241614114		[signature]
John Dadzie	✓				[signature]
Richmon Dadzie	✓				[signature]
			~~0546480659~~		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FISHERMEN Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Planet	Fishmen		0247540328		[signature]
Joseph Gyamah	✓		0247832215		[signature]
Peter Kweku	✓		-		[signature]
Isaac Asere	✓		0548154648		[signature]
Bright Quarm	✓		0206289658		[signature]
Kofi Asareo	✓		0244923530		[signature]
Alfred Adjovo	✓		024908634		[signature]
Kwodjo Dobem	✓		0240596928		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: FISHERMAN Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwaku Francis	FISHERMAN		0242713375		[signature]
Francis Kayanh	✓		0201092586		[signature]
Mandosi Blay	✓		0200168942		[signature]
Joseph Asiem	✓		-		[signature]
Matthew Srebie	✓		-		[signature]
Dogbey Lucas	✓		0547765434		[signature]
Samuel Dogbey	✓		-do-		[signature]
Richard Zoiku	✓		-		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: FISHERMEN Meeting location: ANKOBRA Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Thomas Akamiazah	FISHERMEN		0203832716		[signature]
Peter Avemega	✓		0547766433		[signature]
Enoch Sofedah	✓		0240596838		[signature]
Kwame Nyankey			0540985346 or 0272533887		[signature]
Moses Kwao	✓		0241316918		[signature]
Peter Bendow	✓		✓		[signature]
Peter Ackah	✓		0272542385		[signature]
Thomas Aketo	✓		0249758759		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women's FGD Meeting location: ANKROBA Date: 20 /March

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Gifty Cobbinah		Fish Monger	0200195475		G.C.
Agnes Asabe		" "			A. A.
Dorothy Sekinya		" "			D. S.
Faustina Kwoffie		" "	0241492194		F. K.
Joyce Baidoo		" "	0246515259		J. B.
Christina Offori		" "	0249616638		C. O.
Alice Kabenla		" "	0543788908		A. K.
Gifty Ezoh		" "	0543022963		G. E.

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Lucy Kwesi		Trader	0205768803		L. K.
Paulina Binney		Fish Monger	0275463722		[illegible]
Mary Ayiem		Trader			M. A.
Mawu		Fish Monger			[illegible]
Comfort Kwesi		" "			C. K
Rossina Cudjoe		" "			[illegible]
Patience Avety		" "			RA.
Rejogee Adjauo		" "			R. A

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation:

Meeting location:

Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Kaku		Fish Monger	0546400579		M. K.
Matilda Chapeman		" "	0246809048		M. C.
Gifty Kwofie		" "			G. K.
Janet Kabenla		" "	0240911171		J. K.
Georgina Kwofie		" "	0241647714		G. K.
Georgina Kwame		" "	0204985294		G. K.
Ester Dadze		~~T~~ Trader			E. D.
Mary Yankey		Fish Monger	0546588494		M. Y

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Tandoh		Fish Monger			M. T.
Monica Kwesi		" "			M. K.
Mary Kpokpoye		" "			M. K.
Dorithy Yankey		Trader			
Cynthia Horbah		Trader	0246651100		C H
Agnes Duku		Fish Monger			A D
Cynthia Tandoh		" "	0249444124		C T
Perpetual Tandoh		" "	0244949322		P. T

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Comfort Nwindah		Fish Monger	0248138609		C. N
Gifty Champeman		" "			G. C.
Monica ~~Age~~ Kwofie		" "	0240915297 ~~0240915297~~		M. K.
Bertha Kugbe		" "	0200169640		[signature]
Mary Mansford		" "			M. M.
Lucy Enzah		Store Keeper	0201568962		L. E
Tharesah Kpokpoye		Fish Monger			T. K.
Cecilia Abban		" "			C. A

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Florence Sanye		Fish Monger			F. S.
Victoria Sanye		" "			V. S.
Elizabeth Somiah		" "			E. S
Cecilia Somiah		" "			C. S
Susana Nwadah		" "			S. N.
Agnes Tanoeh		" "			A. T.
Gloria Boquoh		" "	~~020~~ 0200381841		G. B
Nwiaka Mohia		" "			N. M.

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Gladys Baidum		Trader			G. B
Rossina Boquoh		Trader	0200301853		R. B
Gifty Assuah		Trader			G. A.
Patricia Kwofie		Trader			P. K.
Gifty Kweku		Store Keeper	024797131?		G. K.
Regina Amoah		Fish Monger	0548649089		R. A.
Elizabeth Kwesi		Fish Monger			E. K.
Mercy Dodgbe		" "	0204446825		M. D

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation:

Meeting location:

Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Dodgbe		Fish Monger			M. D.
Lidja Christian		" "	0200695529		L. C
Joyce Armah		" "			J. A.
Mercy Kaku		" "	0247919107		M. K.
Abigal Yankey		" "	02~~7~~747112		A. Y
Cynthia Kwesi		" "			C. K
Monica Quashey		" "			M. Q
Lucky Gbenebichia		" "	0246297299		L. G.

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation:

Meeting location:

Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Faustina Kaku		Trader			F. K
Magaret Aflobra		"	0274909973		M. A.
Nyameke Adjo		"			N. A.
Mansah Agbemeva		Trader			M. A.
Dora Somiah		"			D. S.
A. K. Armah	ESL				
Tony Bentil	ESL	Consultant	0208769758	[illegible]	[signature]
Janet Michalek	ERM	"	+27798877725	janet.michalek@erm.com	[signature]

GPS Coordinates:

Elijah B-Ampah Tullow

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: EDUCATION   Meeting location: ANKOBRA   Date: 20/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joan Omo-Sey	G.E.S.	Asst Headteacher	0545242609		[signature]
Andrew Efom ~~Nyameteh~~ Nyameteh	G.E.S.	Headteacher	0246670619		[signature]
Gifty Nyantcoh	G.E.S	Teacher	0246251348		[signature]
A.K. Armah	ESL		0244771707		
Tony Beatty	ESL	Consultant	0208769258	tbeatty@yahoo.com	[signature]

GPS Coordinates: 04° 54.066N   002° ''.281W

KEY:

● Meeting Location

N
W E
S

0 1

Kilometre

TITLE:

BUSUA COMMUNITY
21 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 55,000
DRAWING: Busua.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

ERM

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Village/Community Meeting Meeting location: Bucua Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kweku Frimpong			0274342825		K. F
Mina Aba					M A
Nana Kwekou Nunoo					K. N
Adjoa Kontsinwa					A. W
Kow Tsiaba					K. T
Justice Bentum			0266744575		[signature]
Alexander Ackah			0277978855		
Kelvin Eshun			0201429090		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Community Meeting   Meeting location: Busua   Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Emmanuel Artho			0548153079	kingtchito@gmail.com	[signature]
Hon J. C. Kwofie	Assembly member		0276099098 0240865459		[signature]
A. K Armah	ESL				
ANTONY Benhl	ESL	Consultant	0208769258	tbenhl@gch	[signature]
Janet Mkhabela	ERM		+27793887725		[signature]
Elijah Boyen-Ampah	Tullow				[signature]
Akusua Obour			0249516437		[signature]
Matilda Kwofie					Kwofie

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: BUSUA Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Anar belo					Batoe
Kojo Grey					[illegible]
Alex Cobbinah			0207590072		[illegible]
Safuhen Atankeku					[illegible]
William Ansah					Ansah
Kojo Assafuah					ASSafuh
Kwame Arthur			0204771339		[illegible]
Thomas Agyebu			—		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Fishermen Meeting location: Busua Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ekow Obesu					Ekow
Kweku Ayaw					Ayaw
Kofi Ica					Kofi
Asamoah Daniel					Daniel
Enoch Annan			-		Annan
John Odoom			0276473291		Odoom
C. J Arthur					
A. K. Armah	ESL				

GPS Coordinates:

Tony Bentil	ESL	Consultant	0208769258	tbentil@yahoo.co.uk	ABentil

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Village Meeting Meeting location: Basua Date: 21 March 2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Emmanuel Bordes			0249516437		Emmi
Mary Nyame			0276881685		mary
David Dukeh			0207735964		Dukeh
Comfort Quayson			-		Comfort
Joseph Arthur			0241261224		Arthur
Dorcas Bentum			-		Dorcas
Kweku Bentum			0201082326		K Bentum
Joseph Hasford			0278466282		[illegible]

GPS Coordinates: 04.48.328 N 001.56.370 W

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: BUSUA Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ebusuapayin Bediako			0261439494		[signature]
Kwasi Banyah			–		[signature]
Kobina Richmond			024929545		[signature]
Ekow Ebisiwu			0276362876		[signature]
M.C.A Bentum			0245522910		[signature]
John mensah			–		[signature]
Argatha Quaicoo			0203729615		[signature]
Jennifer otoo			0206548858		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: BUSUA Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Comfort Awotwe			-		[signature]
Kennedy Taiwiah					[signature]
William Kwesi Bentum			0205148030		[signature]
Amos Cudjoe			0275511334		[signature]
Kobina Agyir					[signature]
Francis Ansah			0548871352		[signature]
Henry Pattison			0207635539		[signature]
Anthony Cudjoe			0273158175		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: BUSUA Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOSEPH GABBINAH	Electronic Tech		0209417507	Jscobbinah@yahoo.com	[signature]
Esther Arthur			0273158175		[signature]
Nana Yaw		Bar Keeping	0249726365	Zweilehemcat500@yahoo.com	[signature]
Joseph D. Dadson	Project officer		0245240005	Jsph dadson@yahoo.com	[signature]
David Abaggye			0274886087		[signature]
Patrick ~~Esh~~ ogre			0273063058 ~~0209494484~~	eshunpatrick@yahoo.com	[signature]
Solomon-Kwofie					
Joshua Coleman			0570327172		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: BUSUA Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Asomani Daniel			0243654191	~~Onces-Dan~~ @ hotmail.com	[signature]
SAMPSON ARTHUR					S. A
Thomas Cudjoe			0544842868	Thmcudjoe@ gmail.com	[signature]
Justice Cudjoe			0268206790	Lydia 8 @ gmail.com	[signature]
Solomon Ackon			0246556587	Gaztony17@ yahoo.com	[signature]
John Wilson			0277432174	John.kobby wilson@yahoo	J. W
James Quaicoe			0208175414		[signature]
Alfred Ajeibu			0272721334		A. A

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FGD Women Meeting location: Busua Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Comfort Efua	Fishing/trading	Chief fish Monger			
Nana E. Ampofo		Chief/	0207591707	Queen Mother	[illegible]
Mercy Brew	Trading				[illegible]
Hannah Adam					[illegible]
Sabina Boston					
Mame Boro					
Mame Maye					
Elizabeth Cudjoe					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: FED WOMEN Meeting location: BOSUA Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
[illegible]			N/A		
Sofolerie N[illegible]					
Meme Hannah					
Matilda Kwofie			N/A		
Adjoa Kwentoa					
Cristabel Quaysu.			0209689612		[signature]
Agatha Quince			0203729615		[signature]
Rose C[illegible]			N/A		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: FGD WOMEN Meeting location: BUSUA Date: 28/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Maria Aba					
Nana Afelba	Esum.				
Mane Kombale.					

GPS Coordinates:

KEY:

● Meeting Location

N W E S

0 1

Kilometre

TITLE:

ESSIAMA COMMUNITY
21 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 55,000
DRAWING: ESSIAMA.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Community Meeting
Meeting location: Chief's Palace
Date: 21/3/12
10:20am

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Georgina Annan					[signature]
Martha Blay			0243926455		[signature]
Isaac Donkor	Freedom Fighters	Secretary	0240590431	isaacdonkor99@yahoo.com	[signature]
Joyce Toffay	Esiama Sec. Tech.	Asst. Head mistress	0275772891	ToffayJ@.com	[signature]
Faustina Acquaye			0204463791		[signature]
Ishmael Kwodsa			0541745567		[signature]
Blay Williams	—		0549591205		[signature]
Francis Buah	carpentry	—	0205718789	—	[signature]

GPS Coordinates: N 04° 56.060' W 002° 21.038' El 18m

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Community meeting Meeting location: Chief's Palace Date: 21/12/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Isaac Antwi	G.E.S	Teacher	0541206384	antwiboasiako 23@gmail.com	[signature]
Noah Nuhu ~~Mott~~	GPRTU	Driver	0278126482		[signature]
Moses ~~Ata~~kole	GPRTU	Executive member	0245219139		[signature]
Raymond Kasah	Clergy	Head Pastor	0277788076		[signature]
Sefohere Fatoho	Zoil	Supervisor	0243482576		[signature]
Peter Amo					[signature]
Isaac Mensah			0207938735	0	[signature]
Isaac Kwaw			0549464188		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John Nkrumah			0246934158		[signature]
Emmanuel Armor			0248801495		[signature]
John Moza			0572401693		[signature]
Matthew Miah	Zoomlion Ghana Limited		0260851259		[signature]
Accra					[signature]
Kenyah Cosmos	Zoomlion Ghana limited		0247278647		[signature]
AWUHA BONZOE					[signature]
Emmanuel Anaman	Fish MAN		~~0542487~~ 0542487118		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation:

Meeting location:

Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
~~Dyna~~					
Dyna Kwafie			0266425112		[signature]
Mary Ackah					[signature]
Daniel Afiakoh Andoh	Freedom Fighters	president	0246374204		[signature]
Asuah-Chie Akaba.					[signature]
Agen Ansah Patrick	Student		0268506092	FreshTito@ ~~Gm~~ yahoo.com.	[signature]
Assuah Ehomah Joshua	Student		0208810077		[signature]
Ackon ~~Isaac~~	Student		0268506093	Isaacackon28 @yahoo.com	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
KANIYAH SAMUEL	Student		0848938439		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Chief and Elders. Meeting location: Esiama Palace Date: 21/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kerryn McKune-Desai	ERM	Social Consultant	+27(21) 702 9100	kerrynmckunedesai@erm.com	
Samantha Button	"	"	"	samantha.button@erm.com	
Patrick Ampong	Tullow	Senior Officer Stakeholder Engagement.	0242553386	patrick.ampong@tullow	
ISAAC W. ENNIN	TULLOW	Offshore Security Adviser	0202022195	isaac.ennin@tullowoil.com	
Onwona-Agyemang Appiah	SRC	Social Consultant	0242109854	onwonaagyemang@yahoo.co.uk	
Nana Kofi Ampoe IV	Tradit Chief	Traditional Ruler Esiama	0540806797		
Raymond Gyan Quarm	Head of Family	Head of Family	0549598429		
Hon Jacob Kwofie	Assamblyman	Assembly man	0243917722	Kwofie.Jacob@yahoo.com	

GPS Coordinates: N 04° 56.061' W 002° 21.023'

El: 14m

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Edward Kenya Yalley			0271228167		
J.K Abonmgbo		Omanpanyin			
Asemnyinaa Kwofie			024305692		
Nyameboame Kabbenla					
Moses Zlaku			0245219139		
Albert Ekobo Mensah			0243926343		
Adamah			0570033338		
Hon. Joseph K. Mensah			0202878999		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ande Ezuah					
Raymond Koeah			0277783076		
Diana Koufie			0266425112		~~0266425112~~
Kofi Asare Anderson			0543949760		
James Kwesi					
George Blay					
Georgina Annan			0549461420		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: ~~Fishermen~~ Women

Meeting location: Esiama Beach Date: 21 / 3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Sobo Abenlema					✓
Nyameke Beye					[illegible]
Kofi Kuo Kakwa			0541455634		
Jenever Cobbinah			0571747690		
Fatima Allakwe			0271646526		
Susana Ose			0208741901		
Afia Nowa					
Asuaha Aba			0528937823		Ab

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women FWD Meeting location: Essiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Rebecca Famiye			0279253482 ~~027923382~~		
Elizabeth Dumaklie					
Elizabeth Cudjoe					
Bamade Azaa					
Comfort Mensah					
Elizabeth Acquah					
Enice Nyameketh					
Elizabeth Abo					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women F&D Meeting location: Essiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwo Adwoa					
Mary Sam					
Eba Nyarzozo					
Nda Anima					
Aba-Ekuwa					
Nda Aba					
Yalley Taya					
Mary Yankey			0274812003		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Fed   Meeting location: Essiama   Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Aba Attobam					
Oba-Aija					
Nana-Aba					
Priscilla Yankey				0273269071	
Fuastina Kwaw					
Allo Benie					
Elizabeth Kwofie					
Mary Kwofie					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women FAD Meeting location: Essiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Reginah Acquah					
Nyamboa Adwoa					
Abayie Abena					
Diana Kwaw					
Alice Tiye					
Gorkwe Aija					
Alice Mensah					
Victoria Kwofie					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women Fund Meeting location: Essiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Anastacia Yankey			027		
Alima Ebela					
Mary Essien					
Elizabeth Mozu					
Tanoe Aya					
Sophia Mensah					
Elizabeth Ezane					
Tanoe Wakela					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women Fund   Meeting location: Esiama   Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mahama Yakubu					
Fuastina Akyere					
Mary Aboabo					
Agnes Mensah					
Doris Menlewa					
Elizabeth Blay					
Theresah Mensah					
Diana Awuzi					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women FHD Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Akisi Bakwa					
Grace Dumaewe					
Elizabeth Ezoah				0542639448	
Susana Mensah					
Susana Kwofie					
Nda-yale					
Agnes Enu					
Mary Amihere				0540790925	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women FWD Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nyameke Alluwa					
Philomina Amakwa					
Agnes Ackah					
Adwoa Kwaba					
Gradys Bεgulame					
Mary Aboabo					
Nyameke Eba					
Mary Okodu					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women FWD Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nyame Ahuma					
Hellina Quaison					
Mary Quaison					
Elizabeth Arquah					
Menlebaa Ashiele					
Dorithy Azoh					
Susana Kwofie					
Allo Nyamekeh					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women Fnd Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nyamele-baa Kezela					
Saviour Kwofie					
Comfort Nkettia					
Monica Ocran					
Mary Kabulu					
Abeka Asiata					
Ebame					
Adwoa Esifia					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Fed Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Sophia Abane					
Cecilia Acquah					
Gladys Ezane					
Comfort Cadjoe					
Awaa Famiye					
Ayiza Famiye					
Kabela Babiza					
Margret Mensah					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women FWD Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Cobbinah					
Priscilla					
Mokwa					
Anastasia Baza					
Victoria Yankey					
Ama-Otedu					
Grace Menlekua					
Theresah Kelia					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Fed Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Appiah					
Elizabeth Armoah					
Elizabeth Menlehwa					
Lydia Ackah					
Amela-Ekyie Menlehwa					
Mary Baidoo					
Vivian Gyasie					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women FWD Meeting location: Esiama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Hannah Evdjoe					
Joyce O Oran					
Yela Ezoma					
Ekiji - Tanoe					
Joyce Bezene					
Ekuba					
Lydia Famiye					
Elizabeth Manu					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women FUD   Meeting location: Esiama   Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Olivia Allo					
Naomi Tanoe					
Francis Amoako	Esiama Health Centre	Physician Assistant	0243837475	Awoako65 at Global.Com.	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women FaD Meeting location: Esiama Date:

Name and Surname	~~Organisation~~	Position / Role	Cell phone	Email address	Signature
Rose Bambey					
Neme Akasi					
Abele Melewia					
Kaku Akuba					
Mayia					
Bomo Yazu					
Aya					
Akon Asua					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Fed Meeting location: Esiama Date:

Name and Surname	~~Organisation~~	Position / Role	Cell phone	Email address	Signature
Agabim					
Asa Nuhu					
Ayemeye Awua					
Aka Ebela					
Anite Enuyaa					
Bowala					
Monica Ocran					
Adiaba Ewame.					

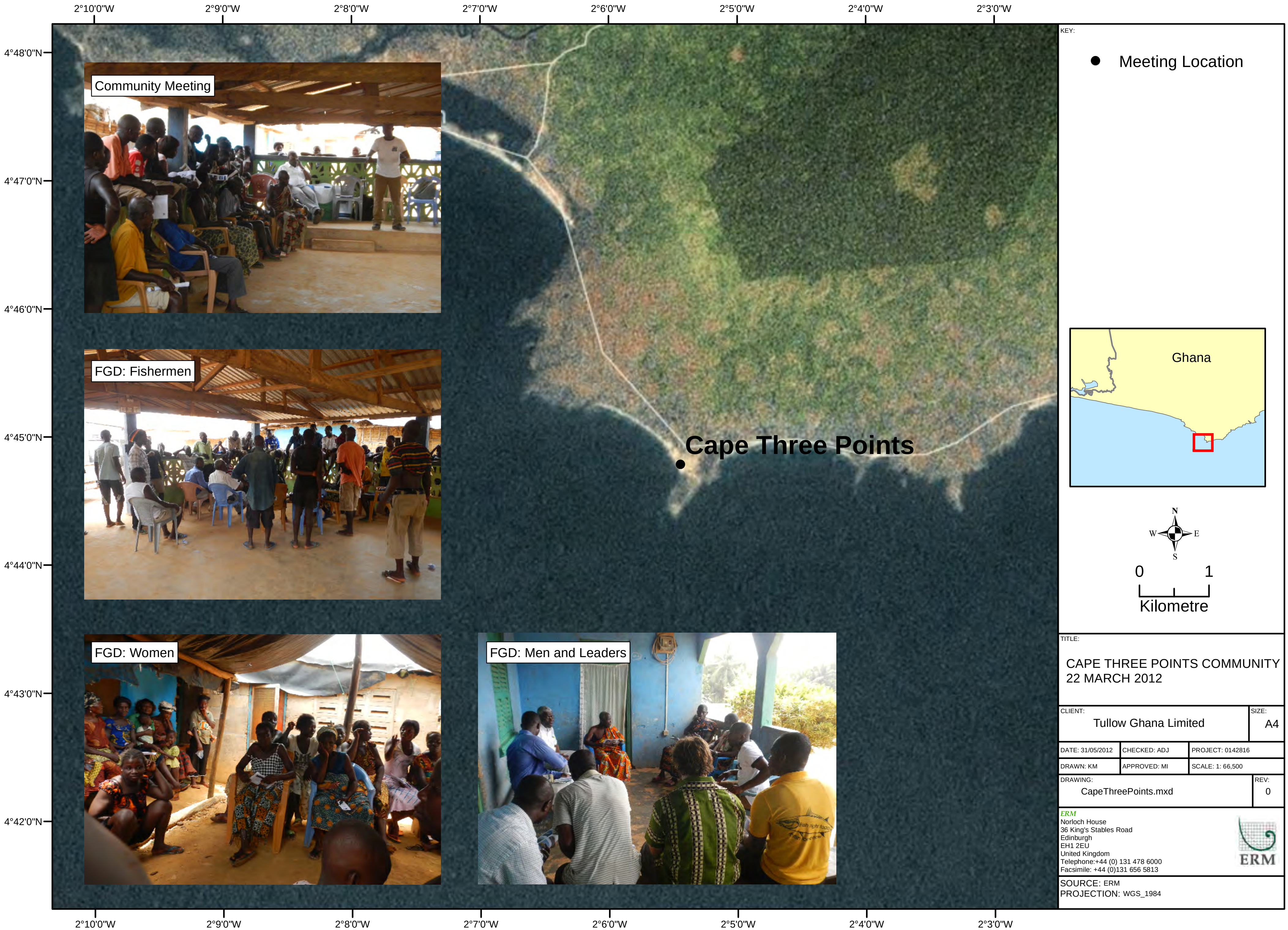
GPS Coordinates:

Elinzabth Tane
Hanna ~~Agei~~ Adgei
Esther Wazio
Eilivia Kofi
~~Ga~~ Alizia Ezie
Mary Melewia
Agnes Bentun
~~Agenes~~ Agnes Yabome
Grace Kabolo
Akezia Donia
Sela Ocran
Rose Kema
Melewia Bozoma
~~Azua~~ ayia
Asuakyi Akaba
Elizebth Akaku

Adwoa Kofi Dwomoh

~~Anite Hawa~~
~~Elizabth~~ Elinzath Musa
Pateince Conbina
Sayer Manu
Ago Kabema
Nyankedua Asidwo
Nyale Ezuma
Doris Melewia
Dinah Dwomoh
Grace Azile
~~A~~nite Maniasa
Diana Benilen
Wazia Akasi
Mahamadu Musa

Mary Ayaa ~~Afe~~ Amiye
Mary yaba Amuzua
Yaba Kabela
Beiba yale
Cecilia Cudjoe
Naomi Fameye
Aku Kojo
Avo Afiba
Kofia Ahyia
Vida Blay
Florence Famiye
Yaba Bolwniboa
Esofo Adwoba
Kofi Aniwah
Aloshia
Yaba



2°10'0"W
2°9'0"W
2°8'0"W
2°7'0"W
2°6'0"W
2°5'0"W
2°4'0"W
2°3'0"W
4°48'0"N
4°47'0"N
4°46'0"N
4°45'0"N
4°44'0"N
4°43'0"N
4°42'0"N
Community Meeting
FGD: Fishermen
FGD: Women
FGD: Men and Leaders
Cape Three Points
KEY:
Meeting Location
Ghana
N
E
S
W
0
1
Kilometre
TITLE:
CAPE THREE POINTS COMMUNITY
22 MARCH 2012
CLIENT:
Tullow Ghana Limited
SIZE:
A4
DATE: 31/05/2012
CHECKED: ADJ
PROJECT: 0142816
DRAWN: KM
APPROVED: MI
SCALE: 1: 66,500
DRAWING:
CapeThreePoints.mxd
REV:
0
ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813
ERM
SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: CHIEF & COMMUNITY LEADERS Meeting location: CAPE THREE POINTS Date: 22/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA AKYE KESSE THE V (Chief)	C'	Chief of the community	0260862116		N.Kessie
Thomas Quicoe		community elder			
Pual Nachimah		community elder			
William Botchwey		Teacher	0268409813		
Emmanuel Bosomtwe		Teacher	0260958615		
~~OFFEI~~ ERNEST OBUOBI		HEADTEACHER	0267990080		
Jake McCommons	PeaceCorps	PeaceCorps Natural Resource Management Volunteer	0541829887	JDMcCommons@gmail.com	
Justice Abban		Chief fishermen	0268326748		Justice

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Eddie E. Adomah	Common Belly ORG. (N.G.O.)	P.R.O. / Exe Sec, Treasurer	0268253055	easysteadyeddie@yahoo.com	[signature]
A K Armah	ESL				
Tony Bentil	ESL	Consultant	0208109258	tbentil@y...	[signature]
Samantha Bolton	ERM				
Elijah B. Ampel	Tullow				

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: COMMUNITY MEETING Meeting location: CAPE THREE POINTS Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Odamusa					
Florence Binnah					
Nicholas Mensah			0267104812		
Boatho			0265030768		
John Quarm					
Joseph Quaye			0261110516		
John Kwofie			~~0269392502~~		
Tandoh Mark			0269392502		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nkapa Asuah					Nkapa Asuah
Sabinal Quayson			0268411236		[illegible]
Joseph Quayson			0266513697		[illegible]
James Aidoo			0268606656		[illegible]
Peter Adae			0268411239		Peter Ad
Zakari Nurudeen			0265900459		[illegible]
Peter Cudjoe					[illegible]
Kobina Badu					[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/2/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Francis Essien					[signature]
Gyemiah Francis			0267019195		[signature]
Tomas Adde			0266737147		[signature]
Victory A. Kwaw			0266507435		Vic
Justice Abban			0268326748		Justice
Joe					[signature]
Matthew Krah					[signature]
Emmanuel Prah			0268554693		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joseph K Quashie			0268256496		
Matthew Adde					
Thomas Kwuaifoe					
Paul Nichema					
James Bnah			0268325179		
Vida Donkor					
Bofo					
Manye					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/8/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Beatrice Kwofie			0267018681		Kwl
Elizabeth Nyarko					ENk
Efuah					Ef
John Essien			0279919057		
John Dimas			0279919057		NAm
Elizabeth Kwofie					EK
Juliana Gadjoe					JGa
Nyowah					Ny

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Affuka					[signature]
Akuah Abah					AA
Menah Boborah					[signature]
Akuah Nyamkomo					[signature]
Nyimah					[signature]
Anlomzo					
Theresa Cudjoe					[signature]
Cecilia Adde					[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Efuah Emisah					
Ehvenle Amakld					
Mary Nredah					
Abah					Abah
Amo Nda					[illegible]
Penyin Yenah					[illegible]
Yaba					[illegible]
EKELA Amah					[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Community meeting Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ebandu Adde					
Mary Ackah					
Ashley Neese					
William Quayson					
Kobu Yankey					
Korangye Nredah					
Albert Eshun			0265749707		
Paul Nredah					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Community meeting Meeting location: Cape 3pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwesi Anyako					[signature]
Benhe			0266417671		[signature]
David Amoako			0268410653		[signature]
Matthew Adae			0265685773		[signature]
Martin Panto			0268253864		[signature]
Dr. Eliza Johannes			+ 217-417-7164	eliza.Johannes @gmail.com	[signature]
Agnes Essien					[signature]
Martha Essien					[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: CAPE 3 POINTS Date: 22/8/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mercy Kwofie					[signature]
Elizabeth Arthur					[signature]
Benard Cudjoe			0268325245		[signature]
Mark Cudjoe					[signature]
Ebenezer Kwamekyi					[signature]
Elizabeth Acquah			0269483432		[signature]
A. K. Armah	ESL				
Tony Bentz	ESL	Consultant	0205769258		[signature]

Samantha Button ERM

GPS Coordinates:

Elijah R-Amankwah Tullow

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Men   Meeting location: Cape 3 pts.   Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ernest Offei			0267990080	mr_king2323@yahoo.com	[signature]
William Botchway			0268409813		[signature]
Martin Paintoo			0268253864		[signature]
Emmanuel Bosomtwe			0260958615		[signature]
Bakari Nuru Deen					
Albert Eshun			0265749707		[signature]
Albert Cudjoe			~~0268410~~ 0268410033		[signature]
Benard Cudjoe					[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Men   Meeting location: Cape 3 pts   Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Peter Adae			0268411239		~~Peter A~~
Samuel Yankey			0267200327		
Samuel Flynn			0260989655		
Francis Essien					
Paul Nredah					
Kwafi Nyame			0268258115		
Mark Cudjoe					Mark.
Paul Amo Nda					Rkhenedah

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Men

Meeting location: Cape 3 pts

Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOSEPH KWAME QUARSHIE				0268256496	
Joe					Joe
John Kwofie					
Joseph Quaye Jr.			0261110516		
Nicholas Mensah			0267408888		
Nuapa Asua					
Justice Abban			0268326748		Justice
Thomas Queicoe					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Men Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
David Amoako			0268416653		[signature]
Matthew Adae			0265685773		
Emmanuel Gyimah					[signature]
James Boah					[signature]
Francis Quaye			0268256637		[signature]
Odamusa					
Korangye Nreda					
Kwesi Anyarko					[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Men Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ebenezer Kwamekyi					
Thomas Abban			0265915490		
John Adde					
Emmanuel Appiah			~~02688~~ 0268554693		
Joseph Quaye			0266513647		
Matthew Arde					
George Arthur			0267019365		
Boafo			0268030768		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: MEN Meeting location: Cape 3 Pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
A. K. Armah	ESL		0244771707	akarmah@...	
Tony Beale	ESL	Consultant	0508769258	tbeale@...	[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Group Meeting location: Cape 3 pts. Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Cynthia Adukwaw			0268254155		
Matter Essien					
Mary Kwofie			0268253924		
Elezabeth Arthur					
~~Ac~~ Acquah Elezabeth			0289483432		
Cecellia Arde					
Serah Arde			0265633338		
Elezabeth Annu			02		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Faustina Boah					[signature]
Paulina					[signature]
Victoria A Kwaw			0266307435		Vic.
Juliana Eudjoe					[signature]
Sophia Esuakuma			0260862124		[signature]
Menamebola					[signature]
Adjow Nyamekye					[signature]
Nyanwo					[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kalama					
Elezabeth Kwofie					
Madam Amoah					
Madam Awuja					
Aba Ekuwa					
Ahanzen					
Beatrice Kwofie			0267018681		
Sabina Quayson			0268411236		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Gp Meeting location: Cape 3 pts Date: 22/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Boafo					[signature]
Comfort Mensah					[signature]
Ekulakyu					[signature]
Aneka					[signature]
Mary Nwadel			0266510502		[signature]
Madam Nyangom					[signature]
Aheni Abaku					[signature]
Cynthia Essien					[signature]

GPS Coordinates:

