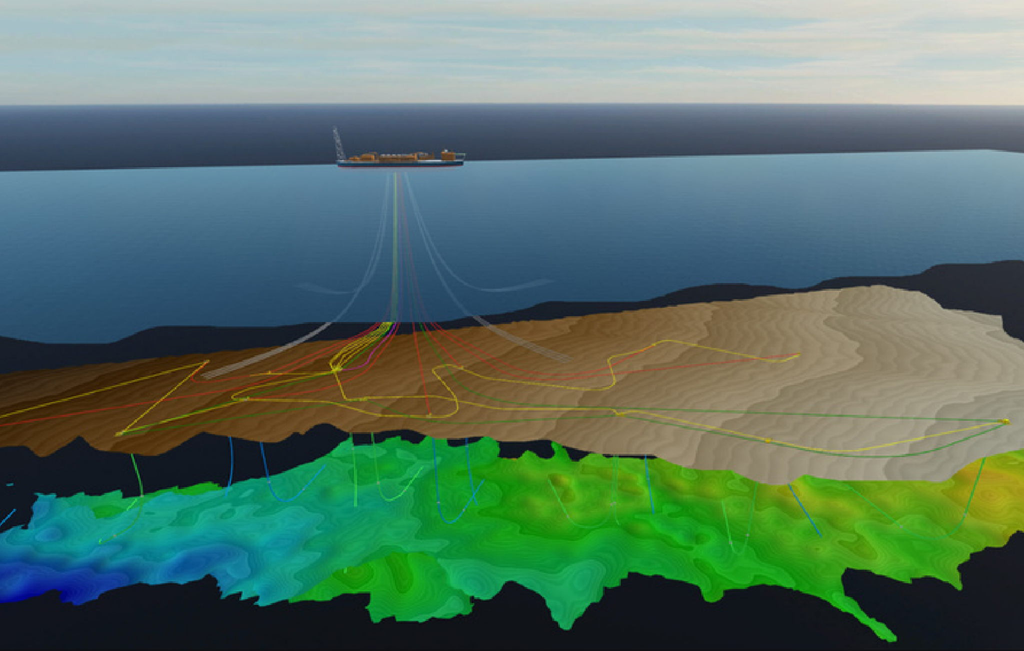
ENVIRONMENTAL IMPACT STATEMENT

for

DEEP WATER TANO/CAPE THREE POINTS BLOCK

PECAN FIELD DEVELOPMENT

December 2023



Pecan Phase 1

Development Project

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03	08.12.2023	Issue for Use	ERM/ESL	Ole Aspholm	Per Arne Nilsen
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Environmental Impact Statement

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Revision Record Sheet

All material changes after rev. 01 shall be listed in this revision record sheet.

Revision	Section	Description of changed/updated sections
01		Issued for Review
02		Updated according to review comments.
	Section 2.11, and Section 3.10.3	References to OOC targets of 2-5% clarified
	Section 2.11.2	Clarification that EPA discharge to water and emissions to air standards apply to onshore activities.
	Section 3.15 and Section 10.3.	References to Fisheries Liaison Officers changed to Community Liaison Officers and number clarified.
	Section 9.6	List of proposed management plans updated
03		Issue for Use

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1.1 The Pecan Project

1.1.1 Introduction

The Project Contractor Group, comprising Pecan Energies, Lukoil Overseas Ghana Tano Limited (LOGT), Ghana National Petroleum Corporation (GNPC) and Fueltrade Limited (Fueltrade), own participating interests in the Contract Area, with Pecan Energies holding 50%, Lukoil 38%, GNPC 10% and Fueltrade 2%. For the purposes of this report Pecan Energies is defined as the Operator within the overall Contractor Group.

The Contractor Group propose to develop the Pecan Field within the Contract Area with an initial development phase (Pecan Phase 1 Project).

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 of the Draft EIS for the Pecan Project, and it presents an overview of the EIA process, baseline environment, and impact assessment and mitigation measures. Following a review of the draft EIS and the public hearing process then a final EIS will be submitted to the regulator.

The EIA was undertaken by Environmental Resources Management Ltd (ERM) and ESL Consulting Ltd (ESL), jointly referred to as the EIA team. It follows the EIA Scoping Report and Terms of Reference submitted to and endorsed by the Ghana Environmental Protection Agency (EPA) (endorsed in May 2022).

The Draft EIS has been submitted to the EPA for expert panel review and disclosure for public comments, under EPA's direction. A final EIS will be prepared and submitted to the EPA for approval once this process has been completed, taking onboard the regulators and public comments.

1.1.2 Project Overview

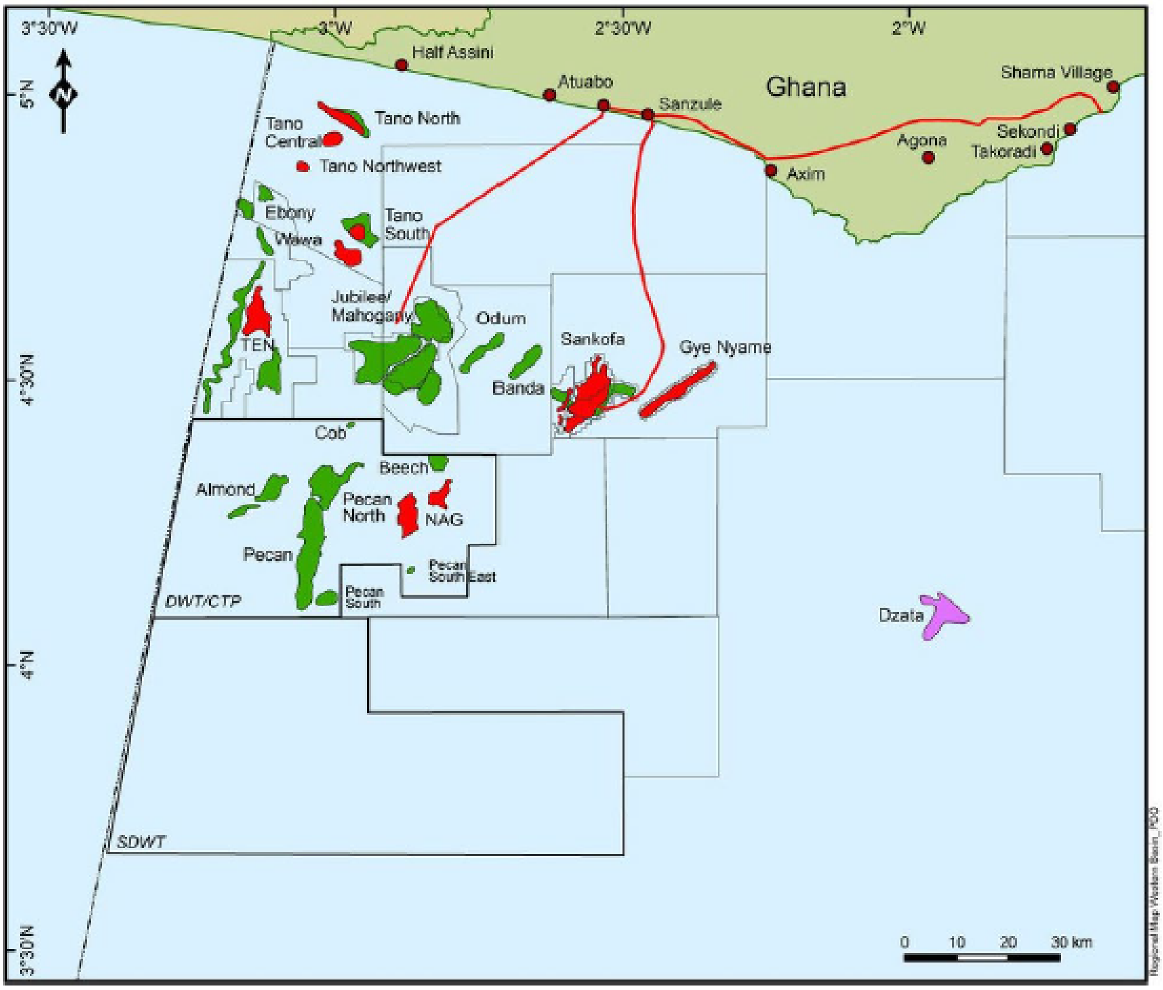
The Contract Area is located off the Western Region of Ghana, about 70 km from the coast at the nearest point, covers an area of approximately 200,000 ha (2,000 km^2) and is located in water depths of approximately 1,600 m to. 2,800m. An exploration and appraisal programme has been undertaken over the Contract Area involving seismic surveys and well drilling to define oil and gas resources.

There are four identified commercial oil discoveries within the Contract Area: named Pecan, Beech, Almond and Pecan North and two gas condensate discoveries: named Paradise and Hickory. These are illustrated in Figure 1, along with previous discoveries and developments to the north.

The Contractor Group proposes to develop the DWT/CTP discoveries in a series of phases with facilities comprising a subsea production system tied back to a spread moored leased Floating Production Storage and Offloading (FPSO) vessel. The initial phase (Phase 1) will be the development of the Pecan discovery, which will comprise the following.

1. Drilling of seven oil and gas producing wells and seven water and gas injection wells, with the wells tied back to a spread moored FPSO located to the west of the discovery.
2. Wells will be drilled using one mobile offshore drilling unit (MODU) over an approximate three-year period.
3. The FPSO will be capable of storing up to approximately 1.285 million barrels of oil and located approximately 113 km offshore in 2,620 m of water.
4. The FPSO would offload directly to conventional export tankers approximately every ten days.

5. Water and gas will be injected for increased oil recovery.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

NTS-Figure 1 Location of DWT/CTP Contract Area and Neighbouring Fields and Existing Pipelines (Integrated Plan of Development)

1.1.3 Project Need and Benefits

The Ministry of Energy is responsible to promote the exploration and development of Ghana's petroleum resources and to ensure that Ghana obtains the greatest possible benefits from these developments. To this end, the Ministry of Energy grants oil exploration, appraisal, and production licences for the commercial development of these resources. The commercial development of the hydrocarbon resources complies with Ghana's national development strategy (Growth and Poverty Reduction Strategy) which includes infrastructure development and private sector development as priority areas. Reducing the costs of imported oil through facilitating private sector investment in the domestic oil and gas sector, and generating direct income through selling extracted hydrocarbons, are central to this strategy.

The proposed Pecan 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 and supply chain taxes that will benefit of the people of Ghana. The Project would also generate employment and training opportunities directly and indirectly through service, supply, and support industries.

1.1.4 Purpose of EIA

For the purposes of the EIA, the Project was defined as all activities necessary for the Pecan 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.

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 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 Environment Health and Safety (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 describe how the mitigation measures will be implemented, and residual impacts managed, through the provision of an outline Environmental and Social Management Plan (ESMP). This will also require the development of monitoring plans for various environmental and social impacts and a mechanism for audit, review and corrective action.

1.2 Legal and Policy Framework

1.2.1 Environmental Assessment Regulations

The EIS has been compiled in compliance with the requirements of the Environmental Assessment Regulations (LI 652, 1999), 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:

- Environmental Assessment in Ghana, a Guide to Environmental Impact Assessment Procedures (1996).
- EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2011).

1.2.2 Petroleum Legislation

Relevant Petroleum Legislation includes:

- The Petroleum Commission Act 2011 (Act 821) established the Petroleum Commission to regulate and manage the exploitation of petroleum resources.;
- the Ghana National Petroleum Corporation Law (Act 64 of 1983), established the GNPC to promote exploration and development of petroleum resources; and
- the Petroleum (Exploration and Production) Law (Act 84 of 1984) requires that adverse effects on the environment, people and resources are prevented, and that a Plan of Development and Emergency Response Plans are submitted and approved by the Government of Ghana.

1.2.3 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.
- 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).

1.2.4 State and Classification Requirements

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. The MODU and other Project vessels are likely to be flagged and will therefore be required to comply with safety regulations, such as those of the International Maritime Organisation, the requirements of the relevant classification society, as well as the relevant Ghanaian environmental and safety regulations.

1.2.5 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 (1982) 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 wastewater discharges.

The *International Convention of Oil Preparedness, Response and Co-operation Convention* (1990) requires the Operator to establish an Oil Spill Contingency Plan to combat accidental pollution to be coordinated with the National Oil Spill Contingency Plan. It also requires approval by the EPA. Ghana joined the International Labour Organisation in 1957.

1.2.6 Good Practice Standards and Guidelines

The International Finance Corporation Performance Standards for Environmental and Social Sustainability (2012) and associated EHS Guidance address environmental and social requirements that may apply to projects and are considered to represent Good International Industry Practice. The following guidelines are relevant to the Project.

- 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.

Guidance is also provided by:

- International Association of Oil & Gas Producers which has established industry guidelines and standards on environmental protection and personnel safety; and
- International Petroleum Industry Environmental Conservation Association on oil spill response and contingency planning for the marine environment.

1.2.7 Pecan Energies Policies and Standards

The Pecan Project will also be conducted in compliance with the environmental and social policies and standards of Pecan Energies (as Operator or as otherwise approved by the Contactor Group), and recognised industry practice standards, design codes and practices. These include the overarching Pecan Energies Code of Conduct. The Code of Conduct addresses:

- Human Rights;
- Labour Standards;
- Health, Safety and Environment;
- Corporate Social Responsibility; and
- Local Content and Long-Term Local Value Creation.

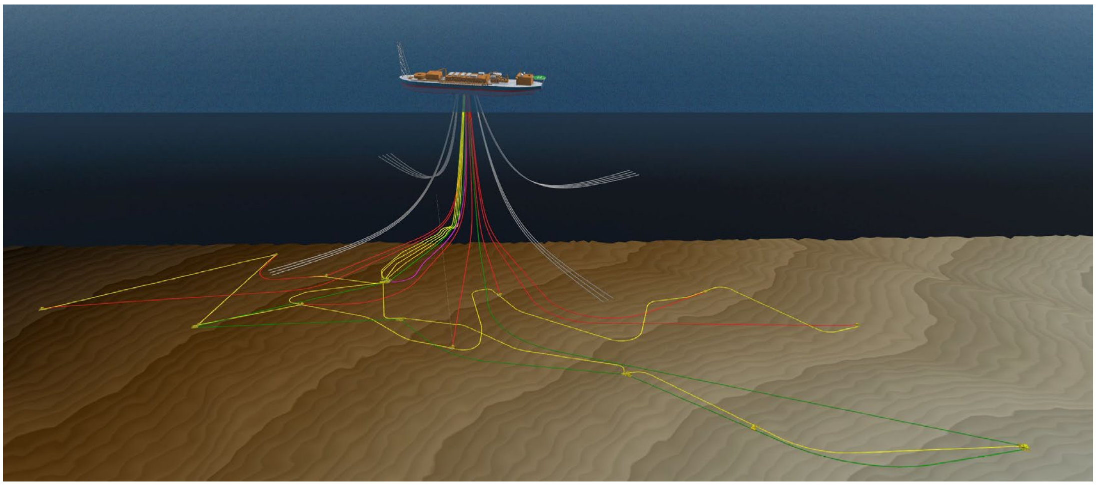
In addition, the Pecan Energies Health, Safety, Security, Environment and Quality Policy (HSSEQ) will apply to the Project activities.

1.3 Project Overview

1.3.1 Pecan Development and Schedule

A phased development of the resources in the Contract Area will start with the development of the Pecan Field, as Phase 1, based on a FPSO as a field processing and crude export centre.

Phase 1 will have a total of 14 subsea wells to be developed over two sub-phases: Phase 1a and Phase 1b. Phase 1a will have seven wells and Phase 1b will have seven wells. Figure 2 illustrates the seabed locations for the Phase 1a and Phase 1b wells.



NTS-Figure 2 Pecan Phase 1a and 1b illustration

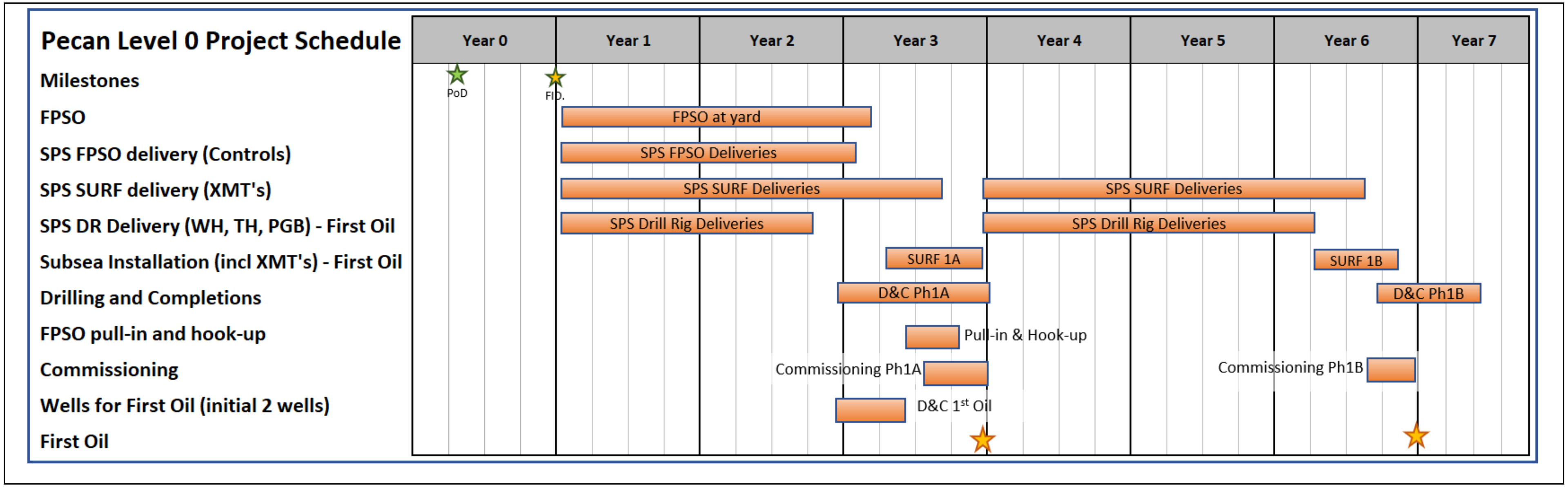
Figure 3 shows the indicative schedule for the Pecan Phase 1 Project up to the commissioning of Phase 1b. The schedule is based on the time required for FPSO conversion/fabrication, sub-sea installation and hook up, well drilling and completions, and commissioning following the project execution startup after final investment decision. 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 Phase 1a oil producers give an initial production of approximately 70,000 to 80,000 barrels per day, which will be maintained when Phase 1b comes on stream three years after first oil. Offloading of the cargo crude will be approximately every ten to fourteen days to export tankers, when on plateau production.