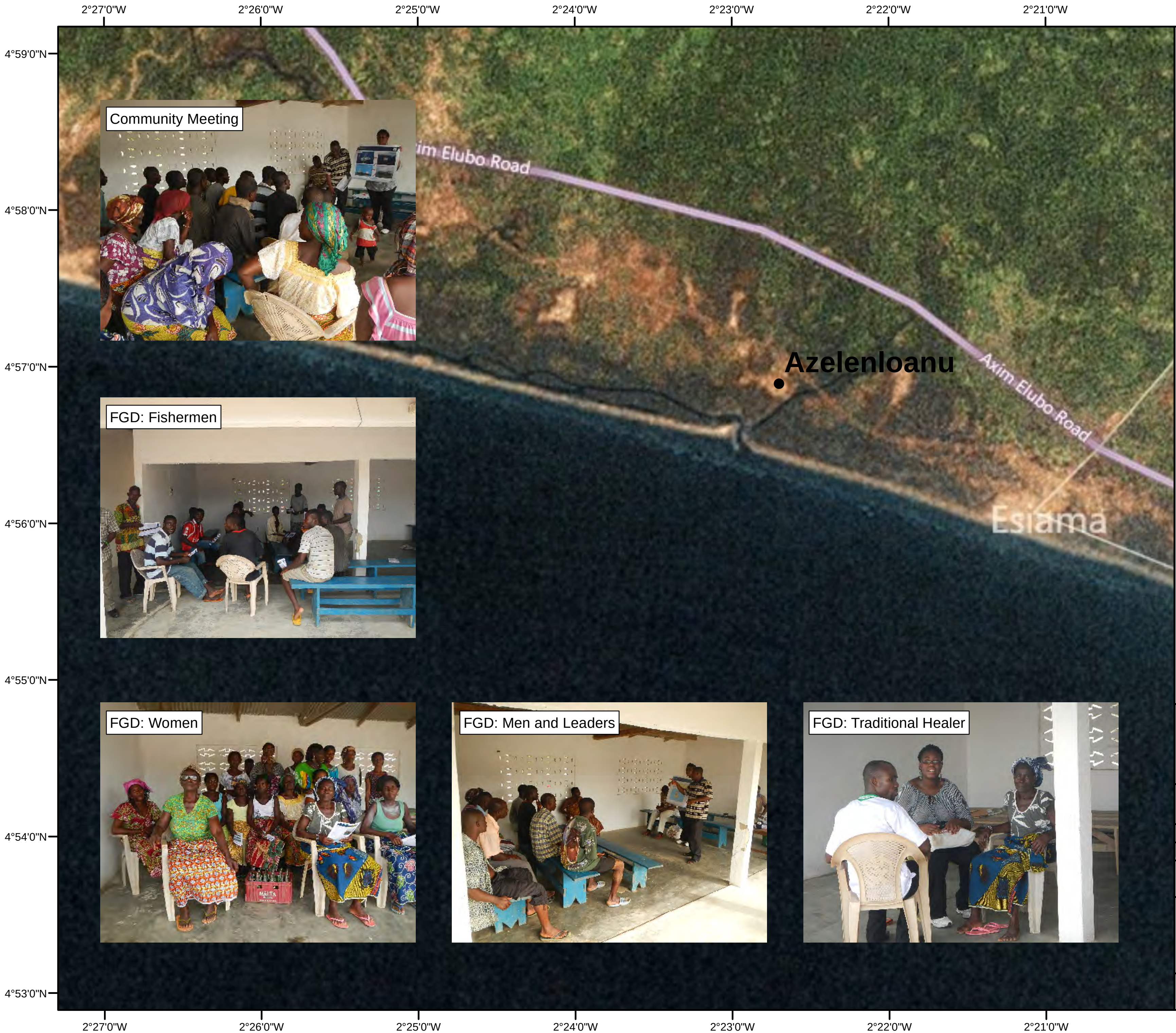
T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Group Meeting location: Cape 3 points Date: 23/8/12

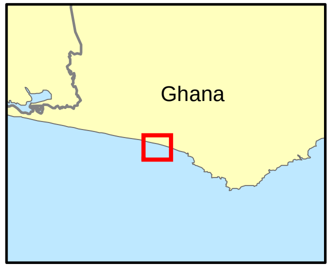
Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Aba Kwakyewa					[signature]
Ana Efua					[signature]
Nana Awuba					[signature]
Mangi					[signature]
~~Mamba~~ Cecilia Arde				~~0268681620~~	[signature]
Agnes Mensah				0268681620	[signature]
Samantha Button	ERM				
Elijah B-Ampah	Tullow				

GPS Coordinates:



KEY:

● Meeting Location



N
W E
S

0 1
Kilometre

TITLE:
AZELENLOANU COMMUNITY
22 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 60,500
DRAWING: Busua.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Community (Azulenloanu) Meeting location: Chief's Palace Date: 22/03/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John Mensah					
Musah Mensah					
James Nyankson					
Evans Adu					
John Bleah					
Mary Kwaw					
Issah Fatima					
Mary Nketiah					

GPS Coordinates: N 04° 56.897 El 82 ft
W 002° 22.737

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Amoah					
Amokwan Gifty					
Enwonggyia Boahenma					
Eva ~~Awoy~~ Awoin					
Kofi Bomo					
George Ackah					
Matthew Nhesah					
Soloman Adam					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ANTHONY ACKAH	GES	Teacher	0272035851 0247825061	guypaapam@gmail.com	[signature]
EMMANUEL KAINYAH			0241199334		[signature]
ARABA KWANSEMA					
ESTHER ACKAH					
James Ngeda Kwesie					[signature]
Kojo muah					
maame Koole					
Charity Gabianu			0240294510		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Wilfred Yankey			0248486166		
MICHEAL Ekomoh					
Kobina Avaijah					
Acquah Afunu					
Nyamekey Sulonye Nyonha					
Dorcas Avo.					
Nketsia Angbomah.					
Cecilia Avay			0272088376		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Asana Issaah					
Christiana mensah					
Hon Lord S.K Cudjoe	Tullow	CLO	0248105318 0272035871	lordcudjoe4u @yahoo.com	[signature]
KATE BOAH	FISHMONGER				KBoah
JOHN KPOLLEY	-		0268669741	-	[signature]

GPS Coordinates:

KEY:

● Meeting Location

N
W E
S

0 1
Kilometre

TITLE:

LOWER AXIM COMMUNITY
23 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 60,500
DRAWING: LowerAxim.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: AXIM Date: 23/2/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Grace Asuman	fish monger				GA
Esi Anko	fishmonger				EA
Grace Tetteh	✓				GT
Juliana Rockson	✓		0275533265		JR
Grace Adiabi	✓		0209316006		GA
Hannah Ansah	✓	Konkohene	0245858558		HA
Elisabeth Arthur	✓		0249155829		EA
Aba Ekins		Konkohene	0249142456		AE

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation:

Meeting location:

Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Hannah Kofi	Kenkey/fish seller				HK
Ama Nkeriba	fish monger		0244028504		AN
Mansa	✓		0241613006		M
Ama Baido	✓				AB
Victoria Amissah	✓		0209193836		VA
Ama Alesua	fish monger & Gari seller		0274231882		AA
Theresa freeman	fishmonger		0246603371		
Vida Eyougie	✓		0240520445		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Dominic Mensah	Fisherman				
Isaac Kofi	✓				
Samuel Kwesi	✓		0202439343		
Paul Nyanko	Mechanic / fisherman		05465 3072		
Daniel Boateng	fisherman		0271636694 0203822291		
Kwesi Afram	✓		0205424390		
Kwesi Awotwi	✓		0249833899		
Samuel Adjei	fishes Commission	Technical Assistant	0208090492		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John Afedzi	fisherman		0244540820		
Alasan Koto babi	✓				
Nania Abban	Carpinta		0541002848		[signature]
Kweku Isa Attaur	fisher /farming boat owner		0242120718		
Anthony Adjei Assabil	boat owner		0244711574		
Francis Bonzi					
Eqya Asiful	Fisherman/		~~020101594~~ 020109154 94		
Papa Andoh	✓				

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Uncle Esson	cold store/ fisher man		0242251269		
James Haal	fisher man		0207421645		
Elizabeth Graham	boat owner/ fish monger		0208188779		Eli
Magratte Graham	✓		0208188778		
Emmanuel Adiah	carpenter	Assemblyman	0243762174		Adiah
Agbe Kokdey	Fish monger				
Dzawaber Esther	fishmonger				
Kobina Nyamea	fish ma		0241153397		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: COMMUNITY MEETING Meeting location: Axim Date: 23/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Akosua Mensah	~~Sh~~ fishmonger		0542825392		
~~E~~ Stephen Bin	fisherman		0246321429		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FISHERMEN   Meeting location: AXIM   Date: 23/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwabena Acton			0200227772 0272809776		
Kwamena Nyimpanka			0208708822		
Kwesi Nketsia			0543255493		
Kwofie Esuon			~~020~~		
Samuel Ebo ~~Adjei~~			0208090492		[signature]
Kwodjo Pegu			0203070017		
Kabi			0241931473		

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Abban			0541002848		
Efsiwa Kojo			0541831167		
Kwaku Issah Arthur			0242120718		
Tetteh Monokum					
~~Oko~~ Okoe Annan					
Kwaku Mensah					
Isaac Kwofie					
Egya Awortwe			0278088484		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nyameye			0241153397		
Kwame Bentum			0243915980		
Emmanuel Baidoo			0245530886		
Alex Nketsiah			0570850538		
Daniel Boateng			020 3822291		
John Kwesi Nyamekye			0544778227		
Kwesi Awortwe			0249833899		
Papa Kwesi Anny					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joseph Annan			~~0540862560~~ 0540586256		
Benjamin K. Nketsiah			0244111456		
Nana Kojo Eshun			0249712526		
Francis K.B. Eshun			0243359277		
Egya Ebu Kwofie			0242255178		
Kwodjo Kakraba			0208176528		
John Abotar					
Ebenezer Afful			0244181722		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Michael Nkoe			020-8198515		Michael Nkoe
Nana Kwesi Binn		Abohow-hene	020-8187976 0249717695		
John Afedzie			0244540820		
Kwesi Amfam			~~02~~ 020~~2~~401059		
Abass Korsah		Assembly man Ekpawosi[illegible]	0201036510 0247252699		[illegible]
Emmanuel Adiah		Assemblyman Botokule	0243762174 0271021003		[illegible]
Anthony Adjei Assabil		Boat owner	0244771514		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women's Fed Meeting location: Axim Date: 23/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Adwoa			0248506252		
Cynthia Amos					
~~Stella~~ Salome Kofi			0547015105		
Grace Say			0208298724		
Janet Mensah			0209287848		
Elizabeth Sekam			024078304		
Cecilia Abonsah			0242255178		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women's FGD Meeting location: Axim Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Abena laye	fish mange		0243661392		
Yanicey hannah	✓		0240496586		
Mama Araba Afui	✓		0243525489		
Akosua Afui					
Theresa mensah					
Esi mensa					
Mary Kofi					
Matha Yebah					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women's FGD Meeting location: Axim Hall Date: 23/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mame Alata					
Eastha Tawiah					
Adwoa Aquasia					
Esi Badu			024 667 0191		
Mary Amakyi			0243963753		
Comfort Mozi			0243963753		
Mena Akosua					
Adwoa Nyama					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women's Fed Meeting location: Axim Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Mensah	fish monger		0209292282		
Gasther Tetteh	✓		~~0954 55 46~~ 11 0546411 65		
Maria Essump	✓				
Esi Awotwi	✓		0546893775		
Regina	✓		0540996908		
Ama 1	✓		0241198457		
Ruth Dawson	✓		0278222827		
Elizabeth Awotwi	✓		0245833207		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women's FGD Meeting location: Axim Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Felicia Mensah					
Mary Mensah			0571373731		
Theresa Acquah					
Akosua Asum					
Akua Esson					
Rose Ali			024582114y		
Rebecca Essel					
Stella Quaisoo					

GPS Coordinates:

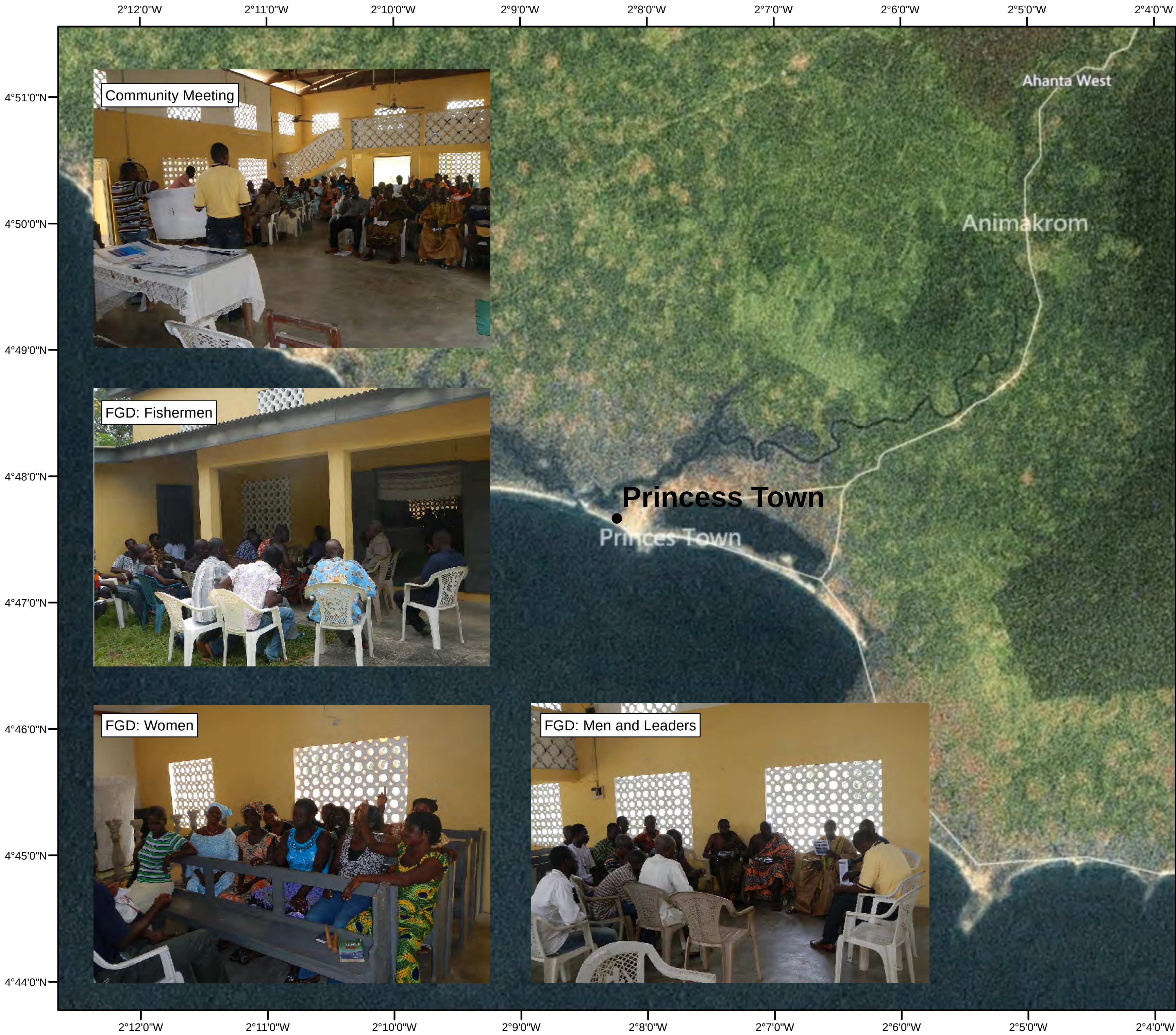
T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: HEALTH KEY INFORMANT MEETING Meeting location: AXIM Date: 23/2/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Francis Sackey-Enu.	Axim Hospital	Principal Accountant	0243574043 0203089461	[illegible] @ yahoo.com	[signature]
Mercy Doris Sey	Axim Hosp.	Senior Nursing Officer	0244947986	–	[signature]
A. K. Armah	ESL		0244771707	akarmah@yahoo	
Tony Bentil	ESL		0208709258	tbentil@yahoo	[signature]

GPS Coordinates:



KEY:

● Meeting Location

N
W E
S

0 1

Kilometre

TITLE:

PRINCESS TOWN COMMUNITY
23 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 75,000
DRAWING: PrincessTown.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

ERM

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

~~Organisation:~~ Prince's Town Meeting location: SDA Chapel Date: 23/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Abban		Nkosuohen	0244987684		[signature]
Nana Kundumah IV		Divisional Chief	0204409891		[signature]
Nana Ndama Kundumah IV		Divisional chief	0243671013		[signature]
Nana Kofi Nyame II		Sub chief	0243570509 0203980871		[signature]
Joe Kwesi Mensah		Chairman 7 member Royal Com	0242873797		[signature]
Augustine Yaw		Ebusuapayin	0201613850		[signature]
Kofi		Kwawo	0209887076		[signature]
Joseph		Mensah	0241758244		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
CHARLES K. ADJEI		STOOL SEC.	0246831278	K.Adjei online.com	[signature]
Joseph Addoh		Mamagia/ben	0241310431		[signature]
Kodo Ku Abisi Arde					
Koku Asuaboah Amwomeah		Ghana Police Service	0244407441 0265654306		[signature]
Francis Kwaw Essuman		Asafo-hene			[signature]
Samuel Kwaw Quarcoe			0204019640		[signature]
Emmanuel Quaison		Member of Family	0200508644		[signature]
Bismark Armoo		Member of Family	0244762958		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Eunice Tawiah		Trader	0205494482		[signature]
Alex Kwofie		Tow Gard	0203922425		[signature]
Simon Archar		Unite Comm. Member	0241632768		[signature]
Rose Osei		TRADER			[signature]
Bismark B. Blay		Trader.	0240187188		[signature]
Godfred Kwofie		Masion	0240909442		[signature]
Obeng Gianwase		Trader	—		[thumbprint]
Cecilia		Dress Maker	0248395298		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mad Berta Nonko		Sintrew	0547924494		[signature]
Hannah Arthur		Student	0205127599		[signature]
Irene Prah		Treader	0200858766		[signature]
Mary Quarm					[signature]
Peter Eshun		unit committee secretary	0202550014 0245134572		[signature]
LUCY ESHUN		Teader	0543463184		[signature]
John Quansoe		unit Comity	0243461358		[signature]
Ebenezer Maclev		unit	0272996836		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kofi Naomah		Fisherman	—	—	
Appiah - Sroman		Fishermen	—	—	
Sampson K. Quarcoe		Opt. leader	0243812540	—	
Ebenezer Yankson		Photoo	0247819236 0262819236	—	
Grace Tandoh		Opt. Leader	0543056500	—	
Samuel Tandoh		Cheif Fishermen	0246399743	-	
Kwadfeng Beyila		Cheif Fishermen	-	-	
~~Essuman~~ Phulemon		fisher man	0241181517	-	

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Samuel		Ediafo	0246455327	–	
Anthony		ERZUAH.	/	/	
Cliff Yalley		–	0205599528	–	
Joseph Amakyi		Peace Council member	0207545529		

GPS Coordinates:

Princess Town

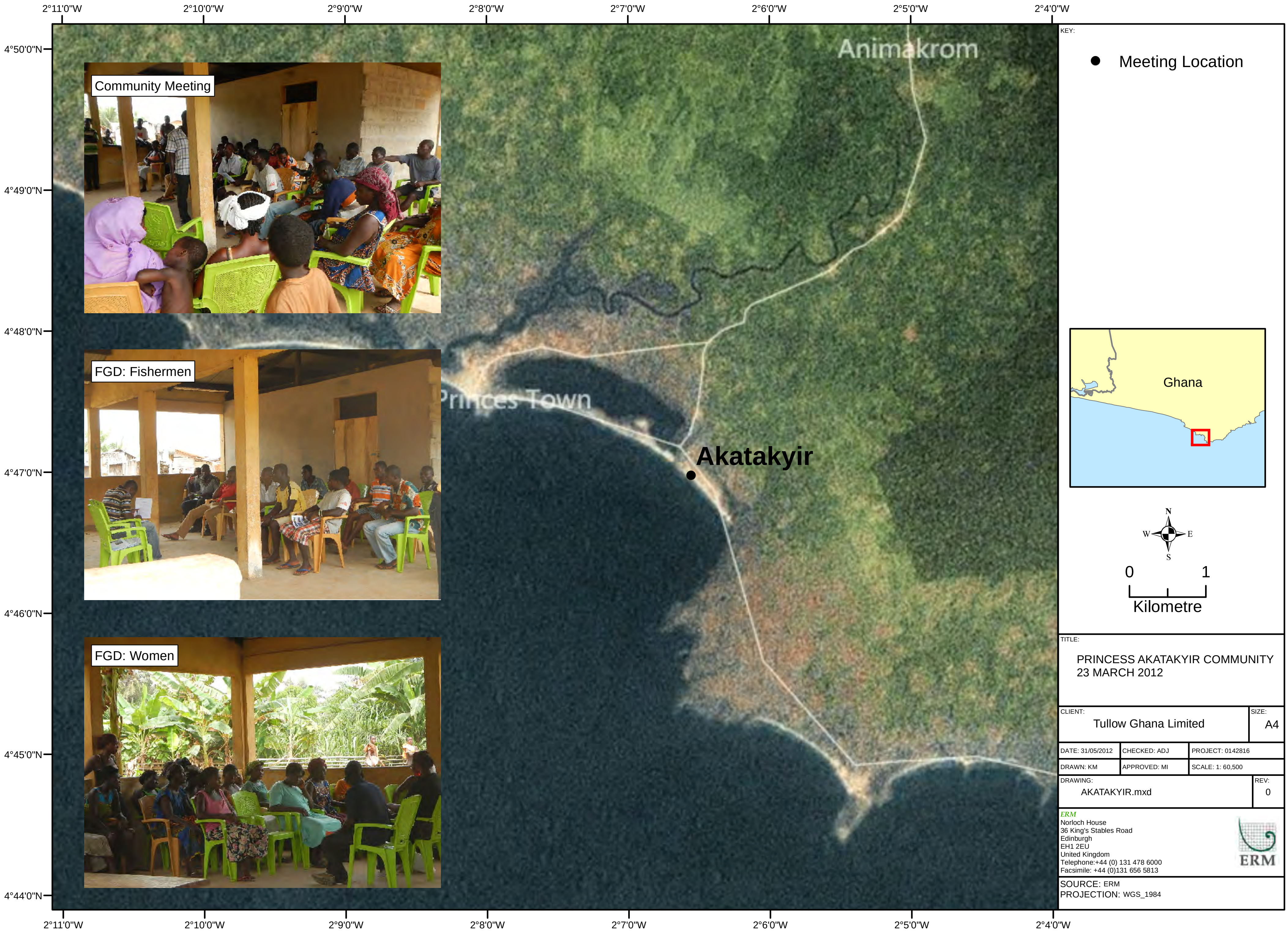
Name	No
1. Thomas Abrokwa Kwofie	0246114908
2. Sampson Kingsley Quarcoe	0243812540
3 John Quarcoe	0243461388
4 Peter Eshun	0245134572
5 Simon Archer	0241632768
6 Philemon Essuman	0241181517
7 Ebenezer Micheal	0272996836
8 Bismark B. Blay	0240187188
9 Samuel Edisfoe	0246455327
10 Cliff Yalley	0205599528
11 Srominey Appiah	
12 Nuoma	
13 Ebenezer Yankson	0262819236 0247819236
14 Anthony Erzua	
15 Joseph Amakye	0207545529
16 Samuel Tandoh (CF)	0202514377
17 Joseph Amakye (Peace Council)	020754-5529
18 Uncle Kwantsen Beyera (Abusuapanyin)	

~~19~~
~~20~~

FGD - FISHERMEN

Health Princess Town

Name	Organisation	Signiture	
Mabel Howusu	G. H. S		Princes Town
Emmanuel Baiden	P. P. A. G		Ahanta West
Felicia F. Kwofie	H. P. O		Princess Town
Gertrude Ntsiful	G HS		Princess Town
Gyabeng Kwame	GHS		P. Town
Daniel Yaw Brew	DSW		Princess Town
JOSEPH BAAH	PRINCESS CATH. PRIM. SCH		PRINCESS TOWN
Adriana Etroo	Princess cath Prim sch		Princess Town
Boakye-Ansah Yaw	Princess cath JHS		Princess Town


2°11'0"W
2°10'0"W
2°9'0"W
2°8'0"W
2°7'0"W
2°6'0"W
2°5'0"W
2°4'0"W
4°50'0"N
4°49'0"N
4°48'0"N
4°47'0"N
4°46'0"N
4°45'0"N
4°44'0"N
Animakrom
Princes Town
Akatakyir
Community Meeting
FGD: Fishermen
FGD: Women
KEY:
Meeting Location
Ghana
N
W
E
S
0
1
Kilometre
TITLE:
PRINCESS AKATAKYIR COMMUNITY
23 MARCH 2012
CLIENT:
Tullow Ghana Limited
SIZE:
A4
DATE: 31/05/2012
CHECKED: ADJ
PROJECT: 0142816
DRAWN: KM
APPROVED: MI
SCALE: 1: 60,500
DRAWING:
AKATAKYIR.mxd
REV:
0
ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813
ERM
SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Samuel		Ediafo	0246455327	–	[signature]
Anthony		ERZUAH.	/	/	[signature]
Cliff Yalley		–	0205599528	–	[signature]
Joseph Amakyi		Peace Council member	0207545529		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Akotoku

Meeting location:

Date: 23/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Peter N. Bok Yes			0201610621		
ARCHER MARTIN		NSS Personnel	0541388339	martinarcher87@yahoo.com	[signature]
GYASI ERIC OHENE		NSS PERSONNEL	0245774295	ericohenegyasi@yahoo.com	[signature]
Asolen Daniel		NSS Personnel	0240979780	daniel.grin@yahoo.com	[signature]
Egya Ngeda		Fisherman			
Kofi Nkansa		Fisherman			
John Bonzeh		Fisherman			
Paul Yalley		Driving			

GPS Coordinates: 04° 47. 030N 002°, 06 581W EL 76F

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Roland Arde Mensah		Fishing	0200228682		
Joseph Kwame		Fishing			
Richard Baidoo		Fishing	0203923161		
Isaac Kwaw Ankah		Fishing	0547918578		
Peter Kingsford Ephraim		Fishing	0244083280		
Egya Kyea		Fishing			
Samuel Aggrey		Fishing	0547918578		
Anthony Kwajokyi		Fishing			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Brother Ansah		Fishing	0240468035		
Tei Sokpoli		Fishing			
J.B. Arde-Mensah		Fishing	0203026121		
Isaac Fynn		farming	0209877986		
Anthony Gokah		Fishing	0206487160		
Yakub Mensah		Teaching	0248159034		
Justice Eghan		Fishing	0244839878		
Janet Armoo		Fish monger			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Cecilia Queicoe		Fishmonger			
Magret Mensah		Fish monger			
Confort Ofori		Fishermonger			
Abbiba Nyame		Trader			
Georgina Arthur		Trader			
ELizabeth Assirifi		Farming			
Vivian Baidoo		Trader			
Faustina Eshun		Trader			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Akutakyi Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ama Akyereba		Fish monger			
Perpetual Erzoah		Fish monger			
Obinim Adekyemu Asem.		Stone Quayrrer			
Theresah Yankey		Fish monger			
Helina Molegeahee		Farming			
Amanfer		Farming			
Mavis Ahwere		Farming			
Daniel K. Oppong		Teaching	0245006340		[signature]

GPS Coordinates:

AKITEKYI 23-03-12

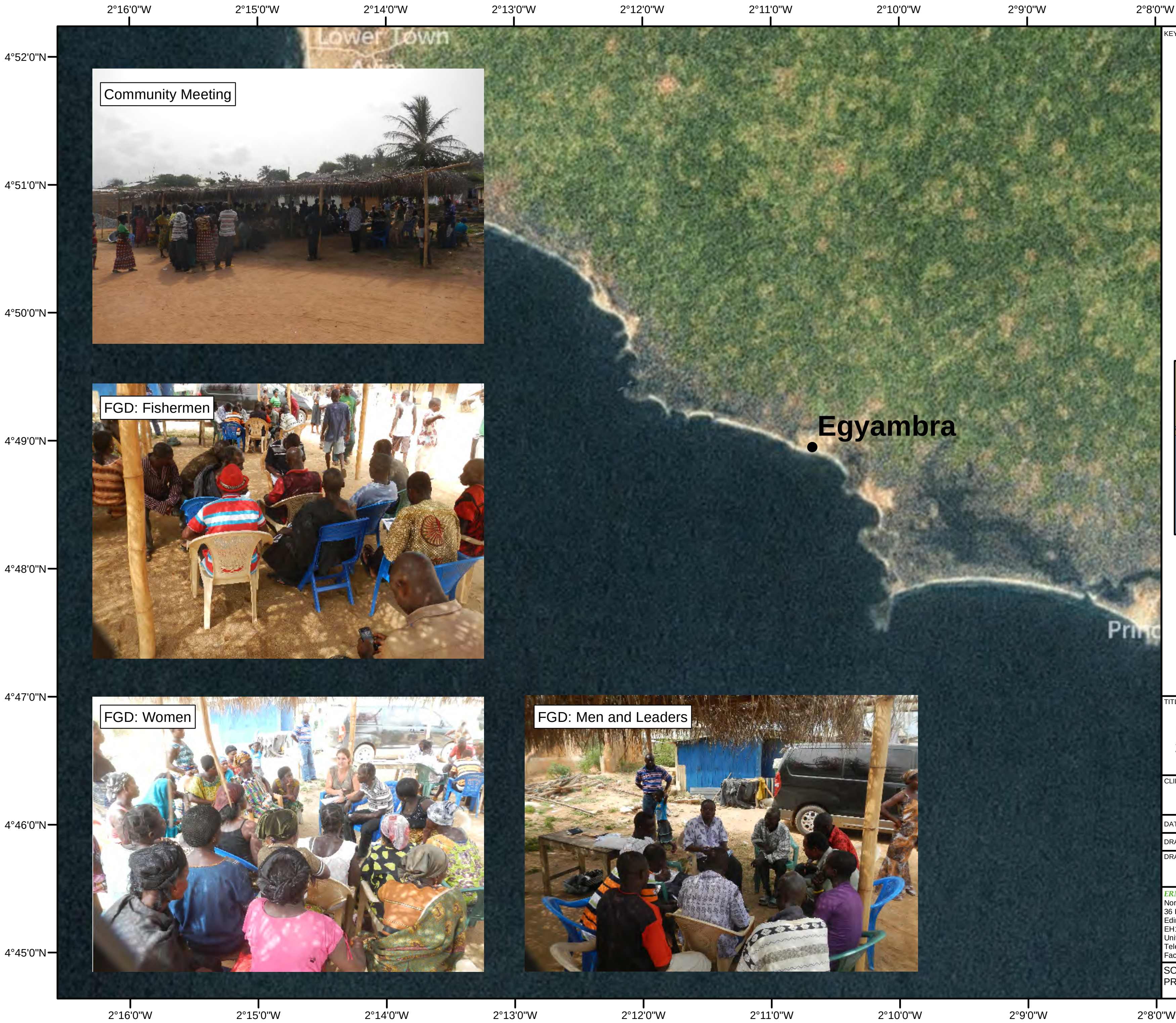
Name	Contact No
1 Alizah Kwame	
2 Kwasi Korange	0203973161
3 Asafuah	- 0507918578
4 Mr. Ansah	. 0240468035
5 Bro. Blay	0200228682
6 v Ekow	
7 ~~J B~~ Arde-Mensah	0203026121
8 Tee Sopoli	-
9 Anthony Kojokyi	-
10. Bro Nredah	
11. Kofi Nkansah	
12 John Bonzi	
13 P.K. Ephraim	- ~~0244~~ 024432080

FGD - FISHERMEN

~~48949~~

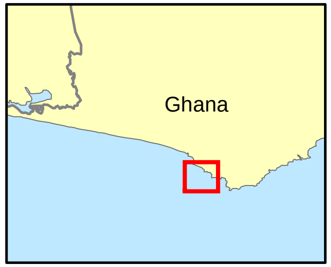
~~48928~~

21



KEY:

● Meeting Location



N
W E
S

0 1
Kilometre

TITLE:

EGYAMBRA COMMUNITY
24 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 66,500
DRAWING: EGYAMBRA.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984_UTM