1.3.2 Facilities Description

1.3.2.1 Floating Production Storage and Offloading Vessel

The FPSO will receive hydrocarbons from the production wells, process them and store the crude oil until it can be offloaded onto an export tanker. The Project will use an existing FPSO that will be modified to operate on the Pecan field (see Figure 4 for illustration). The FPSO has a cargo storage capacity of 1,285,000 barrels. It has a double bottom and the starboard side, where supply vessels can approach, will be modified with a Sandwich Plate System for added collision protection. Port side will have an arrangement of riser pipes from the seafloor to the vessel and will be a restricted area for all vessels. The original steel in the sides of the DB-1 FPSO is very thick and strong. The FPSO will be moored in position using a spread anchor mooring system in approximately 2,700 m water depth.



NTS-Figure 3 Pecan Phase 1 Drilling, Installation and Commissioning Schedule

NTS-Figure 4 Photograph of FPSO Dhirubhai-1 (Ghana FPSO Company)

1.3.2.2 Safety Zones and Advisory Areas

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 (e.g. fishermen) when potentially close to the FPSO or MODU (when present). These areas will be mapped on international nautical charts and formally designated by the Ghana Maritime Authority and endorsed by the International Maritime Organisation. The enforcement will also be applied by project standby and guard vessels.

There will be a permanent safety zone of 500 m radius surrounding the FPSO facility and a temporary safety zone of 500 m radius applied at each of the drill centres when the dril ship is present. In addition there will be a 3 nautical mile (5.556 km) radius advisory area around the offloading tanker waiting area where tankers will be located prior to coupling for crude oil offloading.

1.3.2.3 Subsea Systems

Subsea infrastructure will be required to support production, water injection, gas injection and for system control. There will be one combined production loop for Phase 1a and 1b, where the Phase 1b wells will be connected to the production loop at the later stage.

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. A combined water alternating gas injection system will be used for reservoir pressure support and increase oil recovery. All gas that are not used for gas turbine fuel or artificial gas lift, will be injected in the reservoirs through the injection wells. There will be no routine flaring of gas.

1.3.2.4 Shore Base

The Pecan Energies headquarters are in Accra, and it is likely that these facilities will be expanded as well as offices established in Takoradi to support supply chain and project management functions. Contractors providing services such as rental of drilling equipment and provision of drilling fluids will operate out of their own shore bases.

Marine vessels and helicopters will be required to support the 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. Other than offices and access to port facilities, including some storage areas, Pecan Energies do not require to set up a separate shore base.

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 FPSO will undergo conversion/fabrication in a yard outside Ghana, although some modules and systems may be fabricated in other locations. Fabrication of items such as suction piles, supporting engineering services, and installation activities may be undertaken within Ghana, subject to capacity and contractual agreements.

1.3.3 Project Activities

1.3.3.1 Drilling and Completions

A drill ship will be used for drilling and completing the development wells. There will be two types of wells: oil producing wells and injection wells (capable of alternating between using gas and seawater). Two types of drilling fluid are typically used: Water Based Muds for the upper well sections; Non-Aqueous Drilling Fluids (NADF) for the lower well sections.

Drilling the seven Phase 1a will take approximately one to two months per well, over a 12-month period with the Phase 1b wells taking a similar time per well, commencing three years later.

After wells have been drilled a process known as well completions and clean-up 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, sand filters and pressure and temperature gauges will be installed into producing wells to provide improved operational control and 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 and clean-up will take about a month per well.

1.3.3.2 Infrastructure Installation

The FPSO would sail under its own power or be towed from the conversion yard to the installation site. Installation of the FPSO mooring suction piles will be performed prior to FPSO arrival. Subsea Production Systems and flowlines, umbilicals and risers will be installed as a part of the subsea infrastructure.

1.3.3.3 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 flowlines and subsea equipment will be pressure tested (hydrotested) to verify system integrity and flushed with potable or treated seawater prior to commissioning. The specific chemicals and additives that would be used would be in line with the Harmonized Offshore Chemicals Notification Format to ensure the least hazardous available chemicals are used.

1.3.3.4 FPSO Operations and Export Tanker Operations

The FPSO will be operated by the FPSO Owner according to an Operation & Maintenance agreement with Pecan Energies. 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.

- Produced water will be treated and discharged overboard.
- Seawater and excess gas will be treated and injected into the reservoirs to maintain reservoir pressure.

Other contracts with external vendors will include the following.

- Shore base facilities and storage areas.
- Quayside /berth area.
- Helicopter transportation and booking services.
- Marine operations (construction and supply vessels, tanker offloading support vessels, guard vessels).
- Production and injection chemicals.
- Diesel and fresh water supply.
- Waste handling services.

1.3.4 Emissions, Discharges and Waste Generation

1.3.4.1 Emissions to Air

Emissions to air will result from the combustion of fuels, such as marine gas oil, gas and aviation fuel, consumed to support field development (Drill ship, field support vessels and construction support vessels and production operations (FPSO and vessel engines, FPSO topsides equipment and helicopters).

These will result in emissions of greenhouse gases and pollutants such as carbon dioxide (CO_2), methane, volatile organic compounds, carbon monoxide, oxides of nitrogen (NOx) and sulphur (SOx), and particulate matter.

The generators existing on the FPSO are being replaced by low NOx Dry Low Emission gas turbine generators resulting in approximately 65% reduction in NOx emissions from this source.

Associated gas will be used for fuel on the FPSO or for gas reinjection. There will only be gas flaring undertaken during the commissioning phase but there will be no routine flaring of associated gas, other than under specific situations to maintain safe conditions or during activities such as process start-up and maintenance shut-downs.

FPSO cargo tanks will be maintained in a pressurised state using a hydrocarbon ‘blanket’ gas 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 in a recovery unit and sent to the gas handling system for mixing with produced gas.

1.3.4.2 Light

Offshore activities will require 24 hr operations therefore light is required to maintain a safe working environment on the drill vessel, FPSO, construction and support vessels. Onshore operations will require some 24-hr working, for example at the port, and adequate lighting will be required for safety and security.

1.3.4.3 Discharges

The drill ship, FPSO, construction vessels and support vessels operations will result in routine discharges to sea (i.e. sewage, grey water, food waste, bilge water, ballast water and deck drainage. In addition, the drill ship will discharge cleaned drill cuttings from the drilling of the well, with small amounts of residual drilling fluid. FPSO operation discharges will include produced formation water that has been treated to remove oil droplets. The treated formation water will contain low concentration of oil droplets as well as production chemicals. Drilling, completion and production chemicals will be chosen to have minimum impacts on the aquatic environment. The Guidelines on Environmental Assessment and Management in the Offshore Oil and Gas Development in Ghana (EPA 2011) define four hazard categories of chemicals, with green chemicals as the most environmentally friendly. The Project will have procedures to substitute chemicals with more environmentally friendly substances whenever possible.

Discharges to water from the drilling, completion, installation and commissioning activities, are outlined in Table 1.

NTS-Table 1 Summary of Discharges and Treatment

Discharge and Source	Treatment
Black Water from vessels, MODU and FPSO	Treat with approved sanitation unit. Maceration and Chlorination
Grey Water from vessels, MODU and FPSO	Remove floating solids
Food Waste from vessels, MODU and FPSO	Macerate to acceptable levels
Deck Drainage from vessels and MODU	Oil-water separation
Bilge Water from vessels, MODU and FPSO	Bilge water separator
Ballast Water from vessels	Replace ballast water on acceptable distance from national waters when arriving from other regions.
Drill cuttings and fluid from drill ship	Water based mud drilled section: No treatment – discharge to seafloor. Unused fluid will be returned to supplier. NADF drilled section: Mud recycled using solid control equipment. Unused retuned to supplier
Cement returns from drill ship	None
Cement slurry and washdown water from drill ship	None
Completion fluids from drill ship	Oil-water separation. Any acids used will be neutralised to pH 5-7 by addition of soda ash or similar prior to discharge
Pre-commissioning - treated seawater from FCG, hydrotest and leak tests.	No treatment prior to discharge.
Pre-commissioning - gas system dewatering fluids – treated seawater and MEG.	No treatment prior to discharge.
Production system commissioning fluids from FPSO – treated seawater, diesel or crude.	Treated water processed on FPSO via oil in water treatment system.
Produced water from FPSO	Centrifugation and floculation filtering.

1.3.4.4 Accidental Releases

Accidental releases of chemicals and / or hydrocarbons may occur. Barriers to prevent spill to sea are the primary measures to reduce risk for accidental releases.

The main well control barriers during drilling operation will be from the following.

- Primary Well Control, a conditioned and monitored drilling fluid is the primary means of well control in all well construction operations.
- Secondary Well Control is the Blowout Preventer that will shut down the well flow in case of loss of primary well control.
- Tertiary Well Control will be needed in case both primary and secondary well control is compromised and will be deployment of a capping stack at the well head or drilling of a relief well.

The FPSO will be designed with a separate drainage system for areas with risk for spill of chemicals or hydrocarbons.

The secondary measure will be oil and chemical spill response. The FPSO and drill ship will have oil and chemical spill response equipment to contain and recover small spills onboard the installation. In the unlikely event of a large oil spill, there will be an oil spill response according to the Project oil spill contingency plan (OSCP). The OSCP, part of the Project's Emergency Response Plan, will be developed, based on input from an oil spill risk assessment and an oil spill contingency assessment, giving requirements for response capacity and capability.

1.3.4.5 Underwater Noise

The MODU and installation vessels and support vessels will introduce sound into the marine environment during their operation from propeller cavitation and propulsion. Underwater noise will also be produced from drilling activities and during operational equipment such as flowlines and valves.

1.3.5 Solid Waste Management

Non-hazardous and hazardous solid waste will be generated at onshore and offshore facilities during all project phases. Most of the solid wastes generated offshore will be transferred from the FPSO, drill ship and support vessels and appropriately managed onshore. Waste will be treated and disposed in accordance with procedures outlined in the Project Waste Management Plan (WMP) to be developed as part of the ESMP.

1.3.6 Local Content

The achievement of the local content strategic objectives will be facilitated through the implementation of the Local Content Management Plan. In addition, all subcontractors will be required to outline their proposed Local Content Management Plan in their bid documents with the expectation that, if selected, their plan will be incorporated in the corresponding Contract.

Pecan Energies has developed guidelines on recruiting and employment practices, training and succession practices, and reporting of training and employment activities, to ensure compliance with applicable requirements and to achieve Pecan Energies strategic local content objectives.

1.3.7 Decommissioning

At the end of economic life of the Pecan Field, the Field facilities and wells will be decommissioned and/or abandoned in accordance with the Petroleum Agreement, applicable Ghanaian Acts and Regulations and relevant international petroleum industry practices. A detailed Decommissioning and Abandonment Plan will be submitted to the EPA between two and five years prior to the planned cessation of production operations, as required by the Petroleum Agreement. The Decommissioning and Abandonment Plan will include decommissioning methods and procedures for individual components of the Pecan 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.

1.4 Baseline Environmental and Social Conditions

1.4.1 Baseline Data Collection

The baseline includes information on receptors and resources that were identified during the 2019 scoping phase and through stakeholder consultations undertaken as part of the EIA between November 2021 and March 2023 as having the potential to be significantly affected by the proposed Project. Stakeholders included national, regional and district authorities, traditional leadership, Non-Governmental Organisations and communities in the coastal districts of the Western Region.

A marine Environmental Baseline Survey (EBS) was undertaken in 2013/2014 within the Contract Area which included physio-chemical data on water and sediment quality and characterisation of benthic communities. Geotechnical and geophysical surveys as well as additional water and sediment samples were collected in 2021.

1.4.2 Physical Environmental Baseline

1.4.2.1 Climate and Meteorology

Regional climatic conditions are 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 movement of the ITCZ.

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.

Climate variability is linked to changes in the movement and intensity of the ITCZ as well as variations in the timing and intensity of the West African Monsoon, which is influenced by the El Niño Southern Oscillation. El Niño is connected to below normal rainfall in West Africa.

1.4.2.2 Air Quality

The Project is located between 90 and 103 km from the coast of Ghana (locations of the closest and farthest away wells) and the FPSO location is approximately 98 km from the nearest coast. The Project is 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 in the proximity as well as vessels involved in oil and gas operations in the area including process emissions from the Jubilee Field FPSO and TEN Field FPSO to the north of the Contract Area, and combustion emissions from exploration and appraisal well drilling in the vicinity. In general, the airshed in the Project Area offshore is considered un-degraded.

Onshore air quality in the Western Region of Ghana 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 Sekondi-Takoradi Metropolitan Assembly (STMA), due to combustion sources used for cooking and space heating, road traffic, local and industry. The principal source of atmospheric pollution in urban areas in the region are from biomass burning, e.g., firewood for cooking and heating, and controlled burning for agriculture. Other sources of urban air pollution will be from transportation, industrial pollution, and non-combustion sources.

1.4.2.3 Climate Change

The Ghana Government ratified the United Nations Framework Convention on Climate Change in September 1995. The Environmental Protection Agency calculated the greenhouse gas GHG emissions for Ghana that have increased from 25.34 metric tonnes (Mt) CO_{2e} in 1990 to 42.15 Mt CO_{2e} in 2016. Countries with a dependence of the majority of the population on agriculture, particularly rain-fed agriculture as well as widespread poverty that reduces the population's ability to withstand climate stress are vulnerable to the effects of climate change. In Ghana 25% of the population lives along the coast and 45 % of the workforce depends on rain-fed agriculture.

1.4.2.4 Hydrology and Oceanography

Tides, Currents, and Waves

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. Surface water temperatures are warm (24ºC to 31ºC) with the daily sea surface temperature cycle showing annual variability. The water temperature decreases with depth to below 5°C near the seabed.

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 March. 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.

Bathymetry and Topography

The continental shelf at about 200 m water depth off the coast of the Western Region of Ghana is at its narrowest off Cape St Paul in the east (20 km wide) and at its widest between Takoradi and Cape Coast in the west (90 km). The continental slope is steep, and the depths increase sharply from approximately 100 m on the shelf and drop to approximately 1,600 m at the deepest part of the slope. The Project Area is located on the deeper portion of the continental slope in water depths ranging between 1,600 to 2,700 m.

Water Quality

Water samples collected during the 2013/2014 EBS showed the water quality to be good with low levels of nutrients, suspended solids and contaminants such as hydrocarbons and metals.

Sediments

Sediment samples analysed from the EBS and a later survey in 2021 showed that sediments across the Contract Area were found to be generally similar, mainly comprising fine or medium silt with low levels of organic carbon. Sediment quality is generally good with concentrations of metals, hydrocarbons typical of background levels.

Noise, Vibration, Light

Existing noise, vibration and light levels in the Project Area will be from natural sources (such as water movement, weather events and natural light cycles) as well as from marine traffic.

1.4.3 Biological Baseline

1.4.3.1 Plankton and Invertebrates

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 main upwelling season which starts in June to October. 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 2013/2014 EBS found that the macrofaunal community in the Contract Area has a low abundance but proportionally high diversity. Many of the sites exhibited a high level of bioturbation indicating burying fauna. Polychaetes, arthropod, crustaceans and molluscs dominated species composition and abundance, with relatively few echinoderms or other taxa present in the samples (see example in Figure 5). No potentially sensitive or threatened species were observed during the EBS. No corals were observed in the EBS or in the seabed mapping surveys undertaken in 2021.

Molluscs and Crustaceans

A variety of molluscs and crustaceans are known to be present within the DWT/CTP blocks. These mostly occupy the closer to shore, shallower waters and are not found in the water depths at the Pecan field. These include the common cuttlefish, pink cuttlefish, common squid, common octopus, the royal spiny lobster, deep-sea rose shrimp and other shrimps.

1.4.3.2 Fish

Pelagic Fish

The pelagic fish are those that live in the water column. The distribution and quantity of each population largely depend on hydrological conditions, with each species distributed according to the optimum temperature and salinity required for growth and reproduction. Most of the fish species have spawning grounds offshore Ghana and spawning of different species takes place throughout the year, typically with a peak from April to November.

Small pelagic fish in the coastal and offshore waters of Ghana include round sardinella, flat sardinella, European anchovy and chub mackerel. The large pelagic fish species include skipjack tuna, yellowfin tuna and bigeye tuna, swordfish, Atlantic blue marlin and Atlantic sailfish. Shark species include blue shark and hammerhead shark.

Demersal Fish

Demersal fish species are those that live on or near the seabed. They are usually found over the continental shelf and the continental slope. Their distribution and composition is influenced by oceanographic conditions and specifically by the upwelling that results in changes of the bathymetric extension suitable for different species. The density of demersal species is higher on shallower waters up to 50 m depth. Surveys have shown that demersal fish are widespread on the continental shelf along the entire length of the Ghanaian coastline. Species composition is a typical tropical assemblage including porgies or seabreams, grunts, croakers or drums, goatfish, snappers, groupers, threadfins, emperors and triggerfish.

Fix282: Silt with occasional shell fragments, Echinodermata (Scotoplanes sp.)

Fix286: Silt with occasional shell fragments Mollusca (Scaphopoda), Bioturbation

Box Core: Fine silt with clay, no visible live fauna

Sieve: Sand, shell fragments and small clay aggregates Fauna, no visible live fauna

NTS-Figure 5 Example Sampling and Seabed Photograph from Pecan-A (Gardline 2014)

Deep Sea 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, including approximately 110 that are principally pelagic, 60 that are principally demersal and 10 that frequently migrate between the bottom and higher layer of the seabed.

Protected or Endangered Species

The main fish species of concern offshore Ghana according to the International Union for Conservation of Nature (IUCN) Red List are angle sharks as they are considered as Critically Endangered and shortfin mako, longfin mako and whale sharks as they are Endangered. The tuna species are subject to international regulations and monitoring.