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

~~Organisation~~: Egyambra   Meeting location: Comm. Centre   Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Francis Quaicoe		Farming			
Samuel Nkrumah		Electrician	0205486186		
Samuel Cudjoe		Welder	0542609449		
Albert Aekom		Capenter	0540258078		
Charles Quarm		Farming	0240294459		
Mensah Salamata		Farming			
Nyame Amaku		Farming			
Annie Bomba		Farming			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Maame Nyameke		Farming			
Charlote Armoo		Teaching	0204571746		
Emelia Asuam		Farming			
Nda Kyie		Farming			
Hannah Koomson		Farming			
Mary Dadzie		Farming			
Veronica Nyamekye		Fishmonger			
Philomina Maclar		Student	0544778654		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Grogena Assmah		Trading			
Susana Yankey		Farming			
Mary Bluah		Farming			
Theresa Quayson		Trading			
Elizabeth Quaicoe		Farming			
Cynthia Quarm		Fishmonger			
Mavis Quarm		Trading			~~Quarm~~
Mary Kwayeah		Farming			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Bosomamah Yalle		Farming			
Felicial Quacoe		Trading	0541572593		
Ekua Wiam		Farming			
Phelomina Hemzy		Farming			
Ama Acken		Fishmonger			
Elizabeth Eshun		Farming			
Elizabeth Nyamekye		Farming			
Yaw Nyameke		Farming			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Eyaambra Meeting location: Community center Date: 24/3/2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Kwame		Farming			
Sarah Nkeshaba		Trading			
Matthew Duku		Farming			
Maame Adjiebah		Farming			
Victoria Ackah		Farming			
Cynthia Ekem		Trading			
Alice Armoo		Fishmonger			
Theresa Quarm		Trading			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Eyyambra Meeting location: Community Center Date: 24/3/2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Pateince Ansoe		Hair Dressing			
Rebecca Ebehow		Farming			
Elizabeth Acquah		Farming			
Elizabeth Amoakyie		Fishmonger			
Susana Dekyem		Fishmonger			
Emilia Bentum		Trading			
Rose Mensah		Farming			
Theresa Quaidu		Farming			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Eyeambra Meeting location: community center Date: 24/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Theresah Kwofie		Trading			
Samuel Sarbah		Capenter			
Koomson Arthur		Farming			
Agnes marcler		Farming			
Lucy Quayson		Dressmaker			
Quashie Ndakyie		Farming			
Chiefer Akoempong		Fishmonger			
Gladys Ackah		Fishmonger			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Eyyamba | Meeting location: community center | Date: 24/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
~~Ern~~ Ernestina Quayson		Teaching			Erno
Hannah Mensah		Trading			
Georgina Ansah		Trading			
Elizabeth Dunkor		Farming			
Joseph Cobbinah		Manson			Ahm
Rose Ngoom		Farming			
John Amoako		Env. Health			Dede
Mary Sule		Trading			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Eyigyamba   Meeting location: Community Center   Date: 24/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Peter K. Dabel		farming	0247788066		Dabel
Lawrence Wilson		Baker	0246857159		[illegible]
John Cudgoe		Farming			
Comfort Ezah		farming			
patricia Kwame		Trading	024789881		[illegible]
Agnes Christ		Forming	024 ~~772~~ 675		[illegible]
Anthony Nyamebeye		Forming	0208456708		[illegible]
Francis Ndoli		Farming			FNdoli

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Eyyamboa Meeting location: community center Date: 24/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Emmanuel Apelie		Chain saw opreator	0202566708		
Joseph Cudjoe		farming	0247787456		
James Nyamekye		farming	0206168420		
Apaalse Peter A.		National service personnel	0243012177		
Cynthia Yalle		farming			
Mary Ackah		farming			
Georgina Bentum		farming			
Doris Cobbinah		Trading			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Eyyarbra Meeting location: Community Center Date: 24/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John Sam		Farming	0200653989		
Quit Aekah		Trading			
Mary Bansoo		Farming			
Emmanuel Eshun		Farming			
James K. Aekah		Driving	0201615148		Aekah
Eric Koomsa		mason			
Cecilia Aidoo		Farmer			
Chris Hamidu		mason			

Hanofkeal

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mavis Quarm					
Nyame-Amaku					
Boboo					
NyameKbla					
Mary Kwegyah					
Ndaraya Ehone					
Agnes Christ					
Theresa Acque					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Gladys Ackah					
Elizabeth Amoky					
Elizabeth Nkrumah					
Hanna Koomson					
Hanna Mensah					Hanna
Quashie Ndachar					
Emelia Assuanim					
Elizabeth Kayah					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Bosomayale					
Elizabeth Alfu l					
Veronica Nyamekye					
Sarima Manza					
Cecilia Effrim					
Amosiv Efibab					
Susana Denkyem					
Augustina Egyan					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Dadze					
Sasva Quaicoe					
Betrices Cobbina					
Mary Baidoo					
Monica Owsu					
Rose Ngoah					
Faustina Ejeidu					
Agnes Mensah					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mercy Yaw					
Chifab Aponmah					
Ama Ackon					
Surboa Akyiwah					
Kwawomesa Nkere					
Mena Ama					
Dorcas Eshun					
Comfort Quaico					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Egyambra Leaders a Man

Meeting location: Comm. Centre Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joseph Eudjoe		Assemblymen	0204587073		
James H.A. Kwogie		Leaders	0200482731		
John Sam Seki		Leaders	0200653489		
John Atta Eudjoe		Leaders			
Diesen Nyanko		Leaders			
John Eudjoe		Leaders			
Npettia Kofi		Leaders	0200480712		
Aelxon Albert		Leaders	0540258078		

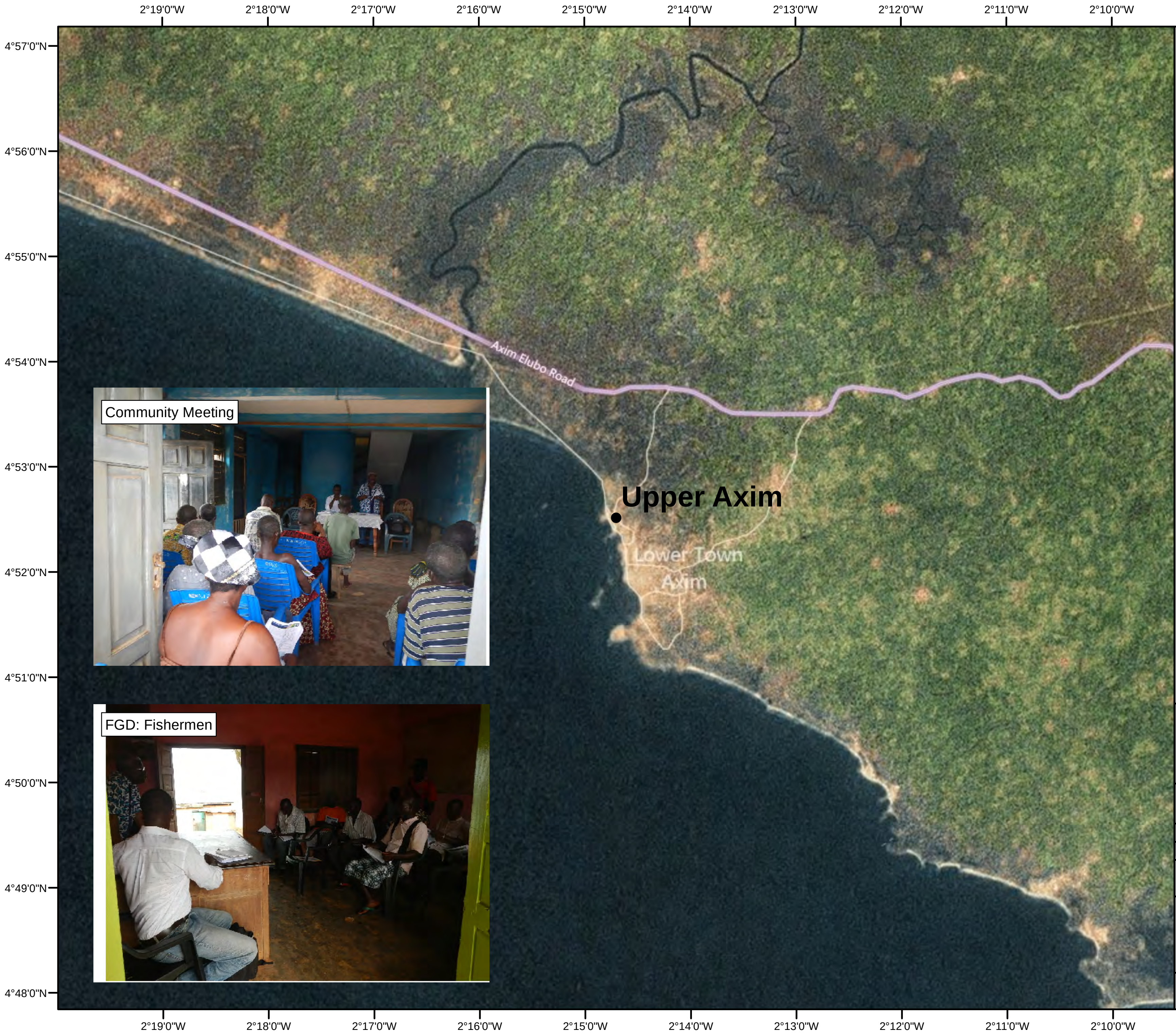
GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Esyambra Leaders & Men. Meeting location: Comm. Centre Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Goakah Anetipde					
Christ Hamudu					
Lawrence Wilson			0246853159 0206498111		

GPS Coordinates:



KEY:

● Meeting Location

N
W E
S

0 1

Kilometre

TITLE:

UPPER AXIM COMMUNITY
24 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 90,000
DRAWING: UpperAxim.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY ~~LEADERS~~ MEETING & MEN Meeting location: UPPER AXIM (BRIEWIE) Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Francis	Bondze		0548293379		B.
~~Lida Ledia~~ ~~Lidt Mensah~~			~~0207107808~~		
~~Josepina~~ ~~Josephine~~ ~~Josin~~	~~Blay~~ ~~Bicle~~		~~0202916996~~		
Comfot ~~Gboil~~	Yakey		~~0545732FF~~		
Mary	ATa				
Efua	Dabiaasem ~~DahAsem~~				
Augestina	Baidoo		0548845553		
Emma	Ackah				

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: COMMUNITY MEETING   Meeting location: UPPER AXIM (BREWIE)   Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kingsford	~~Asembly~~ man Abekah		0243957049		[signature]
Kofi ~~Christ~~	Christian		0249117257		[signature]
Joseph	Kenyah		0206714540		[signature]
J.K	Authur				[signature]
Papa	Andor		0549282845		[thumbprint]
Issac	Mensah		0546402977 ~~054…~~		[thumbprint]
Kowku ~~Kuku~~	Akuban				[thumbprint]
Nana Kofi	Aman	Chief fisherman	020 8225201		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: UPPER AXIM (BREWIE) Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Joseph	Akah				[signature]
Emmanuel	Quequ ~~Kuku~~		0201091594		[signature]
Kwesi	awote ~~Atu~~				[thumbprint]
John	Sesu				[thumbprint]
Kwabena	Bentum				[thumbprint]
Kwame	Tawiah				[thumbprint]
Kofi	Basew				[thumbprint]
James	Bedu		0205631892		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: UPPER AXIM (BREWIE) Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Yaw					
Kwesi	Esuin				
Mercy	Quegg		0201492120		
Kwaben	Yaathur				
Grace	Amramah				
Nana Kofi	Mensah		0547666253		
Kwesi	Brohah		0205756805		
Francis	Bonzie		0544874870		Adom

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Community Meeting   Meeting location: Upper Axim (Brewie)   Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John	Akorha		0273360944		
Mary	Kwabeng				
Akosoa	Esun		0540723348		
Josephne	Bray		0272916997		
Lydia	Mensah		0207107808 ~~02079~~		
Therisah	Aban				

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: ~~FISHERMEN~~ ~~UPP MEN~~ FGD

Meeting location: AXIM UPPER (APEOSIKA)

Date: 24/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
C. K. ATTAH	Fishermen Council	Secretary	027772256		[signature]
Mike Nyame	Fishermen Council	Fishermah	0249121564		[signature]
Frank Cobbina	Fishermen Council	Fisherman			RT
Michael MacCarthy	Fishermen Council	Fisherman			
Joseph Aborkwa	Fishermen Council	chief Linquist	0541573035		[signature]
Joseph Swanzy	Fishermen Council	Fisherman (Elder)	0271630366		
Victor Appah	Fishermen Council	Outboard motor Repairer	0242964206	[signature]	
Charles Shebrah	Fishermen Council	Fish Monger	0243120989	[signature]	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Fisherman Fed. Meeting location: UPPER Axim (APEOSIKA) Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
	UPPER AXIM				
Anthony Aborkwah	Axim Upper Fisherman	Fisherman	0200386595		
Raymond Nyarko	Axim Fisherman Council	Fisherman	0546101024		
Emmanuel Kweku	Axim Upper Fisherman Council	Fisherman	0205938245		
Frank Cobbinah	Fishermen Council	Fisherman			
* Joseph Swanzy	Fishermen Council	Fisherman			
John Quansah	Fisherman Council	Fisherman ~~os~~	020219715		
Egya Nda Renya	Fishermen Council	Chief Fisherman	0208082058 0547666254		
Kofi Sam			0240786 9118		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Fishermen FGD Meeting location: UPPER AXIM (APEWOSIKA) Date: 24/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Anthony Abrodama			0208198465		A
Kofi Yankey			0248483880		[illegible]
J.K. Arwah					
Janet Mikabela					
Elijah B-Ampah					
Tony Beatus					
Philip Kwasi					Siayo
Eric	Adio				

GPS Coordinates:

KEY:

● Meeting Location

N
W E
S

0 1

Kilometre

TITLE:

ABOADZE COMMUNITY
26 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 75,000
DRAWING: ABOADZE.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

ERM

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/2012.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Attom III	Chief	Chief	0242140134		
Nana Kow Miamo	Chairman	Chairman	0249784451		
Kodwo Assefuah	Linguist		0547466543		
Raymond Abakah	Secretary		0249520698		
Ebudu Heavy	Opinion Leader		0243785541		
Uncle Issah (799)	✓	✓	0570406852		
Kofi Essuon	✓	✓	0245544647		
Kodwo Sevaman	Messenger		—		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA ADAM EDWARD	CANOE FISHERMAN	CHIEF FISHERMAN	0243932886		[signature]
BENJAMIN DADZIE	✓ ✓	SEC	0240904755		[signature]
KWESI BENTUM	GHANA NAVY	C/P O-1 (RSM)	0249167600		[signature]
KWESI NYAMEKYE	CANOE FISHERMAN	LINGUIST	0200958551		[signature]
KOBINA ANDOH	✓ ✓		0209100994		[signature]
KWAME TAWIAH	✓ ✓		0272401338		[signature]
KOFI KOKOO	✓ ✓		0541156599		
THEOPHILUS SAM	✓ ✓		0246547222		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
EBOW CARPENTER	CANOE FISHERMAN		0248783262		
MARTIN BANSOO	OPINION LEADER		0245111492		
JOSEPH ACKON	✓ ✓		0243632330		
NANA AKYEABOE	CANOE FISHERMAN ~~LINGUIST~~	LINGUIST	024011634		
KOFI KODA	CANOE FISHERMAN		0279167068		
FELIX COBBINAH	OPINION LEADER		0543510247		
Sulemanu Allah	Opinion Leader		024574823		
Shaibu Issah	Canoe fisherman		0248642178		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwesi Addoh		Opinion Leader	—	—	
Salamata Adam		Head Fishmonger	—	—	
Grace Essuman		Member	0541743118		
Aba Assefuaba		✓	—	—	
Grace Cobbinah		✓	~~0541663171~~ ~~0546631?71~~	—	
Aba Essuon		✓	—	—	
Mamuna Haruna		✓	0248149088		
Adjoah Yawedu		✓	—	—	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Araba Dadzeasa		Member	—	—	
Efua Tawiah		✓	0245111492		
Efua Sekyiwa		✓	—	—	
Ekua Abbem		✓	—	—	
Esi Mankuwa		✓	—	—	
Esi Bo		✓	—	—	
Adjoah ~~Motei~~ Motei		✓	—	—	
Mary Yaaboh		✓	—	—	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Theop Armah	Youth		0242935215		
John Sam	Youth		0543711904		
Emma Amoah	Youth		0277986092		
Raymond Sackah	Youth		0209131256		
Peter Addo	"		0249980571		
Farouk Quansah	Youth		0542806595		
Methack Abakah	Youth		0246694116		
A-Ayew Kwesi	Youth	P.R.O.	0243032389		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Charles Baidoo	Youth	Organizer	0546014492		
Nicholas Akatiel	Youth	member	←		
Issah Makola	Youth	member	0240911284		
Judith Adoko	Youth	—	0275824831	-	
Joseph Yawson	✓	—	—		
James Kwofie	✓	—	—		
Tijani	✓	—	—	—	
Enyo Assan	✓	✓	—	—	

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: ABOADZE Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
A.K. Armah	ESL		0244771707	akarmah@yahoo.	
Janet Mkhabela	ERM				
Elijah B-Arnyel	Tullow				
Tony Bentil	ESL	Consultant	0208769258	tbentil@yahoo	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women Gp.   Meeting location: Alawadze   Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Grace ~~Esi~~ Cobbinah			0245603171		
Abu Asejoah Aba					
Samantha Adam					
Grace Essuman			0541743118		
Akua Abam					
Efua Sekyiwaa			0204771057		
Aduo Dadaasi					
Aba Essuman					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Esi Mankua					
Memuna Herman			0248149088		
Susan Kodua					
Esi Takyiwa					
Akua Abdua					
Adjoa Amodey					
Esi Adizah			0544779507		
Mary Yaboah					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Jemima Ennem					
Salamatu Tigini					
Philomina Banson.					
Alaba Asamu					
Magret Acquah					
Akua Attah.					
Cecelia Gola Annoo					
Anas Ansah			0246486270		~~A.K.S.O.~~

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women FED Meeting location: Hasodze Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Antoinette Ahin			0277582717		[signature]
Cecilia Adams			0277532470		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Youth F&D Meeting location: Aboaze Date: 26/03

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Augustina			0544841325		[signature]
Anthonieta Arhin					[signature]
Jones Fraban	Eledue [illegible]				
Eugena					[signature]
~~Meshack~~	~~Essie~~				
Gloria					
Panyin					
Faustina					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Eunice					
John Conney			0244725276		
Nanas					
John					
Josphen			0273669658		
Anans			0246486270		
Cecilia ADams			0277532470		
Kwesi Woska					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Faustina					
Nicolas					
John Kwofong					
Judith Adeko			0275826831		
Gloria			0546575769		
Blankson			0272291248 ①240452680	Blankson.Ebenezer @gmail.com	
Ammisah Samuel					
Emmisah Enock					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

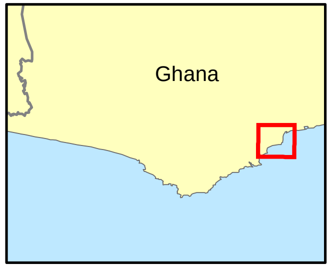
Organisation: HEALTH KEY INFORMANT VRA Hospital   Meeting location: VRA HOSPITAL (ABOADZE)   Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John Gbletadie		Administrator	0244944509 0202517698	John.gbletadie@vra.com	[signature]
Janet Mkhabela					
Tony Bentil					

GPS Coordinates:

KEY:

● Meeting Location



N
W E
S

0 1

Kilometre

TITLE:

SHAMA APO AND BENSTIR COMMUNITY 26 MARCH 20122

CLIENT: Tullow Ghana Limited			SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816	
DRAWN: KM	APPROVED: MI	SCALE: 1: 80,000	
DRAWING: ShamaApo.mxd			REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM

PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Shama Community Meeting Meeting location: Date: 26/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOHN ETROO			0243082519		[signature]
EBENEZER KOOMSON			0242506826		[signature]
~~ATTA~~ PA MENSAH			0243109252		[signature]
EGYA ANSAAKO			024272574		[thumbprint]
THOMAS ~~SUA~~ ANAPEM			0244992743		[signature]
MERCY ASARE			0247411923		[signature]
STELLA AWORTWE			020493514		[thumbprint]
SERAH ESSUN			0244118588		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Comm Meeting Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA TWEBA			0248395337		
COLLINS BAIDOO			0272845447		
BERNARD PEGU			0272667425		
KWASI ANUMAH KWASI			14/16 APO		
SIMON KAY			026124454		
RICHARD ASEFUAH			0246886656		
FRANCES ASEFUAH			HSE NO_ S/44 APO		
ALEX MENSAH			0277054916		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA ADWOA					
AKUA BADU					
ADWOA KUKUAH					
MENA ABENA					
Samuel Badu			0207570865		SAA
JOHN ARTHUR			0542784958		Arthur
JOSEPH BONDZIE			0245168045		
KWASI BOSOMTWE			0207385992		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ATTA KAKRA					
NORBERT MENSAH			0570123492		
EMMANUEL SAGOE			0248814504		Emmil
ANTHONY ASEFUAH					
DOMINIC BOSOMTWE					
BISMARK ANNAN					BAnnan
EMMANUEL QUAICOE					
JOHN GABRAH					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOHN MASTIN					
OSEI FRIMPONG			0277808023		
JOHN ARTHUR					
SAMUEL BASSAW			0242265544		
ALBERT AFFUL			0273473173		
ESYA KWABENA			0242361791		
KWASI WILLIAM					
JOHN ARTHUR			0271041510		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Shama - Community meeting Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA KWASI BADU			0275405587		
BENJAMIN ANNAN			0275481523		Ben
NANA FOSU					
PETER AADDIE			0261728029		
ALBERT ABEIOAH			0246198562		
SAMUEL KOOMSON					
ANDREW ACOLATSE			0272936551		ABA
KWEKU ENNIN			0547551466		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
FRANCIS ESHUN			0244442413		
EGUA KWASI FOWAH			0272993633		
NANA KWAW OTU			0245492568		
EGUA KWAW					
KWELOY PEBIL					
KOFI ANNAN			0540978797		
SAMUEL MACKITTAH			0276193572		
NANA FOSUWAA					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
SAMUEL KWOFIE			0274540543		
ISAAC ANSAH					
ISAAC MENSAH					
FRANCIS ROBINSON			0275634153		
SAMUEL MENSAH ~~ES~~ ETTUN			0275591623		
ESYA BOAME			0243521283		
MARY ARTHUR			0570448165		
SERAH ETTUN					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
MAAME AMA ATTA					
NORA BENSHAW			0244805022		
MERCY BASSAW			0247415617		
KWEKU GHAN					
JOHN ANNAN			S 32/4 APO SHAMA		
MICHEAL FIIFI MENSAH			6B/12		
NATHANIEL NUNOO			0571764365		
JAMES NUAMAH					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Community Meet Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
KWABENA MENSAH					
EGYA KWAW SEGU					
NANA AMOO BASSAW					
J-K KOJO AMPONSAH					
EGYA KWAS ACKON					
Nana Kwesi Ackon			0242522193		
KWESI BAAH			0201927766		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Omanhene Community Leaders & Men Meeting location: Shama Afo Date: 26/3/2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Osabarima Nana Kwaku Brempah III	Shama Trd. Council	Paramount Chief	0244783182	~~0244783182~~	N.K.Brempah III
Francis Darko	Shama T/Council	Registrar	0246561444		[signature]
Dorothy Eshun	Shama T/C	Typist GI	0274465417		[signature]
Nana Kwesi Agyenkwa II	Shama Trd. Council	Omanhene's Linguist Asst			
Kojo Wangara	Shama Trd Council	Linguist			
Benjamin Atsiatorme			0273162779		[signature]
Nana Appenteng		Principal Elder			
John Amissah			0271777465		

GPS Coordinates: 05° 00.258" N 001° 38.026" W El 6m

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Fishermen FAD Meeting location: Shama APO Date: 26/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Bassan Samuel	Fisherm		0242265544		[signature]
Albert Affu	Fisherman		0273473173		Afful
Egya Kow Segu	Fisherman				
Nana Kwesi Ackah	chief fisherman		0242522193		[signature]
Kwesi Ackah	fisherman		—		—
Kobena Mensah	fisherman		—		—
Egya Ekow Segu	fisherman		—		—
Nana Ebu Bassaw	fisherman		0246826399		—

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation:

Meeting location:

Date: Shama APO

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Apprusah	Fisherman		—		—
Anthony Asifuah	Fisherma				
Simeon Kay	Fisherma		0261244549		Kay
Egya Noma Kwesi	Fisherman		—		—
Peter Dadzie	Fisherman		021		
Kwamina Bosometwe	Fisherman				—
Egya Kobina	Fisherma		0244361791		—
Bismark Annan	Fisherma				—

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
John Arthur	Mason		0271041510		—
Ggya Ansaku	Fisherman				—

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Shama ~~Apo~~ Bentsir Beach Meeting location: ~~[illegible]~~ Date: 26/3/12 FGD: Fishermen

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Hon. Timothy Ayensu	JDA	Assemblyman	0208227271		[signature]
Susana Bissue	Konkolen Bentsir		0272817318		[signature]
Isaac Quainoo			0544842437		[signature]
Emmanuel Mbeah			0278202261		[signature]
Bright Kumson			0241591164		[signature]
Evelyn Kumson			0544842487		[signature]
Matthew Cobbinah			0249902841		[signature]
John Eshun			0244740595		[signature]

GPS Coordinates: 05° 00.324' N EL 14th
001° 37.841' N

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Shama Bentsi Board Meeting location: Conference room Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Efirim	G.C.F.C.	Chief fisherman	0248449155		
Joseph B. Etroo			0272228285		
Isaac Dontoh			0273040604		
Joseph Etroo			0272228285		
Mensah-Etroo			0207355560		
George bordoh			054 777734		GB
Nana Tawiah			0242523294		NT
Ekow ousie			0273832655		EK

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Shama Bentsir Board Meeting location: Conference room Date: 26/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Isaac Etroo			0274 220351		[signature]
Abraham Dontoh			0273 419022		[signature]
Stephen Kwofie			0241798487		[signature]
Solomon Badu			0540999017		[signature]
Eric Ndease			0548232623		[signature]
Kojo Bena			0242224169		[signature]
Kofi Rockson			0244109413		[signature]
Kofi Achon					[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women's FGD Meeting location: Axim Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Felicia Mensah					
Mary Mensah			0571373731		
Theresa Acquah					
Akosua Asun					
Akua Esson					
Rose Ahin			024582114y		
Rebecca Essel					
Stella Quaizoo					

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Women's FaD Meeting location: Shama Date: 26/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA AMA ATTA					
ADWOA KOKOWA					
MENA ABENA					
NANA ADWOA					
EMMA					
NANA YOKO					
EKUA BAIDO					
NANA ABA AME					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

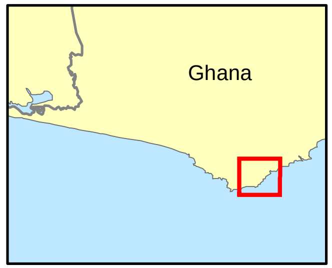
Organisation: Women's FWD Meeting location: Shama Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
RAKRA					
MARTHA NUAMAH					
HANNAH ATTA					

GPS Coordinates:

KEY:

● Meeting Location



N
W E
S

0 1
Kilometre

TITLE:

BUTRE COMMUNITY
27 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1:90,000
DRAWING: Butre.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

ERM

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: COMMUNITY MEETING Meeting location: BUTRE Date: 27/3/12

	Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
(9)	Kofi Essoun	fishermen	fishing			[signature]
(10)	Ekow Kar	✓	✓			[signature]
(11)	Kwabina Tawiah	✓	✓			[signature]
(12)	Kwasi Atta	✓	✓			[signature]
(13)	John Duku	✓	✓	0277894724		[signature]
(14)	Eyi Adzi Esuv	✓	✓			[signature]
(15)	Atta Payin	Opp. Leder	Comm,			[signature]
(16)	Kwasi Dadzi	fisherman	fisherman	0207596420		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: BUTRE Date: 27/8/12.

	Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
(17)	Mary Boaffo	Women org.	W group			
(18)	Monica Dadzi	✓	✓			
(19)	Araba Ayisiwa	✓	✓			
(20)	Esi Nyametiye	✓	✓			
(21)	Mena Araba	✓	✓			
(22)	Maame Kakraba	✓	✓			
(23)	S.S. Kobaba	✓	✓			
(24)	Abidsam Kakra	✓	✓			

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: MEETING Butire Comm Meeting location: BUTIRE Date: 27/3/12

	Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
(25)	Ekua Essoun	Women group	Fishmonger	✓	✓	[signature]
(26)	Sis, Abrekwa	✓	✓	✓		[signature]
(27)	Ekowa Morrovia	✓	✓	✓		[signature]
(28)	Nana Ekua Vatta	women Leader	✓	0278219092 ~~0278219~~		[signature]
(29)	Adjoa Rose	W/G	✓			[signature]
(30)	philomina Aidoo	✓	✓			[signature]
(31)	Esi Christian	✓	✓			[signature]
(32)	Maame PETE	✓	✓			[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: MEETING Meeting location: BUTRE Date: 27/3/12

	Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
(33)	Daniel Blea	Fishermen sec,	sec,	0204154815	✓	~~Black~~
(34)	Boniface ~~Donsuful~~	Fisherman	~~Fishing~~ Group	✓	✓	[signature]
(35)	maame yekoah	Women group	Fishmonger	✓		[signature]
	A.K. Aarch					
	Janet Mphahlela					
	Elijah B-Ampah					
	Tony Bentil	ESL	Consultant	0208764258	tbentil@yahoo.com	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: FGD Fishermen Meeting location: Butre Date: 27/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
J. K. Asankomah	Fishermen	Chief Elder	0277641410	Box 4 Dix	
Kojo Tawiah	Fishmen	Chief Elder	0572513481	Box 4	
Nana E. Essoun	Chief fisherman	Chief	0207794864	Box 4	
Kofi Essun	Fishmen	Fishmen		Box 4	
Fayo Ekow Nixe	Fishmen	Fishmen		Box 4	
Kwesi Dadzie	Fishmen	Fishmen	0207596420	Box 4	
Kwesi Nta	Fishmen	Fishmen		Box 4	
John Duku	Fishmen	Fishmen	0277394224	Box 4	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FGD FISHERMEN Meeting location: BUTRE Date: 27/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Onuelza Isua	Fishmen	Fishman		Box 4	
Robina Tawiah	Fishmen	Fishman		Box 4	
Daniel Blee	Fishmen	Chief Elder	0244154815	Box 4	

GPS Coordinates:

KEY:

● Meeting Location

N W E S

0 1

Kilometre

TITLE:

DIXCOVE COMMUNITY
27 MARCH 2012

CLIENT: Tullow Ghana Limited	SIZE: A4

DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 60,500

DRAWING: Dixcove.mxd	REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

Attendance Register*

*The Team was not able to take a formal register during the meeting. The community had a function on the day and provided us with a 30 minutes time slot of their agenda to present information about the project. This list was later provided to us by the Chief Fisherman as proof of people who were present at the meeting.

Date: March 27, 2012

Venue: Piado, Dixcove

In attendance:

1.	Nana Kwamena Acheampong	Male
2.	Nana Kweku Dadzie	Male
3.	Nana Kojo Krah	Male
4.	Egya Awortwe	Male
5.	Christina Arthur	Female
6.	Naana Safohene	Female
7.	Joana Koomson	Female
8.	Hon. Isaac Simmons Bassaw	Male
9.	Emmanuel Bentum	Male
10.	Mena Atta	Female
11.	Mena Ano	Female
12.	Mena Abaano	Female
13.	Sister Antobam	Female
14.	Wonka Ntomodo	Female
15.	Agartha Forson	Female
16.	Mena Ama Nyarko	Female
17.	Maame Alata	Female
18.	Ante Maanan	Female
19.	Egya Ankoma	Male
20.	Eric Dadzie	Male
21.	Ata Kakra	Male
22.	Egya Bedu	Male
23.	Egya Assafuah	Male
24.	Nana Kabransah	Male
25.	Kojo Esson	Male
26.	Mena Baidoo	Male
27.	Papa Bucklar	Male
28.	Paul Kwesi Pegu	Male
29.	Emmmanuel Pegu	Male
30.	Uncle Kwesi Andoh	Male
31.	Nana Brekuni	Male
32.	Egya Kwesi Ninsisn	Male
33.	Uncle Kwaw Yaw	Male

34.	Egya Tutuainoo	Male
35.	Uncle Kweku Assafuah	Male
36.	John Bassaw	Male
37.	Issac Cromwell	Male
38.	Papa Sor	Male
39.	Kwesi Warabae	Male
40.	Anthony Badwe	Male
41.	Ebo Ansah	Male
42.	Egya Issifu	Male
43.	Nana Kwamena Yao	Male
44.	Egya Kwesi Bin	Male
45.	Francis Quarshie	Male
46.	Enock Eshun	Male
47.	Ebenezer Quarshie	Male
48.	James Arthur	Male
49.	Kofi Tawiah 1	Male
50.	Kofi Tawiah 2	Male
51.	Joseph Mensah	Male
52.	Uncle Opah	Male
53.	Patrick Dadzie	Male
54.	Anthony Mensah	Male
55.	Nana Etsia Yaw	Male
56.	Kwesi Ackon	Male
57.	Uncle Abedu	Male
58.	Papa Arhin	Male
59.	Egya Essamoah	Male
60.	Egya Kwesi Patakaw	Male
61.	Egya Kwesi Esson	Male
62.	Sam Johnson	Male
63.	Ekow Maison	Male
64.	Alex Cromwell	Male
65.	Agness Aban	Female
66.	Felix Eshun	Male
67.	Papa Afenyin	Male
68.	Mena Ampomah	Female
69.	Aba Afadua	Female
70.	Papa Adjobiah Acquah	Male

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: WOMEN FGD Meeting location: DIXCOVE Date: 27/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Theresa Ackon	fish monger		0273157733		
Regina Ek Mensah.	fish monger				
Ma. Gladys Baidoo	fish monger				
Ama Nyarko	fish monger				
Nana Besema	fish monger	Queen			
Joana Kamson	fish monger		0273055311		
Christiana Arthur	fish monger		0209367860		
Rosemary Arakyi	Fishmonger		0209650713		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: KEY INF. INT. EDUCATION Meeting location: DIXCOVE Date: 27/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ESTHER AKU DORTUMOR	DIXCOVE METH. JHS	ASST. HEADMISTRESS	0243573986 / 0209052108	akudort@gmail.com	[signature]
Ellen Wibah Botchway	Dixcove Meth J.H.S	Teacher	0240149750/ 0209205929		[signature]

GPS Coordinates:

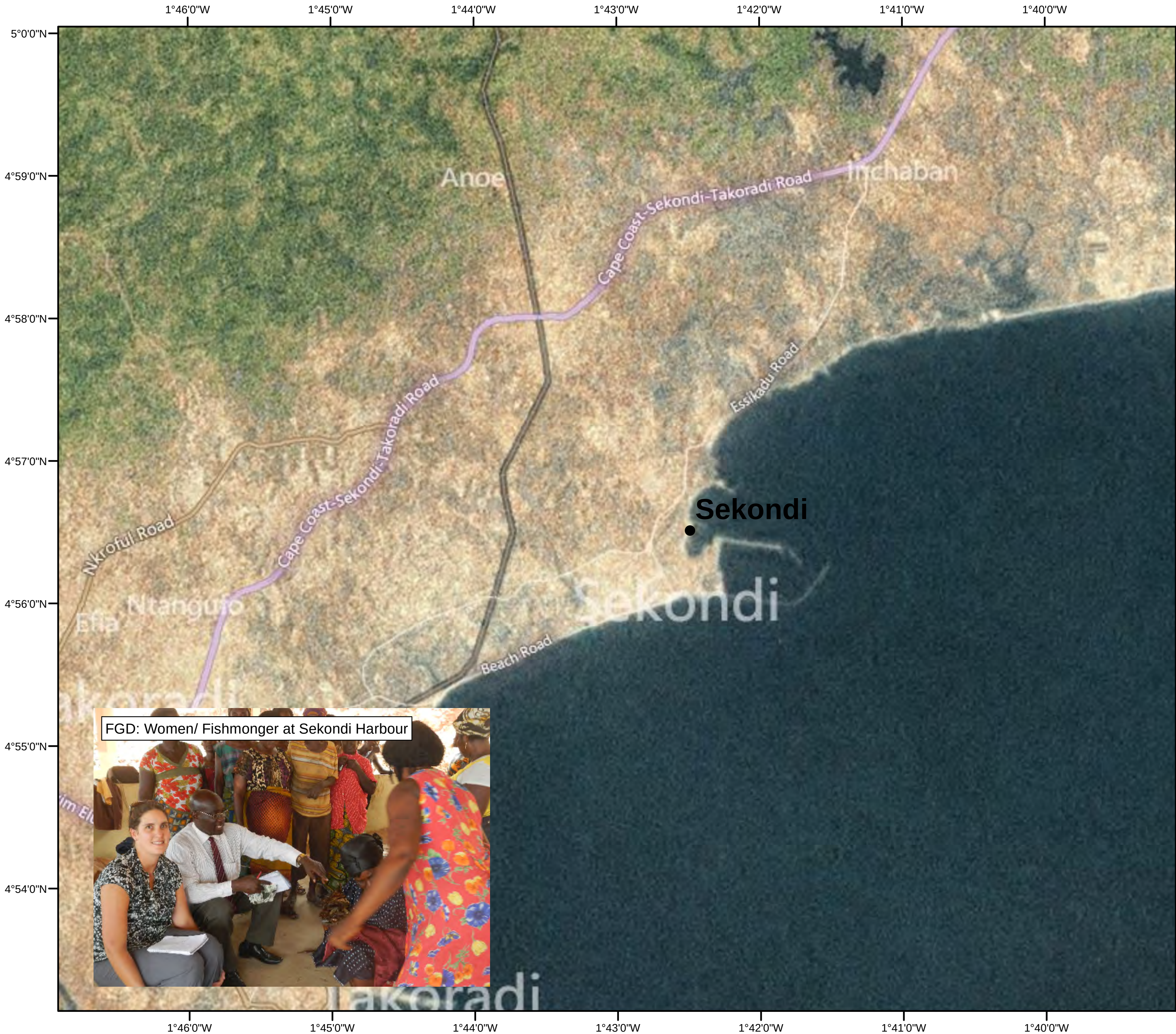
T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FGD FISHERMEN. Meeting location: DIXCOVE Date: 27/3/12

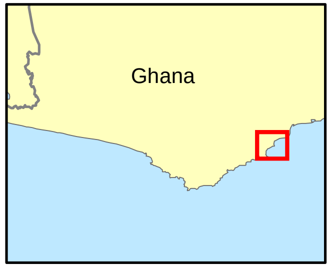
Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Kwamina Yawo	Chief Fisherman (Linguist Lower		0205270501.		
Nana Kweku Daadzie	Chief Fisherman (upper).		020 7943492		
Nana Kojo	Chief Fisherman (lower)				
Anthony Badwe.	Opinion leader (Fisherman)		0207357114		
John Aseyaw. ~~Mr Baidoo~~	Fisherman'				
Mr Baidoo	Fisherman.		0241283354.		
A. K-Armah	ESL				
Tony Bentil	ESL				

GPS Coordinates: Elijah B-Ampiah TSL.



KEY:

● Meeting Location



N W E S

0 1

Kilometre

TITLE:

SEKONDI HARBOUR
27 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 66,500
DRAWING: Sekondi.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

ERM

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women's FGD Meeting location: Sekondi Date: 27/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
GRACE ANDERSON		Fish monger	0549654630		
MARY ARMAH		Fish monger			
AFUA ESUMABA		Fish monger			
JOSPHENINE GRANT		Fish monger			
FELICIA ANSAH		Fish Monger	0200453331		
GRACE ARCHIL		Fish Monger	0247196683		
CECILIA ESHUN		Fish Monger			
MARY CUDJOE		Fish Monger			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women

Meeting location: Sele

Date: 27/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
MARY KOOMSON		Fish Monger	0549654630		
SANDRA TETTEH		Fish Monger	0247583981		
DEBORA AKESSEH		Fish Monger	0546178540		
CECILIA KUM		Fish Monger	0541061001		
MARY ABIADOO		Fish Monger			
KATE AMOASI		Fish Monger	0548059839		
MATHA ANDOH		Fish Monger			
SELINA SAM		Fish Monger			

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

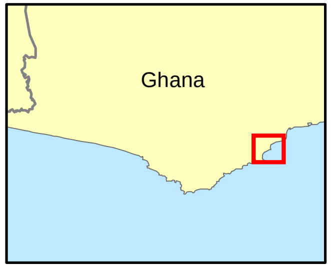
Organisation: Women Meeting location: Sek Date: 27/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ELIZABETH ABAIDOO		Fish Monger			
AMA TOMFO		Fish Monger	0266885413		
ABENA BOAHMA		Fish Monger	0271426430		
EVELYN SACKEY		Fish Monger	0540618680		
JOANA MENSAH		Fish Monger	0243985071		
ELIZABETH KWAKYE		Fish Monger			
JEMIMA HENSON		Fish Monger			
ROSE GANNY		Fish Monger	0272891308		

GPS Coordinates:

KEY:

● Meeting Location



N
W E
S

0 1
Kilometre

TITLE:

SEKONDI - EUROPEAN TOWN
27 MARCH 2012

CLIENT: Tullow Ghana Limited	SIZE: A4

DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 66,500

DRAWING: SekondiEurope.mxd	REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: ~~Northern Affairs~~ Community Meeting

Meeting location: European Town

Date: 27-3-12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Richard Jabin	Security		0204460949		
Mark Arthur			0545649922		
Kwao			0245544382		
Kwao			0245122174		
Kwaku Kwansah			0208315332		
Sammuel Eshun			0541437688		
Francis Mensah			0271769355		
Peter Ainoo			0275280461		

GPS Coordinates:

Minutes (Notes in Jotter)

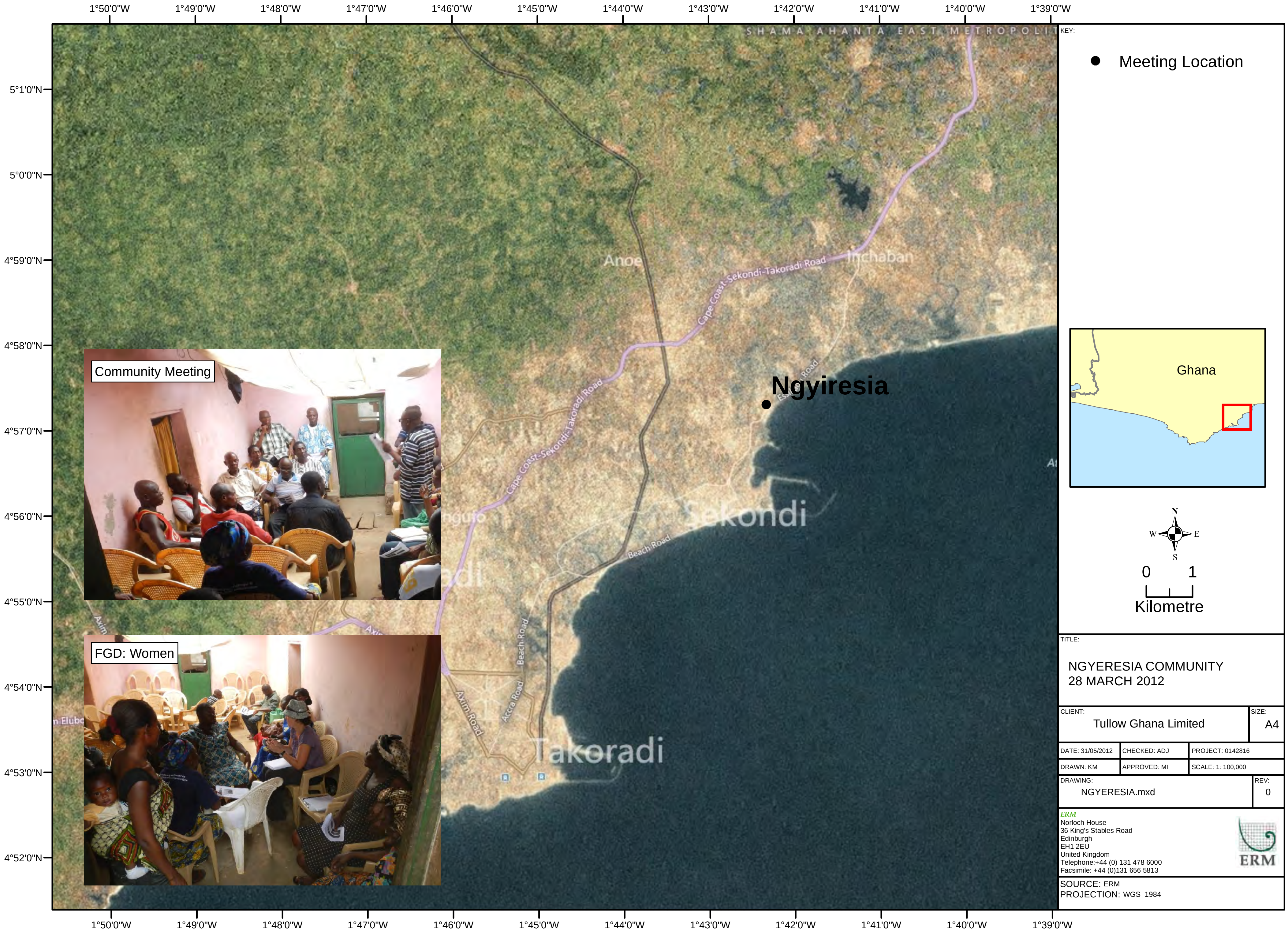
T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Richard Mensah			0240157153		
Bright N. Aggrey			054 476055		
Kwabena Aponah			0267263088		
Ebenezer Awotwe			0279049565		
Obiri Yeboah			0265151883		
K.D. Afful			0544876403		
John Didiyey			0269377389		
Emmanuel Ansah			0277415532		

GPS Coordinates:


1°50'0"W
1°49'0"W
1°48'0"W
1°47'0"W
1°46'0"W
1°45'0"W
1°44'0"W
1°43'0"W
1°42'0"W
1°41'0"W
1°40'0"W
1°39'0"W
5°1'0"N
5°0'0"N
4°59'0"N
4°58'0"N
4°57'0"N
4°56'0"N
4°55'0"N
4°54'0"N
4°53'0"N
4°52'0"N
SHAMA AHANTA EAST METROPOLIT
Anoe
Inchaban
Cape Coast-Sekondi-Takoradi Road
Ngyiresia
Sekondi
Beach Road
Takoradi
Axim Road
Accra Road
Community Meeting
FGD: Women
KEY:
Meeting Location
Ghana
N
W
E
S
0
1
Kilometre
TITLE:
NGYERESIA COMMUNITY
28 MARCH 2012
CLIENT:
Tullow Ghana Limited
SIZE:
A4
DATE: 31/05/2012
CHECKED: ADJ
PROJECT: 0142816
DRAWN: KM
APPROVED: MI
SCALE: 1: 100,000
DRAWING:
NGYERESIA.mxd
REV:
0
ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813
ERM
SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Nygaresta Meeting location: Comm Meet Date: 28/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Okyeame Kwesi Dadzie			0276884452	—	[signature]
Hon. Solomon Mintah	S.T.M.A	Assemblyman	0201410101	esmintah@gmail.com	[signature]
Unit Com Chm. Stephen Quagie	S.T.M.A	Committee Chairman	0277032027	—	[signature]
Sec. Stephen Nkrumah	S.T.M.A	Committee secretary	0272145646	humble26@gmail.com	[signature]
Treasurer Emelia Baidoo	S.T.M.A	Committee Treasurer	0243163989	—	[signature]
Headm. Peter C. Tawiah	GES	Headteacher	0272508731	—	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: NGYIRESIA Meeting location: PALACE Date: 28/3/2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kweku Kwesa	FISHING	member	0548638395 ~~024~~		
KOBINA ABAKA	✓	✓	0572515670 ~~0277396893~~		
KWAME ATTA	✓	✓			
KOBINA TAWIA	✓	✓	0249117299		
KOBINA MENSA	✓	✓			K.B.
ESI DONKOH	FISHMONGER	VICE KOKOHEN			
MAXWELL CUDJOE	FARMER				
Appiah Onwona Agyeman	SRC	Social Consultant	0242109884	onwonaagyeman@yahoo.co.uk	[signature]

GPS Coordinates:

Community Meeting

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Ngyiresia   Meeting location: Palace   Date: 28/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOANA R. YANKSON	NGYIRESIA FI PAG	SECRETARY	0275167798 0548-059375		[signature]
ADJOA AMISSAH	FISHMONGER	KOKOHENI			[signature]
KOFI ENYIMA	NGYIRESIA FISHING	~~KOKO~~	0246586418		[thumbprint]
DURO NYIMPA	✓		0275431734		[thumbprint]
KOBINA ABAIDOO	✓				[thumbprint]
EKOW NKRUMAH	✓	KYEAME KAKRABA			[thumbprint] RTP
KOBINA ANTWI	✓			0277396893	[signature]
KWESI ABU	✓			0248393974	[thumbprint]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FISHERMEN Meeting location: NGYIRESIA ~~NGEER~~ Date: 28 - 03 - 2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
KOFI DADWEN					
NANA KOBINA MBER		CHIEF ~~OF~~ FISHERMAN			
KOBINA ANIWI					
EKOW MBIR					
KOBINA ABAKAH					
KWESI NKETSEA					
KOJO TAEWIA					
EKOW SURONYMPA					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
KOFI YAW					
KOFI ENYIMAH					
EGYA ABAIDOO					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

~~Organisation:~~ Chief and Elders Ngyiresia   Meeting location: Palace   Date: 28/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwamina Nana Aootwe			0277319996	TDI. P.O. Box 2176	
Ebo Kobina Dekyi					
Safohen Aootwe			0571465966		
Omanpanyin Kofi Abbey			0244454799		
Asafohen Kobina Mbir			0273899997		
Okyeame Kofi Dadwen					
Okyeame Koffi					
Okyeame Kow Mbir			0208318337		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Ngyiresia FGD Women Meeting location: Palace Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOANA RITA ARTHUR	FIPAG	SECRETARY	0277516779 0548059375		RArthur.
ADJOA AMISSAH	NGYIRESIA	KOKO HEMAA			
ADJOA FOTO	✓				
ESI DONKOH	✓				
AMA AGYAPOMA	✓		0269471268		
AMA AKYEREM	✓				
AMA TAWIA	✓				
ADJOA KWEMMA	✓		0542023860	~~0542023860~~	

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Ngyiresia FGD Women Meeting location: Polase Date: 28/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ARABA AFUREBA	FIPAG	MEMBER	0275167798		
BADU KUMABA	✓	✓			
EFUA MANSA	✓	✓			
Elizabeth Moses		Teaching	0244243526		[signature]
Maggie Hayford		✓	0244420968		MBHayford
Helena Tandoh		Teaching	0244434590		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Ngyiresia FGD Women Meeting location: Polane Date: 28/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ARABA AFUREBA	FIPAG	MEMBER	0275167798		
BADU KUMABIA	✓	✓			
EFUA MANSA	✓	✓			
Elizabeth Moses		Teaching	0244243526		
Maggie Hayford		✓	0244470968		M Hayford
Helena Tandoh		Teaching	0244434590		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

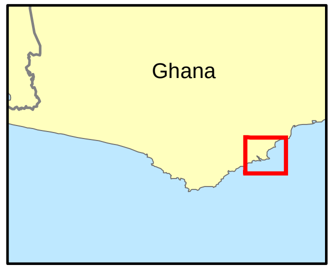
TULLOW

Organisation: Ngyiresia FGD Women Meeting location: Polave Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOANA RITA ARMOON	FIPAG	SECRETARY	0275167798 0548059375		[signature]
ADJOA AMISSAH	NGYIRESIA	KOKOHEMA			
ADJOA FOFO	✓				
ESI DONKOH	✓				
AMA AGYAPOMA	✓		0269471268		
AMA AKYEREM	✓				
AMA TAWIA	✓				
ADJOA KWEMMA	✓		0542022861	~~0542323860~~	[signature]

KEY:

● Meeting Location



N
W E
S

0 1

Kilometre

TITLE:

NEW TAKORADI COMMUNITY
28 AND 29 MARCH 2012

CLIENT: Tullow Ghana Limited	SIZE: A4

DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 90,000

DRAWING: Takoradi.mxd	REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING. Meeting location: NEW TAKORADI Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ebo Aijhan			0542428815		
Abigail Aggrey			0244611902		Aggrey
Sylvia R. Atkins			0205460693		SR Atkins
E.E. AJOKO			0277035382		
LYDIA MEIZER			0279416702		
Kofi Yeboah			0275 16212		
Ritah Eshun			0277374529		
Kwamina Afful			—		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING. ~~FISHERMAN~~ Meeting location: NEW TAKORADI ~~[illegible]~~ Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Kow Ackon			0276744868		RTP
Kofi Adzekye			0277774781		RTP
Op Nyimpatsirmu			—		RTP
ANTHONY AFFUL			0248614590		[signature]
Adwoa Bardu			—		RTP
Kumpa Tawiah			0276744868		[signature]
Dibrera Ackon			—		RTP
Maame Tandoh			0274547258		RTP

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: COMMUNITY MEETING Meeting location: NEW TAKORADI Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Esi Mansa			—		RTP
Ama Payin			0276744868		RTP
Ekua Anscebah			0541461004		[illegible]
Maame Essoun			0275870976		RTP
Maame Efua Essoun			0570032434		[illegible]
Ama Aekon			—		RTP
Araba Queyba			0279416712		RTP
Patrick Okyer			0276089659		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Cm

Meeting location:

Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Wudwah			—		RTP
Araba Sekum			—		RTP
Ama Nsuwah			—		RTP
NEWLOVE Koomson			054544611.		NEWLOVE
Egya Mensah			—		RTP
Samuel Mensah			0243155548		[illegible]
Kobina Mensa			0278894576		[illegible]
Robert Landis Eshun			0278894576		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nathanael wiredu			0271116365		
Ankie Twaba			—		RTP
Adwoa			0244		
Efua Essoun			—		RTP
Adwoa Adizer			—		RTP
Nana Bentum			—		RTP
Monica Fenoyi			0276126016		RTP
Maame Yakoba			—		RTP

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nana Aba			—		RTP
Kate Amoah			0271934109		
Nyame Nyeadom			0571092361		RTP
Kofi Mensah			48/1		48/1 RTP
Mena Ekua			—		RTP
Miss Mercy Assifuah/Mprah			0242322571		RTP
Theresa Assifuah			0242640110		RTP
Vida Arthur/Lawson			0274002592		RTP

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Mary Conduah			—		RTP
Cecilia Anumel			—		RTP
Aba Essumaba			0240572357		RTP
Maame Yehen			—		RTP
Alice Oduro			0570032434		
Ama Akyere			—		RTP
Elijah ~~A~~ Aryin			0571413479		
Kwame Obow			—		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
ATIOFUAYE CLOTIFY			0261060240		
Joseph Owusu			0279415108		
John Bonney			—		
Mary Arthur			—		RTP
Ekua Akyer			—		RTP

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: LEADERS & MEN Meeting location: NEW TAKORADI Date: 28/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
NANA EKOW ACKON		APOFO HENE	0271024035		
KOBINA MENSA		TRADER	0278894576		
ADEKYEE MU ASEM		APOFO HENE 2 (COMAND)	0277774781		
EGYA KOJO BOSSOMWI		APOFO HENE 2 (COMAND)	0265451755		
JOHN KWATENA ATOTOABO		APOFO HENE (SECURITY)	0276744868		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: FGD FISHERMEN Meeting location: NEW TAKORADI Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
(1) Ebenezer Essien			0241649105		Essien
(2) Paul Essien			0544899310		
(3) Francis Addzie			0570906165		
(3) Collins Arhin			0543042903		
(4) John Forson			0277038717		John
(5) Joseph Kwofie			0256626765		
(6) Antwi Daniel			0543497873		
(7) Eunice Antwi			0277414407		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: WOMEN Meeting location: NEWTAKORADI Date: 28/3/12

	Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
1	Amma Acquah					RTP
2	Lydia Mensah				027941612	027941612
3	Amma Quansah					RTP
4	Cyclina Amoah				0268411111	0268411111
5	Amma Tawia					RTP
6	Asiedu Baah					RTP
7	Alice Quansah					RTP

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: EDUCATION Meeting location: NEW TAKORADI Date: 28/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Sylvia Ruth Aikins	New Takoradi Methodist JHS	Assistant Head.	0205460693		[signature]
Adu Hannah	New-Takoradi Methodist J.H.S	School Secretary/Teacher.	0248-285344		[signature]
Tony Bentil	ESL	Consultant	0205769258	[illegible]	[signature]

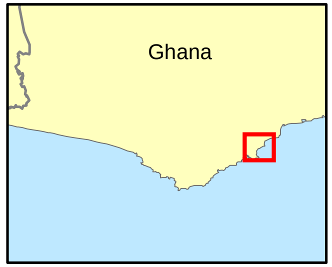
GPS Coordinates:

FISHERMEN NEW TAKORADI 29/02/2012

NAMES		CELL PHONE	SIGNATURE
8 MR. FRANCIS	APPIAH	0268388991	[illegible]
9 ANTHONY K	PRAH	—	
10 ROBERT	KWOFIE	—	[illegible]
11 KWESI	MENSAH	0277415988	
12 STEPHEN	KOOMSON	0267262626	

KEY:

● Meeting Location



N W E S

0 1
Kilometre

TITLE:
BAKAKYIR COMMUNITY
29 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 65,000
DRAWING: BAKAKYIR.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Bakaekyir Leaders and Men

Meeting location: BAKAEKYIR BAPTIST CHURCH

Date: 29th March, 2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
GODWIN APAU	-	Opinion Leader	0209357091	apaugodwin@yahoo.com	
FRANCIS K. DOE		"	0279927435	P.T. 207	
Hawa Saley	-	"	0209316247	P.T. 130	
AYISHATU ALIU	-	"	0266668353	P.T 29	AU
Rev. John Ernest Kwofie		"	0244 992910 020-2577778	Morde2004@Yahoo.co.uk PT 1	
REV. EMMANUEL AMIM-OTOHERE		"	0248228321	elkarow@hotmail.com PT 1	
~~Rev.~~ L Hon. Samuel Brown Papaga Dagodee		Assembly man Bakaekyir area.	0208966567 0266719201		
ZARATusalifou		"	0248201651	P.T 29	ZIAK

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Bakaekyir Leaders and Men.

Meeting location: BAKAEKYIR BAPTIST CHURCH

Date: 29TH MARCH, 2012.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Bless Borkloe	Radio Silver	News Editor	0274842715	gusbinghi@yahoo.com	
Kuden Adjei	Radio Silver	News Reporter	0207286927	africanallstar@yahoo.com	
EFUA ESUMABA	TRADER	CEO	0274221884		
PHYLLIS AMISSAH	TRADER	CEO	0547251846		Amissah
AMA ESUMABA NOONOO	TRADER	CEO	0207072253		
REGINA ADAMS DADZIE	TRADER	CEO	0546894529		
ELIZABETH AMA CORNAN	BAPTIST SCHOOL	CLEANER	0200219043		
COMFORT CUDJOE	TRADER	CEO	0274395035		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Baptist Leaders and Men.   Meeting location: BAKAEKYIR BAPTIST CHURCH   Date: 29TH MARCH, 2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Beatrice Gordon	Trader	Women Org.	0242245455	2200 Mic Takoradi	Bgordon

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Bakaekyir Community Meeting   Meeting location: The Heavens   Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
EMMANUEL BENTIL	DRIVER		0276339016		[signature]
CHARLES AMOS ARKO	DRIVER		0264497800	Yo Charles Amos Arko	[signature]
Andrew Blankson	Scripture	/	0571462880		[signature]
HAMICK	DRIVER	-	0279052990	-	[signature]
Esther Teboah	Teacher	-	0208304217	-	[signature]
Beatrice Gordon	Trader	-	0242245455	-	[signature]
EVA SOMAH	Trader	/	0277166818	/	[signature]
J.S. Mensah	Pensioner	/	0241608163	/	J.S. Mensah

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Bokaa Dyir Community Meeting   Meeting location: The Haveno   Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Gloria Mteiful	~~Secretary~~ Hell. dot com	Secretary	0200259920/ 0274942914	—	[signature]
AYISHATU ALIDU	T. D	—	0266668353	—	[signature]
Sampson Oku odoi	—	—	0279416320 or 0265169769	—	[signature]
Alex Effirim Amoah	—	CIVIL ENG.	0274096581	effirimnana@hotmail.com	[signature]
Zariah Salifu	T. D	—	0248201651		[signature]
Daniel Kweku Owusu	G.P.R.T.U	Chairman Sekondi branch	0540479291		[signature]
Agnes oppong	T. D	—	020578450	—	[signature]
ABIDA	T. D	—	0277037018	—	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW OIL

Organisation: Ba-Kaakyir Community Meeting   Meeting location: The Heavens   Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Faustina Yankey	–	–	0265096687	–	[signature]
I.K. Mensah	Man of God	–	0272543983 0275225634	–	I.K. Mensah
Emmanuel Ampenyi	–	–	0548212438	–	[signature]
Maxwell Anti	Plumbering	–	0208771594	–	[signature]
Ursula Tawiah	GEPA	–	0249454924	–	[signature]
John Aidoo	plumbaring	–	0267848531	–	[signature]
M.Y. Darkoh	Painter	–	0243727382	–	[signature]
Consarts	T.d	–	0247276549	–	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Ko-kwe Payin Community Meeting   Meeting location: The Heavens   Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Emmanuel Bentum	Baptist CHURCH	DEACON	0244875857	k	
Rev John Ernest Kwofie	Baptist Church	Opinion Leader and Peace Council Member W/Region	0244 992910 020-2577778	Morde2004@Yahoo.Co.UK	
Rev EMMANUEL ANIM-OTCHERE	POTTERS SANCTUARY CHAPEL	PLANT ENGINEER PROJECT MGT (OIL)	0248228321	elkanow@Hotmail.Com	
Rose A Bello	–	–	0274602475	–	
Suleman Monica	T.D	–	0241719910	–	
Gyedu Emmanuel	–	–	0244960360	Imkde20@yahoo.Com	
Henry-Kweku Daniels	–	–	0544898076	–	
Eric LOKKO	Tailor	CEO	0277636795	–	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Bokaekyir Community Meeting Meeting location: The Heavens Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Abdulai Adams	"	Technician mechanic	0547442413	adams.cola@yahoo.com	[signature]
MIRIAM OPPONG	CENTRE FOR NATIONAL CULT.	METRO CULTURAL OFFICER	0209179384	—	[signature]
Amina Isah	T. d	—	0276525219	—	[signature]
Labaran Alsaah	T. d	—	0243282674	—	[signature]
Florence	T. d	—	0208219895	—	[signature]
Kojo Hayford-wilson	Fordwilson Company	Director	0546418679	Hayfordwilson@yahoo.com	[signature]
GODWIN K APAU	—	—	0266720073 0209357091	apaugodwin@yahoo.com.	[signature]
~~Sa~~ HON. SAMUEL BROWN PAPAGA DAGODZO	-	—	0208966567	—	[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

1

Organisation: Bakaekyir Women F. G.