1.4.3.3 Marine Mammals

The water of the Gulf of Guinea and offshore Ghana are considered favourable to the presence of marine mammals, especially due to the seasonal upwelling, which boosts productivity and therefore ensures food availability for these species. The results of surveys, including the EBS (which recorded sperm whale, Bryde's Whale, short-finned pilot whale, clymene Dolphin bottlenose dolphin, melon-headed whale, Fraser's dolphin, spinner dolphin and pantropical spotted dolphin) and historic beach standings data indicate that the whale and dolphin fauna of Ghana is moderately diverse with 18 sub-tropical pelagic species identified. The main marine mammals of concern are sei whale as they are considered as Endangered and sperm whale, as they are classed as Vulnerable.

1.4.3.4 Sea 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 loggerhead, olive ridley, hawksbill, green turtle and leatherback. Olive ridley, green and leatherback sea turtles are known to nest in Ghana regularly, and hawksbills are thought to have nested historically. Records of loggerhead turtles nesting on one beach have also been recorded. The beaches of Ghana from Keta to Half-Assini in the Western Region of Ghana are important nesting areas for sea turtle species.

The IUCN Red List classifies hawksbill turtles as Critically Endangered, green turtles and loggerhead turtles as Endangered and olive ridley and leatherback turtles as Vulnerable. All five species of sea turtles are listed by the Convention on International Trade in Endangered Species (CITES) and National Wildlife Conservation Regulations.

During a seismic survey of areas in the Contract Area carried out from November 2013 to April 2014 leatherback, olive ridley and hawksbill turtles were observed.

1.4.3.5 Seabirds

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. 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. Species of waders known to migrate along the flyway include sanderling and knott.

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.

1.4.3.6 Protected and Sensitive Areas

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). These coastal habitats are important for their biodiversity as well as for rare and endangered species.

Ghana has not established any marine protected areas, however five coastal areas are currently protected. These areas are all located onshore and are protected under the Ramsar Convention. None of these protected areas are located along the coast of the Western Region. There are six Important Bird Areas (IBAs) along the coastline of Ghana, with one, the Amansuri Wetland (which is the largest stand of intact swamp-forest in Ghana) is located along the western coastline.

1.4.4 Socio-Economic and Health Baseline

1.4.4.1 Introduction

The baseline draws on primary data collected through extensive consultations on national, regional and local level, as well as available secondary data (eg district development plans and census data) and. Secondary data included the 2021 Population and Housing Census.

1.4.4.2 Administrative Structure

There is a dual system of governance in Ghana made up of formal government structures and traditional leadership structures. The decentralised Local Government System comprises three levels of administrative authorities, namely national, regional and district in both systems.

The Local Government System is made up of the Regional Coordinating Council (RCC), four-tier Metropolitan and three-tier Municipal/District Assemblies. Under these fall the Sub-Metropolitan District Council, Zonal Council and Urban/Town/Area/ Councils, as well as Unit Committees. A District Assembly is established by the Minister of Local Government and serves as the highest political authority in each district.

The Western Region has Sekondi-Takoradi as its capital. Within the Western Region there are 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.

1.4.4.3 Demographic Profile

Demographics

The population of Ghana is approximately 30.8 million (2021 data), an increase of over 6 million since the 2010 census. The 2021 Ghana Population and Housing Census indicated there was a big difference between the rate of growth of the urban and rural population in Ghana, reflecting a shift of the population from rural to urban localities. The new Western Region (formed after the 2018 administrative reorganisation) had a total population of 2,060,585 or 6.7% of the national population.

The birth rate per woman in 2020 was 3.8. The life expectancy at birth for Ghana was 64 years (both sexes combined), increasing from 46 years in 1960.

Age and Gender Distribution

In the Western Region, 44.8% of the population is below the age of 14, 51.9% between 15 and 64 and 3.3 % above 65. The high proportion of youth leads to a relatively high dependency level in the Region. This dependency places a demand on the economically active sector of the population and thus households have difficulties in maintaining and/or improving their standards of living.

Urbanisation

Approximately, 51.6 % of the Western Region is urbanised and the remaining 48.4% is rural (the rural/urban classification of localities is population based, with a population size of 5,000 or more being urban and less than 5,000 being rural).

Population Change

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.

Ethnicity and Language

The official language of Ghana is English, and it is the main medium for teaching in schools from the fourth year of basic schooling. Other languages spoken in Ghana include Akan, Dagaare, Dagbani, Dangme, Ewe, Ga, Gonja, and Kasem. The dominant ethnic group in Ghana is Akan, which is made up of a number of smaller ethnic groups, each of which has its own language. The population in the Western Region consists predominantly of people from Akan decent and is dominated by two ethnolinguistic groups: the Nzema and the Ahantas.

Religion

The predominant religion in the coastal districts in the AoI in 2020 is Christianity (82.65%) followed by Islam (8.3%). The rest of the population are either Traditional believers, belong to other religious affiliations (i.e., Buddhists, Hindus, Rastafarianism, etc) or profess no religion.

1.4.4.4 Human Rights, Poverty and Conflict

The Ghana Commission on Human Rights and Administrative Justice has a mandate to protect universal human rights and freedoms, especially those vested in the 1992 Constitution. These include labour rights, fair treatment and equal pay, child labour and forced labour.

According to the 2015 Ghana Poverty Map, STM, Jomoro and Wassa Amenfi Central are the districts with the highest number of poor persons in the Western Region. Vulnerable groups that may be present in the coastal districts include:

- low-income households;
- female-headed households;
- households with a high number of dependents;
- households with limited or no access to land;
- households with limited or no alternative livelihood activities other than fishing;
- households with elderly and/or disabled individuals; and
- people with HIV/AIDS.

Conflict in communities may occur because of many factors. Indebtedness, ethnic/ tribal conflict, political differences, land disputes, chieftaincy, and religion, among others, are mostly the cause of conflict in communities. In the Western Region, chieftaincy was the major cause of conflict in communities, followed by land disputes and conflict due to ethnic/tribal differences.

According to the Ghana Statistical Service (2019) the majority of communities in Ghana), had never experienced any force or violence by other groups of people or one group against the other, although approximately 20% of communities indicated that their communities occasionally experienced this in the three years prior to the 2019 survey. At the regional level, the Western Region ranked third out of the ten regions with the highest percentage of people indicating they feel very safe with only 0.5% of the people in the Western Region indicated to be feeling very unsafe.

1.4.4.5 Land Tenure and Use

Ghana maintains a dual land tenure system, comprised of customary and statutory land tenure. Customary owners own about 78% of the total land area in Ghana, the State owns about 20% percent while the remaining 2% percent is held in dual ownership. Most of the land in the Western Region is used for the commercial exploitation of natural resources. In the coastal districts, land is mostly used for community infrastructure and subsistence farming.

1.4.4.6 National and Regional Economy

The Gross Domestic Product (GDP) in Ghana was 68.53 billion US dollars in 2020, according to official data from the World Bank and projections from Trading Economics. Per capita GDP in 2020 was 2,205.5 USD. Ghana's service sector is the largest sector of the economy, followed by agriculture (including fishing) and industry.

The Western Region's economy currently revolves around agriculture (including fishing and forestry), mainly small landholders and artisanal fishers. Other major sources of employment include mining and quarrying and manufacturing. The Western Region has considerable natural resources (minerals: gold, manganese, bauxite, forest reserves, timber, cocoa, oil palm and coconut), which gives it a high level of economic importance within the context of the national economy. Other economic activities undertaken in the Western Region includes offshore oil & gas production, imports and exports, and, to a limited extent, tourism.

According to the 2020 Census Data for the Western Region, approximately 60.2% of the population were economically active, with 85.2% of these being gainfully employed. 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.

Fisheries

Information on fisheries was derived from published sources and through primary research undertaken to obtain information on fisheries activities in the Pecan Project area.

There is a long tradition of both artisanal and commercial fishing in Ghana. Ghana's marine fisheries are spread along 550 km of coastline and concentrated on its approximately continental shelf. The fisheries sector contributes significantly to the local economy in the Western Region in terms of food security, employment and poverty alleviation.

These waters form part of the Gulf of Guinea Large Marine Ecosystem and are highly productive due to the Central West African Upwelling. Fishing occurs all year with periods of higher landings linked to the upwelling periods when 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.

The fish biomass is primarily composed of small pelagics: primarily round sardine, flat sardine, chub mackerel and anchovy. These species also support populations of large pelagics such as tuna, marlin, swordfish and sharks. In addition, the upwellings support important demersal fisheries along the continental shelf.

The artisanal fishery accounts for about half of the total marine catch in Ghana. It involves the use of canoes or dug-out wooden boats with inboard or outboard engines. The fishing gears are diverse, including beach seine nets, purse seine nets, set nets, drift gillnets, and hook and line. Artisanal fishers are mobile following the small pelagic fish stocks that in turn are dependent on the location of the upwelling, which can vary along the coast during the fishing season. They operate anywhere in the Ghana Exclusive Economic Zone, although most fishermen operate in the inshore, shelf waters (typically within 15 km of the shore).

However, artisanal fishermen have been observed in deeper waters near offshore oil drilling and production installations at distances of beyond 60 km from the shoreline. The latest statistical survey (from 2016) estimated 11,583 active fishing canoes in the artisanal fisheries in Ghana.

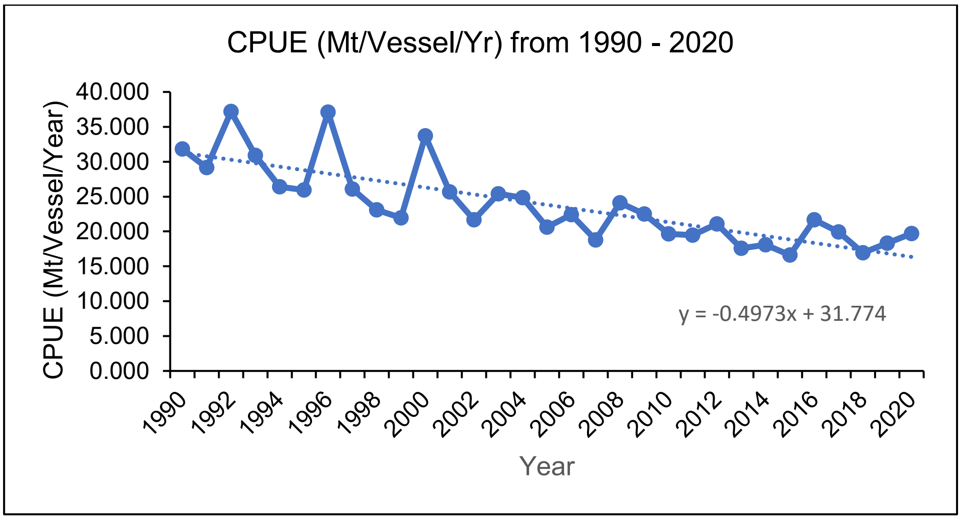
The inshore (or semi-industrial) fishing fleet consists of locally built wooden vessels fitted within inboard engines ranging between 8 and 37 m in length. The vessels are generally multipurpose and carry both purse-seine and bottom trawl gear, exploiting both small pelagic and demersal species. There are approximately 224 inshore vessels operating from seven landing centres.

The industrial fleet comprises large, steel-hulled, foreign-built trawlers, shrimpers, tuna pole-and-line and tuna purse-seiners. Trawlers are normally 35 m in length and mainly exploit the demersal fish, including sole and flounders, groupers and cuttlefish as well as shrimps and pelagic tunas. They also target other species including porgies or seabreams, jacks, snappers, croakers, goatfish. In 2020 there were 76 active vessels.

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 30 vessels registered in 2020, 16 were purse-seiners and 14 were pole-and-line vessels. Most tuna vessels operate outside the continental shelf.

Ghana is faced with several forms of Illegal Unregulated and Unreported fishing practices, including the use of illegal fishing gears, overexploitation, overcapacity, light fishing, fishing with explosives, and illegal transhipment at sea.

Figure 6 shows the Catch-Per-Unit-Effort (CPUE), in tonnes of fish caught per vessel per year, from 1990 to 2020 for the artisanal, semi-industrial and industrial trawler sectors. The figure shows a general decline in fish stocks over the past three decades (1990 - 2020), indicative of diminishing stock due to overfishing. Catch from artisanal fisheries make up about 55% of total marine capture fisheries.



NTS-Figure 6 CPUE from 1990 to 2020 (Ghana Fisheries Commission 2022)

Oil and Gas Activities

Oil and gas was discovered off the coast of Ghana's Western Region in 2007 with the first production commencing in 2010. Ghana has three offshore and one onshore petroleum basins, which comprise the Tano-Cape Three Points Basin/ the Western basin; the Saltpond Basin / central basin; Accra–Keta Basin / eastern basin and the onshore Voltaian Basin. The Western Basin is currently the most active and includes the Deepwater Tano and Cape Three Point basin. The Jubilee Field straddles Tano and Cape Three Points, the TEN Fields are located in Tano, and the Sankofa Field is located in Cape Three Points. The Central Basin has Ghana's longstanding Saltpond field. The Eastern Basin includes both Accra and Keta Blocks, where exploration has been carried out without much commercial result to date. Lastly, the Voltaian Basin covers 40 per cent of Ghana's land mass and may have the potential for onshore petroleum extraction.

The country also has an active midstream and downstream oil and gas sector including a refinery at Tema and storage and distribution systems for refined products.

Tullow Ghana Ltd built a technical training centre at the Takoradi Polytechnic to provide skills to young people so they can be employed. In addition, there is the USAID Ghana Supply Chain Development Program that provides capacity support to small and medium enterprises and business service providers to participate in procurement tenders for contracts within the oil sector.

Mining

There are five major gold mines in the Western Region namely Teberebie and Iduapriem, Prestea/Bogoso, Tarkwa and Aboso-Damang gold fields. Tarkwa is one of the largest gold mines in Ghana and it is owned and operated by Gold Fields Limited. The mine is served by the main road connecting to the port of Takoradi some 60 km to the south on the Atlantic coast. The Damang concession lies to the north of and joins the Tarkwa concession, which is located near the town of Tarkwa. The area is served by access roads with established infrastructure, and the main road connects the mine to the port of Takoradi, some 90 km to the southeast.

Informal Economy

According to data from the Ghana Statistical Service (2019) more than 71% of employed persons in Ghana were employed informally and about 29% were engaged in the formal sector, with woman and urban dwellers more likely to be engaged in formal employment.

The informal sector in Ghana consists of various small-scale businesses, for example, producers, wholesalers and retailers. Informal sector workers are largely self-employed persons such as farmers, traders, food processors, artisans and craft workers.

The rural informal economy centres on the following.

- Agricultural activities focused on family farming units or community-owned assets. Farming is generally on a low technology basis dependent on family labour.
- Artisanal fishing is predominantly undertaken by males. Women generally undertake processing activities, including the smoking and marketing of fish in coastal villages.
- Rural agro-based processing activities of local crops. These include processing cassava, palm kernel, groundnut and copra oils, brewing distilling, and traditional soap making. These activities are generally undertaken by women.

The urban informal economy centres on the following.

- The services sector, for example, urban food traders, domestic workers and repairmen and women.
- The construction sector, for example, masons, carpenters, and small-scale plumbers (mainly men).
- The manufacturing sector includes, food processing, textiles and garments, wood processing and metal works.

Gender-based livelihoods

According to the WRCF Community Perceptions and Socio-Economic Survey (CPSES) Baseline Report (2016) data, both male and female heads of household in the coastal districts of the Western Region are engaged in the fishing and farming sector (44% of men and 38% of women) with the women mainly engaged in fish processing. Female heads of household are much more likely to be engaged in trade and sales and accommodation and food services. None of the female-headed households was engaged in the transportation and storage, construction, or public administration sectors, all of which employed substantial numbers of men.

Tourism

Ghana has a wide range of natural, cultural and historical attractions, which provides the basis for a growing tourism industry. The primary tourist sites in the Western Region pertain to national parks or reserves, forts and cultural heritage and beaches. These are considered sites that can attract tourists but would still need associated infrastructure developed to boost tourism in the region.

1.4.4.7 Education

Ghana has a basic education system that is compulsory up to the age of 15 (to end of junior high school).

According to 2016 data provided by the Ghana Statistical Service, the ratio of students enrolled in basic education schools across the six districts is higher than 20%, reaching approximately 40% in Sekondi Takoradi Metropolis. Attendance at senior high school and tertiary education is optional. There are currently 753 primary schools, 563 junior secondary schools and only 32 senior high schools in in the six districts within the AoI i. Many children, particularly those from the rural areas, are unable to access education, especially senior high schools, due distance and affordability. Nearly half (48%) of female heads of households had received no formal schooling, compared to 13% of male heads of households.

Schools across the six districts face significant challenges in terms of access to electricity, access to sanitary facilities, adequate teaching resources and insufficiently trained teachers across all sectors. Literacy levels for the over 6 years olds was approximately 70% in 2021. This could also be attributed to high levels of employment in the agricultural and fishing sectors requiring no formal education.

1.4.4.8 Health Care

The Ghana Ministry of Health is responsible for the health system in Ghana. There are 1,811 government-owned healthcare facilities and 1,356 private healthcare facilities (2020 data). In addition, the Christian Health Association of Ghana has a network of 302 health facilities and health training institutions providing health care to vulnerable and underprivileged population groups, particularly in remote areas. The use of traditional healers is common in Ghana and is recognised by the Ghana Health Service.

In the 2017 annual health report, the 895 health facilities recorded in the Western Region were made up of 50 Hospitals, 80 Health Centres, 126 Clinics, 601 National Community Health Planning and Services compounds and 38 Maternity Homes.

The National Health Insurance Scheme (NHIS) is a social intervention program introduced by the government to provide financial access to quality health care for residents in Ghana. The NHIS is managed by National Health Insurance Authority. In 2017, there were 10.5 million people, active members, within the NHIS, resulting in a coverage of approximately 35% of the population.

Various illnesses are prevalent throughout the Western Region. In data recorded in hospitals in the region malaria, diarrhoeal diseases, and anaemia were the top three reasons for admission. Road accidents show an increasing trend over the last few years.