Meeting location: Ekwese Fish Smoking Shed

Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
MATILDA STEPHENS ANTE ESI ESSUON ST					
ADWOA KWEIBA					
SERAH ABROKWA					
SELINA NYAMEKYE				0242134159	
MARY ANSAH				0275383564	
GEORGINA ANSAH				0275267121	
GLORIA ODAME				0549542737	
ESTHER AMPAH				0245859023	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

(2)

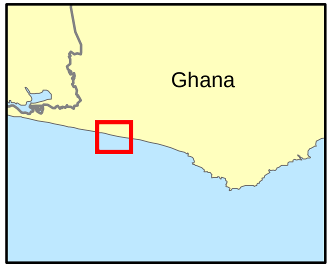
~~Organisation:~~ Bakaekyir Women   Meeting location: Elmina Fish Smoking Shed   Date: 29/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
SELOMEY TAWIAH				–	
ESTHER ASSAN				0272243532	
ANTEE DAPAAH				– /	
SIS. NANA AMBA				0274411544	
MENA ARYEE					
MENA AMBA KYEWA					
ANTIE EKUWA					
ADWOA BADU					

GPS Coordinates:

KEY:

● Meeting Location



N
W E
S

0 1

Kilometre

TITLE:

ATUABO COMMUNITY
30 MARCH 2012

CLIENT: Tullow Ghana Limited	SIZE: A4

DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 75,000

DRAWING: ATUABO.mxd	REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Atuabo Community Meeting location: Palace. Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
David Anana		Electrician	0542894314		D
Robert Anana		Electrician	0245964615		RA
Matthew Ariza Cobbold		Bar Keeper			Matt
Simon Anana		chalco burner	0206170479		[illegible]
Kakukyie K. Sampson		Student	0241122067		Samp
Ewusi Daniel		Student	0547466093		[illegible]
Michael Amoah		Student	020 9845926		S
James Jonah Bley		Farmer	0267185670		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Atuabo Community Meeting location: Palace Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Very Rev John Ansong	METHODIST	DISTRICT PASTOR	0246612486	rev.johnansong@yahoo.com	
Olivia Boateng		food seller	0544896474		
Monica Adjewa Armah					
Afia Nagolea		farmer			
Philip Dyankey		fisherman			
Monica Amadu					
Ama Anoma					
Aka Ebale Aunt Akasi					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Ahobrakyir Women Atuabo Community Meeting location: Chiefs Palace Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ernest Aro Cobbold		fisherman	0544896474		[signature]
Daniel Kwasi		fisherman			[signature]
Ebial Ghana		fisherman	0277009584		[signature]
Isaac Nyanzu		fisherman	0243121445		[signature]
Stephen K A Cudjoe		student	0206170472		Akonda
Kofi Kpole		farmer			[signature]
R. S Andoh		farmer			[signature]
Mark Arthur		Contracter	0208520258		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Atwabo Meeting location: CM Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
EBANYENLE KERMAH		CHIEF FISHERMAN	0246559618		[illegible]
Safohene Etibah		fisherman	0275970992	[illegible]	
Elder Annah Kojo		farmer			
Snr. Capt. A.T Bbay		farmer			AkahBlay
Elder Napoleon Elder H/Kodjoe		farmer			Napoleon H/Kodjoe
Linguist Kofi Menlah		Fisherman			Menlah
Joseph Akpapi Snr		fisherman			[illegible]
John Ebangele		Meison	0249282097		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: ~~Egyambra~~ Atuabo Meeting location: Comm Meeting Date: ~~24~~ 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ndallia	-	farmer	- -	Atuabo P.O. Box	
Agnes Afful	-	✓	-	P.O. Box 3 Atuabo	
Vada Ackal	-	fish marka	0278396119	Atuabo P.O Box 3	
Patricia Ackal	-	Stone Keeper	- -	P.O. Box 3 Atuabo	
Emeria A. Blay		dress making	0247975841	Atuab P.O Box 3	Blay
May Meah	-	Trader	-	P.O Box 3 Atuabo	
Kamrah	-	fish marka	0279049157	Atuabo P.O Box 3	
Adda Arend	-	fish marka	- -	P.O. Box 3 Atuab	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Atuabo Community Meeting location: Ralatta Date: 30/3/2012

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ade	—	Rice Seller	—	Atuabo P.O Box 3	
Hagai		Farmer	—	Atuabo P.O.Bx3	
Miss Gibbah		Sell Cloths		P.O.Box 3 Atuabo	
Nda Kpanji	—	fish marke	—	Atuabo P.O. Box3	
Afiah		Seller Sugar Cain	—	Atuabo P.O Box 3	
Queshi Aku		dress making	0272548269	P.O.Box3	
Bulu Abena		fish marke	—	P.O Box Atuabo	
Elizabeth Nyamike		fish marker	0265790022	Atuabo P.O.Box11	

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Akwabo Meeting location: Palace Date: 30/3 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ayo Kamal	Elder	Bussines	0278301563	Akwabo P.O Box 3	Emmanuel
Juliat Koku	–	Trader	0546820498	Akwabo P.O Box 3	
Philomina		Seller	0202867741	P.O. Box 3 Akwabo	
Grace Arhin	–	fish Monger	0545087418	Akwabo P.O. Box 3	
Constance Kwesi		Trader	0241661603	Akwabo P.O. Box 3	
Agatha Kudjoe	–	Head dress	–	P.O. Box 3 Akwabo	[illegible]
Polina Adade	–	Farmer	– –	Akwabo	[illegible]
Nyanko Chie	– –	Coconut Bussines	0541155908	Akwabo P.O. Box 3	[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Atuabo Community Meeting location: Chiefs Palace Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Antwi Richmond		Carpenter	0248874124		[signature]
Maxwel Kwaw		Electrician	0248396119		[signature]
Michael Kofonziah		Fisherman	0542892409		[signature]
Ezekiel Eric		Student	0546613938		[signature]
Alfred Kwesi		C & J	054669592		[signature]
Amgbome Seth		Student	0240455284		[signature]
William Anaman		Driver	0247009148		[signature]
Patrick Amgbome		Student	0544859384		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

Organisation: Atuabo Community Meeting location: Palace Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kwame Ndo		fish monker	—	P.O. Box 3 Atuabo	
Esane		fish monker		P.O. Box 3 Atuabo	
Ahuma		farmer		P.O. Box 3 Atuabo	
Comfort Acka		fish monker	—	P.O. Box 3 Atuabo	
Nuia mozu		fish monker		P.O. Box 3 Atuabo	
Asenda Ahua		farmer	—	Atuabo P.O. Box 3	
Elizabeth Oseyo		fish monker	—	Atuabo P.O. Box 3	
Nyameke maria		Trada	0278301563	P.O. Box 3 Atuabo	[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Atuabo Community Meeting location: Chief's Palace Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ackon Akba	~~trader~~		No	Atuabo Box 3	
Anthony Yankey B.	~~Youth~~ A.G.L.	Lab. Chn.	✓	✓	A. Yankey
Mary Nyaky	Trader	fish monger	0274354384	Atuabo P.O Box 3	Mary
Nicholas K. Arkoh		Famer	0266508117	Atuabo Box 10	Sam
Rose Nyaky		farmer	— —	Atuabo P.O. Box 3	~~Ab~~
Dorothy Kwesi		fish monger	0248781564	Atuabo P.O. Box 3	
Mathilda Blay	—	fish monger	0240989003	Atuabo P.O. Box 11	
Sylvia Adjei		farmer	0207591367	Atuabo P.O. Box 3	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Atuabo Community Meeting location: Palace. Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Lucy Blay		fish monger	0 ~~5859~~ 9962368	Atuabo. P.O. BOX 3	
Sabbah Eshun		fish seller	–	Atuabo P.O. Box 3	
Agnes Anlwe		Bread maker	0248884197	Atuabo M.P. P.O Box 3	
Monica Nwah		fish monger		Atuabo M. P. P.O. Box 3	
Faustina Kikuramah		fish monger	0542563193	P.O. Box 3 Atuabo	
Gladys Hemans		farmer	–	P.O. Box 3 Atuabo	
Monica Amoo		fish monger	–	P.O. Box 3 Atuabo	
Augustina Allu		Store keeper	0247815778	P.O. Box 3 Atuabo.	

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Atwabo Meeting location: Polorce Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Kakuchie Kusame		fisherman	0546892069		
John Alluh		Mason	0247962757		
Emmanuel Kwaw Arizie		fisherman	0546811174		
James Amanzule		fisherman	027592948		
Patrick Aneman		fisherman	0240500381		
Matthew K Ezzah		fisherman			
Kwame Boday		fisherman			
Philip Aka		Student	0202875452		
Patrick Bla		fisherman	0244580880		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Atuabo Fishermen Meeting location: Chief Fishermans House Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
EBANTEULE KERMAH		CHIEF FISHERMAN	0246559618		[signature]
JAMES AMONZULE AWOTWE		FISHERMAN	0275992948 ~~0275892948~~		[signature]
ADAMA KAKY		✓	—		[signature]
SOLOMON N-ZAMEKYE		CARPENTER	020 6747741		[signature]
MATTHEW K. ERZAH		FISHERMAN	—		[signature]
ANDREW K. ACKERSON		✓	0274035899		[signature]
SAMUEL KWAW		✓	—		Samuel Kwaw
EMMANUEL KWAW ARIZIE		✓	054601174		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Atuabo fishermen Meeting location: Chief fisherman's House Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
JOHN ACZAH		FISHERMAN	0241947864		John
AARON ERUAHENE		✓	0240509744		[illegible]
PATRICK KOJO K-S		✓	0273875758		[illegible]
Appiah Omwone-Agyemang	SRC	Social Consultant	0242109854	omwoneagyemang@yahoo.co.uk	[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women Group   Meeting location: Atuabo   Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ndabenea	-	farmer	- - -	Atuabo P.O. Box 3	
Kanra	-	fish mork	0279049178	Atuabo P.O Box 3	
Acka Adela	- -	fish mork	- -	Atuabo Box	
Mary Ehwe	- -	Trader	0546407430	Atuabo P.O Box 3	MARY Ehwi
Alua	-	farmer	0271549686	P.O. Box 3 Atuabo	
Nwie Nyameka	- -	Sumtrader	0278998266	Atuabo	
Nyameba	✓	Trader	- -	Atuabo	
Asua Acka Benea	✓	farmer	- -	Atuabo P.O Box	

GPS Coordinates:

...ma Aluola   farmer   —   Atuabo P.O Box

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women Group Meeting location: Atuabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Dorkas		Trader	0244502453	Atuabo P.O. Box 3	Bud
Azone K Kanwal		Seller	0545044530	Atuabo	HO
Ndabela Fortune		fish monger	0542563193	Atuabo	Ndabela
Awule		fish monger		Atuabo	
Ase		Trader	— —	Atuabo P.O Box 3	
Ackah Bobole		Trader	—	P.O. Box 3	
Gift Kwaw		Trader	—	P.O. Box 3	
Gloria Kwaw		Trader	—	P.O Box 3 Atuabo	

GPS Coordinates: ~~Glomet~~ Ackasi fish monger — Atuabo P.O Box

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women group Meeting location: Atuabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Georgina Ampa		Trader	0273509470	Atuabo P.O Box 3	
Acka Nyamke Jime		farmer	—	Atuabo Box 3	
Mattrida Bloy		fish monger	0204093900 3	Atuabo	
Sylivia Adjoa		Store Keeper	—	Atuabo P.O. Box 3	
Addo Arenh		fish monger	0542783914	Atuabo Box 3	
Mamza Ekya		Seller	—	Atuabo Box 3	
Adwoba		fish monger	—	Atuabo P.O Box	
Baby Abeng		fish ✓	—	Atuabo	

GPS Coordinates:

Mary Anoma		head treasury	0277477995	Atuabo P.O Box 3	

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women group Meeting location: Atuabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Sella Addo	–	Cooking	0241104297	Atuabo Box 3	
Tajiba	–	Sello	–	Atuabo PO Box 3	
Mary Nyamela		Cooking	0278301560	Atuabo PO Box	XXX
Elizabeth Buah		Cutting	0272569021		Eli Buah
~~[illegible]~~	Augustina Ackerson	Bread maker	0246742040		ANKA
Dorcas Buah		Trader	0272569021		D. Buah
Esama		fish mon	–	Atuabo	
Aboa Nyamfa	A XX	fish mo	0247785433		

GPS Coordinates:

Victoria Wilson		Cooking	–	Atuab	

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women group Meeting location: Atuabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Nyameke-Quachie Benier	Famer				
Esther Aboagye	Famer		0542882485		
Hanna Blay	Trader		0201254509		
Sabina Blay	Trader		0278969677		
Mary Alimah	Trader		—		
Fuastina Tanoe	Trader		—		
Mary Annamon	Trader		—		
Kwasi Abelema	Trader		0543958773		

GPS Coordinates: Trading Constance Kophie 0548154051

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women Group Meeting location: Atwabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Ama Somah	Trader		0274769047		~~Ama~~
Nwiavola	Trader		0540300247		[illegible]
Adema Afiba	Trader		0274354384		[illegible]
Rose Ngankay	Trader		—		~~Rose~~
Ajavoa Armah	Trader		0277939009		Aj
Abelima Macry Akason	Trader		0249025899		~~Abelema~~
Amala	Farmer		—		
Aka Ebola	Trader		=		+

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Women group Meeting location: Afuako Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Esofo NDA	trader		0248812261		Esofo Ndla
Susana Brown	trader		—		S Brown
Kwame Asse	trader		—		A S
Mahi Chershu	trader		0247974777		Mathilda Eshun
Cecilia Kessi	trader		0541155908		
Grace Jando	Farmer		0547045714 ~~0245338617~~		
Eforiba	Trade		0241635151		
Manle Keale	Trader		0240055029		E

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women Meeting location: Atuabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Rose Gibbah	Trader		0273942148	027	RGibbah
Dora Ahelkwasi	Owner		—		
Avie Kuhakele	Farmer		—		
Adiaba Akuba	Farmer		—		
Kokiva Akou			—	House No. A/18	
Base Yaba	Chope Brow.		0278998266		
Edola Ekyie	Fanchi		—		
Nyami Keluah	Kyi-Nda Finchi		—		

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Women's FaD Meeting location: Atuabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Felicia Meah	Fishing		—	House N-A/61	
Asua - Akka Eba	Farmer		—	House No. G/20	
Mercy Andoh	Seller		0273812300		M Andoh
Blay Avola	Fishing		—	P.H.C 10040	
Aku Anlima	— —		—		
Rebecca Amanan	Trader		0245374252		
Asenda Aluwa	Cleaner		—		
Grace Amanan	Fishing		0545087418		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Women's FGD Meeting location: Atwabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Atoba	Chape Bar		0271665623		
Hanna Acker	seller		0244159878		Hannah Ack
Miss Gibba	Chape Bar		—		
Nyamozu	Farmer		—		
Monica Amo	Fishing		—		
Palluna Ackah	Mason		—		
Mieza Ahaly	Farmer		0272547523	H/No B 32	
Asabia Nyima	Fishing		—		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

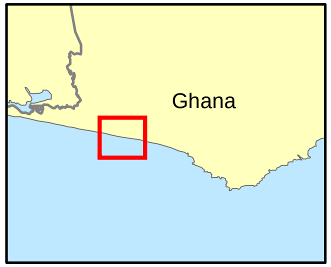
Organisation: Women's FGD Meeting location: Atwabo Date: 30/3

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
Hanna Ama	Farmer		—		
Mary Arzi	Trader		—	A/45	
Constance Essien	Trader		0570071808		Essien
Amoo Faustina	Trader		0202857341		Farmer
Ershun Saikauna	Heat dresser		—		ESo
Emilia Ama Blay	Seamstress		0276192368		
Mavies Anaman	Seller		—		
Lucei Blay	mamcer		0549902368		

GPS Coordinates:

KEY:

● Meeting Location



N
W E
S

0 1
Kilometre

TITLE:

ENOKYI COMMUNITY
30 MARCH 2012

CLIENT: Tullow Ghana Limited		SIZE: A4
DATE: 31/05/2012	CHECKED: ADJ	PROJECT: 0142816
DRAWN: KM	APPROVED: MI	SCALE: 1: 100,000
DRAWING: ENOKYI.mxd		REV: 0

ERM
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU
United Kingdom
Telephone:+44 (0) 131 478 6000
Facsimile: +44 (0)131 656 5813

SOURCE: ERM
PROJECTION: WGS_1984

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: COMMUNITY MEETING Meeting location: ANOCHIE Date: 30/3/12

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
GLADYS ACKAH					
AGNES KWOFIE					
JOSEPH ANAMAN					
KWAME BOSEY					
ISAAC BOAH					
CUDJOE FRANCIS					
KWAME AKA					

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: LEADERS & MEN Meeting location: ANOCHIE Date: 20/3/12.

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
MORKEH ANNOR		CARETAKER			MOKEANO.
DAN. BLAY AFFUL		ELDER	0277479449		[illegible]
PAUL KAKU		TUFOHENE	0265511823 0276382509		[illegible]
MARY ESHUN		ELDER	0272032936		[illegible]
J.A. AFFUL		ELDER	0273063479		[illegible]
ANTHONY ARMOH		ELDER	0570404183		Thoffy
ARMAH MIEZAH		ELDER	0572471250		[illegible]
JE ACKAH		"	0		[illegible]

GPS Coordinates:

T.E.N. EIA Community Consultations Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
VICTORIA GIDJOE					
JOHNSON ARTHUR		LINGUIST (OKYEAME)	054 4472181 0274202782		
THOMAS K. NELSON		ELDER			
PETER ERZOAH		ELDER	0273846863		
NANA ABS. SAMUEL K. ELLEAMO		ABUSUAPANIN			
NANA BORSAM		OBAAHEMMAH			RTP
AKA TONOR		ABUSUA KYEAME			RTP
TAYI AKA		ELDER	0570032979		

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
GLADYS BOAH		ELDER	0278744152		[signature]
SUSANA ENKOAH		ELDER	0279956788		[thumbprint]
CECILIA CUDJOE		ELDER	0272798466		[thumbprint]
GRACE NYANE		ELDER			LTA [thumbprint]
ELIZABETH BLAY AFFUL		"	0207591591		[signature]
MARGARET ~~ARKO~~ AFFUL		"			[thumbprint]
ISAAC ATTOBRAH		SAFOHEN			[signature]
FRANCIS ANNOR		UNIT COMMITTEE SECRETARY	0548938465		[signature]

GPS Coordinates:

T.E.N. EIA Community Consultations
Attendance Sheet

TULLOW

Organisation: Meeting location: Date:

Name and Surname	Organisation	Position / Role	Cell phone	Email address	Signature
GLADYS ACKAH		ELDER			CAckah
THERESAH MENSAH (EMMA)		ELDER			
~~CATHERINE ZAABA~~					

GPS Coordinates:

Effasu Community Consultations - Tuesday, 19th June, 2012

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Joseph Cudjoe	Businessman	0571467352		32	Bedzra Robert	Fisherman	0273940238
2	Anatole Blay	Businessman	0543565974		33	Aho Wackson	Fisherman	0273363820
3	Theresa Assuah	Trader	0273118223		34	Veronica Ahizi	Fishmonger	0572651484
4	Princes Gabriel Ekumi	Agriculturalist	0275151053		35	Rebecca Evonran	Fishmonger	0278970579
5	Janet Tanoe	Teacher	0273946633		36	Maame Adjoa Badu	Fishmonger	
6	Salifu Yakubu	Shoemaker			37	Maame Ama Essoun	Fishmonger	
7	Abizi Nyameke	Farmer	0275274038		38	Agnes Pentsi	Fishmonger	
8	Frank Paul Yanzu	Businessman	0273127342		39	Nyame Ndae	Fisherman	
9	Daniel J. Hagan	Businessman			40	John K Serkyi	Fisherman	0274641393
10	Agnes Amihere Eba	Farmer			41	John Quaansah	Fisherman	0570120697
11	Lucy Ebulley	Fishmonger			42	Esi Amanyima	Fishmonger	
12	Ansong Daniel	Teacher	0273564788		43	Ekow Dadzie	Fisherman	
13	Peter Yaboah	Teacher	0544760477		44	Kwabina Yaboah	Fisherman	0570127168
14	Hon. Kofi Nkumson	Teacher	0275255386		45	Albert Sagoe	Fisherman	0271392921
15	J.E Yankson	Farmer			46	Daniel Quayson	Fisherman	0274476711
16	Joseph Yanzu	Farmer	0275127521		47	Dora Laye	Fishmonger	0274205304
17	Acquashe Abekan	Farmer			48	Aba Bosua	Fishmonger	
18	Prince Joseph Ekumi	Farmer	0274224298		49	Esi O.B Three	Fishmonger	0570127168
19	Nana Kwagyakyi	Farmer	0273986160		50	Agnes Boabeng	Fishmonger	
20	Joshua Boame Serkyi	Fisherman			51	Julius Kwame Avu	Fisherman	0274637933
21	Kaku Kwaw	Farmer			52	Nana Yaw	Fisherman	0279528774
22	E.K. Ackah	Farmer			53	Emmanuel Sakey	Fisherman	0274476711
23	Charles Anui Ebulley	Farmer	0279222171		54	Mary Ebulley	Fishmonger	
24	Paul Nda Egili	Farmer	0273986160		55	Nana Yagulley	Fishmonger	
25	Ekumi Lucy	Student	0274796561		56	Sarah Nyanko	Fishmonger	0271801347
26	Christina Eshun	Trader	0274796561		57	Philip Kofi Ackah	Farmer	
27	Theresa Nda Egili	Fishmonger	0570028772		58	Kojo Nokwaw	Fisherman	
28	Daniel Noah	Electrician	0272841790		59	Esther Yaboah	Fishmonger	0571753573
29	Kwame Ebulley	Farmer	0276390254		60	Kojo wiazie	Fisherman	0279539805
30	Kwabina Mensah	Fisherman			61	Kwasi Quansah	Fisherman	
31	Cecilia Ekumi	Trader	0570121784		62	Kofi Antobam	Fisherman	

Ahobre Community Consultations - Wednesday, 20th June, 2012

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Nana Erzuah Ebulley	Farmer			43	Mary Anahoma	Fishmonger	
2	Alahasan Anwomiah	Farmer	0543965234		44	Adjoa Nyamebekyre	Fishmonger	
3	Augustine Kakukyi	Farmer	0546039742		45	Sarah Acko	Fishmonger	
4	Ambrose Annor	Fisherman	0546400522		46	Ekua Amoah	Fishmonger	
5	Mark Nwore	Farmer	0240578053		47	Grace Annan	Fishmonger	
6	Kwasi Sampson	Fisherman	0540974205		48	Edith Ndaa	Trader	
7	Akesseh Christopher	Farmer	0241648231		49	Elizabeth Asabia	Trader	
8	Thomas Ehnie	Farmer	02241973942		50	Linda Owusu	Trader	
9	John Acher Nyamekeh	Fisherman	0240510560		51	Raymond Abraham	Fisherman	
10	Papa Armah	Farmer			52	Ekua Bagyinah	Fishmonger	
11	Acher B.I	Farmer	0243610285		53	Ekua Baifua	Fishmonger	
12	Christine M Meneabe	Teacher	0242086966		54	Mary Anohomah	Fishmonger	
13	Bernardine Blay	Teacher	0545026264		55	Ama Obi	Fishmonger	0546822688
14	Abigail Mintah	Nurse	0546538902		56	Sarah Acko	Fishmonger	
15	Cecilia Erzah	Teacher	0242086852		57	Ama Assimah	Fishmonger	
16	John Abizi	Artisan	0247280473		58	Areba Donko	Fishmonger	
17	Enock K Muzah	Student	024728028		59	Ekua Boateng	Fishmonger	
18	Gideon Appiah	Student	0247814315		60	Comfort Amoah	Fishmonger	
19	Biney Patrick	Nurse	0245547417		61	Ama Acher	Fishmonger	
20	Adu Kofi	Welder	0544752373		62	Paulina Mensah	Fishmonger	
21	Kofi Stephen	Student	0242561826		63	Abina Abam	Fishmonger	
22	Entsey Isaac	Student	0242561826		65	Aba Yaa	Fishmonger	
23	Fredrick Abizi	Student	0548136512		66	Adiza Bukali	Fishmonger	
24	Augustina Alimah	Trader	0540973001		67	Esi Efuah	Fishmonger	
25	Theresa Awotwie	Trader	0241621193		68	Adjoa Etoabah	Fishmonger	
26	Elizabeth Mensah	Farmer			69	Sarah Lucky	Fishmonger	
27	Abudulai Yakubu	Trader	0547661948		70	Abina Quansima	Fishmonger	
28	Moses Samereka	Farmer	0240572287		71	Ebenezer Anzuku	Fisherman	0543965028
29	Fredrick Homiah	Teacher	0241974343		72	Ekow Boateng	Fisherman	
30	Ekua Wankyie	Fishmonger	0241963412		73	John Sam	Fisherman	
31	Sophia Asankoma	Trader	0546068958		74	Nana Kwamina Kaya	Chief Fisherman	0549510773
32	Abeka AJohnson	Retired Teacher			75	Kojo Besah	Fisherman	0245867143
33	Elizabeth Acquah	Trader			76	Etia Charles	Farmer	
34	Thomas Kakuyi	Farmer			77	Kwaw Mensah	Fisherman	0543985742
35	John Ehonea	Farmer			78	John Binney	fisherman	0245865092
36	Hannah Edye	Fishmonger	0548136506		79	Kofi Kwo Ansah	Fisherman	
37	Aba Assimah	Fishmonger			80	Egya Adoku	Fisherman	0241152884
38	Maxwell Adjei	Driver	0241506943		81	Kwaw Mensah	Fisherman	0546820691

39	Joseph Nizan	Businessman	0245650887		82	Isaac Arthur	Fisherman	
40	Joyce Yaw	Trader	0241977258		83	Isaac Mensah	Teacher	0546974213
41	Akua Boateng	Fishmonger			84	Hannah Yankson	Fishmonger	
42	Cecilia Arthur	Trader			85	Anthony Arthur	Farmer	
86	Bro. Moro	Fisherman	0548439894		101	Sophia Eshun	Fishmonger	
87	Kwame Quainoo	Fisherman	0241155217		102	Mary Odoom	Fishmonger	
88	Kojo Carpenter	Carpenter	0546836811		103	Lawrence	Fisherman	0542780382
89	Esi Abam	Fisherman	Fishmonger		104	Obeng Emmanuel	Fisherman	0248028871
90	Sheitu Cudjoe	Fishmonger			105	Aba Yaremo	Fishmonger	
91	Matthew Annan	Fisherman	0545008134		106	Ama Ebo Nyima	Fishmonger	0240464491
92	Ekua Anyisua	Fishmonger			107	Efua Okesse	Fishmonger	0548136537
93	Ezuku Bossoma	Fishmonger			108	Old Lady A.Y	Fishmonger	0543957740
94	Aba Edoma	Fishmonger	0247404066		109	Monica Cudjoe	Fishmonger	0247814289
95	Elizabeth Egril	Fishmonger	0247417744		110	Aba Esi-fua	Fishmonger	0247814289
96	Comfort Dadson	Fishmonger	0247404066		111	Abina Nketsia	Fishmonger	0247814289
97	Mary Bann	Fishmonger			112	Alex Annan	Trader	0547479495
98	Comfort Egrili	Fishmonger			113	Felix Dadzie	Mason	0245252372
99	Comfort Forson	Fishmonger			114	Vida Gyesi	Fishmonger	
100	Albert Ezuah	Mechanics	0240468602		115	Dominic Asuah	Teacher	0242167996
					116	Jefred A. Cudjoe	Teacher	0247281888

Bonyere Community Consultations - Thursday, 21st June, 2012

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Ackese Anmonie	Farmer			60	Ndede nyikyi	Trader	
2	Albert Nwi-Mozu	Teacher	0208718712		61	Esther Adeba	Teacher	0248661564
3	Ackah K Sylvester	Teacher	0240865332		62	Hannah Ebi	Trader	
4	Ramous Tanoe Kaku	Farmer			63	Mary EBI	Trader	
5	Avon Ackah Miazan	Farmer	0540478806		64	Lucy Nyan-Kwasi	Farmer	
6	Sampson Essuman	Farmer	0242381014		65	Francis Anno	Farmer	0548915716
7	Adam Bin Adam	Farmer	0542609002		66	Margret Angrufi	Student	
8	Bernard Tayie Mensah	Farmer	0248956960		67	Maame Ekua	Fishmonger	
9	Ayekpah Nyankekyi	Farmer			68	Veronica Emia	Student	
10	Mariama Azizi	Dressmaker	0245726186		69	Lydia Emia	Hairdresser	
11	Bernice M Ackah	Dressmaker	0542894354		70	Adjoa Donko	Farmer	
12	Joseph Yankey	Mechanics	0269535010		71	Benjamin Ahado	Carpenter	0542486141
13	James Blay	Farmer	0240546491		72	Stephen Affenyi	Student	
14	Paul Akromah	Farmer	0549463463		73	Kofi Bentum	Fisherman	
15	Joseph Cudjoe	Farmer	0240080008		74	Agnes Kkuban	Trader	
16	Nana Ebalekyi	Trader	0267164848		75	Francis Sapolito	Fisherman	0240546640
17	Stephen Kaga Kwofie	Businessman			76	Ernest Eliam	Student	0249713989
18	Abudulai Mohamed	Farmer	0546018395		77	Kwasi Abrokaw	Fisherman	
19	Yakubu Adudulai	Driver	0248641221		78	Samuel Otoo	Farmer	
20	Richard Anim Yaboah	Teacher	0241633328		79	Sarah Dadzie	Trader	
21	Samuel Stanly Bassaw	Teacher	0246777518		80	Ekua Akre	Trader	
22	S.T. Awuah	Teacher	0260551307		81	Mary Yaboah	Trader	
23	Emmanuel Baidoo	Carpenter	0249082782		82	Mary Akuban	Farmer	
24	Joseph K. Mensah	Teacher	0245315615		83	Paul Cudjoe	Farmer	
25	B.B. Cudjoe	Farmer	0545005486		84	Kojo Abiw	Manson	
26	Gabriel E.B. Tobis	Tailor	0247407860		85	John Bosco	Farmer	
27	Lewis Nyameke	Welder	0245442010		86	Izekiel Yaboah	Manson	0240581721
28	Appu Thomas	Student	0245758922		87	Agnes kwaw-Etsi	Farmer	
29	Michael Evi	Student	0544760455		88	Nyame Beye	Fishmonger	
30	Nwi-Mozu	Student	0241758646		89	Felicia Kwaku-wei	Fishmonger	
31	Sam Johoahson	Farmer	0245930694		90	Mensah Liaus	Farmer	0271645298
32	Miyam kwaw	Farmer			91	Adu Boahene	Farmer	0242380611
33	Ngowa Badi	Farmer			92	Kwasi Quansah	Fisherman	
34	Afo-Kwagyay Anthony	Rev.Minister			93	Jacob Appiah	Student	
35	Monica Fanton	Trader	0249641673		94	Kwabina Appah	Fisherman	0242379722
36	Ebroni Alphonse	Plumber	0266069361		95	Kwaku Afrane	Fisherman	
37	James T. Aluekeh	Farmer	0245711252		96	Kwasi Essoun	Fisherman	
38	Mary Nyia Ackah	Trader	0247785850		97	Abraham Quansah	Fisherman	

39	Prosper Danful Mills	Teacher	0248437046		98	John A. Essien	Architect	0245261765
40	Stephen Blay	Fisherman	0241948070		99	John Bentum	Fisherman	0249893315
41	Adolf Senzah	Framer	0540997135		100	Kwaw Mensah	Fisherman	
42	Boanmeiza Francis	Farmer	0202537907		101	Kojo Kakraba	Fisherman	
43	Joseph Atobra	Plumber	024880754		102	James Quaicoe	Fisherman	
44	Jude Kwasi Badu Abi	Farmer			103	Kwasi Abiye	Fisherman	
45	Veronica Nosiamah	Dressmaker			104	Maxwell Odoom	Fisherman	
46	Hannah Ackah	Trader	0273149902		105	Kwaku Badu	Fisherman	
47	Mavis Sam	Dressmaker	0275557718		106	Kwame Bentum	Fisherman	
48	Beatrice Elliason	Trader	0207493990		107	Kofi Nkrumah	Fisherman	
49	Elizabeth Nyameke Eba	Zoil	054474816		108	Francis Quayson	Manson	0248372788
50	Raymond Mensah	Zoil	0248070673		109	John affanyi	Farmer	0546080137
51	Blay Miazan Tanie	Farmer			110	Kwasi panyin	Fisherman	
52	Joseph Armah	Zoil			111	Daniel Yaboah	Chainsaw operator	0547474572
53	Mohamed Abogan	Driver	0242847532		112	Papa Akodaa	Fisherman	
54	Francis A. Neme	Farmer	0245765119		113	Ama abam	Fishmonger	
55	Erzoah Charles	Student	0540972346		114	Ekua kyabah	Fishmonger	
56	Stephen Blay	Driver			115	James Abizi Polley	Teacher	0542791476
57	Nana Ehia	Trader	0245162127		116	Bernard Ebowyi	Driver	0541157378
58	Emmanuel menla	Farmer			117	Alfred Boah Assafuah	Tailor	0279640543
59	Dominic Enu-Eduku	Driver	0546762391		118	Andoh Quarm	Retired Teacher	0265228545

Half Assini Community Consultations - Friday, 22nd June, 2012

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Ackah Nzane	Farmer	0207751613		27	Joseph Buobae	G.N.F.S (Fire Officer)	0279909968
2	Nana Ayebie Amihere	Chief	0243922589		28	Mark Hamilton	G.N.F.S (Fire Officer)	0277745159
3	Adjoba Ndah	Farmer			29	Philip Abpalu	Student	0279525228
4	John Nyameke	Teacher	0209169134		30	Pious Amenemah	Businessman	0278991554
5	Joseph Kwame	Student	0572115597		31	Francis Tayi	Chief Fisherman	0208262502
6	Alex Miazah	Nurse	0245715732		32	Nana Kwasi Mayian	fisherman	0272848934
7	Patrick Ebi Edeyilea	Fisherman	0200991546		33	Maame Avoka	Fishmonger	
8	Paul Muah	Businessman	0208530348		34	Efua Anseba	Fishmonger	
9	Joseph Quansah	Student	0248985927		35	Kwabina Nsako	Fisherman	0240802178
10	Helena Bandzie	Trader	0284843922		36	Aba Tekyiba	Fishmonger	
11	Mary Essoun	Trader	0284823922		37	Paul Homiah Tanueh	Farmer(Assembly member)	0207450061
12	Philomena Acquaye	Fishmonger	0546894233		38	John Ekobor	Teacher (Assembly member)	0542377949
13	Cecilia Quansah	Fishmonger	0275110824		39	Albert Benle Afful	Student	
14	Ama Ataa	Fishmonger			40	Mark Asmah Arthur	Farmer	0208110441
15	Oscar Pardoh	Businessman	0241156925		41	Atimbire Patience	Teacher	0243859154
16	Nyame wuho	Fisherman			42	Eshun Emmanuel	Teacher	0242054388
17	Oba Yaa	Fishmonger	0247280414		43	Justice Ette Menwubi	Teacher	0248591206
18	Aba Ewusiba	Fishmonger			44	Kodwo E. Edjah	Teacher	0244753443
19	Papa Aban	Fisherman	0207205663		45	Afful Benle Albert	Teacher	0208314225
20	Kwame Acquaye	Fisherman	0241556632		46	Isaac Kulu Armah	Teacher	0209764514
21	Amba Awotieba	Fishmonger			47	Francis Kadu Kofi	Teacher	0267137890
22	Ekua Akaba	Fishmonger			48	Alex Korankye	Manso	
23	Agbodo Paul	Student	0248115352		49	Peter Otisiabah	Fisherman	05448558501
24	Francis Ackah	Manson	0209332742		50	Joseph Nyameke Ohajah	Farmer	0572516406
25	Pott Richardson	Druggist	0275072987		51	Mary Tofie	Fishmonger	0204987188
26	Abina Panyin	Fishmonger			52	Sarah Edom	Fishmonger	

New Town Consultations - Saturday, 23rd June, 2012

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Sub. LT Labo Rabiu	Navy	0244686200		37	Paul Amonle	Fisherman	0275274466
2	CPO Osi O Patrick	Navy	0243356390		38	Kofi Asoku	Fisherman	
3	AB 1 Boamah B.C	Navy	0243233010		39	Kofi Ataa	Fisherman	
4	AB 1 Budu EO	Navy	0540837790		40	Kojo Badu	Fisherman	
5	AB 1 Ahomiah J.	Navy	0273877642		41	Peter Edufful	Fisherman	
6	OS Bio Bright	Navy	0244506636		42	John Andoh	Farmer	
7	OS Appiah Joseph	Navy	0245743241		43	Ackah Atsi	Farmer	
8	Evans Ziddah	Navy	027690390		44	Nda Ama	Farmer	
9	Tette Bia	Fishmonger			45	Lucy Nguan	Fishmonger	
10	Joseph Brimah	Fisherman			46	Cecilia Etobile	Fishmonger	
11	Nana Badu	Fisherman			47	Mary Arthur	Fishmonger	
12	Philip M Essuandor	Fisherman	0275186191		48	Abina Demah	Fishmonger	
13	Oaul Owusu Addo	Fisherman	0276321556		49	Anastasia Kwame	Fishmonger	
14	Edward Nobah	Farmer			50	Rose Nyameke	Fishmonger	
15	Adjei Francis	Teacher	0276865231		51	Elizabeth Annaman	Fishmopnger	
16	Esi Essoun	Fishmonger			52	Kofi Afful Nda	Driver	
17	Araba Abam	Fishmonger			53	Janet Achempong	Fishmoger	
18	Maame Bosomah	Fishmonger			54	J-B.T. Mozou	Head Teacher	0274201945
19	Esi Akyre	Fishmonger			55	Francis Cudjoe	Student	
20	Ernestina Abudu	Fishmoner			56	Kofi Bayina	fisherman	0276326645
21	Agnes Bayila	Fishmonger			57	Alexander Kolomziah	Driver	0272548851
22	Paulina Mensah	Fishmonger			58	Mr. Otoo	Fisherman	0271615146
23	Florence Cudjoe	Fishmonger			59	Ekow Bossomtwe	Fisherman	
24	Fatima Isa	Fishmonger			60	Mr. Otoo	Fisherman	0271615146
25	Mary serkum	Fishmonger			61	Ama Aworte	Fishmonger	
26	Margret Essuman	Fishmonger			62	Seth Kabenlachie	Student	
27	Agnes Kwame	Fishmonger			63	Nyame Douglash	Fisherman	0272240511
28	Ama Mansah	Fishmonger			64	Adjoa Mowimah	Fishmonger	
29	Ama Yorson	Fishmonger			65	Emma Acquah	Fishmonger	
30	Esi Abadaye	Fishmonger			66	Buah Gladys	Fishmonger	
31	Rebecca Egiri	Fishmonger	0272108234		67	Jennifer Assafuah	Fishmonger	
32	Albert Mensah	ZOIL	0272498632		68	Beatrice Armah	Fishmonger	
33	Nana Nmoah Ackah	Fisherman	0274369388		69	Philip Kwasi	Student	0244836751
34	Martin Kwasi	Teacher	0275332358		70	Kojo Pizalo	Farmer	
35	Kofi Amissah	Fisherman	0276192641		71	Maame Esi	Fishmonger	
36	John Akuban	Mechanic	0274801078		72	Adjoe Mansah	Fishmonger	
					73	Gloria Koomson	Fishmonger	0278996992

Beyin Consultations - Monday, 25th June, 2012

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Raphael Annaman	Fisherman	0242120371		40	Faustina Kesse	Fishmongers	
2	John E. Kwasi	Fisherman	0246052104		41	Ewia Annazie	Fishmongers	
3	Kojo Sam	Fisherman	0247788113		42	Maame Avlokyie	Fishmongers	
4	Sylvester Annaman	Fisherman	0241607332		43	Comfort Kwateng	Fishmongers	
5	Peter Enderson	Fisherman	0243460140		44	Victoria Ezuah	Fishmongers	0248201392
6	Thomas Boateng	Fisherman	0547667290		45	Faustina Kesse	Fishmongers	
7	Francis Armoo	Fisherman	0248556433		46	Sophia Mensah	Fishmongers	
8	Anthony Holena	Fisherman	0542816318		47	Martha Afful	Fishmongers	
9	Monica Edwuah	Fishmonger			48	Margret Kwofie	Fishmongers	0245310410
10	Florence Kwaminah	Fishmonger			49	Monica Annor	Fishmongers	0248030343
11	Paulina Deyine	Fishmonger			50	Akroma Enie	Fishmongers	
12	Stephen Ackah	Fisherman			51	Charlotte Kangah	Fishmongers	0542816317
13	Isaac Amihere	Fisherman	0543925911		52	Elizabeth Emakpole	Fishmongers	
14	Kwame Bonzulo	Fisherman			53	Sarah Mian	Fishmongers	0247564780
15	Albert Kulu	Fisherman	0248434996		54	Mayin Tamone	Fishmongers	
16	Francis Kulu	Fisherman	0241158758		55	Mary Abizi Nyameke	Fishmongers	0546887748
17	Justice Nyameke	Fisherman	0249839481		56	Elizabeth M Amuzua	Fishmongers	0248767703
18	Mr. John Kaku	Fisherman	0542484422		57	Elizabeth Kwofie	Fishmongers	
19	Kofi Mann	Fishmonger			58	Sophia Morkeh	Fishmongers	0247784131
20	Mary Benson	Fishmonger			59	Hannah Ackah	Fishmongers	
21	Agnes Kwaw Nunoo	Fishmonger			60	Mary Mensah	Fishmongers	
22	Agnes Aboagye	Fishmonger	0241302262		61	Maame Ama	Fishmongers	
23	Theresa Kokowah	Fishmonger			62	Ofori Nda Eke	Fishmongers	
24	Janet Blay	Fishmonger	0240475497		63	Theresa Mian	Fishmongers	
25	Veronica Quayson	Fishmonger			64	Sophia Bevele	Fishmongers	
26	Janet Blay	Fishmonger			65	Joyce Amakyie	Fishmongers	02459618110
27	Veronica Quayson	Fishmonger			66	Margret Dadzie	Fishmongers	
28	Mary Mensah	Fishmonger			67	Rebecca Nwia	Fishmongers	
29	Elizabeth Aboagye	Fishmonger			68	Justina Ebulley	Hairdressing	
30	Ewie Auila	Fishmonger			69	Ackah Abela	Fishmongers	
31	Cecilia Yaw	Fishmonger			70	Elizabeth Annaman	Fishmongers	
32	Essel Ebela				71	Anna Forjoe	Fishmongers	0545040198
33	Juliana Armoo		0547552932		72	Naclna Aku	Fishmongers	
34	Nyameke Bajoe				73	Elizabeth Amihere	Fishmongers	0245711493
35	Patricia Amanku		0240475493		74	Blay Miaza Emaa	Fishmongers	
36	Betty Enderson	Fishmongers	0248106831		75	Mary Brawn	Fishmongers	
37	Moro Ajala	Fishmongers	0547473816		76	Elizabeth Blay	Fishmongers	0245820114
38	Abole Ayaa	Fishmongers			77	Ackah Esi	Fishmongers	0543944332

39	Ezam Agiba	Fishmongers			78	Mary Dadzie	Fishmongers	0245772220

Benyilin Community

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Rendof Ofori	Fisherman	0542891255		19	Nyameke Kwaw	Fisherman	0241302297
2	John Ehwi Forjoe	Fisherman	0544472172		20	Kofi Buah	Fisherman	
3	Andrews Nobah	Fisherman			21	Egya Kwasi	Fisherman	0245335513
4	Prah Williams	Fisherman	0541063186		22	Ezua –Ackah Hoba	Fisherman	024047547
5	Alex Menyina	Fisherman	0544865796		23	Martin B Oholade	Fisherman	
6	Ebenezer Sampeni	Fisherman	0242108240		24	Edward Beyela	Fisherman	0542893022
7	James Cudjoe	Fisherman	0547473869		25	Evans Kpolley	Fisherman	0248483685
8	Matthew Eduah	Fisherman			26	Felix Cudjoe	Fisherman	0245006386
9	Dominic Annaman	Fisherman	0541157898		27	Emmanuel Emmuah	Fisherman	0241154559
10	George Kaku Buah	Fisherman	0542893022		28	Stephen Kwofie	Fisherman	0549595641
11	Kofi Boadu	Fisherman	024058010		29	Kinsley Boyeah	Fisherman	0247796042
12	Lawrence Nwiah	Fisherman	0207596137		30	Francis Tandoh	Fisherman	0244802650
13	Bernard Bonyah	Fisherman	0248435876		31	Kofi Nyameke	Fisherman	
14	Evans Ackah	Fisherman	0540834815		32	Francis Alu	Fisherman	
15	Thomas Ebulley	Fisherman	0241109763		33	James Kwasi	Fisherman	0241649340
16	Anthony Cobbinah	Fisherman	0548212655		34	Eric Tayi	Fisherman	
17	Augustine N. Ackah	Fisherman	0240668826		35	James Kwofie	Fisherman	0541157894
18	Bro. T Jean-Claude	Fisherman	0542776435					

Ngelekazo Community

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Bombo Enyina	Fishmongers			9	AsilieBusa	Fishmonger	
2	Lydia Ewuah	Fishmongers			10	Christina Tebah	Fishmonger	
3	Sarah Eyili	Fishmongers			11	Panyineyena Abekan	Fishmonger	
4	Kanga Nda	Fishmongers			12	Ediemu Mbike	Fishmonger	
5	Kalimoah Maame	Fishmongers			13	Sylvester Kaku	Fisherman	
6	Ezum K Kwaw	Fisherman			14	Ishmael Kangah	Fisherman	
7	Peter James Marphy	Fisherman			15	Francis Cudjoe	Fisherman	
8	Joseph Yankey	Fisherman	0207398669		16	Kojo Ezuam	Fisherman	0245964537

Elloin Community

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Samuel Ayepa	Fishmongers			7	Aza Kwasi	Fisherman	
2	Stephen Nwian	Fisherman	0266512983		8	Justice Yankey	Fisherman	
3	Dominic Armah	Fishmongers			9	Charles Kammah	Fisherman	0249028143
4	Vida Emakpole	Fishmongers			10	Luke Bandoe	Fisherman	0207762927
5	Constance Eyanku	Fishmongers	0203026316		11	Peter B Ackah	Fisherman	
6	Beatrice Quayson	Fishmongers	0246835020		12	Kaku Kojo	Fisherman	

Ekebaku Community

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Stephen Edde Aggaln	Fisherman	0245364189		3	Simon Bomo	Fisherman	0245542909
2	Kow Miezan	Fisherman	0248107354		4	Anna Mensah	Fishmongers	

Kegeni Community **Nzoliozu Community**

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Faustina Abarkom	Fishmongers			1	Lydia Nyameke	Fishmongers	

Keyian Community **Twenen Community**

No	Name	Occupation	Contact		No	Name	Occupation	Contact
1	Richard Ezuah	Fisherman	0241649072		1	Matthew Nwoley	Fisherman	0285414682

Appendix 6

Register of Issues from Community Consultations

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Compensation	What would be the compensation package for women since their livelihood would be affected just as how fishermen would also be impacted?	Agatha Arthur	Fish Monger
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Decommissioning	Where would the subsea materials be taken to after decommissioning? If outside the country, why don't the Government of Ghana request for these materials to be used in metal works/smelters or other industries in the country?	Andrew Nyameke	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Negative Impacts	What are the negative impacts of the oil production?	Mary Kenyah	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Community Benefits	What are the benefits to be experienced from this project?	Joseph Gyimah	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Employment	What employment opportunities are available to the local population, as some fishermen have sent through their job applications but have never received even acknowledgement of receipts from TGL?	Thomas Kabenla	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Community Benefits	TGL has not done anything for the Ankobra community even though promises were made during the Jubilee EIA.	Gifty Cobinnah	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Employment	All TGL employment issues are dealt with in Accra which puts the local population at a disadvantage when competing with Accra based job seekers.	Benjamin Yankey	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Request(s)	A request for the establishment of an ICT centre for the community was made.	Andrew Nyameke	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	TGL Scholarship	How can the community access the scholarships?	Mary Kenyah	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Oil Spill	In case of an oil spill, how will the fishermen be compensated and what programmes are in place as alternative livelihoods?	Francis Amihere:	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Alternative Livelihoods	What alternative livelihoods plan does TGL have in place for the community in case of an oil spill?	Francis Amihere:	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	Suggestion	TGL should set up subsidiary business entities or oil related businesses in the community. This would provide both direct and indirect job opportunities for the community members	Joseph Gyimah	Community Member
20-Mar-12	Village Meeting	Ellembelle	Ankobra	General Comment	The unemployment rate in the community was high, thus the youth need jobs and opportunities to further educate themselves and make a good living for themselves.	Gloria Obeng	Community Member
20-Mar-12	FGD: Fishermen	Ellembelle	Ankobra	Negative Impacts	Afraid of the negative impacts of the development. Nothing positive would come out of the development for the community.		Fisherman
20-Mar-12	FGD: Fishermen	Ellembelle	Ankobra	Seaweed/ Algae Invasion	Livelihood would be affected and there would waste disposal problems as well as sea weeds problems continues.		Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
20-Mar-12	FGD: Fishermen	Ellembelle	Ankobra	Alternative Livelihoods	Alternative livelihood in the form of aquaculture establishment to cushion the fishermen on the effect of declining stocks. Also establish a plantation for the community to manage.		Fisherman
20-Mar-12	FGD: Women	Ellembelle	Ankobra	Seaweed/ Algae Invasion	The seaweed are destroying our livelihoods.		Community Member
20-Mar-12	FGD: Women	Ellembelle	Ankobra	Suggestion	TGL should provide the community with a cold room where they can store fish, so that when there is huge decline in the fish catch, the community can continue to have fish.		Community Member
20-Mar-12	FGD: Women	Ellembelle	Ankobra	Community Benefits	What is TGL going to do for the community?		Community Member
20-Mar-12	FGD: Women	Ellembelle	Ankobra	Negative Impacts	The community is scared of the new project, Jubilee has already destroyed livelihoods and caused the sea weed, now TGL is planning another development.		Community Member
20-Mar-12	FGD: Women	Ellembelle	Ankobra	Support for Small Businesses	TGL should provide women with business loans at very low interest so that they can start new businesses or improve existing ones.		Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Farming	The oil activities at will affect on land farming activities. How does TGL plan to mitigate for these effects?	Safohene Fatoho	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Seaweed/ Algae Invasion	Can you tell us about the sea weeds and its potential effects?		Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Employment	How is the project going to benefit those who do not go to school?	Kofi Asare-Anderson:	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Community Benefits	How can TGL help the children of the fishermen? May be TGL can assist the local secondary technical schools by equipping them with science labs.	Joyce Toffay	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	General Comment	The first oil exhibition was held at Takoradi and not anywhere else in the Region, it should have been held across the affected districts.	Joyce Toffay	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Air Quality	We are told that the project is far in the sea and the gas may have consequent impacts on our health. What are you doing to mitigate the impact?	Moses Elakole	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Community Benefits	What is TGL doing to help polytechnics and universities from Ellembelle to upgrade their skills?	Ntiako Andoh	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Other	What has TGL learned from other oil and gas project in terms of impacts on society from around the world?	Ntiako Andoh	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Air Quality	We have heard that telecommunication masts emit some waves that cause cancer, surely the gas from the oil field will affect fishing stock and fishermen.	William Blay	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Other	In the presentation, its indicated that the TEN project is westwards towards Cote D'Ivoire. Is Cote D'vote not going to lay claim on it?	Matthew Miah	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Suggestion	Loan facilities should be given to women along with others living on the coast who are likely to be affected by the project.	John Nkrumah	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Community Benefits	The people of Nzema only have the sea as their livelihood, but now the oil companies come and take the oil and the communities do not see any benefits. We'd like to know our share of the revenue for the resources taken. The TV TGL gave us is no longer working.	Paul Archer	Community Member
21-Mar-12	Village Meeting	Ellembelle	Essiama 5	Community Benefits	What is the share of the Nzemas from the project when they cannot even pay their electricity bills. What are we going to benefit from the TEN project?	Isaac Mensah	Community Member
21-Mar-12	FGD: Women	Ellembelle	Essiama 5	Farming	The coconut plantations have been failing since the oil production has started.		Community Member
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5		Is this project different from TGL's Project [Jubilee]?		Community Member
22-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 6		How will the fishermen be affected?		Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5	Community Benefits	Benefits are not equally shared between the various districts and the coastal towns; the majority of benefits are given to the District capitals. TGL should increase the number of scholarships given and these should be given to people in all districts and specifically to people living in the coastal towns.		Community Member
22-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 6	General Comment	Why is the project called Tweneboa Enyenra Ntomme (TEN) The name has nothing to do with Nzema?		Community Member
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5	Issues related to CLOs	Who is the CLO's "we the community don't know him/her?"		Community Member
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5	Seaweed/ Algae Invasion	TGL should research the origins of this algae and the seaweeds that keeps on washing onshore.		Community Member
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5	Community Benefits	TGL is listening to the politicians regarding the distribution of benefits. TGL should not benefit any of the inland communities as they are not part of the affected communities - the focus should be on the coastal towns/ communities.		Community Member
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5	Other	Is it true that there is a dispute between Côte D'ivoire and Ghana about the ownership of the oil?		Community Member
21-Mar-12	FGD: Leaders and Men	Ellembelle	Essiama 5	General Comment	Unemployment is high in the community and the youths are struggling to make ends meet.		Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Community Benefits	What are the benefits of the project to the project affected people?		Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Seaweed/ Algae Invasion	People are illiterate and can only work at sea (fishing mainly). The algae bloom destroys their nets, can TGL address the algae problem.	Kelvin Nii-Blay	Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Alternative Livelihoods	Fishing is no longer a viable source of income, how else can the community survive?	Paul Aikins	Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Seaweed/ Algae Invasion	Fishing activities have been reduced by the presence of the algae bloom and the government has not offered to help neither has anyone else for that matter.	Abraham Mensah	Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Seaweed/ Algae Invasion	Algae bloom only started when oil and gas activities started, it was not there before. Marine specialists knew that this was a potential effect of the oil and gas activities but they did not notify the communities. Algae bloom has had a negative impact on the people.	James Nkumah	Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Other	TGL has a lot of money, they should bring more money or employ more people.	James Kudjoe	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Negative Impacts	The community appreciate TGL's efforts to improve schooling but how will they get the money to send children to school? For example, he has been living without an income for the past 4 months and has ran up a high debt from borrowing from his neighbours and friends. TGL activities are destroying livelihoods, TGL must do something about it.	Kojo Polley	Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Seaweed/ Algae Invasion	Used to another type of algae bloom. this one is dangerous. Fishermen are increasingly becoming thieves.	Isaac Mensah	Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Project Activities	Due to drilling activities rocks are being exposed and then destroying peoples nets.		Community Member
				Request(s)	TGL must provide fishermen with outboard motors to assist in pulling nets. Nzema could be control point for this activity. This is NB (outboard motor and canoe) for safety.		
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Suggestion	TGL need to establish a school dedicated to teaching fishermen's children only, this will enable children to receive good education and complete schooling.		Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Community Benefits	Schools that TGL is helping are already rich, fishermen will not benefit.		Community Member
21-Mar-12	FGD: Fishermen	Ellembelle	Essiama 5	Request(s)	TGL should assist with storage of fish by providing the community with cold rooms.		Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Oil Spill	What measures are in place deal oil spills and the dumping of waste oil by some tanker vessels offshore?	Kweku Bentum	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	Village Meeting	Ahanta West	Busua	Employment	The community was concerned that more foreigners are employed in the oil and gas sector than local people.	Kweku Bentum	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Safety Zone	The safety zone has reduced fishing grounds and also had also served as a refuge for the fishes thus the decline in fish catch.	Nana Kweku Nunoo	Chief Fisherman
21-Mar-12	Village Meeting	Ahanta West	Busua	ESIA Process	Complained about the fact that the BIDs were not received by the community early enough for members to discuss the information before the meeting. He suggest the BIDs should be sent early enough whenever another meeting was to organised.	Nana Apenteng	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Harassment of Fishermen	Concerns over the growing number of fishermen being harassed by the Ghanaian Navy when they get too close to the FPSO is on an increase.	Nana Apenteng	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Other	What percentage of the project is ownership by the Government of Ghana?	Albert Agbenu-Heve	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Community Benefits	What are the oil companies doing to improve the livelihoods of the people living in coastal communities, more specifically people of Busua?	Albert Agbenu-Heve	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Request(s)	Request was made regarding the renovation of local schools including learning aids and computer laboratories.	Albert Agbenu-Heve	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	Village Meeting	Ahanta West	Busua	Request(s)	Request for the provision of portable water supply since the community is in dire need of a portable water supply.	Albert Agbenu-Heve	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	TGL Scholarship	Request was made to reiterate the information about the TGL educational scholarship and how the community could benefit from it?	Osofo Elizabeth Enim	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Community Benefits	How will the local people benefit from the project?	Osofo Elizabeth Enim	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Issues related to CLOs	Complain was raised about the absence of the Community Liaison Officer (CLO) at post. Some people have visited the CLOs office on many occasions but CLO was not present.	Joseph Arthur	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Fisheries Resources	Fears that within the next five years there will be no fish in the sea. Should this happen how is TGL going to address this issue? A suggestion was made that TGL should compensate fishermen.	MCA Bentum	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Other	The sea defences at the Busua beach are deteriorating fast and if not fixed Busua settlement will be lost to sand erosion. Can TGL assist the community with this problem?	William Kwesi Bentum	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Oil Spill	An oil spill will have a great effect on tourism in the area as most tourists who visit the area come to the area to enjoy the beach. A suggestion was made that TGL needs an effective oil spill contingency plan for the community that will also ensure maximum use of the local community in clean up operations.	William Kwesi Bentum	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	Village Meeting	Ahanta West	Busua	Employment	In terms of employment, no one from the community has been employed by TGL and as such TGL had not done enough to improve the community's livelihood. What will TGL planning to do to improve the community's livelihood?	Abusuapanyin Bediako	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Compensation	A community member demanded that the community should be compensated for coming to the meeting, as some of the community members had neglected all their duties for the day to attend the meeting and would be disappointed if they were not compensated for their time or at least be provided with refreshment.	Dorcas Bentum	Community Member
21-Mar-12	Village Meeting	Ahanta West	Busua	Oil Spill	In the event of an oil spill the livelihood of the whole community would be negatively affected. Fishermen would be most affected but since fishermen play an important role in the economics of the community, the whole community will suffer. TGL would have to develop a comprehensive livelihood restoration programme now and this will have to be done In consultation with the affected communities.	J.C. Kwofie	Assemblyman
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Seaweed/ Algae Invasion	Algae bloom is caused by the oil activities.		Fishermen
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Compensation	TGL should compensate fishermen for the decline in the fish catch as they are not allowed to fish in safety zone where all the fish are stationed.		Fishermen
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Alternative Livelihoods	TGL should assist fishermen in finding alternative livelihoods as in 10 years time there will be no fish in the sea.		Fishermen

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Project Activities	The service boats destroy fishing nets and generally disturb smaller canoes.		Fishermen
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Fishing Issues	The decline in fish catch is not only caused by the oil activities but also by the use of illegal fishing methods used by some of the fishermen.		Fishermen
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Issues Related to Jubilee	TGL should honour promises made during the Jubilee EIA in terms of employment and provision of scholarships for their children.		Fishermen
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Request(s)	Can TGL help the fishermen to acquire fishing gears and purchase premix fuel?		Fishermen
21-Mar-12	FGD: Fishermen	Ahanta West	Busua	Request(s)	Can the oil companies help in cleaning up the beaches, the current cleaning companies do not pay their workers well as such the cleaners do not clean usually clean the beaches. May be the oil companies can finance these activities.		Fishermen
21-Mar-12	FGD: Women	Ahanta West	Busua	Issues Related to Jubilee	The prospect of another oil and gas projects is scary as Jubilee has led to many problems.		Community Member
21-Mar-12	FGD: Women	Ahanta West	Busua	Fisheries Resources	The project will lead to a decline in fish stock.		Community Member
21-Mar-12	FGD: Women	Ahanta West	Busua	Other	The idea of cumulative impact is also a big worry, how will they cope.		Community Member
21-Mar-12	FGD: Women	Ahanta West	Busua	Issues Related to Jubilee	Jubilee is the main cause of all the problems experienced now, seaweeds, low fish catch and poverty in the community.		Community Member
21-Mar-12	FGD: Women	Ahanta West	Busua	Suggestion	TGL should build a University in the Region.		Community Member
21-Mar-12	FGD: Women	Ahanta West	Busua	Other	Some of the children have been encouraged to go to school ever since the discovery of oil as they would like to work for TGL one day.		Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Mar-12	FGD: Women	Ahanta West	Busua	Request(s)	Can TGL provide a cold room which can be used to store fish?		Community Member
21-Mar-12	FGD: Women	Ahanta West	Busua	Support for Small Businesses	Women need to start new businesses and need financial support and training.		Community Member
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Seaweed/ Algae Invasion	Ever since the oil production started there has been an invasion of sea weeds and a sharp decline in fish catch. These issues have led to the decline in income levels in the community. TGL needs to investigate the causes of the sea weed.	Justice Abban	Chief Fisherman
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Request(s)	The community needs TGL to support the education system by providing teaching and learning aids, qualified and experienced teachers.	Justice Abban	Chief Fisherman
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Seaweed/ Algae Invasion	Fishermen who go in small pelagic and even large pelagic such as Tuna usually return with sea weed entangled in their fishing nets and thus making their fishing expedition fruitless and very expensive (fuel and supplies are wasted).	Albert Eshun	Community Member
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Community Benefits	The community has not seen any benefits from the oil production. Currently there is no electricity and only one borehole provides the community with portable water.	Phillip Quayson	Community Member
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Oil Spill	Oil production is a contributing factor to the decline in fish catch. In terms of Corporate Social Responsibility (CSR), what is TGL was doing to restore the livelihood of the community since the oil production had negatively affected their livelihood?	Jake McCummings	Volunteer
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Oil Spill	Is TGL prepared to deal with oil spills and its potential consequences?	Jake McCummings	Volunteer