1.4.4.9 Utilities, Infrastructure and Services

There are a series of major sources of drinking water in Ghana: piped (inside the dwelling, outside the dwelling, tanker supply), well (covered, uncovered), borehole and natural (spring, river, stream, lakes and rainwater). A number of these are reported as being non-functional and many were below the basic acceptable levels. Approximately 54 to 90% of houses in the region have access to treated water. The highly urbanised districts have 90% viability of, or accessibility to, piped water. This is in contrast to rural districts where over half of households use rivers, streams, dugouts, spring or rainwater as their main source of water.

Based on 2017/2018 data, only 66.5% of the population in Western Region has access to improved sanitary facilities, similar to the 65.2% national average. The use of public toilet facilities or open defecation is common.

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. Electricity dominates in urban areas and kerosene lamps in rural areas. Charcoal and fuel wood are the main sources of cooking fuel in the region (including urban dwellers), however liquid petroleum gas and coconut husks are also used as a source of cooking fuel.

The predominant means of waste disposal is either by dumping, at specified sites, or indiscriminately burning or burying refuse. The majority of landfills for solid waste are open, unlined, and largely unmanaged, giving rise to scavenging activities on the dumping sites and associated risks of disease, infection and personal injury.

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 Western Region is limited and the conditions of the roads can be very poor, particularly in the rainy season.

Ports and Harbours

The Ghana Ports and Harbours Authority (GPHA) 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 in STM in the west. Approximately 85% of Ghana’s trade is done through these ports.

The Port of Takoradi possesses the majority of the basic infrastructure required to support the current offshore oil and gas industry. It has embarked on a major expansion and investment program to transform the port’s capacity, facilities and operations, including the extension of the breakwater; provision of a bulk terminal/jetty to handle bulk commodities and dredging of the access channels and berths. 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.

In the Western Region, there are four other ports at Apam, Mumford, Elmina and Axim that provide landing facilities for inshore vessels.

Artisanal Fishing Landings Sites

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 fishing harbour, Elmina and Mumford. 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.

Information and Communication Technology

Ghana's Information and Communication Technology sector includes telecommunication service providers, internet service providers, software developers and training institutions. It plays an important role in Ghana's economic growth. The percentage of the population using the internet increased from 53% in 2019 to 58% in 2020. The percentage of households having a mobile phone is approximately 92 %.

1.4.5 Cultural Heritage

There is generally very little information on offshore marine heritage sites in Ghana, with the main sources being the site surveys undertaken by oil and gas operators. Marine surveys undertaken on behalf of Pecan Energies for geophysical and geotechnical purposes in 2021 and the EBS in 2013/14 did not identify any seabed wreckage or other sites of potential heritage value. During any future site surveys prior to drilling and laying anchors, additional information on any potential wreck sites will be identified, as these are areas to be avoided for drilling and field development purposes.

For the onshore areas, the Project will use facilities at Takoradi Harbour. The approved development of Takoradi Harbour was subject to its own EIA process in 2015. The issue of cultural heritage was scoped out of that EIA as the development was at an existing port. The Project will use contractors with existing shore bases in Takoradi and no new sites to be developed with Takoradi are planned. Therefore, potential impacts on onshore cultural heritage have been scoped out of the EIA.

1.5 Impact Assessment

1.5.1 EIA Assessment Methodology

The EIA scoping process identified key issues for assessment in the EIA based on industry knowledge of sources of potential impact associated with offshore oil and gas development and production and the issues raised during the scoping consultation process.

A methodical impact assessment was then carried out to predict the magnitude of impacts following the key stages below.

- Identification of potential environmental and social receptors.
- Identification of the activities of the proposed drilling, installation, commissioning, production and decommissioning activities with the potential to contribute to or cause impacts to environmental and social resources and receptors.
- Assessment of the likely magnitude of the impact (depending on its intensity, its duration, its scale, etc.), and the sensitivity of the resource and receptors affected to determine its significance.
- Impact significances are assessed for the Project including the embedded controls (i.e., those that have been incorporated into the Project design), and residual impact significances are assessed based on a consideration of the embedded controls and additional mitigation and management measures that have been defined during the IA process. 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.
- In addition to predicted impacts from planned activities, those impacts that could result from an accident or unplanned event within the Project (e.g. pollution event from a fuel or oil spill) are considered. 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, i.e. considering both the consequence of the event and the probability of occurrence. A summary of the EIA process is presented in Figure 7.

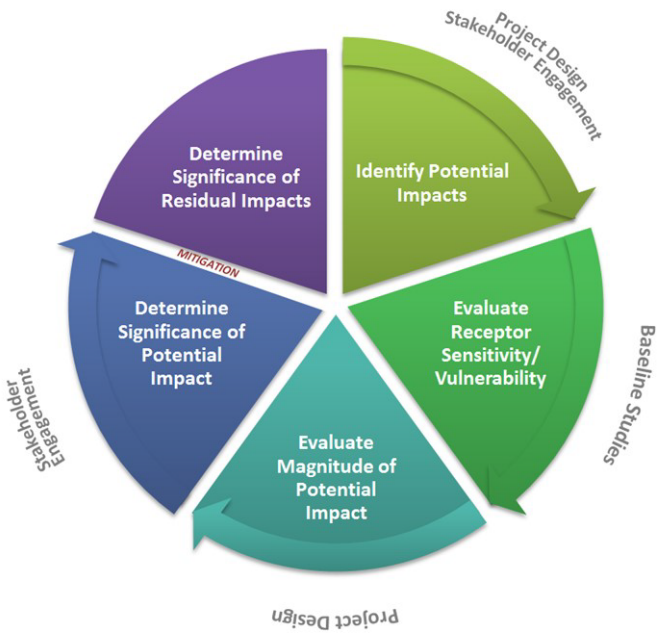
1.5.2 Summary of Impacts and Mitigation Measures

The assessment of impacts considered 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. A summary of the source of potential impact from the planned activities, the committed mitigation measures to address these impacts and the assessment of the residual impacts is presented in Table 2.

Overview

The purpose of the impact assessment process is to identify any likely significant effects on receptors/resources as a result of impacts from a Project and develop appropriate mitigation measures to effectively manage these environmental and social effects. The process is iterative and can be summarised by the figure to the right.

The detailed impact assessment methodology used is in accordance with widely accepted international practice for impact assessment. The overarching principles of this methodology are illustrated here, but note that each topic area will have specific criteria for defining receptor sensitivity/vulnerability and impact magnitude.



Evaluation of Significance

The significance of the potential effect on receptors/resources is determined through the combined consideration of:

- **the importance of the affected environment and its sensitivity/vulnerability to the particular impact being assessed, and**
- **the magnitude of the potential impact.**

Note that the term '**magnitude**' is used as shorthand to encompass various possible dimensions of the predicted impact, such as:

- the nature of the change (what is affected and how);
- its size, scale or intensity;
- its geographical extent and distribution;
- its duration and frequency; -and
- where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

		Sensitivity of Resources/Vulnerability of Receptors		
		Low	Medium	High
Magnitude of Impact	Negligible	Not Significant	Not Significant	Not Significant
	Small	Not Significant	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

There is no statutory definition of significance however, for the purposes of this assessment, the following practical definition is proposed:

An impact will be judged to be significant if, in isolation or in combination with other impacts, the effects will be a notable change from baseline conditions and may require mitigation to management environmental/social effects and risks.

Magnitude and vulnerability/sensitivity will be looked at in combination to evaluate whether an impact is significant and if so its degree of significance. The principle is illustrated here.

The impact assessment process evaluates both beneficial and adverse impacts, however the magnitude rating is only assigned for adverse impacts.

Residual Impacts/Effects

Is it still significant?

Once mitigation has been identified, a re-assessment of impacts to determine the magnitude and significance of any residual effects (after mitigation) will be undertaken.

The results are represented in the EIA Report, with an explanation of how the impacts have been reduced to as low as reasonably practicable (ALARP) levels.

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NTS-Figure 7 Environmental Impact Assessment Method

NTS-Table 2 Summary of Impacts and Mitigation Measures

Issue	Impact Summary	Key Mitigation Measures	Residual Impact
Seabed impacts on the benthic environment.	The 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, sediment disturbance, disruption to defined areas of the seabed and impacts on seabed habitats and species that rely on these habitats.	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.	Not significant
Underwater sound.	The Project will be the source of underwater sound from a number of activities including drilling, facilities installation and operation. Noise impacts will occur mainly to marine mammals but also to a lesser extent to turtles and fish.	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. 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 using vessels operating in the field.	Minor significance
Aerial noise impacts on natural populations.	Close to sensitive receptors the main potential impacts will be from general port activities involving Project vessels and helicopter flights to and from the offshore Project area.	Helicopter flight planning will make provisions to avoid sensitive areas of population and nature conservation. Pecan Energies will assure that the helicopter operator follows national and local regulations and restriction regarding flight routes.	Not significant
Lighting and flaring impacts mainly on birds, but also fish and turtles.	Lights (and flaring when used) on the MODU, FPSO and support vessels could potentially attract, disturb and disorientate seabirds and turtles feeding or passing through the area. Attraction or disorientation could increase the risk of collisions with the drill ship, FPSO and other vessels.	The requirements for lighting and use of flaring will be dictated by operational safety. Light will use the lowest intensity lighting appropriate for the task. Closed flare with no pilot flame. No operational flaring, except for during start-up, maintenance, gas injection downtime and when required for safety reasons.	Not significant
Risk of collision with marine mammals and turtles.	Large fauna swimming at or near the sea surface are most likely to be at risk from collision with the Project vessels. Turtles and species of larger, slow-moving whales are usually considered to be most at risk from vessel collision.	Measures for reducing vessel-animal collision risk will include direct observation, communication and navigational responses, particularly speed restrictions when the risks of collision are expected to be high. Support and supply vessels will adopt observation as part of regular navigation, communication and navigational responses, to reduce collision risks with marine mammals and turtles.	Not significant

Issue	Impact Summary	Key Mitigation Measures	Residual Impact
Emissions from vessel engines, impacts on air quality.	The Project will emit various pollutants to atmosphere as a result of combustion products (e.g. from power generation, vessels' engines) and from processes on board the FPSO. There is also the potential for fugitive emissions (e.g. volatile organic compounds during loading of oil to the shuttle tankers). However, it is a large distance from sensitive coastal receptors. Emissions from shore-based activities will be negligible compared with existing terrestrial emissions.	The FPSO, drill ship, construction vessels and supply vessels will comply with MARPOL standards with regards to emissions to air. The Project will use low NOx GTGs and use marine diesel fuel. Methods for controlling and reducing leaks and fugitive emissions, such as the use of fuel gas for crude oil storage tank blanketing together with a vapour recovery unit, will be implemented. Routine flaring will be avoided, and non-routine flaring will be kept to a minimum to maintain safe conditions or during short-duration activities such as commissioning, start-up, re-start and maintenance activities.	Not significant
Greenhouse gas emissions.	Project activities will emit varying amounts of Greenhouse Gases (GHGs) (e.g. carbon dioxide and methane, which contribute to global climate change). GHG emissions have been estimated for the Project and include well drilling and completions, subsea and FPSO installations, commissioning and operations.	The mitigation measures aimed at reducing GHG emissions to as low as reasonably practicable are built into the design of the FPSO and focus predominantly on: • efficiency of power generation; • optimisation of overall energy efficiency; • reduction in flaring; and • reduction in venting.	Moderate significance
Drilling discharges (fluids and cuttings).	Impacts on sediment and water quality and associated benthic and water column fauna. Modelling shows that small areas near the drill ship will be affected.	Solids control systems will be used, including dryers to reduce oil on cuttings to a target of 2 to 5% based on the Best Available Technology assessment undertaken by Pecan Energies. 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.	Not significant
Well completion and workover discharge.	Potential effects on water quality and marine biota.	Chemical selection and use will be advised by the EPA (2011) Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development. Completion fluids will be tested for total oil and grease content to ensure that it is below the specification for discharge to sea (i.e. 40 mgl^{-1} or the 30-day average of 29 mgl^{-1} as per EPA guidance. If the fluids exceed the specification, they will be retained on the vessel and shipped for onshore disposal.	Not significant

Issue	Impact Summary	Key Mitigation Measures	Residual Impact
Black and grey water discharge.	Discharges of black water (from toilets) and grey water (from washing, laundering, bathing and showering) and macerated food waste. Potential effects on water quality and marine biota.	Black water will be treated using a marine sanitation device that treats the waste and produces an effluent with a maximum residual chlorine concentration of 0.5 mg l^{-1} and no visible floating solids or oil and grease. Food wastes will be macerated to acceptable levels such that they will pass through a 25 mm mesh.	Minor significance
Hazardous deck drainage from drill ship and FPSO.	Residual hydrocarbon content after treatment. Impacts on water quality and marine biota.	Hydrocarbon contaminated fluids will be routed to a hazardous drain tank with oil/water separation. Process fluids sent to the hazardous drain tank will not be recycled into the process unless approved.	Minor significance
Non-hazardous deck drainage discharge from various Project vessels.	Occasional impacts on water quality and marine biota near the vessels.	Non-hazardous drains will be provided with removable covers to prevent debris from entering the drains systems. The system will have provision for biocide treatment.	Not significant
Bilge water discharge from various Project vessels.	Occasional impacts on water quality and marine biota near the vessels.	Treatment in the bilge water separator to achieve no free oil and maximum 15 parts per million instantaneous reading oil water threshold.	Not significant
Ballast water discharge from various Project vessels.	Occasional impacts on water quality and marine biota near the vessels.	Discharges will meet the requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments. Project vessels will have onboard and implement a Ballast Water Management Plan.	Not significant
Discharges of pre-commissioning treated seawater from flooding, cleaning and gauging flowlines, hydrotest and leak tests and pre-commissioning gas system dewatering fluids.	Impacts on water quality and marine biota close to the seabed points of release. The larger volumes discharged during hydrotesting may lead at most to temporary, small, localised effects on benthic communities.	Chemicals will be chosen to be minimise impacts on the aquatic environment in accordance with the EPA (2011) Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development.	Minor significance
Discharges of production system commissioning fluids from FPSO.	A small-volume one-off discharge with impacts on temporary, small, localised effects water quality and marine biota.	Treated water will be processed on the FPSO via the oil in water treatment system. Diesel / crude will be routed to the crude oil stock tanks.	Not significant
Releases of hydraulic fluid.	Occasional infrequent release of small quantities of low-toxicity fluids with temporary localised impacts on water quality and marine biota.	The subsea control system will use a water-based hydraulic fluid that is biodegradable with low toxicity and minimal impact to the marine ecosystem rated yellow according to the Ghana Guideline on Environmental Assessment and Management (EPA 2011).	Not significant

Issue	Impact Summary	Key Mitigation Measures	Residual Impact
Discharge of cooling water from FPSO.	The discharge will introduce a temperature differential and residual chlorine with impacts on water quality and marine biota. Modelling shows adequate dilution within 500 m.	Chlorine dosage will be kept to the minimum required to achieve disinfection and will be verified through monitoring.	Not significant
Discharge of produced water from FPSO.	Residual hydrocarbon content after treatment will have impacts on water quality and marine biota. Modelling shows the impacts will be over a small area. Mobile species will tend to avoid or be less exposed than plankton.	Produced water will be continually monitored and if oil in water exceeds the daily limit of 40 mgl^{-1} or the 30-day average of 29 mgl^{-1} as per EPA (2011), the water will be routed to the off-specification tank for further treatment prior to any discharge.	Minor significance for plankton
Potential impacts on the marine and onshore environment from waste segregation and storage.	The Project during its various stages will produce a variety of wastes that will require handling both offshore and onshore. Inappropriate or inadequate storage of wastes could lead to impacts on the marine and terrestrial environments.	There will be designated areas for the temporary storage and segregation of waste on the FPSO, drill ship 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. The key procedures for controlling wastes from offshore and onshore will be set out in the Project WMP.	Not significant
Potential impacts on the marine and onshore environment from transport of waste.	The Project during its various stages will require wastes to be transported to port and then from port to waste management facilities. Inappropriate or inadequate handling of wastes during transport could lead to impacts on the marine and terrestrial environments.	Mitigation of potential impacts during waste transport will be by the way of operational controls. These will be documented in the Project WMP.	Not significant
Potential impacts on the environment (onshore) from the treatment and disposal of waste.	Even with the application of reuse and recycling as part of Project waste management procedures there will be residual hazardous and non-hazardous wastes that require disposal.	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. Waste will be tracked, treated and disposed in accordance with procedures outlined in the Project WMP.	Minor significance
Impacts on fishing activity due to the presence of the Drill ship and FPSO.	The Project area is in an offshore area in water depths that precludes trawling or other bottom fishing activities. Pelagic fishing methods are used in these areas, mainly targeting large oceanic species, using passive gear (longlines) and active gear (pole and line, purse seines).	CLOs will liaise between fishermen and the Project to provide information to fishing communities and deal with any grievances. Mariners will be notified of the presence of the FPSO, MODU and other marine operations within the Project area and the safety and advisory areas will be marked on nautical charts as cautionary advice to all sea-usersThe safety zones will be monitored by Pecan	Not significant

Issue	**Impact Summary**	**Key Mitigation Measures**	**Residual Impact**
		Energies with the assistance of the agencies of the Government of Ghana.	
Impacts on fishing activity due to the movement of vessels between Pecan field and shore.	Vessels in transit could interfere with fishing activity over a wider area, including smaller fishing vessels nearer to shore.	A vessel transit route will be agreed with the Ghana Maritime Agency and communicated to fishermen and other marine users through the CLOs.	Minor significance
Benefits to Ghana nationally from increased Government revenue.	The primary economic impact of the operational phase of the Project will be the payment of taxes and royalties related to the income production by the Pecan Project.	Good governance and fiscal management are the key measures for Ghana's benefit from the economic gains by the royalties and taxes paid by the Project. The absolute value of oil will depend directly on market prices. Pecan Energies 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.	Moderate significance (positive)
Potential benefits from employment and skills development.	The Project is expected to contribute to the creation of direct and indirect employment opportunities in the Western Region. Given the nature of the Project's activities, the majority of the jobs will need to be filled with qualified and experienced personnel.	Pecan Energies will seek to enhance local employment and skills development from direct and indirect employment through the development of an Employment and Training Plan as part of the Local Content Management Plan.	Minor significance (positive)
Opportunities to provide benefits through the procurement of goods and services.	During the lifetime of the Project there will be procurement of goods and equipment (e.g. food, fuel, chemicals and other consumables), and services (e.g. onshore administrative support, accommodation staff, security, catering, cleaning) from national and, where possible, local businesses.	Additional measures will be included into the Local Content Plan in order to enhance procurement of goods and services from companies in Ghana.	Minor significance (positive)
Protection of workers' rights.	Workers' rights, including occupational health and safety, will be addressed to avoid accidents and injuries, loss of man-hours, labour abuses and to ensure fair treatment, remuneration and working and living conditions. These will apply to those who are directly employed by Pecan Energies and its contractors (including sub-contractors) and within the supply chain.	Pecan Energies has developed a People Policy, , company Code of Conduct, including contractor requirements for hiring, workers' rights, terms and conditions and monitoring of compliance with these requirements.	Minor significance

Issue	Impact Summary	Key Mitigation Measures	Residual Impact
Impacts on commercial shipping.	Additional vessel movements associated with the Project could arise as a potential source of impact on existing navigation and shipping traffic in the area. During the installation phase more vessels will be involved, and impacts would therefore be largest during this phase.	Pecan Energies will develop a Marine Traffic Management Plan which will also consider vessel movements associated with other Projects in the area as well as fishing and commercial shipping traffic. The plan will aim at reducing risk of vessel collision and minimising inconvenience to other sea users through a number of Project-specific measures.	Minor significance
Potential impacts on community health, safety, and security.	Onshore activities associated with the Project could affect the health, safety and security of the communities around the shore base facilities (e.g. worker-community, interactions, traffic movements, pressure on health care resources).	Pecan Energies has developed a Health Safety Security and Environment (HSSE) management approach outlining its responsibility for its personnel by means of systems. CLOs will inform local fishermen from the coastal communities of the offshore activities, locations, vessel movements, routes and timing, as well as the safety reasons for keeping away from operational areas.	Minor significance
Potential impacts from an influx of job seekers.	The expansion in communication, energy, transportation, water and sanitation, the social interactions of people and the development of the oil and gas industry over the past years, mainly based in STM, act as a pull factor to attract migrants into the city from different parts of the country. As the development of the oil and gas sector continues, additional influx of employment seekers can be expected into STM and surrounding areas.	Facilitated by its Stakeholder Engagement Plan, Pecan Energies will seek to develop strong partnerships with government agencies, traditional authorities, district assemblies, youth groups, non-governmental organisations, community-based organisations, civil society, fishing communities and other relevant stakeholders. In all its Corporate Social Responsibility projects, Pecan Energies will seek to actively engage affected stakeholders and local communities.	Minor significance
Risk of heightened and unmet expectations regarding potential benefits.	People in the Western Region are anticipating that oil and gas developments in the region will provide employment opportunities. More specifically, the communities are expecting that jobs will be made available for the youth who are unemployed or who are employed but seeking alternate employment.	Implementation of the Stakeholder Engagement Plan will be the key mitigation measure to redress public perceptions about potential Project benefits and to addressing public expectations related to development opportunities and investments.	Minor significance
Impacts on local communities from shore-based activities.	In addition to the expansion of the existing offices in Accra, the Project will establish a base within Takoradi port, comprising the use of a supply vessel berth, offices and material storage and laydown areas. These will all be within the existing established complex. In addition, accommodation in Takoradi for Pecan Energies staff will be required.	Pecan Energies will undertake periodic audits and reviews of its and its contractors' shore-based operations to review site EHS performance and take corrective actions as required. A Traffic Management Plan will be developed including a number of Project-specific measures.	Minor significance

Issue	**Impact Summary**	**Key Mitigation Measures**	**Residual Impact**
	Existing facilities will be adequate to support the Project and therefore no new-build infrastructure dedicated to the Project will be required.	Pecan Energies' CLOs will disseminate information about the Project to the community and process any suggestions, complaints or grievances received.	
Impact on Cultural Heritage.	Offshore, there are no historical records of wrecks sites in the Project area or evidence of wreckage from the site surveys undertaken. The location of shore-based offices will be within existing facilities at Takoradi port therefore there is minimal potential for impacts, therefore no mitigation is required.	For offshore operations a chance find procedure will put in place for any installation activities in areas not previously surveys.	Not significant
Offshore cumulative impacts.	The offshore impacts from the Project are generally localised to the Pecan field area, and specifically at the FPSO and subsea infrastructure locations. The Pecan field is some distance from other offshore oil and gas activity and the potential for impacts on the same receptors is limited.	The mitigations measures presented under the individual Project impacts in this table are also relevant to controlling cumulative impacts.	Not significant.
Onshore/nearshore cumulative impacts.	Closer to shore the support and supply vessels for the Project will add to the general maritime traffic moving between oil and gas fields and shore bases and cumulative impacts on other sea users (including fisheries). Onshore, the potential exists for both positive and negative impacts, particularly if Takoradi continues to develop as a base to serve a growing offshore oil and gas industry.	Strategic actions by government and industry will be required to manage nearshore/onshore impacts if the oil and gas industry develops further in Ghana.	Minor significance
Navigation Risk.	The drill ship and the FPSO present a hazard to passing third party shipping (as well as to supply, support and standby Project vessels and the visiting offloading tankers). Collision between vessels of sufficient energy could lead to injuries, fatalities, loss of assets and release of harmful materials (especially fuel oil or crude product oil) to sea.	The Project vessels will adhere to standard navigational procedures while on station, together with Project-specific operational procedures in accordance with the International Guidelines for Offshore Marine Operations. Details of the planned drilling programme and production operations will be notified to other sea users through the Notice to Mariners system, as well as through navigation communication systems.	Collision risks are assessed as being low.

Issue	Impact Summary	Key Mitigation Measures	Residual Impact
Oil spill and potential consequences to the marine and coastal environments (natural populations and humans uses).	The risk of an oil spill into the marine environment is inherent in all offshore oil developments. The likelihood (probability) of significant oil spills, i.e. those that can reach the shoreline or other sensitive areas from the Pecan Project area is very low with most oil spills associated with offshore installations being small and having only limited environmental effects. Oil spill scenarios for the Project have been modelled.	Mitigation of oil spill incidents will be addressed through the implementation of oil spill prevention and oil spill preparedness measures. Pecan Energies will be responsible for ensuring that oil spill risks have been fully considered and addressed to the extent that residual risks have been reduced to as low as reasonably practicable (ALARP). Pecan Energies will have in place the fundamental components of preparedness and response, including an OSCP which sets out the strategy and procedures that will be taken in the event of an oil spill. The OSCP will be based on the standard 3-tiered response approach.	All four spill scenarios examined (which included a worst case) are rated as risk level: 'tolerable if as low as reasonably practicable'.

1.6 Mitigation and Monitoring

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 potential negative impacts and to create or enhance potential positive impacts such as environmental and social benefits. For the purposes of this EIS the term mitigation measures has been used to include aspects of 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 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. 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. Table 2 summarises the key proposed mitigation measures together with the impact assessment.

The focus of mitigation is to avoid or reduce negative impacts through the Project design. Where that is not practicable then operational and management measures are taken to reduce the magnitude of potential impacts. The final approach in the mitigation hierarchy is to respond to significant impacts that may occur such as through Emergency Response Plans or repair or remedy actions. This can include compensation for loss or damage.

A series of monitoring programmes are proposed. The overall objectives of the Monitoring Plan will be to:

- verify predictions made in the EIA;
- verify that mitigation measures are effective and implemented in the manner described in the EIS; and
- inform future operations and contribute to continuous improvement in the management of environmental and social issues related to the Project.

Through the process of inspection, monitoring and auditing, Pecan Energies will seek to ensure that the requirements of the ESMP and its applicable standards, procedures and guidelines are complied with.

Specific monitoring requirements will apply to the various Project phases such as drilling, installation, commissioning, operations, and decommissioning. This will include a schedule for HSSE and quality audits / inspections of the principal contractors and primary supply chain facilities, who will also be required to establish a similar schedule for their activities and those of any subcontractors and suppliers. The frequencies of inspection, monitoring, audits and reporting will be based on Project risk management requirements and standard industry practices.

In addition to routine reporting, a bi-annual monitoring report, aggregating the data produced by the other reporting processes, will be submitted to the Ghana Government (Petroleum Commission and EPA), Project Partners and lenders.

1.7 Environmental and Social Management Plan

1.7.1 Introduction

The findings and outcomes of the EIA process will be implanted through a Pecan Project ESMP. The outline ESMP presented in the EIS will inform the Project ESMP to be developed by Pecan Energies to cover the implementation of the Project following its approval.

The overall objective of the Project ESMP will be to ensure that mitigation measures identified and committed to in this EIA and in any subsequent studies are translated into practical management actions, which can be adequately implemented, resourced, monitored and reported against through all phases of the Project.

The ESMP will be applied to all phases of the Project including onshore logistics; drilling; offshore construction, installation and pre-commissioning; production; and decommissioning.

1.7.2 Roles and Responsibilities

Pecan Energies is accountable for ensuring that contractors and suppliers appointed to deliver the Project also deliver relevant commitments made in the ESMP. Using a team of Technical and HSSE professionals, Pecan Energies will tender and appoint companies to deliver the Project. The contractor selection processes will include the review of contract specific HSSE aspects.

The contractors will mobilise sufficient resources to deliver their activities for the Project in accordance with the commitments laid out in the Project ESMP. All contractors will identify and define roles, responsibility and authorities, and ensure that human, technical and financial resources are provided to enable compliance with the ESMP requirements.

1.7.3 Proposed Management Plans

The key management plans to be developed as part of the Project ESMP are listed below based on the mitigation measures and management actions required to address the potential impacts identified through the EIA process.

- Waste Management Plan.
- Chemical Management Plan.
- Greenhouse Gas and Energy Management Plan.
- Traffic Management Plan (including onshore and marine traffic).
- Stakeholder Engagement Plan (including Grievance Mechanism).
- Pecan Local Content Plan.
- Workers Management Plan.
- Recruitment, Employment and Training Plan.
- Community Health, Safety and Security Management Plan.
- Decommissioning Plan.
- Emergency Preparedness and Response Plan for Ghana operations (including Oil Spill Contingency Plan).

In addition, there will be a number of other plans to address standard operational requirements. These will include the following.

- Audit and Verification Plan.
- Project Monitoring Plan.
- Cultural Heritage Plan (including Chance Finds Procedure).
- Onshore Security Plan.
- Safety Zone Management Plan.
- Ballast Water Management Plan.
- Supply Chain Management Plan.

- Resource Efficiency and Conservation Management Plan.
- Retrenchment Plan as part of Pecan Energies Ghana Ltd. Employee Handbook.

1.8 Summary and Conclusion

1.8.1 EIA Process

This EIA for the proposed Pecan Project was undertaken in accordance with the Ghanaian Environmental Assessment Regulations. 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.

Potential impacts were assessed as being significant or not significant. Impacts that were assessed as significant were rated as being of Minor, Moderate or Major significance. The assessment considered the magnitude of impacts, and sensitivity, importance or value of the affected resource or receptor. The assessment of impacts considered 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.

1.8.2 Overall Conclusion

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 Pecan Project all impacts of Major significance can be avoided and impacts of Moderate and Minor significance reduced to as low as reasonably practicable levels, through design, use of control technology and operational management controls. Positive impacts include increased government revenue, employment and skills development and procurement of goods and services.

2. Introduction

2.1 Purpose of Report

This report has been produced by Environmental Resources Management Ltd (ERM) and ESL Consultants Ltd (ESL) on behalf of Pecan Energies Ghana Ltd (Pecan Energies), former named Aker Energy Ghana Ltd, and its Contractor Group partners (see Section 1.2 below). It is the Draft Environmental Impact Statement (EIS) of the Environmental Impact Assessment (EIA [1]) that has been undertaken for the Pecan Phase 1 Development Project (Project), in the Deep Water Tano Cape Three Points (DWT CTP) Contract Area (Contract Area), offshore Ghana.

Permit applications for oil and gas field developments in Ghana require to be supported by an EIS, as specified under Schedule II of the Environmental Assessment Regulations (LI 1652, 1999). 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.

Under the name of Aker Energy Ghana Ltd, Pecan Energies undertook an EIA Scoping Process in 2018 and issued a Scoping Report to the EPA in February 2019. Following delays to the Project due to ongoing field optimisation studies, as well as delays due to the Covid-19 pandemic, the Project recommenced in August 2021 and an updated Scoping Report was submitted to the EPA in November 2021 and endorsed in May 2022. The scoping exercise was intended to ensure that the EIA focuses on those issues that are most important for design, decision-making and stakeholder interest. Details of the EIA process is provided in Chapter 2: Section 2.4.1.

This Draft EIS has been submitted to the Ghana EPA for expert panel review and disclosure for public comments, under EPA's direction. A final EIS will be prepared and submitted to the EPA for approval once this process has been completed, taking onboard the regulators' and public comments.

This introductory chapter presents a brief overview of the Project along with the need for the Project and Project benefits. The structure of the remainder of the report is also presented.

2.2 Project Overview

The Project Contractor Group, comprising Pecan Energies, Lukoil Overseas Ghana Tano Limited (Lukoil), Ghana National Petroleum Corporation (GNPC) and Fueltrade Limited (Fueltrade), own participating interests in the Contract Area, with Pecan Energies holding 50%, Lukoil 38%, GNPC 10% and Fueltrade 2%. For the purposes of this report Pecan Energies is defined as the Operator within the overall Contractor Group.

The Contract Area is located off the Western Region of Ghana, about 70 km from the coast at the nearest point, covers an area of approximately 200,000 ha (2,000 km^2) and is located in water depths of approximately 1,600 m to. 2,800m.

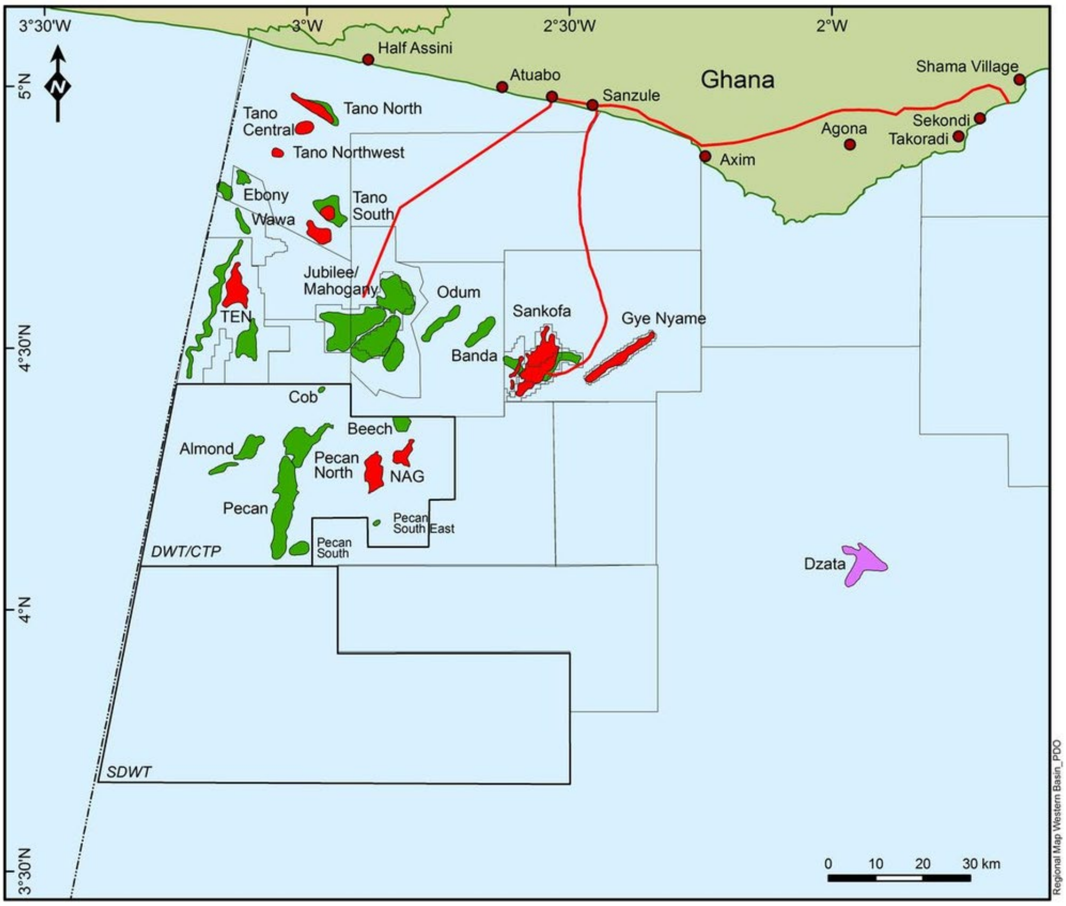
There are a number of geological features within the Deep Water Tano Basin where potential hydrocarbon reserves have been identified (known by geologists as 'plays'). These include the Albian, Cenomanian, Turonian and Campanian plays. There have been several discoveries in the Turonian play, including the Pecan, Pecan South, Pecan North, Almond, Beech and Cob discoveries in the DWT/CTP Contract Area and the existing

(1) The term EIA is used here as that is the term used in the Environmental Assessment Regulations. The term Environment is taken to include the natural, health and socio-economic environment and is therefore taken to be synonymous with the term Environmental and Social Impact Assessment (ESIA). The EIA report is called an Environmental Impact Statement (EIS) in the regulations.

producing Jubilee and Tweneboa, Enyenra and Nttome (TEN) fields to the north of DWT/CTP.

The Turonian play in the Contract Area has been subdivided into four sequences, Tu1, Tu2, Tu3 and Tu4. The main reservoir in the Pecan field belongs to the Tu1 sequence and is interpreted as having been deposited from deep marine turbidity currents within a confined canyon/slope channel area.