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
22-Mar-12	Village Meeting	Ahanta West	Cape Three Point	Community Benefits	The community had not benefited from the Jubilee production and as such some members of the community are disappointed. The community will not attend anymore meetings (consultations) if they do not receive any benefits soon.	Sabina Quayson	Community Member
22-Mar-12	FGD: Leaders and Men	Ahanta West	Cape Three Point	Issues Related to Jubilee	Jubilee has affected the community negatively causing a decline in fish, it also caused the seaweed issues which has affected the activities of fishermen.		Community Member
22-Mar-12	FGD: Women	Ahanta West	Cape Three Point	Issues Related to Jubilee	The community had high expectations during Jubilee and made main plans but nothing happened, they were deceived. Hopefully, this project will provide better for the people.		Community Member
22-Mar-12	FGD: Women	Ahanta West	Cape Three Point	Community Benefits	The community is not expecting to benefits from this project.		Community Member
22-Mar-12	FGD: Women	Ahanta West	Cape Three Point	Issues Related to Jubilee	The community was promised a health facility but it has not been built.		Community Member
22-Mar-12	FGD: Women	Ahanta West	Cape Three Point	Farming	Coconut palms have softened from the discovery of oil – there is a particular heat coming from the ground which is killing the roots of crops.		Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Employment	The fish catch has declined TGL should create some jobs for the local people so that they can earn some money.	Boahema Awuhia	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Seaweed/ Algae Invasion	The sea-weed affect has been caused by the presence of the project and it affects everyone who does drag net fishing.	Sulemana Adama	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Suggestion	TGL must at least employ 5 people from each community along the coasts. The scholarship process should be made more transparent. and lastly TGL should give business loans to women so that they can start up new businesses.	Anthony Ackah	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Other	The Nzemas are going to face more hardships because of mining activities on the land and oil and gas projects at the sea especially because of restrictions as a result of the project.	James Mia	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Seaweed/ Algae Invasion	The sea weed is really disturbing our fishing activities so do more to help our children.	Kooley	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Safety Zone	Why cant fishermen fish in the safety zone?	Mary Nketsiah	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	TGL Scholarship	Please tell us more about the scholarship?	Mary Nketsiah	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Other	TGL has put notices on the lagoon preventing people from cutting trees. Why?	John Mensah	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Other	Adamus' presence resulted in high rent charges. Now TGL has come. The indigenes do not have access to employment in these companies. What is the government doing to control rent charges?	Raphael Ackah	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	TGL Scholarship	There are many who have not been to school but are intelligent. What is the company doing about them? Organise training programmes for JHS graduates.	Raphael Ackah	Community Member
22-Mar-12	Village Meeting	Ellembelle	Azulenloanu 6	Other	Loans should be given to women to facilitate their small businesses.	Raphael Ackah	Community Member
22-Mar-12	FGD: Fishermen	Ellembelle	Azulenloanu 6	Safety Zone	Demarcate the safety zone clearly with buoys so that fishermen will not enter the area.		Fisherman
22-Mar-12	FGD: Fishermen	Ellembelle	Azulenloanu 6	Suggestion	Facilitate communication offshore by using frequencies/communication gadget that can be accessed by fishermen in distress.		Fisherman
22-Mar-12	FGD: Fishermen	Ellembelle	Azulenloanu 6	Request(s)	TGL must provide financial support to the fisher folks.		Fisherman
22-Mar-12	FGD: Fishermen	Ellembelle	Azulenloanu 6	Alternative Livelihoods	TGL must introduce APLs in the fishing communities.		Fisherman
22-Mar-12	FGD: Women	Ellembelle	Azulenloanu 6	Fisheries Resources	TEN will affect the fish catch like Jubilee did.		Community Member
22-Mar-12		Ellembelle	Azulenloanu 6	Fisheries Resources	Worried about the declining fish catch, the community's children are the ones suffering.		Community Member
22-Mar-12		Ellembelle	Azulenloanu 6	Support for Small Businesses	Can TGL provide women with a cold room where they can store fish to sell when the catch is low?		Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Issues Related to Jubilee	During the Jubilee EIA, certain recommendations and mitigation measures were made but most of them had not been implemented. The EPA should have accompanied the team during this TEN development ESIA to ascertain the extent to which the recommendations had been met and if not sanctions applied. Ever since the Jubilee field started operation, the operators had not addressed most concerns raised during the Jubilee EIA and now the livelihood of the fishermen and the whole community was at risk if not destroyed.	Michael Nokoe	Community Member
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Seaweed/ Algae Invasion	The sea weeds gets entangled the nets of the fishermen (canoe and Inshore Tuna vessels) thus rendering the net incapable of fish catch. The weeds eventually deposit on the beaches making the shoreline very dirty and smelly. A suggestion was made that an investigation should be conducted to find out the cause of the proliferation of sea weeds.	Michael Nokoe	Community Member
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Negative Impacts	A concern was raised that some negative effects have been observed in oil producing countries like Nigeria and that there is a likelihood that these can occur in Ghana.	Francis K. B. Eshun	Community Member
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Harassment of Fishermen	The fishermen are harassed by the Ghana Navy when they get close to the FPSO's safety zone, they get their net seized and sometimes get assaulted by the navy personnel.	Francis K. B. Eshun	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Fishing Equipment	The increase in vessel movement which tends to destroy their nets. The government and the oil companies to institute schemes to improve upon their livelihood. The scheme could also assist in subsidising fishing gears and premix fuel. This would enable the fishermen to acquire these gears and fuel at a cheaper rate. Provision of a landing beach and a fishing harbour would promote the fishing activities in the community.	Francis K. B. Eshun	Community Member
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Safety Zone	In order to prevent further confrontations between the fishermen and the Ghana Navy that the safety zone should be clearly demarcation around the FPSO. The demarcation would help in warning/alerting the fishermen when they get close to the FPSO since they are sometimes caught up in strong ocean currents which drags them to the safety zone.	John Afedzi	Community Member
23-Mar-12	Village Meeting	Nzema East	Lower Axim	Suggestion	A suggestion was made that TGL should allow fishing near the FPSO at certain times (opening and closing times). Fishermen should be allowed to fish around the FPSO for some months (2) each during the major and minor fishing season. The fishermen would not bother to come close the FPSO outside these agreed times.	John Afedzi	Community Member
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Other	Positively, more revenue for the government for developments. Negatively, affect the livelihood of fishermen by hampering fishing activities.		Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Suggestion	TGL should suspend operations at the FPSO for 4 months (July, Aug and Sept and December) during the major fishing season so that the fishermen can fish around the FPSO. In return, the fishermen would stay away from the FPSO. This will help the fishermen get bumper harvest at the same time avoid getting close to the FPSO.		Fisherman
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Request(s)	TGL and the Jubilee partners can offer fishing gears to the fishermen at subsidized rate. Also improve facilities at landing sites such as cold storage room.		Fisherman
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Suggestion	TGL should build a fishing port at Axim.		Fisherman
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Harassment of Fishermen	The harassment of fishermen by the Ghana Navy needs to stop. The Navy in collaboration with TGL could rather regulate the fishermen activities at the FPSO.		Fisherman
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Suggestion	TGL and Jubilee Partners can facilitate loan acquisition by fishermen from banks.		Fisherman
23-Mar-12	FGD: Fishermen	Nzema East	Lower Axim	Issues Related to Jubilee	Promises made during the Jubilee EIA had not been met such as establishment of a landing site/fishing port Axim, fishermen welfare fund to take care of fishermen. Would these promises ever materialize?		Fisherman
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Employment	What is TGL doing to employ the youth in these communities?	Charles Kow Agye	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Community Benefits	What measures is TGL putting in place to resource the community clinic and to upgrade roads?	Simon Archer	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	ESIA Process	Are these meetings and focus group discussions not a waste of time?	Simon Archer	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	Village Meeting	Ahanta West	Princess Town	ESIA Process	The oil activities have destroyed the community's livelihood. TGL should come to our aid or else the community will not attend any of your meetings again.	Samuel Tanoh	Chief Fisherman
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Other	Where is the oil being refined? We are only experiencing the negative impacts and know nothing else about the project.	Godfred Coffie	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Negative Impacts	People were sent to understudy oil production in other countries in order to understand the positive and negative impacts of these activities. But this did not happen in Ghana and now we are experiencing the cough, headache and other ailments due to the oil production.	Peter Eshun	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Seaweed/ Algae Invasion	The coast is being invaded by the sea weed, TGL should employ people from the local communities to keep the beaches clean.	Joseph Mensah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Negative Impacts	People living on the coast will die soon, especially the small children due to the oil and gas exploration and production activities. The communities need medical examinations because of this.	Joe Kwesi Mensah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Employment	The community has some smart people, but no one from this community has been employed by TGL.	Joe Kwesi Mensah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Community Benefits	Western Region has made Ghana what it is now., however, people from this Region are neglected and never see any benefits, jobs are promised but nothing materialises. TGL should be transparent and make sure that the communities receive the necessary benefits.	Joseph Ackah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	General Comment	What names have you given to the oil wells?	Amissiade	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Negative Impacts	The community does not have any water sources, some of the boreholes have traces of rust in the water and it is due to the oil.	Kofi Quao	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Air Quality	The air has been polluted greatly and TGL has to provide the community with health facilities.	Nana Abban	Development Chief
23-Mar-12	Village Meeting	Ahanta West	Princess Town	TGL Scholarship	Scholarship should be provided for the community.	Nana Abban	Development Chief
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Fisheries Resources	The oil project has destroyed fishing business and has brought about hardship to the community.	Lucy Eshun	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Seaweed/ Algae Invasion	The effect of the seaweed has a ripple effect on the community.	Cecilia Mensah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	Community Benefits	Sampson Quarcoe: What benefit are we deriving from the oil and gas?	Sampson Quarcoe	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Town	TGL Scholarship	These scholarships would not benefit those of us on the coast.	Cecilia Mensah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Safety Zone	All fishermen who undertake shark fishing go to deep waters and when they cast their nets the currents sometimes drifts them towards the FPSO. What should they do under the circumstances?	P K Ephraim	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Harassment of Fishermen	The navy personnel beat fishermen who drift towards the FPSO, seize their nets and the fishermen have to pay up to GHC 2,000 for the release of their nets.	P K Ephraim	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Fishing Issues	Will the fishermen be allowed to continue with their fishing activities after the second FPSO has been installed?	Theresa Yankey	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Seaweed/ Algae Invasion	What are the cumulative effect of the project on sea weeds?	Martin Arthur	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Seaweed/ Algae Invasion	The sea weeds disturb those who undertake net fishing at deep waters.	Isaac Kwanteh	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Seaweed/ Algae Invasion	Is the seaweed going to be here forever or is it going to stop at some time?	Tei Sapoli	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Seaweed/ Algae Invasion	Are the seaweeds likely to bring diseases to the people and if so, what is TGL planning to help the community?	Isaac Fynn	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Marine Ecology	What are the likely cumulative impacts of the oil activities at sea?	Anthony Gokeh	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Suggestion	TGL need to liaise with Ghana Rubber Estates Ltd (GREL) to expand their rubber operations in the Region thus creating more employment opportunities for the local communities.	David Doku	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	General Comment	Women in the community are suffering as fishing stocks have declined and their farm lands are being taken over by GREL.	Abiba Nyame	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Employment	What types of jobs are available for the fishermen as the fishing industry is slowly declining?	Margaret Mensah	Community Member
23-Mar-12	Village Meeting	Ahanta West	Princess Akitekyi	Community Benefits	TGL should establish Alternative Livelihood Program/ Scheme which will provide people with loans to start up new businesses.	Peter Nyamebekyere	Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Negative Impacts	The TEN fields should not be developed because of the negative effects the community is facing as a result of oil production from Jubilee field. These negative effects include decline in fish catch and the sea weeds invasion all of which affect their livelihood.	Francis Bondzie	Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	EPA	The chief described Jubilee production as TGL Number One (TNO). During TNO EIA, lots of promises were made but none of those promises have been honoured especially those made to fishermen. As part of this consultation process the community expected the EPA, GNPC and the Sector Ministry to be present at these meetings or organise a separate consultation to find out the extent at which TGL had institute recommendations and mitigation measures from the TNO EIA. But to date no such meetings have been held by/ either the authorities, instead, another EIA is being undertaken for TGL Number Two (TNT). The community is disappointed.	Nana Kofi Annan	Chief Fisherman
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Other	Sometime ago, some officials of TGL during a previous consultation meeting told the fishermen that the sea does not belong to anyone so should not act as victims and they should stop making demands. This comment was not well received by the fishermen as all fishing communities along the coast are the first point of contact in the event of an oil spill or any other accident.	Nana Kofi Annan	Chief Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Seaweed/ Algae Invasion	The sea weed invasion is caused by Jubilee operations. The sea weeds were hampering fishing operations since the weeds get entangled in the nets thus no fish can be caught. The sea weeds that get washed ashore tend to make the beach very dirty and smelly; this could pose a health risk to the community. The fishermen are not able to get enough fish to sell as a result they are not able to pay back loans and as such its negative rippling effects on their livelihoods.	Nana Kofi Annan	Chief Fisherman
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Community Benefits	TGL should do more to improve the livelihood of fishing communities.	Nana Kofi Annan	Chief Fisherman
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Lack of Continuous Engagement	There is a general lack of continuous consultations between the fishermen and other oil companies and wished the other companies would also engage with the fishermen. The other operators could also get involve in providing and improving the livelihood of the fishermen.	Nana Kofi Annan	Chief Fisherman
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Other	TGL was cautioned that if nothing is done about the concerns raised at this meeting, fishermen will stop attending any and all meetings organised by TGL or any other oil operator.	Nana Kofi Annan and Emmanuel Ackah	Chief Fisherman and Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Issues Related to Jubilee	Now that the negative impacts of the Jubilee are visible and present, how can the fishermen consult/ communicate with TGL or any of the operators?	Nana Kofi Annan	Chief Fisherman
24-Mar-12	Village Meeting	Nzema East	Upper Axim	ESIA Process	Is the record of this consultation process going to be made public or is it going to be kept internally at TGL?	Nana Kofi Annan	Chief Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
24-Mar-12	Village Meeting	Nzema East	Upper Axim	TGL Scholarship	The community recognises the importance of education but the inability of the fishermen to educate their children was on the rise due to the poor fish catch. A suggestion was made that TGL should establish of an education scholarship scheme for children of fishermen.	Kingsford Abaka	Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Employment	Promises made during the Jubilee EIA had not being honoured especially in the area of employment. Currently, there is high rate of unemployment among the youth in the fishing communities. The youth need jobs from TGL, other operators and Government.	Comfort Yankey	Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Request(s)	The women in the community need some form of skills training in order to secure some employment and earn a living. Training in soap making, dressmaking (the and dye), hairdressing etc would be much appreciated.	Mercy Quequ	Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Harassment of Fishermen	The Ghana Navy personnel are harassing fishermen when they get close to the FPSO. Their fishing nets are seized, get beaten and pay huge sums of money to get the net released back to them or sometimes the nets are destroyed. The Navy cannot continue doing this since there is no visible demarcation around the FPSO showing the safety zone. A suggestion was made that TGL make use of buoys and reflecting nets to clearly mark the safety zone around the FPSO.	Francis Annoh	Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Request(s)	There is a general lack of sanitation and waste management facilities in the area. TGL should support the community by providing toilets and rubbish bins.	Joseph Kenyah	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Suggestion	Regarding the issue of training a suggestion was made that fishermen could be trained in the use of modern fishing gears and methods, thereby modernising the age old fishing practices they were used to.		Community Member
24-Mar-12	Village Meeting	Nzema East	Upper Axim	Request(s)	The community does not have a hospital, can TGL assist the community by building a fully equiped hospital with fast acting medication and state of the art medical equipment?	Nana Kofi Annan	Chief Fisherman
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Fisheries Resources	The rig attracts all fishes and will lead to low catch in fishing. The fishing industry is already running at a loss.		Community Member
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Seaweed/ Algae Invasion	The presence of sea weed is believed to have resulted from oil production in the sea. The weeds are affecting the dragnet business.		Fisherman
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Seaweed/ Algae Invasion	Fishermen get irritated and frustrated when they return to shore with sea weeds instead of fish. This is attributed to the problem caused by the oil activities since they had not witnessed this kind of sea weed invasion before.		Fisherman
24-Mar-12	FGD: Leaders and Men	Nzema East	Upper Axim	Seaweed/ Algae Invasion	TGL and the Government must fight the seaweed. An NGO call Our Coastal Resource (an NGO operating in the Western Region) told the community that the presence of the seaweed is due to the oil and gas activities. According to the NGO, TGL knew that the oil activities would cause the seaweed thus they stared Zoil.		Elder

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Seaweed/ Algae Invasion	The workers on the FPSO are the main architect of the sea weed issue. Some fishermen have seen workers of the FPSO clearing/scraping off weeds from the FPSO. The weeds then drift off and get entangled in fishing nets and or settle on the shores/beaches.		Fisherman
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	TGL Scholarship	TGL had promised to give scholarship to fishermen's children during the Jubilee EIA.		Fisherman
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Request(s)	The local hospital has had no doctor for 8 years, there is a general lack of medicines and equipment. Can TGL assist in upgrading the hospital and providing for a doctor.		Fisherman
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Alternative Livelihoods	Fishermen should be provided with alternative livelihood just in case the fishing industry collapses as a result of the oil activities.		Fisherman
24-Mar-12	FGD: Fishermen	Nzema East	Upper Axim	Fishing Equipment	TGL and the Government should supply to the fishermen fishing gears at a subsidized rate.		Fisherman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Seaweed/ Algae Invasion	Fishermen are affected by the sea weeds.	Williams Kainyah	Community Member
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Support for Small Businesses	TGL and the government should assist unemployed women with loans.		Community Member
24-Mar-12	Village Meeting	Ahanta West	Engyembra	General Comment	None of the companies that come to the community ever keep their promises.	Albert Aakon	Community Member
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Seaweed/ Algae Invasion	There never used to be any sea weeds on our beaches before, but now its everywhere. Some people try to clean it up but it's a big job, government should step in and help with the cleaning up operations.	Francis Graham	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Request(s)	The District Authorities are always sidelining the community of Engyembra. Currently, there are not enough classrooms at the school and approximately 80 pupils per class. TGL should assist the community by building them more classrooms at the school.	James Ackah	Community Member
24-Mar-12	Village Meeting	Ahanta West	Engyembra	ESIA Process	Who should we consult if we need more information or clarification regarding the project?	Hon. Cudjoe	Assemblyman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Community Benefits	Taxes will be paid to the government, what benefits will the coastal areas derive?	Hon. Cudjoe	Assemblyman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Safety Zone	The FPSO has a safety zone – what compensation is there for fishermen who cannot fish in the safety zone.	Hon. Cudjoe	Assemblyman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Negative Impacts	The project may affect the local rivers thus affecting the community's water sources (boreholes)?	Hon. Cudjoe	Assemblyman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Other	When taxes are collected, where do they go?	Hon. Cudjoe	Assemblyman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Request(s)	The local road is very important to the community, can TGL assist in its maintenance?	Hon. Cudjoe	Assemblyman
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Employment	Most workers required for the FPSO are skilled, but because Ghana does not have resources, most of the employees are expats.	Anthony Nyamebeye	Community Member
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Farming	There are rumours going around that the oil activities will/ are affecting coconut trees. How true is this and how is TGL going to help affected farmers?	Patricia Kwame	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Other	Most of the resources in Ghana are from the Western region, but we are neglected in everything. What is the plan of government for the revenue it is deriving?	James Ackah	Community Member
24-Mar-12	Village Meeting	Ahanta West	Engyembra	Health Concerns	The people on the FPSO wear gas masks but the communities have not been provided with any.	James Ackah	Community Member
24-Mar-12	FGD: Women	Ahanta West	Engyembra	Request(s)	1The community's immediate needs are jobs, CHP compound improvements– esp. in terms of equipment and human resources, accommodation for teachers, road network and potable drinking water		Community Member
24-Mar-12	FGD: Women	Ahanta West	Engyembra	Community Benefits	The community has not benefited from the oil production activities.		Community Member
24-Mar-12	FGD: Women	Ahanta West	Engyembra	Seaweed/ Algae Invasion	Because of weeds, men do not get the catch they should. It is difficult to take care of the children and of ourselves.		Community Member
24-Mar-12	FGD: Women	Ahanta West	Engyembra	Health Concerns	The community believes that the sea weed can cause chronic diseases.		Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Safety Zone	The safety zone around the FPSO is limiting the fishing area of the fishermen. At certain times of the year, the fishes move around and could be located in and around the FPSO. What are fishermen suppose to do?	Mr Abaka	Secretary to the Chief
26-Mar-12	Village Meeting	Shama	Aboaze	Other	There are rumours that the Ivory Coast is contesting Ghanaian oil find and want Ghana to share the Jubilee find with them.	Sulemana Kofi Anum	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Other	Since the oil production would last for 25 years, does this means that there would be no more oil after this number of years.	Mohammed Osman	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Air Quality	What are the health effect of the air emission from the rig and FPSO?	CPOI (Rtd) Bentum	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Aboaze	Compensation	The support and service vessels as well as some fishing vessels destroying fishing nets. TGL should institute a mechanism to force such vessels to pay compensation for damaged nets.	Theophilus Sam and Kwame Tawia	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Negative Impacts	The oil activities are negatively impacting on the livelihood of the community. The fish catch had declined over the years and this had affected the activities of fishmongers and sellers. This situation is having a negative rippling effect in the community. Less income in homes, children are not able to go to school because parents cannot pay school fees and general case of hardship.	Benjamin Dadzie	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Fishing Equipment	The government should help by providing for the fishermen an opportunity to acquire fishing gears at a subsidized rate.	Martin Baidoo	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	TGL Scholarship	The government and TGL should institute a scholarship scheme for basic education (JHS) and secondary education (SHS) of wards of fishermen	Aba Asefoaba	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Negative Impacts	Since wells would be drilled at the bottom of the sea, could there be a situation whereby fishermen could be trapped in them?	Grace Cobbinah	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Employment	TGL should be clear with it employment policy since TGL is not employing locals but rather employ foreigners and outsiders even for menial jobs.	Godfred Oduro	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Community Benefits	There has been no programme instituted by TGL in the community to restore or improve livelihood of the fisher folk and the community at large.	Theophilus Amarh	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Aboaze	Other	Ghana is now an oil producer yet fuel prices are on the increase and would like to know why?	Andrew Ayew Kumah	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Issues Related to Jubilee	Promises made for Jubilee have not been fulfilled. The failure of TGL in implementing recommendations from Jubilee have led to the current negative impacts such as the invasion of seaweed, decline in fish catch, high unemployment in local communities, and other effects. He however suggested that the EPA should either be part of this consultation or organise an independent assessment of the extent to which Jubilee recommendations had been met. EPA could have used this opportunity to sensitize the community on environmental issues and the state of the environment per their independent report instead of receiving report from the oil companies.	Joseph Ackon	Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	EPA	A suggestion was made that the EPA should either be part of this consultation or organise an independent assessment of the extent to which Jubilee recommendations had been met. The EPA could have used this opportunity to sensitize the community on environmental issues and the state of the environment per their independent report instead of receiving report from the oil companies.		Community Member
26-Mar-12	Village Meeting	Shama	Aboaze	Other	The fishing industry plays an importance role in the Ghanaian economy as such measure need to be put in place to protect and improve the fishing industry.	Nana Adam	Chief Fisherman
26-Mar-12	Village Meeting	Shama	Aboaze		TGL is “hiding” the other oil companies and is always taking lead in all consultations. Other oil companies involved should also be visible like TGL.	Nana Adam	Chief Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Aboaze	Community Benefits	The Regatta organised by TGL is not enough to improve the livelihood conditions of the community. TGL needs to do more to improve the livelihood of the people.	Nana Adam	Chief Fisherman
26-Mar-12	Village Meeting	Shama	Aboaze	Safety Zone	The safety zone around the FPSO has not been visibly demarcated; this is main reason for confrontation between the security (Navy) and the fishermen. If the zone is clearly demarcated with buoys, ropes and nets, the fishermen would not have any excuse to drift into the zone.	Nana Adam	Chief Fisherman
26-Mar-12	Village Meeting	Shama	Aboaze	Harassment of Fishermen	Harassments by the Ghana Navy should stop. The Navy sometimes beat up fishermen who drift into the zone and seize their nets. The nets are only returned once the fishermen have paid the navy personnel a huge sum which most of them cannot even afford.	Nana Adam	Chief Fisherman
26-Mar-12	Village Meeting	Shama	Aboaze	Ballast Water	The disposal of ballast water in Ghanaian waters by support and service vessels need to be addressed adequately in the EIA. This might be a serious problem when the vessel traffic increases in our waters due to the new TEN production.	Nana Adam	Chief Fisherman
26-Mar-12	Village Meeting	Shama	Aboaze	Request(s)	Request for financial assistance to help fishmongers operate efficiently. The financial assistance would be used to modernise their operation and increase the capacity of their ovens.	Nana Konkohemaa	Queen Fish Monger

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Aboaze	Other	Two or three years ago, there was a chemical pollution by the West African Gas Pipeline Company (WAGPCo) which killed dozens of fish. The community upon seeing dead fishes on the beaches they collected and ate them. This resulted in a major case of food poisoning with lots of the community members admitted and treated at the VRA hospital. When investigation revealed that WAGPCo were responsible, they were asked to clean up the mess, put in mitigation measures including regular monitoring and compensate affected individuals and the community as a whole. WAGPCo adhered to all the recommendation and built for the community hall.	Nana Attom III	Chief of Aboadze
26-Mar-12	Village Meeting	Shama	Aboaze	Issues related to CLOs	The CLO is not following protocol when it comes to the dissemination of information in the community, and neglects to consult the Chief first. Point in question, the Chief just heard about the TGL scholarship scheme but notices had been posted in the community without his knowledge and authorisation. The Chief advised that in the future the CLO to always channel information through his office so that he could be better positioned to offer any help.	Nana Attom III	Chief of Aboadze
26-Mar-12	Village Meeting	Shama	Aboaze	Issues Related to Jubilee	Issues and concerns that were listed during the Jubilee EIA have not been addressed especially issues with employment and improvement in livelihood of the community. All these are the main issues affecting the community and if these are not addressed people from Aboadze will not attend any more consultation meetings.	Nana Attom III	Chief of Aboadze

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	FGD: Women	Shama	Aboaze	Request(s)	TGL can assist the community by providing them with financial assistance to start up businesses, provide training in salt mining skills, improve toile facilities, renovate the local market and provide employment for the local youths.		Community Member
26-Mar-12	FGD: Women	Shama	Aboaze	Negative Impacts	Jubilee had negatively affected the community's livelihood especially women as they head most households, TEN will do the same.		Community Member
	FGD: Fishermen	Shama	Aboaze	Negative Impacts	The oil industry will reduce fishing activities and the quantity of fish catch.		Community Member
	FGD: Fishermen	Shama	Aboaze	Fishing Equipment	Can TGl assist the traditional fishermen in acquiring outboard motors to enhance fishing activities.		Community Member
	FGD: Fishermen	Shama	Aboaze	Fisheries Resources	The involvement of the elite class has pushed up prices of fishing inputs. They came with big vessels and take the remaining fish.		Community Member
	FGD: Fishermen	Shama	Aboaze	Fisheries Resources	The elite have taken over fishing in the area using trawlers and unapproved methods including light fishing, use of carbide, DDT, and dynamite.		Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Request(s)	The best way for TGL to assist the community will be to give loans to the fishermen, provide them with outboard motors and a cold room to store fish.		Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Harassment of Fishermen	The community is facing challenges with the navy near the safety zone. How TGL going to address this issue?		Chief Fisherman
26-Mar-12	Village Meeting	Shama	Shama Apo	Seaweed/ Algae Invasion	The sea is the community's main source of livelihoods, but now the fish catch has declined and the algae bloom is everywhere.	Bismark Annan	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Shama Apo	Fishing Equipment	If the fishing nets get entangled with the FPSO and the nets destroyed will the fishermen be compensated for this?	John Arthur	Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Compensation	People depend on the farmlands and cocoa oil palm for food. If the government wants to do anything on land, they always pay compensation. What is the compensation for the loss of fishing space due to the presence of the FPSO?	Samuel Bassel	Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Harassment of Fishermen	Fishermen face a challenges with the navy as the seize nets and beat them up.	Samuel Bassel and Albert Abaka and Egya Ansaku	Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Safety Zone	Fishermen should be allowed to go fish in the safety zone like in Cote D'Ivoire fishermen are allowed to fish in the safety zone. The lights from the FPSO attract fish from 20 km away.	Egya Ansaku and Nana Enu Bassa	Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Request(s)	Can TGL improve the standard of our health facility and possible build a mortuary for the community?	Nana Kwan Out	Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Marine Ecology	The oil production caused the algae bloom and the decline in fish catch.	John Garbrah	Assemblyman
26-Mar-12	Village Meeting	Shama	Shama Apo		The sea levels are rising and getting closer to the community, can TGL assist in preventing the sea water coming into the sheds?	Mercy Asare	Community Member
26-Mar-12	Village Meeting	Shama	Shama Apo	Other	Shama will be a reference point for consultation with fishing communities in the future. TGL should continue engaging the community, they will always be welcomed but they should not come empty handed.	Mercy Asare	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Shama Apo	Air Quality	Concern about the impact of gas and flaring on the community's health.	Ebenezer Koomson	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Oil Spill	This project will have more impacts on the fishing communities. The sea is the source of the community's livelihood and if anything happens to the sea it will affect all the fishing communities. In the event of an oil spill our catch will be in danger.	Kofi Rockson	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Issues Related to Jubilee	Why has TGL not fulfilled its previous promises?	Kofi Rockson	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Fishing Equipment	The fishermen have been stopped from fishing near the oil fields. About 29 fishing nets have been seized as well as some outboard motors by the navy. The price of outboard motor has now risen from Ghs 2,900 to Ghs 7,500.	Susuana Bisiwa.	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Other	Apparently all the revenue earned from the oil has been used to construct roads in the hinterlands, is this true?	Susuana Bisiwa.	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Harassment of Fishermen	The area around the oil fields is where we have catch more fish, the community has over 275 canoes but the navy treat us badly.	Nana Ephraim aka Nana Pegu	Chief Fisherman
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Harassment of Fishermen	They have even seized nine fishing nets. Where can we get money to buy new nets.	Nana Ephraim aka Nana Pegu	Chief Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Shama Bentsir	TGL Scholarship	TGL is giving 20% of the scholarship to people in the six coastal district. It is not enough.	Nana Ephraim aka Nana Pegu	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Employment	More people from this region need to be employed by TGL.	Nana Ephraim aka Nana Pegu	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Health Concerns	Oil has many impacts; air pollution and ships carrying ballast water which is discharged into the sea. Is this not going to affect the fish in the sea and the communities health? TGL should grant each district a resourced health facility.	Timothy Ayensu	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Negative Impacts	The environmental experts have not explained things to us well. Fishermen always bring sea weed instead of fish. Are the chemical from the oil fields not going to affect us?	Abraham Afenyi	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Safety Zone	The communities have been restricted by the safety zone from some of its fishing waters. What measures has the company put in		Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Community Benefits	What benefits is the community going to get from TGL?		Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Fishing Equipment	How is the seized nets issue going to be dealt with since fishermen bought them with loans?	George Bordoh	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	TGL Scholarship	TGL needs to educate our children.	George Bordoh	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Seaweed/ Algae Invasion	The weeds cannot be attributed to the oil, apparently the weeds comes from the coast of Sri Lanka but TGL/government still need to do the necessary investigation.	Nana Ephraim	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Other	The sea level keeps rising. What is TGL doing to help the sea defence project?	Timothy Ayensu	Community Member
26-Mar-12	Village Meeting	Shama	Shama Bentsir	Safety Zone	The drifting of the nets toward the FPSO is not the fault of the fishermen. We plead with you to tell the Navy to be lenient with the fishermen.	Nana Essoun Ewusiwa	Community Member
27-Mar-12	Village Meeting	Ahanta West	Butre	Safety Zone	The fishing areas had been reduced by the establishment of the safety zone. This had resulted in less catch by the fishermen. With the pending establishment of another safety zone, the fishermen might not get any fish and this could result in a serious conflict if nothing is done. The livelihoods of the fishermen need to be sustained or improved with effective CSR and alternative livelihood programmes.	Auntie Ekua Amerba	Fish Monger
27-Mar-12	Village Meeting	Ahanta West	Butre	Fisheries Resources	Concerned about the issues sea weeds invasion. In recent times, fishermen came back from fishing with net load of weeds with little or no fish, resulting in financial losses. How can the fishermen be supported to deal with this situation?	Kojo Tawia and Kwesi Ntah	Chief Fisherman and Fisherman
27-Mar-12	Village Meeting	Ahanta West	Butre	Compensation	How will the fishing communities be compensated as the development is going to threaten their livelihood? With the second development, the fishermen might not bring in catch affecting the activities of fishmongers and eventually the whole community.	Akua Attah and Egya Kow Wir	Queen of Fish Mongers and Fisherman
27-Mar-12	Village Meeting	Ahanta West	Butre	Farming	How will the oil activities affect farming activities?	Mary Boafo	Farmer
27-Mar-12	Village Meeting	Ahanta West	Butre	TGL Scholarship	Suggested that the scholarship scheme should be extended to Junior and Senior High Students (JHS & SHS).	John Doku	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
27-Mar-12	Village Meeting	Ahanta West	Butre	General Comment	Teachers in the community do not come to teach often because all of them live outside the community. They do not have anywhere to stay in the community. Building teacher bungalows would help solve this situation and improve education in the community.	Esi Nyamekye	Community Member
27-Mar-12	Village Meeting	Ahanta West	Butre	Fishing Issues	The issue of light fishing is very rife in the community. Fishermen use light to fish which is considered illegal. He hoped TGL can help to stop the fishermen from using light.	Kwabena Tawia	Community Member
27-Mar-12	Village Meeting	Ahanta West	Butre	TGL Scholarship	Reiterated the need for a scholarship for JHS and SHS as this would ensure that fishermen have no excuse to educate their children.	Papa Tano and I.K. Boafo	Elder
27-Mar-12	Village Meeting	Ahanta West	Butre	Request(s)	The community is also in dire need of a community centre, where meetings could be held and finally an upgrade in the road network in the community would be greatly appreciated.	Papa Tano and I.K. Boafo	Elder
27-Mar-12	FGD: Fishermen	Ahanta West	Butre	Request(s)	TGL should set up a training facility to train the youth in artisanal jobs (carpentry, masonry, etc).		Fisherman
27-Mar-12	Fishermen Gathering	Ahanta West	Dixcove	Fishing Issues	The proposed project is highly likely to aggregate the decline in fish resources. Generally, fish are attracted to the FPSO. What are TGL's plan to safeguard the community's livelihood?	Nana Kweku Dadzie	Chief Fisherman of Upper Dixcove
27-Mar-12	Fishermen Gathering	Ahanta West	Dixcove	Seaweed/ Algae Invasion	The first development caused the seaweeds and now you are going to start another development. Fishermen cannot catch any fish because of it. This issue does not only affect the fishermen but it also affects the fish mongers.	Juliana Koomson	Fisher Monger
27-Mar-12	FGD: Women	Ahanta West	Dixcove	Seaweed/ Algae Invasion	Hope the new development would improve livelihood.		Fisher Monger
27-Mar-12	FGD: Women	Ahanta West	Dixcove	Seaweed/ Algae Invasion	The project may provide scholarships for the children in the community.		Fisher Monger

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
27-Mar-12	FGD: Women	Ahanta West	Dixcove	Seaweed/ Algae Invasion	The women did not care much about the project as they did not benefit from Jubilee. They are expecting the same with this project.		Fisher Monger
27-Mar-12	Village Meeting	Sekondi - Takoradi	European Town	Safety Zone	Light in the vessels attracts fish, but fishermen are restricted to fish the FPSO where the fish are located. How does TGL plan to resolve this issue?	Isaac Taylor	Community Member
27-Mar-12	Village Meeting	Sekondi - Takoradi	European Town	Employment	Oil drilling brings employment, but only for literate people. Illiterate people have some ideas and skills such as swimming, how can the TGL assist all those with some skills but not educated to get employment?	James Obudai Torgbor and David Kwasi	Community Member
27-Mar-12	Village Meeting	Sekondi - Takoradi	European Town	Employment	In some companies people have to pay bribes to others already working within the company in order to secure employment. The community members are poor and don't have any money, so how are we expected to get employment?	Emmanuel Ninson	Community Member
27-Mar-12	Village Meeting	Sekondi - Takoradi	European Town	TGL Scholarship	The available scholarships are only for a few people, there are so many people in Sekondi who are qualified with SHS/first degree – how can they be helped?	Abubakar Nyarko	Community Member
27-Mar-12	Village Meeting	Sekondi - Takoradi	European Town	Employment	When CSR projects are undertaken, sub-contractors must employ people from the locality.	Chief Lamptey	Community Member
	KI Interview: Habour Master	Sekondi - Takoradi	Sekondi	Safety Zone	Fishermen are frastrated by the safety zone around the FPSO. When the safety zone was implemented the Navy started to not only arrest fishermen, but seize their nets too.	Albert Busomtwi-Sam Fishing	Harbour Master
		Sekondi - Takoradi	Sekondi	Harassment of Fishermen	The issue of the safety zone was extensive sensitisation by TGL through all forms of media.	Albert Busomtwi-Sam Fishing	Harbour Master