An exploration and appraisal programme has been undertaken over the Contract Area involving seismic surveys and well drilling to define oil and gas resources. There are four identified commercial oil discoveries within the Contract Area: named Pecan, Beech, Almond, and Pecan North and two gas condensate discoveries: named Paradise and Hickory. These are illustrated in Figure 2.1Figure , along with previous discoveries and developments to the north.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 2.1 Location of DWT/CTP Contract Area and Neighbouring Fields and Existing Pipelines

The Contractor Group proposes to develop the DWT/CTP discoveries in a series of phases with facilities comprising a subsea production system (SPS) tied back to a spread moored leased Floating Production Storage and Offloading (FPSO) vessel. The initial phase (Phase 1) will be the development of the Pecan discovery, which will comprise the following:

6. Drilling of seven oil and gas producing wells and seven water and gas injection wells, with the wells tied back to a spread moored FPSO located to the west of the discovery.
7. Wells will be drilled using one mobile offshore drilling unit (MODU) over an approximate three-year period.
8. The FPSO (Dhirubhai-1) will be a repurposed existing FPSO, capable of storing up to approximately 1.285 million barrels of oil and located approximately 113 km offshore in 2,620 m of water. It will be controlled and operated by the Operator through an Operations and Maintenance (O&M) Contractor.
9. The FPSO would offload directly to conventional shuttle tankers approximately every ten days.
10. Water and gas will be injected for increased oil recovery (IOR).

Details of the Phase 1 development and proposed schedules are provided in *Chapter 3*.

Definitions of the Project Area and Area of Influence for the Project are provided in *Chapter 4*.

2.2.1 Project Need and Benefits

The Ministry of Energy is responsible, under the *Ghana National Petroleum Act* (1983), to promote the exploration and development of Ghana's petroleum resources and to ensure that Ghana obtains the greatest possible benefits from these developments. To this end, the Ministry of Energy grants oil exploration, appraisal and production licences for the commercial development of these resources. The nature of each development Project is agreed through the Contract Area owners and the Government of Ghana through a Petroleum Agreement (PA) and an agreed Plan of Development (PoD).

The commercial development of the hydrocarbon resources complies with Ghana's national development strategy (Growth and Poverty Reduction Strategy) which includes infrastructure development and private sector development as priority areas. Reducing the costs of imported oil through facilitating private sector investment in the domestic oil and gas sector, and generating direct income through selling extracted hydrocarbons, are central to this strategy.

The Government of Ghana would generate income as a Project shareholder (through the GNPC) and through royalties and taxes and supply chain taxes. The income would have a positive effect in reducing the Ghana balance of payments with respect to energy and be used by the Government of Ghana to the benefit of the people of Ghana. The Project would also generate employment and training opportunities directly and indirectly through service, supply and support industries.

2.3 The EIA Team

Following the recommencement of the Project, ERM and ESL, jointly referred to as the EIA team, were appointed by Pecan Energies (through Competitive Tendering)) in September 2021 to undertake the EIA for the Pecan Phase 1 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 and ESL that have contributed to this report are listed in Table 2.1, along with qualifications and numbers of years of experience.

Table 2.1 The EIA Team

Name	Organisation	Role	Qualifications and Experience
ERM Team			
Mark Irvine	ERM	ERM Project Manager	BSc, MSc, 37 years
Kevin Murphy	ERM	Environmental Specialist	BSc, PhD, 37 years
Gareth Scott	ERM	Environmental Specialist	BSc, 15 years
Charles Le Quesne	ERM	Cultural Heritage Specialist	MA, 30 years
David O'Connor	ERM	Cultural Heritage Specialist	MA, 25 years
Clive Able	ERM	GHG Specialist	MEng, 16 years
Chris Hazell-Marshall	ERM	Air Quality Specialist	MSc, PhD, 15 years
Yves Verlinden	ERM	Air Quality Specialist	BEng, 11 years
Silvana Prado	ERM	Social Specialist	BA, MSc, 7 years
Michael Fichera	ERM	Discharge Modelling	MSc, 25 years
Joy McGrath	ERM	Risk Assessor	MSc, 20 years
Daniel Dixon	ERM	GIS	BSc, 8 years
ESL Team			
Ayaa K. Armah	ESL	ESL Project Director	MPhil, MSc, 33 years
Kenneth Y. Agbi	ESL	ESL Project Manager	MSc, BSc, 22 years
Obed Adjei	ESL	Programme Officer	MSc, BSc, 5 years
Adu Nyarko Andorful	ESL	Socio-Economist	MPhil, BA, 23 years
Eben Anuwa-Amarh	ESL	Socio-Economist	MPhil, BSc, 25 years

The EIA was undertaken with technical inputs from specialists from the Pecan Energies Ghana Ltd and Pecan Energies AS Health, Safety and Environment (HSE) teams, and the Front End Engineering Design (FEED) team at Aker Solutions AS. The mitigation and management measures were developed in collaboration with these Pecan Energies teams. Key contributors include the following.

Name	Role	Qualifications and Experience
My Tran	HSSEQ Manager	MSc, 15 years
Francis Wajah	HSSE Manager	BSc, MSc, 14 years
Ole Aspholm	Environmental and Sustainability Advisor	BSc, MSc, 27 years
Serwaa Anaglate	Environmental Advisor	BSc, MSc, 10 years
Desmond Asiedu	CSR Advisor	BA, MA, 9 years
Emmanuel Appiah	CSR Advisor	MSc, 15 years

2.4 Acknowledgements

Acknowledgements go to the consultees listed in Annex A that provided information for the EIA, raised issues, and made comments on the Project. In addition, baseline information from studies undertaken by Gardline (2014), Fugro (2021), modelling studies undertaken by DNV-GL (2020a and 2020b), and collision risk assessments undertaken by Safetec (2021), and Aker Solutions (2021) have been used in this EIA and are gratefully acknowledged.

2.5 Information Sources and Report Structure

Information sources used in the report are referenced, where relevant, and a list of references is included at the end of this report. The report draws on information provided in the following main reports:

1. Pecan Phase 1 Scoping Report (May 2022).
2. Pecan PoD (Approved by Ghana Authorities June 2023).
3. Project ENVID Workshop (July 2019).
4. Environmental Baseline Survey (EBS) (Gardline 2014).
5. Environmental Baseline Survey (EBS) (Fugro 2021).
6. DREAM Modelling and EIF Calculations for the Pecan Drilling Campaign (DNV-GL 2020a).
7. Oil Spill Modelling at the Pecan Field in Ghana Report (DNV-GL 2020b).
8. CORMIX Wastewater Modelling (ERM 2023).
9. Previous EIA reports for offshore Ghana projects and other public domain data sources.

The structure of the EIS follows that provided by Ghana EPA. The report comprises two volumes; *Volume 1* contains the EIS, while supporting annexes are included in *Volume 2*. The detailed content of each volume is summarised in Table 2.2 and Table 2.3.

Table 2.2 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.
2	Legal and Policy Framework	An overview of relevant national and international legislation, the impact assessment process, and industry standards and guidelines.
3	Project Description	Technical description of the Project; alternatives considered; applicable legislation and standards.
4	Environmental and Socio-Economic Baseline	Description of the relevant environmental, social and health existing conditions, including fish and fisheries.
5	Impact Identification and Assessment	Evaluation of potential impacts; proposed mitigation measures and identification of residual impacts.
6	Mitigation and Management Measures	Summary of mitigation measures including those built into the design and identified through the EIA process.
7	Monitoring Plan	Summary of the monitoring that will be carried out to verify environmental and social performance.
8	Decommissioning and Abandonment	Description of the approach for well abandonment and decommissioning of the facilities at the end of the field's life.
9	Provisional Environmental Management Plan	Outline of the Environmental Management Plan taking into account identified impacts and planned mitigation measures and monitoring requirements.
10	Summary and Conclusions	Summary of the conclusions from the EIA.
References	References	A list of references and websites cited in the text.

Table 2.3 Volume II - EIS Annexes

Annex	Title	Content
A	Consultation Report	A summary of the consultations undertaken during the EIA process as well as a list of stakeholders' issues log, attendance records and photos. [Note that this section will be updated following EPA comments following the technical review of the Draft EIS and the Public Hearings]
B	BAT Assessment Report	Report by Ocean Operations (2022a) on Best Available Technology (BAT) workshop on the FPSO systems to assess possible alternative options. Held in October 2021.
C	Energy Efficiency of Design Report	Report by Ocean Operations (2022b). Assessment of FPSO energy flow and efficiencies and estimated annual fuel consumption and CO2 emissions.
D	Reservoir Drainage and Associated Gas Disposition Strategy Assessment	Report by Pecan Energies (2023) on the comparison and selection of water injection and water alternating gas injection strategies.
E	Environmental Baseline Survey Report	Report by Gardline (2014) on water and sediment sampling for chemical and biological analysis.
F	Environmental Baseline Survey Report	Report by Fugro (2021) on water and sediment sampling for chemical analysis.
G	ENVID Workshop Worksheets	Outputs from the Pecan Environmental Risk Assessment Workshop.
H	Effluent Discharge Modelling Report	Report by ERM (2023) on produced water and discharge modelling.
I	Air Emissions Inventory	Calculation of estimated emissions from the Pecan Phase 1 Project (ERM 2022).
J	Drill Cuttings Modelling Report	Report by DNV-GL (2020a) on drill cuttings dispersion modelling
K	Ship Collision Study	Safetec Nordic Collision Risk Assessment (2021) on passing vessel traffic and visiting vessel collision risks with the FPSO.
L	Collision Impact Analysis Study	Report by Oceans Operations (2021) on the FPSO impact resistance to collisions with a supply vessel.
M	Oil Spill Modelling Report	Report by DNV-GL (2020b) on oil spill modelling study.

3. Legal and Policy Framework

3.1 Introduction

This chapter summarises relevant Ghanaian environmental legislation (including the EIA process), international conventions, lender and industry policies and standards that the Project will comply with.

3.2 The Petroleum Agreement

The Deepwater Tano/Cape Three Points Petroleum Agreement was ratified by Parliament on 19 July 2006 (the *Effective Date*). Under Article 7.1(a), the Contractor must, among other things, 'conduct Petroleum Operations with utmost diligence, efficiency and economy, in accordance with accepted international Petroleum industry practices, observing sound technical and engineering practices using appropriate advanced technology and effective equipment, machinery, materials and methods'.

The Contractor also has the right to bring to Ghana foreign national employees necessary for its operations, and to engage such subcontractors, whether expatriate or Ghanaian national, and to bring them and their personnel to Ghana as necessary 'to carry out the Petroleum Operations in a skilful, economic, safe and expeditions manner' (Arts. 7.2(d); 7.2(h)). Further, under Article 20.1, Contractor must 'give preference to materials, services and products produced in Ghana, but only if they 'can be supplied at prices, grades, quantities, delivery dates and on other commercial terms equivalent to or more favourable than those at which such materials, services and products can be supplied from outside Ghana.'

The Petroleum Agreement grants the Contractor the right to flare Natural Gas under certain circumstances (Article 14.2).

Under Article 17.2, Contractor must also 'take all necessary steps, in accordance with accepted international petroleum industry practice, to perform activities pursuant to the [Petroleum Agreement] in a safe manner' and in compliance with labour, health, safety, and environmental laws and regulations issued by the Environmental Protection Agency of Ghana.

Under article 26.2, the State (including its departments and agencies)

'*shall take no action which prevents or impedes the due exercise and performance of rights and obligations of the Parties [to the Petroleum Agreement] [and] guarantees Contractor the stability…of the terms and conditions of the [Petroleum Agreement] on the Effective Date specifically including those terms and conditions and that framework that are based upon or subject to the provisions of the laws and regulations of Ghana (and any interpretations thereof) including, without limitation, the [1984] Petroleum Law.'*

Accordingly, although this EIS takes into account various legal authorities that came into effect after the Effective Date, in the event of a conflict between a later-passed law, regulation, or rule and the Petroleum Agreement, the latter prevails.

3.3 National Environmental Legislation and Guidelines

3.3.1 Ghana Constitution

The Constitution of Ghana (Article 41(k) in Chapter 6) requires that all citizens (employees and employers) protect and safeguard the natural environment of the Republic of Ghana and its territorial waters. The Constitution is the fundamental law of Ghana and provides the framework on which all other laws stand.

3.3.2 Environmental Protection Agency Act (Act 490 of 1994)

The Act establishes the authority, responsibility, structure and funding of the Environmental Protection Agency (EPA). Part I of the Act mandates the EPA with the advisory role for formulation of environmental policy, issuing of environmental permits and pollution abatement notices and prescribing standards and guidelines. The Act defines the requirement for and responsibilities of the Environmental Protection Inspectors and empowers the EPA to request that an EIA process be undertaken.

3.3.3 Environmental Assessment Regulations

The EIA process is legislated through the Environmental Assessment Regulation (LI 1652, 1999), the principal enactment within the Environmental Protection Act (Act 490 of 1994). The EIA 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 Regulations set out the requirements for the following:

- Preliminary Environmental Reports (PERs);
- Environmental Impact Assessments (EIA) and Reports;
- Environmental Management Plans (EMPs);
- Environmental Certificates; and
- Environmental Permitting.

Schedules 1 and 2 of the 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 addressed within the EIA, how the EIA process should involve the public and outlines the steps to be followed within the process.

3.3.4 Environmental Guidelines and Standards

The EPA has developed several documents providing standards on regulatory requirements for the EIA process and environmental protection.

The following documents are relevant to the Project.

- Environmental Assessment in Ghana, a Guide to Environmental Impact Assessment Procedures (1996).
- EPA Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2011).

Standards issued by the Ghana Standards Authority and relevant for the Project are listed below.

- Ghana Standards for Environment and Health Protection - Requirements for Ambient Air Quality and Point Sources/Stack Emissions (GS 1236:2019).
- Ghana Standards for Health Protection - Requirements for Ambient Noise Control (GS 1222:2018).
- Ghana Standards for Environmental Protection Requirements for Effluent Discharges (GS 1212:2019)

3.3.5 Other Relevant Legislation

A summary of other relevant legislation is provided in Table 3.1.

Table 3.1 Overview of Other Relevant Environmental Legislation and its Application

Law/Regulation	Application
National Museums Act of 1969 (NLCD 387).	This sets out the role of the Ghana Museums and Monuments Board (GMMB) as regulator of cultural heritage in Ghana. This along with Executive instrument (EI 118) of 1969 and the National Museums Regulation (EI 29) of 1973 provide a definition of antiquities, monuments and cultural artefacts and protects a variety of archaeological and cultural heritage resources. In addition, the Act addresses the consent required to remove antiquities from its original site and notification in the event of a discovery.
Wild Animals Preservation Act (Act 43 of 1961) and Wetland Management (Ramsar Sites) Regulations, 1999	The Wild Animals Preservation Act makes provisions for the preservation of birds and fish, as well as other wild animals. The Wetland Management Regulations ratify the 1971 Wetlands Convention and provide for the establishment of Ramsar sites within Ghana. There are five designated Ramsar wetland sites along the coast of Ghana. Articles 6 and 7 of the Regulations establish the activities that are not permitted or restricted in the designated sites such as pollution of water, removal of vegetation, disposal of waste, hunting wild animals and grazing livestock, fishing using certain gear and in certain seasons, and other activities that may have an adverse effect on the environment. The Act requires that potential impacts on coastal wetlands and marine fauna should be fully assessed, and appropriate mitigation measures should be put in place to prevent, reduce and remedy any such effects.
Fisheries Act (Act No. 625 of 2002)	The Fisheries Act repeals the Fisheries Commission Act (Act 457 of 1993) to consolidate and amend the law on fisheries. Section 93 of the Fisheries Act stipulates that, if a proponent plans to undertake an activity that is likely to have a substantial impact on the fisheries resources, the Fisheries Commission should be informed of such an activity prior to commencement. The Commission may require information from the proponent on the likely impact of the activity on the fishery resources and possible means of preventing or minimising adverse impacts. The Act requires that fisheries impact assessment be conducted by the proponent. The Act establishes penalties for water pollution and adverse effects on aquatic resources (Section 92).
The Fisheries Regulation (LI 1968 of 2010)	Sets up specific rules for fishing in oil and gas infrastructure exclusion zones.
Nuclear Regulatory Authority Act (Act no 895 of 2015)	Establishes the Nuclear Regulatory Authority (NRA), which replaces Radiation Protection Board of the Ghana Atomic Energy Commission. Provides for the regulation and management of activities and practices for the peaceful use of nuclear material or energy; and provides for the protection of persons and the environment against the harmful effects of radiation. Any operations involving the use of irradiating devices and radioactive materials must be 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. No person, body or institution may generate or manage waste without a valid license from the Board. The Radioactive Waste Management Regulations established the National Radioactive Waste Management Centre

Law/Regulation	Application
	(NRWMC), which currently serves as a location for collection, segregation, treatment, and storage of waste from generators. If Naturally Occurring Radioactive Material (NORM[1]) is found during well drilling or production, it can be disposed through (i) canister disposal during well abandonment; (ii) injection into the annular space of a well; (iii) shipment to shore for disposal in a landfill within sealed containers; or, depending on the type of NORM, (iv) discharge to sea with the drainage effluent. NORM-containing sludge, scale, or equipment should be treated, processed, isolated and/or disposed of according to guidelines from the International Atomic Energy Agency (IAEA) 2013 Management of NORM Residues.
Hazardous and Electronic Waste Control and Management Act (Act No 917 of 2016)	Controls the import, export and transport of hazardous and electronic wastes. It addresses Ghana's obligations under the Basel Convention on the Control of Transboundary Movement of hazardous Waste and their disposal.
Hazardous, Electronic and Other Wastes (Classification), Control and Management Regulations, 2016 (LI 2250)	The purpose of these Regulations is to: • regulate the classification, control and management of waste; • establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Permit; • prescribe requirements for the establishment of take-back systems; • prescribe requirements and timeframes for the management of wastes listed in the First Schedule of the regulation; • prescribe general duties of waste generators, waste transporters and waste managers; and • prescribe requirements for the disposal of wastes. The regulations apply to waste generators, waste transporters and waste managers.
Petroleum (Exploration and Production) (Health, Safety and Environment) Regulations, 2017 (LI 2258)	These regulations are intended to prevent adverse effects on, and promote high standards for, health, safety and the environment from petroleum activities. The regulations require that operators and contractors in the petroleum sector have in place a HSE management system, a health and safety plan and facility Safety Case which are required to be submitted to the Petroleum Commission. The regulations cover a wide range of HSE issues including the design of production facilities in a manner that chemical and energy consumption is reduced and there is minimal pollution of the external environment. The regulations also contain various requirements relating to emissions and discharges, including reporting of flaring events, oil in water measurement, formation testing and well clean up, and use and discharge of chemicals.