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
		Sekondi - Takoradi	Sekondi	Harassment of Fishermen	There have been rumours that the navy is harassing fishermen in their homes.	Albert Busomtwi-Sam Fishing	Harbour Master
		Sekondi - Takoradi	Sekondi	Suggestion	The fishermen wish for someone (e.g. govt) to help them to fish more conveniently. In some countries, there are places which the government had demarcated for fish breeding, the same can be done here in Ghana.	Albert Busomtwi-Sam Fishing	Harbour Master
		Sekondi - Takoradi	Sekondi	Fishing Equipment	The fishing equipment is very expensive, outboard motor: 2,900GHC in 2009; now 8,000	Albert Busomtwi-Sam Fishing	Harbour Master
		Sekondi - Takoradi	Sekondi	Fishing Issues	The majority of the fishermen are against dynamite fishing because it is not allowed and kills many fish which are not ready for harvesting. Dynamite fishing also causes a different tasting fish.	Albert Busomtwi-Sam Fishing	Harbour Master
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Fisheries Resources	Fishermen are not allowed to fish close to the FPSO, but light from the vessel attracts the fish this affects the community's livelihoods.	Kofi Dadwen	Fishermen
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Fishing Equipment	The sea drifts our nets towards the FPSO and the navy seizes our nets. When bigger vessels drop their anchor it sometimes fall on our nets and get them entangled.	Kofi Dadwen	Fishermen
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	TGL Scholarship	In other countries where oil has been found, scholarships are given to people. Scholarships should be given to the children of fishermen.	Kofi Dadwen	Fishermen
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Issues Related to Jubilee	The community does more fishing than Sekondi, however, the community was not consulted as part of Jubilee.	Kofi Dadwen	Fishermen

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Oil Spill	How does TGL plan to deal with an oil spill? How will those affected be compensated?		Chief of Ngyerisia
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Community Benefits	We have not benefitted yet from TGL.	Kojo Tawiah	Community Member
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Issues related to CLOs	Is it possible for TGL to establish offices at the various coastal communities so that fishermen can report incidents?	Kofi Abbey	
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	TGL Scholarship	Happy with the scholarships but would like to know what TGL is doing for those at the basic level?	Peter Tawiah	Headmaster, JHS
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	TGL Scholarship	Is the scholarship for SHS only for those who have completed university?	Adwoa Amissah	Fish Seller
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Ballast Water	Concerned that ballast water will negatively affect the fish.	Kobina Antwi	Community Member
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Other	Sometimes the Ghanaian fishermen encounter fishermen from Cote d'Ivoire with their lights off fish close to the FPSO.	Kobina Antwi	Community Member
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Other	The department currently being established at Takoradi Polytechnic (as well as the scholarships) should have protocol positions for those from the affected communities, and the same thing should apply to the scholarships.	Hon. Solomon Mintah	Assembly Member for the Ngyiresia EA
28-Mar-12	Village Meeting	Sekondi - Takoradi	Ngyiresia	Employment	Concerning employment, TGL can employ people with low skills from these affected communities to do jobs such as messengers, cleaners and labourers at their onshore locations.	Hon. Solomon Mintah	Assembly Member for the Ngyiresia EA

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
28-Mar-12	FGD: Women	Sekondi - Takoradi	Ngyiresia	Suggestion	The men do not have life jackets. It would also be helpful if there were some trained life guards and the people were taught proper swimming.		Community Member
28-Mar-12	FGD: Women	Sekondi - Takoradi	Ngyiresia	Negative Impacts	Women use to buy fish on credit from canoe owners but that has all changed due to the decreased fish catch.		Community Member
28-Mar-12	FGD: Women	Sekondi - Takoradi	Ngyiresia	General Comment	Big trawlers catch more fish than the small canoes and by the time the smaller canoes come along all the fish are gone.		Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Employment	Some of the people here can swim, they should be employed.	J K Mensa	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	General Comment	Some people who work for TGL are not well paid.	J K Mensa	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	The oil and gas industry uses a lot of water. How can will the community's water supply be affected by this?	Rev. John Ernest Kwofie	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	How will the sea salt be affected by the oil and gas activities?	Rev. John Ernest Kwofie	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	Is TGL going to contribute to depletion of the ozone layer due to possible release of CFCs?	Rev. John Ernest Kwofie	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	There are rumours that some of the Ghanaians working in the oil and gas industry have told the oil companies that they are overpaying people and now the oil companies are paying Ghanaians very low salaries.		Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Employment	How can the youth secure employment with TGL? Currently, the majority of the people employed by TGL are all from outside the Region and country.	Henry Kwaku Daniels	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	The headquarters of the oil companies should be in the Western region, not in Accra.	Emmanuel Bentum	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Employment	If Ghanaians does not have the right experience, why does TGL employ expats? They should concentrate on the Jubilee field until the Ghanaian people have enough skills. They should not be in a hurry to start the other fields and should get the people trained.	Rev. Emmanuel Enin Okyere	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	How can local people get admission into the program at Takoradi polytechnic?	J K Mensah	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	Bakakyir	Other	During Jubilee, TGL promised to meet up with the community at the Lagoon Side Hotel to talk about other work opportunities (such as road construction and gutters, but this has not happened.	Godfred Appau	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Air Quality	What would be the effect of the flaring of gas on coastal communities?	Lydia Neizer	Fish Monger
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Other	A sea defence wall was built by TGL to save some section of the community from being eroded away. The wall was not completed and hoped that the benefits of the TEN development would be used to complete the sea defence wall.	E. Adoko:	Assemblyman
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Fisheries Resources	The oil activity was the main reason for the decline in fish catch. The light from the FPSO had attracted all the fish to it and with the safety zone around the FPSO, the fishermen can not fish there.	Anthony Afful and Ebo Arthur	Fishermen

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	General Comment	Parents in the community are not able to educate their children because of the decline. She wished TGL would roll out a scholarship scheme targeting the basic and secondary education of their children.	Maame Ekua Anaba and Kwabena Nyipanitrim	Fish Mongers
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	TGL Scholarship	The TGL scholarship should not only target people who already have degrees but it should be extended to pupils in basic and secondary school too.	Maame Ekua Anaba and Kwabena Nyipanitrim	Fish Monger
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Oil Spill	In case of accidental oil spills, how prepared is TGL to deal with it? Fishing activities would be hampered thus would like to know how the fishing communities would survive.	Nana Ekow Ackon	Chief Fisherman
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Health Concerns	There are many companies operating in the area (Ghana Ports and Harbours authority, Ghana Cement Company, Ghana Railway Company, Cirrus Oil, Bauxite company, and others). These companies are polluting their environment (air emission, water, noise etc) and as such the community has been experiencing some health problems. An upgrade of the health clinic to a hospital with adequate doctors and nurse as well as equipment would go a long way to help solve some of these problems.	Ama Tawia, Maame Efua Essoun and Sam Mensah	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Request(s)	Can TGL provide the community with a cold storage room to freeze and store fish?	Ama Tawia	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Community Benefits	Most of the youth are not highly educated thus cannot access the TGL scholarship or any other scholarship. In this case, what would be done for them?	Mensah	Youth Leader
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Project Activities	Since the oil production would last for 25 years, does this means that there would be no more oil after this number of years?	Anthony Afful	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Support for Small Businesses	How could TGL help people engaged in small scale business flourish? Most of these businesses need financial assistance such as low interest loans.	Robert Eshun	Community Member
29-Mar-12	Village Meeting	Sekondi - Takoradi	New Takoradi	Request(s)	The community needs cleaning tools such as rake, cutlass, wheelbarrow, etc. These tools would encourage the youth to take part in communal labour to get rid of filth in the community. This would also reduce the health issues in the community.	Nana Ekow Ackon	Chief Fisherman
29-Mar-12	FGD: Fishermen	Sekondi - Takoradi	New Takoradi	Negative Impacts	Nothing good would come out of this development.		Fisherman
29-Mar-12	FGD: Fishermen	Sekondi - Takoradi	New Takoradi	Community Benefits	TGL would have to improve the education facilities in the community. The community needs a police station and a bank.		Fisherman
29-Mar-12	FGD: Fishermen	Sekondi - Takoradi	New Takoradi	Safety and Security	TGL can enhance communication offshore by installing gadget on the FPSO with frequencies that can be accessed by the fishermen especially in times of distress.		Fisherman
29-Mar-12	FGD: Leaders and Men	Sekondi - Takoradi	New Takoradi	Fisheries Resources	The project will negatively affect the community as its likely to destroy the fishing industry.		Fisherman
29-Mar-12	FGD: Leaders and Men	Sekondi - Takoradi	New Takoradi	Request(s)	TGL and government can assist the community by providing them with the following: free medical checks, support for the local schools, alternative livelihood programs, subsidies for building materials, upgrade the road network, efficient town plan, and dredge the lagoon to reduce the case of malaria and provide a space for the community to moor its canoes.		Fisherman
29-Mar-12	FGD: Women	Sekondi - Takoradi	New Takoradi	Safety Zone	The oil activities affect the fishing activities of the community, especial the safety zone.		Women
29-Mar-12	FGD: Women	Sekondi - Takoradi	New Takoradi	Suggestion	May be TGL can help the community by starting a fish farms where fish can be spawned.		Women

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
29-Mar-12	FGD: Women	Sekondi - Takoradi	New Takoradi	Employment	There is a general lack of employment opportunities in the area. TGL should provide jobs for local people.		Women
29-Mar-12	FGD: Women	Sekondi - Takoradi	New Takoradi	Community Benefits	The community has not seen many benefits from the presence of TGL.		Women
29-Mar-12	FGD: Women	Sekondi - Takoradi	New Takoradi	TGL Scholarship	The TGL scholarship should not only target people who already have degrees but it should be extended to pupils in basic and secondary school too.		Community Member
30-Mar-12	Village Meeting	Ellembelle	Atuabo	Other	Will the FPSO station affect the coastal communities?	Bangram Yankey	Community Member
30-Mar-12	Village Meeting	Ellembelle	Atuabo	Fishing Issues	Now that TGL is taking over the sea, and we will not be allowed to fish what will we do?		Fish Monger
30-Mar-12	Village Meeting	Ellembelle	Atuabo	Seaweed/ Algae Invasion	The seaweed is affecting our catch, we think it is as a result of the oil. Men struggle to fish and so the women struggle to get fish to sell. It was not here before the oil.	Lucy Blay	Community Member
30-Mar-12	Village Meeting	Ellembelle	Atuabo	Seaweed/ Algae Invasion	It is true that the weeds were here 20 years ago but current weeds sure different.	Mr Blay	Community Member
30-Mar-12	Village Meeting	Ellembelle	Atuabo	Negative Impacts	Fishing businesses are collapsing as the fish catch has declined. What is being done about this?		Community Member
30-Mar-12	Village Meeting	Ellembelle	Atuabo	General Comment	There are plans for the construction of a gas plant in the area, how will local people get jobs?	Mason	Community Member
30-Mar-12	Village Meeting	Ellembelle	Atuabo	ESIA Process	Is an EISA an NGO?	Beeza Sabuh	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
30-Mar-12	Village Meeting	Ellembelle	Atuabo	ESIA Process	How do we know that TGL will submit the right report to the EPA and that this will be a fair representation of what has occurred here?	Beeza Sabuh	Community Member
30-Mar-12	FGD: Women	Ellembelle	Atuabo	Health Concerns	The oil will make us cough and get colds. The sea will make smoke which will affect human life.		Community Member
30-Mar-12	FGD: Women	Ellembelle	Atuabo	Fisheries Resources	This project will create noise which will affect a big part of the sea and disturb the fish so there will be no fish in the sea.		Community Member
30-Mar-12	FGD: Women	Ellembelle	Atuabo	Other	Many of the children in the community are not interested in going to school. This is due to their interest in 'quick money" which they make from construction work. Can you please come back to the town to meet with the youth and inspire them to go back to school before the start of this project?		Community Member
30-Mar-12	Village Meeting	Ellembelle	Enokyi	Other	The influx of job seeks into the community would pose a serious problem when they do not get jobs and decide to settle in the community. How the situation would be managed?	Gladys Ackah	Community Member
30-Mar-12	Village Meeting	Ellembelle	Enokyi	Safety Zone	Fishermen are worried about the negative effects of another FPSO and safety zone on their fishing activities.	Agnes Kwofie	Community Member
30-Mar-12	Village Meeting	Ellembelle	Enokyi	Harassment of Fishermen	Also the harassment by the Ghana Navy needed to be addressed.	Agnes Kwofie	Community Member
30-Mar-12	Village Meeting	Ellembelle	Enokyi	Community Benefits	How will the elders in the community benefit from the project?	Joseph Anaman	Community Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
30-Mar-12	Village Meeting	Ellembelle	Enokyi	Alternative Livelihoods	TGL should let the community know what alternative livelihood projects had been drawn up for fishing communities.	Kwame Bots	Community Member
30-Mar-12	Village Meeting	Ellembelle	Enokyi	Employment	The uneducated in the community could also be employed for some kind of job. TGL should look into this, since a large population of the youth in the fishing communities are uneducated or lowly educated.	Kojo Francis	Community Member
30-Mar-12	FGD: Leaders and Men	Ellembelle	Enokyi	Other	The community is excited about the project and wants to dwell only on the positives even though there may be negatives, they do not care for them as the positives will outweigh the negatives.		Community Member
30-Mar-12	FGD: Leaders and Men	Ellembelle	Enokyi	Other	The community is looking forward to potential employment opportunities for the local youths.		Community Member
30-Mar-12	FGD: Leaders and Men	Ellembelle	Enokyi	Fishing Issues	Reduction in fishing areas due to the cumulative space occupied by the two FPSOs with it safety zones is a concern for the community.		Community Member
19-Jun-12	FGD: School	Jomoro	Effasu	Community Benefits	Will TEN project be different to Jubilee in terms of benefits to the fishermen who will be affected by the exclusion zone and consequently affect their children as the fishermen's income will be reduced.	Daniel Anson	Head Teacher
19-Jun-12	FGD: School	Jomoro	Effasu	Community Benefits	Why are the scholarships being given only to graduates when scholarship for graduate studies when most fishermen have children at basic,primary, and senior high school level?	Peter Yeboah	

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
19-Jun-12	FGD: Fishermen	Jomoro	Effasu	Safety Zone	Is it possibility for the safety zones to be open to fishermen at certain times of the year? being opened to fishermen once in a while	Anthony Armah	Fisherman
19-Jun-12	FGD: Fishermen	Jomoro	Effasu	Fishing Issues	There has been a significant decline of the fish catch over the last three years as result of the oil production activities.	Daniel J Haggan	Fisherman
19-Jun-12	FGD: Fishermen	Jomoro	Effasu	Other	How was the name TEN derived?	Blay Anatole	Fisherman
19-Jun-12	FGD: Fishermen	Jomoro	Effasu	Request(s)	Can TGL provide the community with free electricity to power up the communities' water pump as it is currently disconnected due to outstanding fees?	Frank Paul Nyanzu	Fisherman
19-Jun-12	Community Meeting	Jomoro	Effasu	Safety Zone	Creating another exclusion zone for the TEN will double the plight of fishermen.	J. E Yankson	Community member
19-Jun-12	Community Meeting	Jomoro	Effasu	Safety Zone	Two exclusion zones will restrict access to a large fishing area.	Prince Gabriel Kumi Odeneho	Community member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
19-Jun-12	Community Meeting	Jomoro	Effasu	Negative Impacts	Noise from the helicopters could affect the fish at sea, apart from its effect on genera biodiversity. What is the company doing about this issue?	Prince Gabriel Kumi Odeneho	Community member
19-Jun-12	Community Meeting	Jomoro	Effasu	Waste Discharge	The various types of waste that are generated in the oil and gas and operational activities will affect the fish. What does the company intend to do about the situation?	Prince Gabriel Kumi Odeneho	Community member
19-Jun-12	Community Meeting	Jomoro	Effasu	Oil Spill	Any oil leakages or spillages at sea will affect fishing and make the people (fishermen) even poorer.	Prince Gabriel Kumi Odeneho	
19-Jun-12	Community Meeting	Jomoro	Effasu	Oil Spill	The possibility of involving the local people in the oil spill programme can help the people earn some money.	Prince Gabriel Kumi Odeneho	

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
19-Jun-12	Community Meeting	Jomoro	Effasu	Seaweed/ Algae Invasion	Many fishermen are unable to go fishing anymore due to interference of the seaweeds, instead of catching fish, the nets only harvest seaweeds which in turn destroy the nets.	Joseph Ekumi	
19-Jun-12	Community Meeting	Jomoro	Effasu	Seaweed/ Algae Invasion	The weeds originate from the oil project, since the problem started only about 6 to 9 months ago, and therefore fishermen need to be assisted.	Joseph Ekumi	
19-Jun-12	Community Meeting	Jomoro	Effasu	Education	The weak educational foundation of the children makes them unable to qualify and compete for any of the scholarships. What is TGL doing to support such children?	Assemblyman	
19-Jun-12	Community Meeting	Jomoro	Effasu	Seaweed/ Algae Invasion	The seaweeds collected from the local beaches can be buried or turned into compost. .	Prince	Chief
19-Jun-12	Community Meeting	Jomoro	Effasu	Suggestion	Why does TGL not transfer the TEN natural gas directly to the Osagyefo Power Barge Plant, in order to get it running?	J. E Yankson	
20-Jun-12	FGD: School	Jomoro	Ahobre	Safety Zone	Increased restriction zone likely to drive many fishermen out of business.	Clementine M Mokuameneabe	Teacher
20-Jun-12	FGD: School	Jomoro	Ahobre	Social Issues	Concerned about the increased of social vices in the communities due to influx of job seekers.	Bernedine Blay	Head Teacher
20-Jun-12	FGD: Health	Jomoro	Ahobre	Health Concerns	Concerned by the pressure on health facilities and thereby reducing the quality of health care.	Abigail Mintah	Community Health Nurse

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
20-Jun-12	FGD: Fishermen	Jomoro	Ahobre	Seaweed/ Algae Invasion	Communities can assist TGL with the clean-up of the beaches, in turn TGL can provide pay those assisting and also provide them with the necessary equipment.	Kojo Bessae	Fisherman
20-Jun-12	FGD: Fishermen	Jomoro	Ahobre	Suggestion	TGL should provide educational scholarships, credit assistance and maternal health services for women.	Isaac Mensah	Fisherman
20-Jun-12	FGD: Fishermen	Jomoro	Ahobre	Fisheries Resources	Oil production has caused drastic change in the fishing business. Fishing is now a very expensive and less profitable endeavor compared to 3 years ago.	John Benyin	Fisherman
20-Jun-12	FGD: Fishermen	Jomoro	Ahobre	Fishing Issues	The bright light on the rigs and the FPSO attract fish to the oil installations.	Kobbina Carpenter-	Fisherman
20-Jun-12	Community Meeting	Jomoro	Ahobre	Health Concerns	A fear that the gas injected into wells could erupt in future, and may adversely affect the on the health of the coastal communities.	Augustine Bekoe	
20-Jun-12	Community Meeting	Jomoro	Ahobre	Request(s)	The community lack cold storage facility to handle the now occasional fish bumper harvest to preserve the fish for lean times.		
20-Jun-12	Community Meeting	Jomoro	Ahobre	Seaweed/ Algae Invasion	The massive seaweed menace started about 9 months ago (about last September), and it is so severe that many near-shore fishermen have virtually given up on fishing. What measures is TGL putting in place to compensate fishermen?	Assemblyman	

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
20-Jun-12	Community Meeting	Jomoro	Ahobre	Employment	People of Jomoro should receive priority when employment opportunities come along as they will be the most affected by the projects.	Assemblyman	
20-Jun-12	Community Meeting	Jomoro	Ahobre	Seaweed/ Algae Invasion	The Ahobre community shares the responsibility of cleaning up the seaweeds from the beaches. Any support from TGL would be welcomed. Compost fertilizer can be made from the seaweeds.	Sampson Kwasie	
20-Jun-12	Community Meeting	Jomoro	Ahobre	Education	The weak educational foundation of the children make them unable to qualify and compete for any of the scholarships.	Bernadon Blay	
20-Jun-12	Community Meeting	Jomoro	Ahobre	Export Tanks	How is oil that is piped into the export tanker gauged?	Sampson Kwasie	
21-Jun-12	FGD: Health Services	Jomoro	Bonyere	Health Concerns	Concerned about the extent of pressure on health facilities in host communities.	Martin E Anudu	
21-Jun-12	FGD: Fishermen	Jomoro	Bonyere	Safety zone	Increased implementation of safety zone will increase the problems of the fishermen, who are already suffering due to the seaweed invasion (which has a fawl smell).	Kobbina Appa	Fisherman
21-Jun-12	FGD: Fishermen	Jomoro	Bonyere	Social Issues	Possibility of resettlement to prevent excessive impact on the community.	Stephen Blay	Fisherman
21-Jun-12	FGD: Fishermen	Jomoro	Bonyere	Tar balls	Thick black substance also found at the shore some months ago.	Kobbina Appa	Fisherman

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
21-Jun-12	FGD: Fishermen	Jomoro	Bonyere	Community Benefits	Extension of electricity, water and loan facilities to the community.	Kofi Bentum	Fisherman
21-Jun-12	FGD: Fishermen	Jomoro	Bonyere	Community Benefits	TGL should assist communities by providing them with scholarship, input subsidy and supply assistance by making it more accessible and available to the community. This can be achieved through setting of supply stations and through providing the community with a fishing boat.	Kwasi Quansah	Fisherman
21-Jun-12	Community Meeting	Jomoro	Bonyere	Community benefits	The oil activities are all carried out from only Takoradi, (including use of the Harbour, the refurbishment ofTakoradi Polytechnic project benefiting from scholarships to study abroad and recruitments). People from Bonyere do not benefit from any of these.	Thomas Ewa	
21-Jun-12	Community Meeting	Jomoro	Bonyere	Oil Spill	What will happen to fishermen at sea during an oil spill? There How will the fishermen in such a situation be assisted?	Lady	
21-Jun-12	Community Meeting	Jomoro	Bonyere	Community Benefits	TGL's assistance given to Half Assini Senior High School is commendable, but a similar support should be extended to the Awulae Annor Adjaye Senior High School in their community.	Lady	
21-Jun-12	Community Meeting	Jomoro	Bonyere	Employment	Employment opportunity should be made available to the illiterate as well as vocational training and support for aquaculture development (financially and technically) to the youth.	Samuel Bessa	
22-Jun-12	FGD: School	Jomoro	Half-Assini	Fisheries Resources	Any districution and pollution of the sea will lead to the death of certain fish species.	Emmanuel Eshun	Assistant Head Teacher

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
22-Jun-12	FGD: School	Jomoro	Half-Assini	Monitoring	Measures for strict adherence to regulations and standards of operation should be put in place and for independent monitoring activities.	Kodwoh E. Edjah	Head Teacher
22-Jun-12	FGD: Health	Jomoro	Half Assini	Negative Impacts	Rumors and expectations of high risk and likely negative impacts are causing fear and panic on the people.	Miezah Alex Amihere	Nurse
22-Jun-12	FGD: Fishermen	Jomoro	Half Assini	Seaweed/ Algae Invasion	The seaweeds have been caused by the oil and gas activities since it started only recently.	Francis Tayi	Fisherman
22-Jun-12	FGD: Fishermen	Jomoro	Half Assini	Oil Spill	Are the correct measures in place to deal with the impacts of an oil spill at the community level?	Patrick Ebi Edeyilea	Fisherman
22-Jun-12	FGD: Fishermen	Jomoro	Half Assini	Education	TGL should organize skill training programmers for the youth, fishermen and fishmongers.	Nyame Wuho	Fisherman
22-Jun-12	Community Meeting	Jomoro	Half Assini	Issues Related to Jubilee	The EIS for the Jubilee was technical and many did not understand it and there was not enough time to review and understand it.	Pius Amelema	
22-Jun-12	Community Meeting	Jomoro	Half Assini	Safety Zone	Increasing the exclusion zone is going to affect fishermen. The fishing industry is going to be destroyed by the multiple blocks being developed.	Pius Amelema	

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
22-Jun-12	Community Meeting	Jomoro	Half Assini	Health Concerns	Flaring is causing miscarriages.	Pius Amelema	
22-Jun-12	Community Meeting	Jomoro		Fisheries Resources	Herrings have disappeared altogether.	Pius Amelema	
22-Jun-12	Community Meeting	Jomoro		Health Concerns	There is heavy metal mobilization from the sea bed affecting the food chain.	Pius Amelema	
22-Jun-12	Community Meeting	Jomoro	Half Assini	Oil Spill	Local people need to know and be part of the oil spill response plan. .	Pius Amelema	
22-Jun-12	Community Meeting	Jomoro	Half Assini	TGL Scholarship	Scholarship programme should start at SHS level for the fishermen's children, some of whom are very good but drop out due to financial difficulties.		Headmaster
22-Jun-12	Community Meeting	Jomoro	Half Assini	Request(s)	As support for teachers refresher courses must be organized, this will serve as a motivation for teachers not to leave the area. TGL should also provide teachers with accommodation/ cottages.		
22-Jun-12	Community Meeting	Jomoro	Half Assini	Marine ecology	Within the past two years, there have been nine whale deaths that have washed up on the beaches; this can be attributed to the oil and gas activities. .	John Ekow Abour	Assemblyman

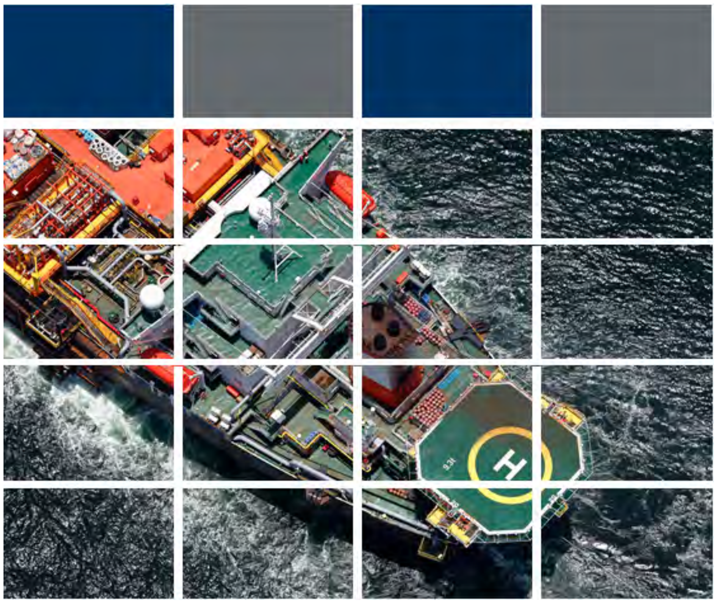
Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
22-Jun-12	Community Meeting	Jomoro	Half Assini	Ballast Water	Is there any monitoring of Ballast Water?	John Ekow Abour	Assemblyman
22-Jun-12	Community Meeting	Jomoro	Half Assini	TGL Scholarship	How is the process of selecting scholarship beneficiaries undertaken?	Kwasi Menya	
22-Jun-12	Community Meeting	Jomoro	Half Assini	Fear Mongers	NGOs are passing on frightening information to the local community. This is creating fear of the industry.	Francis Tei Nda	
22-Jun-12	Community Meeting	Jomoro	Half Assini	Fisheries Resources	The decline in the fish catch was happening before the oil industry started its activities.		Chief of Half Assini
23-Jun-12	Community Meeting	Jomoro	New Town	Issues Related to Jubilee	TGL is not acting on issues and promises made during the Jubilee consultation.	Kojo Abaidoo	Community Member
23-Jun-12	Community Meeting	Jomoro	New Town	Seaweed/ Algae Invasion	Seaweeds are posing a threat to the fishing industry. The only solution to this is to stop all oila and gas activities as they are the main cause of the seaweeds.	Peter Adduful	Community Member
23-Jun-12	Community Meeting	Jomoro	New Town	Lack of Continuous Engagement	Concerned about the partial disclosure of information particularly with regards to the negative impacts of production activities like flaring on the community.	Owusu Addo Paul	Chief Fisherman's Secretary

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
23-Jun-12	Community Meeting	Jomoro	New Town	Employment	Employing more youth to boost and strengthen the Eco-Brigade so that they can assist in cleaning the beaches.	Martin Kwaysi	Community Member
23-Jun-12	FGD: Fishermen	Jomoro	New Town	Community Benefits	Support should be given to fishermen through the provision of cold store-refrigerators and other fish storage facilities. A certain percentage of the revenue generated from the oil and gas activities should be used to provide credit assistance to fishermen, establish a disaster management fund,cooperative credit scheme, input subsidy programmes and setting up input supply stations.	Joseph Boadi	Fisherman
23-Jun-12	FGD: Fishermen	Jomoro	New Town	Request(s)	Tullow needs to provide educational assistance to fishermen.	Kofi Begina	Fisherman
23-Jun-12	FGD: Fishermen	Jomoro	New Town	Lack of Continuous Engagement	TGL should maintain regular engagement with the fishing communities.	Kofi Begina	Fisherman
23-Jun-12	FGD: Fishermen	Jomoro	New Town	Compensation	Is there a contingency fund to assist fishermen in case the fishing industry collapses?	Philip Emi-Essando	Fisherman
25-Jun-12	FGD: School	Jomoro	Beyin	Fishing Issues	How will the TEN project impact on fishing?	Samuel Ackah	Acting Headteacher
25-Jun-12	Community Meeting	Jomoro	Beyin	Seaweed/ Algae Invasion	Are seaweeds caused by the oil and gas activities?	Albert Akrofi	Community Member
25-Jun-12	Community Meeting	Jomoro	Beyin	Oil spill	Will fishermen be able to fish during an oil spill?	Enokpole Kwasi	Community Member
25-Jun-12	Community Meeting	Jomoro	Beyin	Alternative Livelihoods	During Jubilee EIA, there were several discussions, e.g. on alternative livelihood for fishermen. There has been no support so far.	Peter Anderson	Assembly Member

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
25-Jun-12	Community Meeting	Jomoro	Beyin	Safety zone	More oil and gas discoveries will be made in future, will this mean more exclusion zones will be created. Isn't there technology that eliminates the need for an exclusion zone? How many fields will Tullow develop?		
25-Jun-12	Community Meeting	Jomoro	Beyin	Flaring	The seaweeds come in large quantities because of the flaring.	Elder Ajawu	
25-Jun-12	Community Meeting	Jomoro	Beyin	Community benefits	The location of TEN is closest to the Jomoro District and so will be the impacted Jomoro should be considered as the host District. Why are developments going on in other districts but not in the 'host district'?	Awulae Annor Adjeya III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Employment	How many people from Jomoro are in the employment of TGL since the start of the oil and gas activities?	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Community Benefits	If oil is the priority over fishing, then let us know how the oil impacts the lives of the local people. Help the people and let the oil revenue benefit the Western Nzema area.	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Fishing Issues	Fishermen should be considered a vulnerable group. Fishing is now in crisis. Fishing should be allowed at certain periods in the exclusion zone as done elsewhere.	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Fishing equipment	Small boats are crushed by big vessels and fishermen lose their lives.	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Oil Spill	An oil spill occurred and the company paid a fine, but the affected people did not benefit from it.	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Takoradi Operations	The use of Takoradi for oil and all related activities is not good enough; the Navel base is a security zone and must be recognized as such.	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	Community Meeting	Jomoro	Beyin	Seaweed/ Algae Invasion	TGL must clean the sea of seaweeds to help fishermen and the fishing industry.	Awulae Annor Adjaye III	Paramount Chief

Date	Consultation Type	District	Village/ Town	Discussion Areas	Issue Description	Commentator (s)	Position
25-Jun-12	Community Meeting	Jomoro	Beyin	Request(s)	Tullow should help build two ICT Centers for the area.	Awulae Annor Adjaye III	Paramount Chief
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Fishing issues	Tullow should help revive the fishing industry.	Thomas Boateng	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Seaweed/ Algae Invasion	As a result of the seaweeds, fishermen are unable to fish and some have made loans that they are not to pay. TGL must help them.	Kaku Kodwo	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Seaweed/ Algae Invasion	I employ about 50 people and have contracted a loan, but there is not work because of the seaweeds and now cannot repay these. Can TGl assist in the re-payment of these?	Mathew Mwolley	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Financial Assistance	There is the need to prepare a database of fishermen in the area and to help them settle their loan debts.	Peter Blay Acka	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Education	TGL needs to provide support for education, especially at the SHS level due to the failing fishing business.	Francis Amon	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Alternative Livelihoods	Fishing business is being destroyed; alternative livelihoods are needed for the local people.	Steven Kwao	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Compensation	Fishermen should be paid compensation.	Steven Ede Agyala	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Seaweed/ Algae Invasion	Compensation must be paid to fishermen as a result of the seaweeds caused by oil and gas activities, the banks are chasing the fishermen for loan repayments.	Luke Baidoo	Fisherman
25-Jun-12	FGD: Fishermen	Jomoro	Beyin	Fishing Issues	The decline in fishing is affecting all fishing communities in turn affecting the local children whose parents cannot afford to pay school fees for their education.	Patrick Gyasi	Fisherman

ERM has over 140 offices across the following countries worldwide



Argentina
Australia
Belgium
Brazil
Canada
China
Colombia
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Korea
Malaysia
Mexico
New Zealand
Panama
Peru
Poland
Portugal
Puerto Rico
Romania
Russia
Singapore
South Africa
Spain
Sweden
Taiwan
Thailand
The Netherlands
United Arab Emirates
United Kingdom
United States
Vietnam