[1] The geologic formations that contain oil and gas deposits may also contain naturally-occurring radionuclides, which are referred to as NORM. Because the extraction process concentrates the naturally occurring radionuclides and exposes them to the surface environment and human contact, these wastes are classified as TENORM.

3.3.6 Social Legislation

A summary of relevant social legislation and its application in the Pecan Project is provided in Table 3.2.

Table 3.2 Overview of Relevant Social Legislation and its Application

Law/Regulation	Application
Labour Act (Act 651 2003)	The Labour Act consolidates and updates various pieces of former legislation and introduces provisions to reflect International Labour Organisation (ILO) Conventions ratified by Ghana. Occupational health and safety conditions are discussed in Part 15 and include general health and safety conditions, exposure to hazards, employer occupational accidents, and diseases reporting. Article 122 regulates the inspection of workplaces to guarantee the enforcement of the Act's provisions.
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.
Children's Act (Act No. 560 of 1998)	Prohibits engaging a child in exploitative labour (Sections 12 and 87).
National Vocational Training Act (Act No. 351 of 1970)	Obliges employers to provide training for employees to carry out their duties and enhance their careers.

3.3.7 Maritime

A summary of relevant maritime legislation and its application in the Pecan Project is provided in Table 3.3.

Table 3.3 Overview of Relevant Maritime Legislation and its Application

Law/Regulation	Application
Ghana Maritime Security Act, 2004 (Act 675)	Aims to enhance marine safety and security and create a legal framework for compliance with the International Ship and Port Facility Code (ISPS)
Ghana Maritime Security (Amendment) Act (Act 824 of 2011)	The Maritime Security Act, 2011 (Act 824), amendment of the previous Act 675 of 2004 gives effect to Chapter XI-2 of the International Convention for the Safety of Life at Sea (SOLAS, 1974). The amendment intends to extend the previous application of the Ghana Maritime Security Act to offshore installations. 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), defined under the International Convention; and to provide for related matters. Requirements specified in these regulations include the development of a Ship Security Plan, a security alert system, vessel inspections and competency checks of personnel on board in terms of their abilities for shipboard security procedures.
Ghana Maritime Authority (Amendment) Act (Act 825 of 2011)	The Ghana Maritime Authority Act (2002) established the Ghana Maritime Authority (GMA) as responsible for the regulation and coordination of activities in the maritime industry and for the implementation of the provisions of enactments on shipping. The Act requires clearance for Project vessels (*eg,* drilling rig, FPSO) travelling into the territorial waters (*eg,* to and from the onshore base) to be obtained from the Ghana Maritime Authority (GMA). Notification should also be made to the Ghana Navy.

Law/Regulation	Application
Maritime Pollution Act, 2016 (932)	This Act addresses the prevention of pollution caused by oil, toxic liquid substances in bulk, harmful substances carried by the sea, sewage, and garbage and air pollution from ships. It ratifies the London Convention (IMO MARPOL) which aims to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. The Act is relevant to discharges of sewage water, food waste and bilge water. As well as accidental spills. The Act also gives contracting parties the mandate to inspect ships including tankers and other supply vessels to ensure that their operations are safe and will not pollute the marine environment.
The Maritime Zones (Delimitation) Law (PNDCL 159 of 1986)	Defines the extent of the territorial sea and Exclusive Economic Zone (EEZ) in Ghana. The territorial sea corresponds to the 12 nautical miles (nmi) (approximately 24 km) of the low waterline of the sea, whereas the EEZ is defined by the area beyond and adjacent to the territorial sea, less than 200 nmi (approximately 396 km) from the low waterline of the sea. The Act also grants the rights, to the extent 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 adjacent 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…'
Oil in Navigable Waters Act (Act No. 235 of 1964)	Regulates the discharge of oil into prohibited areas of the sea (Section 1) and deals with the discharge of oil into Ghanaian waters (Section 3).
Shipping Act (Act No. 645 of 2003), as amended by the Ghana Shipping (Amendment) Act (Act 826 of 2011)	Requires the registration of vessels, seaworthiness certifications, assurance of appropriate communication and signalling devices, and welfare of seafarers, in particular with respect to crew agreements, wages and occupational safety and health. It imposes restrictions on the trading of foreign registered ships in Ghanaian waters (to the 12 nm territorial sea) by preserving local trade in Ghanaian waters to Ghanaian ships. This includes the requirement for foreign vessels working in Ghanaian waters to train at least three Ghanaian seafarers and cadets. The amendment extends the definition of Ghanaian waters to include the waters within the 500 m safety zone generated automatically under the United Nations Convention on the Law of the Sea (UNCLOS) around installations in the exclusive economic zone beyond the territorial sea. It makes provision for the grant of permit to foreign vessels to trade in Ghanaian waters in instances where there are no Ghanaian vessels available or capable of providing those services.
Ghana Shipping (Protection of Offshore Operations and Assets) Regulations (LI 2010, 2012)	The Shipping Regulations, under the Ghana Shipping Act, have the following main provisions: • They provide for the creation and enforcement by the Ghana Maritime Authority and patrol by the Ghana Navy of temporary exclusion zones around pipelines and subsea cables of not more than 100 m and 50 m respectively on either side of a pipeline or cable, and an exclusion zone not exceeding 500 m from each point of the outer edge of offshore installations. • They prohibit vessels entering the exclusion zones without prior authorisation, unless the vessel is engaged in repair or maintenance activities of pipelines and subsea cables (Art. 2). • They prohibit anchoring and fishing activities in the pipelines and subsea cables exclusion zones (Art. 7). • They specify the circumstances under which vessels may enter these zones (e.g., to lay, maintain, renew, or remove a cable or

Law/Regulation	Application
	pipeline or provide logistical support to the installation) under the authorisation from the GMA. • They include specific provisions (Articles 8 and 9) for the use of Mobile Offshore Drilling Units (MODUs). • There are also requirements on the development of a Ship Security Plan, a security alert system, vessel inspections and competency checks of personnel on board in terms of their abilities for shipboard security procedures. • The regulation also requires that persons obtain safety permits for vessels, installations, and subsea infrastructure (cables, pipelines etc.)

3.3.8 Petroleum Sector

A summary of relevant petroleum legislation and its application in the Pecan Project is provided in Table 3.4.

Table 3.4 Overview of Relevant Petroleum Legislation and its Application

Law/Regulation	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, Ministry of Energy 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 the Operator to discuss emergency response plans with the GNPC and EPA before operations commence.
The Ghana National Petroleum Corporation Law (Act 64 of 1983)	The Ghana National Petroleum Corporation Law (Act 64 of 1983) established the Ghana National Petroleum Corporation (GNPC) as mandated, to promote exploration and planned development of the petroleum resources of the Republic of Ghana. Apart from allowing the GNPC to engage in petroleum operations and associated research, the law empowers the GNPC to advise the (now) Minister of Petroleum on matters related to petroleum operations.
Petroleum Commission Act (Act 821)	The Petroleum Commission was established in 2011 by an Act of Parliament, Act 821 to regulate and manage the exploitation of petroleum resources and to co-ordinate the policies. The Commission took over regulation of the sector from the Minister of Energy, who until then regulated the sector with the assistance of GNPC. The Act establishes the Commission's responsibilities, functioning and governance, as well as the interaction of the Commission with other government bodies in relation to petroleum resources.
Petroleum (Local Content and Local Participation) Regulations, Legislative Instrument (LI) 2204 (2013) and L.I. 2435 (Amended Local Content and Local Participation)	The stated purpose of these regulations are to promote the maximisation of value-addition and job creation through the use of local expertise, goods and services, businesses and financing in the petroleum industry value chain and their retention in the country. Local Content refers to the quantum/percentage of locally produced materials, personnel, financing, goods and services rendered to the oil industry, and which can be measured in monetary terms.

Law/Regulation	Application
	The minimum Local Content for any petroleum activity in Ghana is specified under Schedule 1. Provisions are made regarding goods and services, technical capabilities, materials and procurement, well drilling services, among others. The L.I. 2435 amended a few regulations in L.I. 2204 to increase local participation through; • strategic alliance and channel partnerships, • new definition of 'indigenous Ghanaian company' • First Schedule update for goods, services and
Petroleum (Exploration and Production) Act, 2016 Act 919	This Act covers all petroleum exploration and production activities onshore and offshore on territorial land, inland waters, territorial sea, exclusive economic zone and its continental shelf. It aims to ensure safe, secure, sustainable and efficient petroleum activities to achieve long-term benefit for the people of Ghana. The Act provides for the defining and opening of licence blocks for exploration and production activities through Production Sharing Agreements. The Act also requires the Minister to undertake a strategic assessment of the impact of the petroleum activities on local communities; the impact of petroleum activities on the environment, trade, agriculture, fisheries, shipping, maritime and other industries and risk of pollution; and the potential economic and social impact of the petroleum activities. The Act also requires an approved Environmental Report to accompany the POD.
Petroleum (Exploration and Production) (Health, Safety and Environment) Regulations, 2017	The Petroleum (Exploration and Production) (Health, Safety and Environment) Regulations, 2017 (L.I. 2258) are intended to prevent adverse effects on, and promote high standards for, health, safety and the environment from petroleum activities. The regulations require that operators and contractors in the petroleum sector have in place a HSE management system, a health and safety plan and facility Safety Case which are required to be submitted to the Petroleum Commission. The regulations cover a wide range of HSE issues including the design of production facilities in a manner that chemical and energy consumption is reduced and there is minimal pollution of the external environment. The regulations also contain various requirements relating to emissions and discharges, including reporting of flaring events, oil in water measurement, formation testing and well clean up, and use and discharge of chemicals.

3.4 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 and requires registration and authorisation by the Ghana EPA.

The purpose of the EIA is to provide information on the project 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 an outline Environmental and Social Management Plan (ESMP). This will also require the development of monitoring plans for various environmental and social impacts and a mechanism for audit, review and corrective action.

3.4.1 EIA Process

The overall EIA process is shown schematically in Figure **3.1** 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.

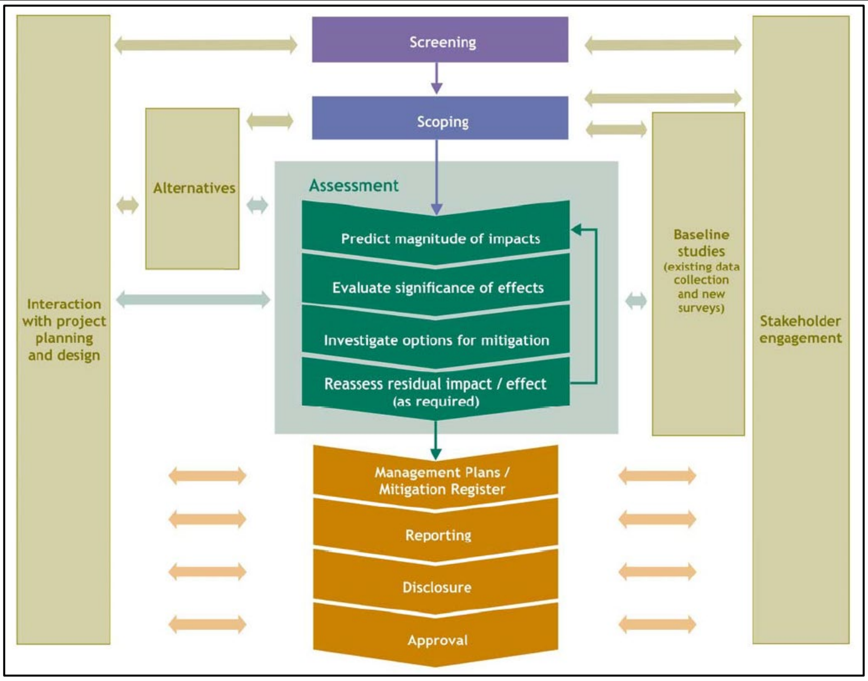


Figure 3.1 Overview of the Impact Assessment Process

Project Screening and Registration

Undertakings likely to have significant impacts on the environment (e.g. 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. 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.

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 communities to identify key issues and sources of information.

For the purposes of the EIA, the Project is defined as all activities that are a necessary part of the Project and have been included in the Plan of Development to be approved by the Government of Ghana. 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 (AoI) of these activities will vary depending on the type of impact being considered. The main areas of influence include the Project Area (seabed footprint and exclusion zone), support vessel and helicopter supply routes to and from shore. For some potential impacts, the area of influence may extend beyond the area directly affected by the Project, e.g. socio-economic impacts or pollution event impacts.

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 modelling studies and the impact assessment.

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 i.e. their nature, condition, quality and extent.
- To provide data to aid the prediction and evaluation of potential impacts.
- To inform judgements about the importance, value and sensitivity or vulnerability of resources and receptors.

Project Planning and Design

A description of the Project is required to present details of the various activities that would occur during the drilling, installation, commissioning, operational and decommissioning phases of the Project. This should be to a level that allows those activities with the potential to cause environmental and social impacts to be identified (e.g. physical presence, emissions, wastes and discharges).

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.

Stakeholder Engagement

Stakeholder consultation starts at the scoping stage of the Project, runs throughout the EIA and then continues through the operational and decommissioning phases 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. The objectives of scoping and EIA consultations are to share Project information, collect baseline data and understand key stakeholder concerns.

Public Hearing, which is a form of participation in which stakeholders & proponents are brought together in a forum to express their opinions and offer suggestions on a proposed undertaking in order to influence the decision-making process forms part of the stakeholder engagement.

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 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 and Social Management Plan (ESMP).

The impact assessment methods are presented in more detail in Chapter 5.

Management Plans

The range of different measures to mitigate impacts identified through the EIA process is reported in EIS within the Project Description and Impact Assessment chapters. These are then brought together within the outline ESMP for the Project.

The outline ESMP 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 ESMP 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 Project plans to be developed (e.g. Oil Spill Response Plan, Waste Management Plan and Emergency Response Plan) are summarised and referenced within the outline ESMP.

Reporting and Disclosure

The outputs of the above key steps are drawn together into the draft EIS and submitted to the EPA for review. The draft EIS is advertised and made available for public review and comment for a period of 21 days and through a series of Public Hearings. Comments received on the draft EIS from the EPA's technical review, stakeholders written comments, and the outcome of the Public Hearings are addressed in the Final EIS to be submitted to the EPA for approval.

3.5 State and Classification Requirements

All countries have full sovereignty to regulate activities on their continental shelves. As the Mobile Offshore Drilling Unit (MODU) and other Project vessels will be operational 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.

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. The MODU and other Project vessels are likely to be flagged and will therefore be required to comply with safety regulations, such as those of the International Maritime Organisation (IMO), the requirements of the relevant classification society, as well as the relevant Ghanaian environmental and safety regulations.

3.6 International Agreements and Conventions

3.6.1 United Nations Convention on the Laws of the Sea

Ghana is signatory to the United Nations Convention on the Laws of the Sea (UNCLOS) (1982). Under this convention, Ghana claims rights within 12 nmi of territorial water and a 200 nmi EEZ. Clearance for Project vessels travelling into the territorial waters (e.g. to and from the onshore port) must be obtained from the GMA and notification should be made to the Ghanaian Navy.

Article 80 on artificial islands, installations and structures on the continental shelf gives the Government of Ghana the right to establish an up to 500 m wide safety zone around installations on the continental shelf.

Although UNCLOS highlights the importance of preparedness (or preventative measures) and contingency planning in the context of offshore installations and devices used in exploration, it does not detail the specific steps that States must take in this context. This responsibility falls to States to '*adopt laws and regulations to prevent, reduce and control pollution of the marine environment*' in connection with marine activities subject to their jurisdiction. Article 208(5) provides that States '*shall establish global and regional rules, standards and recommended practices and procedures to that effect*'.

Ghanaian implementation of this Convention requires vessels travelling into Ghanaian territorial waters to obtain clearance from the GMA and to notify the Ghana Navy.

With respect to pollution from offshore activities, Article 194 provides that '*States shall take all measures necessary to prevent, reduce and control pollution of the marine environment from any source*', including measures '*designed to minimise to the fullest possible extent*' pollution from installations and devices used in exploration or exploitation of the natural resources of the seabed and subsoil, in particular '*measures for preventing accidents and dealing with emergencies*'.

3.6.2 International Tribunal for the Law of the Sea

The International Tribunal for the Law of the Sea (ITLOS) judgment of 23rd September 2017 provides settlement of the maritime boundary dispute between Ghana and Côte d'Ivoire.

The settlement decided that the single maritime boundary for the territorial sea, the EEZ and the continental shelf within and beyond 200 nmi starts at BP 55+ with the coordinates 05° 05' 23.2" N, 03° 06' 21.2'' W (WGS 84 as a geodetic datum) and is defined by turning points A, B, C, D, E, F with the following coordinates and connected by geodetic lines:

A: 05° 01' 03.7" N 03° 07' 18.3" W
B: 04° 57' 58.9" N 03° 08' 01.4" W
C: 04° 26' 41.6" N 03° 14' 56.9" W
D: 03° 12' 13.4" N 03° 29' 54.3" W
E: 02° 59' 04.8" N 03° 32' 40.2" W
F: 02° 40' 36.4" N 03° 36' 36.4" W

From turning point F, the single maritime boundary continues as a geodetic line starting at an azimuth of 191° 38' 06.7'' until it reaches the outer limits of the continental shelf. The DWT/CTP Contract Area is located wholly within the Ghanaian EEZ.

3.6.3 International Maritime Organisation Conventions

Ghana is signatory to the following IMO Conventions (listed in chronological order).

- 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.
- 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 garbage, oil contaminated water discharges (e.g. bilge water) as well as grey and black wastewater discharges. Table 3.5 provides a list of MARPOL provisions relevant to oil and gas development that are ratified by Ghana.

Table 3.5 MARPOL 1973/1978 Provisions Relevant to Oil and Gas Developments

Environmental Aspect	Provisions of MARPOL 1973/1978	Annex
Drainage water	Discharge of drainage water is permitted only if the vessel is 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 cut-off 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 vessel has approved sewage treatment facilities, the test results 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 OPRC Convention

The *International Convention of Oil Preparedness, Response and Co-operation Convention* was adopted in 1990 and came into force in 1995. OPRC provides for the following specific obligations on the parties.

- Undertaking (individually or jointly) all appropriate measures to prepare for and respond to an oil pollution incident.
- Requiring that operators of offshore installations have oil pollution emergency plans in place (co-ordinated with the national system in place and approved by the Ghana Maritime Authority).
- Establishing a national system for responding promptly and effectively to oil pollution incidents, including a national contingency plan for preparedness and response.
- Establishing (either unilaterally or through bilateral or multilateral co-operation) a minimum level of pre-positioned oil spill combating equipment, commensurate with the risk involved, programmes for its use, programmes of exercises and training, detailed plans and communication capabilities and coordinated arrangements.

Implementation of this Convention in Ghana requires the Operator to establish an Oil Spill Contingency Plan to combat accidental pollution to be coordinated with the National Oil Spill Contingency Plan. It also requires approval by the Ghana EPA.

3.6.4 Other Conventions, Treaties, Agreements

Ghana has also ratified the following international conventions, treaties and agreements that may be applicable to the Project (in chronological order).

- Convention on International Civil Aviation (Chicago Convention) 1944.
- Africa Convention on the Conservation of Nature and Natural Resources 1968.
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969.
- International Convention on Civil Liability for Oil Pollution Damage 1969.
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitats 1971 (Ramsar).
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971.
- Convention Concerning the Protection of World Cultural and Natural Heritage 1972 (World Heritage Convention).
- Convention on the Conservation of Migratory Species of Wild Animals 1979.
- Convention for the Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, 1981 (Abidjan Convention).
- International Convention for the Protection of the Ozone Layer 1985 (Vienna Convention).
- Convention on the Conservation of Migratory Species of Wild Animals 1988.
- Montreal Protocol on Substances that Deplete the Ozone Layer 1989.
- African Charter on Human and People's Rights 1989.
- International Convention on Oil Pollution Preparedness, Response and Co-Operation, 1990.
- Convention on the Ban of the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa 1991 (Bamako Convention).
- Convention on Fisheries Cooperation among African States Bordering the Atlantic Ocean 1991.
- Convention on Biological Diversity 1992.
- Framework Convention on Climate Change 1992.
- Memorandum of Understanding Concerning Conservation Measure for Marine Turtles of the Atlantic Coast of Africa 1999 (under the Bonn Convention).
- International Covenant on Economic, Social and Cultural Rights 2000.
- International Covenant on Civil and Political Rights 2000.
- The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 2003 (Basel Convention).

Ghana joined the International Labour Organisation (ILO) in 1957 and has ratified 51 ILO Conventions (of which 37 are in force, 10 denounced and four abrogated), including the following Fundamental Conventions.

- Forced Labour Convention, 1930 (No. 29).
- Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87).
- Right to Organise and Collective Bargaining Convention, 1949 (No. 98).
- Equal Remuneration Convention, 1951 (No. 100): Abolition of Forced Labour Convention, 1957 (No. 105).
- Discrimination (Employment and Occupation) Convention, 1958 (No. 111).
- Minimum Age Convention, 1973 (No. 138).
- Worst Forms of Child Labour Convention, 1999 (No. 182).

In addition, the following Technical Conventions are in force that is relevant to offshore operations.

- Maritime Labour Convention, 2006 (as amended in 2014 and 2016).
- Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to Air Pollution, Noise and Vibration (ILO No 148) 1987.

3.7 Transboundary Issues

The requirement to address potential transboundary issues are included in Part 12(o) of the EIA Regulations requires that the EIA indicates whether any area outside Ghana is likely to be affected by the activities of the undertaking.

In addition, there are obligations with respect to international conventions that Ghana is a signatory to. Ghana is also a party to the Guinea Current Large Marine Ecosystem Project (GCLME) 1999.

3.7.1 UNCLOS

Provisions in UNCLOS that are applicable in the context of transboundary pollution, irrespective of whether it occurred from offshore activities, include the following.

- Notification of imminent or actual damage (Article 198).
- Co-operating on activities that may cause transboundary pollution and jointly developing and promoting contingency plans for responding to pollution incidents (Article 199).
- Monitoring of the risks or effects of pollution (Article 205).
- Publication of the reports presenting the results of the monitoring studies (Article 205).
- Assessing potential effects of activities (Article 206).

3.7.2 OPRC

OPRC provides for the specific obligations on the parties relative to transboundary issues. With respect to contingency plans, OPRC acknowledges the importance of mutual assistance and international cooperation, including exchange of information, respecting the capabilities of States to respond to oil incidents and the preparation of oil pollution contingency plans. OPRC also expresses the need to promote international cooperation to enhance existing national, regional and global capabilities concerning oil pollution preparedness and response, taking into account the special needs of developing countries.

3.8 Financial Institution Standards

3.8.1 IFC Performance Standards

The following IFC Performance Standards for Environmental and Social Sustainability (IFC Performance Standards 2012) address environmental and social requirements that may apply to projects. These usually apply to projects that are being funded, however, they are also considered to represent Good International Industry Practice (GIIP).

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.
- Performance Standard 2: Labour and Working Conditions.
- Performance Standard 3: Resource Efficiency and Pollution Prevention.
- Performance Standard 4: Community Health, Safety and Security.
- Performance Standard 5: Land Acquisition and Involuntary, in case of acquiring of new land area for development of land base facilities.
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.
- Performance Standard 8: Cultural Heritage.

3.8.2 Environmental, Health, and Safety (EHS) Guidelines

EHS Guidelines have also been produced by the IFC and provide a technical reference source, particularly in those aspects related to Performance Standard 3: Resource

Efficiency and Pollution Prevention, as well as certain aspects of occupational and community health and safety. The following guidelines are relevant to the Project.

- EHS General Guidelines (2007).
- EHS Guidelines for Offshore Oil and Gas Development (2015).
- EHS Guidelines for Thermal Power Plants (2017).

3.9 Good International Industry Practice (GIIP)

The following guidelines and best practices standards provided by the International Association of Oil and Gas Producers (OGP), IPIECA and others are relevant to the Project.

- Waste Management Guidelines (1993).
- Environmental Management in Oil and Gas Exploration and Production (1997).
- Environmental, Social Health Risk and Impact Management Process (2007).
- Guidelines for waste management with special focus on areas with limited infrastructure Report No. 413 (2009).
- HSE Management Guidelines for Working Together in a Contact Environment (2010).
- Alien invasive species and the oil and gas industry (2010).
- Guidance on Improving Social and Environmental performance: Good Practice Guidelines for the Oil and Gas Industry (2011).
- IPIECA-OGP. Preparing effective flare management plans: Guidance document for the oil and gas industry (2011).
- IPIECA's Biodiversity and ecosystem services fundamentals. Guidance document for the oil and gas sector (2016).
- Good Practice Guidelines Series on Oil Spill Preparedness and Response, by IPIECA and IOGP (2019) (ipeica.org/resources/).
- IPIECA-OGP online guideline for energy and GHG efficient technologies and practices.

In addition, the following guidance is relevant if Vertical Seismic Profiling is to be undertaken.

- Joint Nature Conservation Committee (2017). JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys.

3.10 Pecan Energies Policies and Standards

All Project activities will be conducted in compliance with Applicable Standards, including Ghana legislation and guidance, lender standards, environmental and social policies and standards of Pecan Energies (as Operator or as otherwise approved by the Contactor Group), and recognised industry practice standards, design codes and practices.

3.10.1 Pecan Energies Code of Conduct

All work will be conducted in accordance with Pecan Energies Code of Conduct (the Code), the company's top governance policy and a public commitment to conducting business with integrity.

The Code applies to Pecan Energies directors, officers and employees, as well as those acting for or on behalf of Pecan Energies such as contractors, hired-in personnel and consultants (referred to as 'Pecan Energies Representatives').

Additionally, Pecan Energies works with business partners, partners in operated licenses and other third parties. These third parties are expected to adhere to standards, which are consistent with the Code, as well as applicable laws and regulations.

The Code includes references to other relevant Pecan Energies policies and procedures and other useful resources and tools, which provide additional, more detailed guidance for expected business conduct. The Code addresses:

- Speaking up.
- People.
- Integrity.
- Safeguarding Pecan Energies assets and interests.
- Health, Safety and the Environment.
- Communities.
- Monitoring, training and Guidance.

A summary of the requirements of the Code, applicable to the scope of the EIA, is provided below.

Human Rights

Pecan Energies aims to conduct its business in a manner that respects the human rights and dignity of people. Pecan Energies supports and acknowledges the fundamental principles of human and labour rights as defined in the Universal Declaration of Human Rights.

Pecan Energies can all contribute to eliminating human rights abuses such as child labour, human trafficking and forced labour. When considering new investments, operations or activities, or when selecting suppliers and business partners, Pecan Energies reviews any associated human rights issues and consider how Pecan Energies can ensure that our operations do not come into conflict with any of these fundamental human rights principles.

Pecan Energies may employ security services for its operations and shall ensure careful vetting and monitoring of such partners to avoid unnecessary use of force and other negative consequences.

Labour Standards

Pecan Energies respects the International Labour Organization’s Declaration on Fundamental Principles and Rights at Work. Pecan Energies does not accept any form of forced labour, including labour based on human trafficking.

Pecan Energies does not accept child labour and does not employ children below the age of 16. Pecan Energies will not use employees between the ages of 16-18 years for hazardous work.

Pecan Energies is committed to ensuring written employment contracts in a language the employees can understand. Working hours shall comply with appropriate national legislation, national agreements and industry standards. Overtime shall be voluntary, shall not be required on a regular basis and shall always be remunerated in accordance with national legislation or collective agreement.

Wages and benefits paid for a standard working week shall at least be sufficient to cover the basic needs of the worker and his/her family. Under no circumstances can wages and benefits be less favourable than those established by national legislation or collective bargaining agreements.

Pecan Energies is committed to ensuring responsible housing and accommodation arrangements for its own and subcontractors’ work force in line with local legislation and tariff agreements where the situation indicates this shall be arranged by the employer.

Health, Safety and Environment

Pecan Energies Code is focussed on the company and staff operating in a manner that avoids harm, damage and injuries to persons, the environment and financial assets, avoids work-related illness ensuing from operations and ensures the technical integrity of our facilities. Protection of the health, safety and security of the workforce and communities where Pecan Energies operates is a key element of the Code.

Pecan Energies commits to act responsibly with an ambition to reduce direct and indirect negative influences on the external environment and avoid them completely where possible. Pecan Energies seeks to minimise environmental impact and shall adhere to relevant international and National legislation and standards. Pecan Energies will work to ensure efficient use of natural resource and limit greenhouse gas emissions.

Corporate Social Responsibility (CSR)

Pecan Energies trust and reputation among our stakeholders is based on how it safeguards its social responsibility. Everything that Pecan Energies does should be to the common interest of its owners, partners and the society. Pecan Energies aims to earn and maintain the support of society through responsible and sustainable operations and our constant focus on safety, rigorous risk management and compliance with the applicable regulatory framework. Pecan Energies acknowledges its role in supporting countries on their path to sustainable development and work together with governments and communities to contribute to sustainable growth, create jobs and invest in people.

Pecan Energies is committed to engaging with our stakeholders to identify areas of concerns and common interest, and address consequences of our operations. Pecan Energies will work actively with its partners to identify relevant stakeholders and to implement adequate measures to secure information and a constructive dialogue.

Pecan Energies shall also perform human rights, social and environmental due diligence where applicable, to ensure that its operations do not negatively affect human rights, and that Pecan Energies avoids or mitigate where possible any potential negative effects on society and the environment.

Local Content and Long-Term Local Value Creation

Local content is a key objective for most governments and regulators of oil and gas. In the Project, Pecan Energies shall seek to employ and train local staff. Pecan Energies shall contribute to local content and long-term local value creation through engagement of local suppliers. It is important for Pecan Energies to work closely with local suppliers and contribute to local value creation by focusing on developing and sharing competence.

3.10.2 Health, Safety, Security, Environment and Quality Policy

Pecan Energies Health, Safety, Security, Environment and Quality (HSSEQ) Policy (2021) is based on its defined values and the Code of Conduct and applies to all Pecan Energies activities. The policy states that Pecan Energies strives to have zero harm to people, environment and assets.

Pecan Energies is committed to:

- Prevent personal injuries, work related illness and major accidents.
- Protect its people and the contractors.
- Protect its business and assets.
- Protect the environment and minimise the environmental footprint of its operations.
- Use material and energy efficiently to reduce consumption and emissions.

Pecan Energies shall:

- Have a systematic approach to HSSEQ management to ensure compliance with laws and regulations and to achieve continuous performance improvement.
- Integrate HSSEQ-related goals, strategies and plans in all its projects and activities.
- Set targets for GHG footprint related to its operations.
- Reduce risk of major accidents at all levels within the company.
- Continuously identify, understand and act to reduce HSSEQ and climate risks.
- Protect information according to sensitivity, irrespective of origin.
- Proactively support employee health and safety.
- Encourage personnel to work in a safe way and intervene if seeing an unsafe act.
- Implement learning from its successes and incidents.
- Ensure that leaders are good role models and demonstrate appropriate HSSEQ behaviour.
- Work with stakeholders, suppliers and business partners in the pursuit of good practice in HSSEQ.

3.10.3 Pecan Energies Management of HSSEQ

All Pecan Energies activities and operations in Ghana shall comply with Acts and Regulations set in the Petroleum Agreement (2006) and relevant amendments and permit requirements.

The Pecan Energies HSSEQ Management Systems are an integral part of its Business Management System (BMS) and will be developed accordance with the ISO 9001 Quality Management, ISO14001 Environmental Management and ISO 45001 Occupational Health and Safety Management industry standards. Pecan Energies shall annually review the management systems to ensure its suitability, adequacy and effectiveness, related to the objectives and strategies. Project level HSSEQ plans shall contain Key Performance Indicators and activities will be subject to routine monitoring, audit, inspections, verification and reporting. HSSEQ systems and plans will be updated, as required. The Project HSSEQ plans, audit and reporting requirements will integrate with Contractor systems and plans.

Health, Safety, Security and Environment

Pecan Energies HSSE principles are presented in its Code of Conduct and HSSEQ policy, described above, and include the following key requirements.

- Risk Management: a process of risk identification, assessment and mitigation and, where required, the development of management plans to be undertaken for all activities and operations.

- Communication: open communication on HSSE issues to internal and external stakeholders.

- Health and Working Environment: ensure a healthy working environment for personnel.

- Environment and Climate: avoiding accidental spills, discharges and emissions, controlling discharges to sea, minimise emissions to air, reduce energy consumption through energy efficiency management, and minimise chemical use.

- Safety: working with contractors and suppliers to maintain a high safety standard in all operations through the design, management and maintenance of all facilities, stop work authorities for all personnel and notification/investigation of serious incidents.

- Security: risk assessment and development of Security Plans.

- Emergency Preparedness and Response: a tiered approach with an Emergency Response Team (ERT) for onshore incidents, an Incident Management Team (IMT) for tactical support for offshore incidents, and a Crisis Management Team (CMT) for strategic support to on/offshore incidents (with details of the roles and responsibilities within specific Emergency Response Plans).

Quality

Pecan Energies Quality principles are presented in its Code of Conduct and HSSEQ policy, described above, and include the following key requirements.

- Risk assessment: a process of risk assessment will be undertaken to manage quality risk and opportunities to avoid rework and ensure efficiency.
- Interface and Stakeholder Management: a stakeholder management plan shall be established to ensure legal requirements are met, ensure clear communication of responsibilities and accountabilities, avoid Project delays, and ensure safe operation of facilities.
- Non-conformity, lessons learned and improvements: mandatory reporting of non-conformities and implementation of required corrective actions, and implementation of quality performance trend and incident root cause analysis.
- Quality requirements in projects: objectives and requirements are specified for each Project phase within the Project Execution Plan, HSSE Plan and Quality Plan

Contractor Management

All design, construction, installation, operations contractors and suppliers will be required to provide adequate resources to manage the HSSEQ issues for their own work-scope and the work sites under their control. This will be managed through tender evaluation and contractual requirements, bridging documents, training and competence assurance systems, and monitoring (through reporting, verifications, audits and incident investigations).

3.11 Project Environmental Standards

The Project will be developed according to Ghana regulations and standards. Where relevant other GIIP standards will be adopted. The Applicable Standards relevant to the Project are as follows.

- Applicable national requirements related to environment, occupational safety, health and social legislation.
- International Law including conventions and treaties adopted, ratified/ signed by Ghana and applicable to the Project.
- International Labour Organisation (ILO) Convention.
- International Maritime Organization (IMO) Conventions and Codes.
- IFC *Policy on Social and Environmental Sustainability (2006)* and Performance Standards (PS) for Environmental and Social Sustainability (2012) – PS1 to PS6, and PS8. Pecan Energies assessed that Performance Standard 7: Indigenous People is not applicable to the Project.
- IFC EHS General Guidelines (2007), and EHS Guidelines for Offshore Oil and Gas Development (2015).
- The Equator Principles IV (December 2019).
- OECD Common Approaches.
- Relevant Oil and Gas sector good practice and industry standards.

The following water, air and noise standards are based on EPA standards, MARPOL, GIIP 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 also been adopted in the Ghana EPA's Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (2011).

3.11.1 Effluent Discharges

Table 3.6 provides EPA, IFC and GIIP standards to be applied to effluent levels from offshore oil and gas operations.

Table 3.6 Applicable Standards for Effluent Discharges

Source	EPA, IFC, Pecan Energies and Good International Industry Practice Standards
Drilling fluid	The EPA has a standard for cuttings treatment to reduce oil on cuttings to less than 2% as a weighted average for low aromatic non-aqueous drilling fluids (NADF). The IFC have a standard for reinjection, ship to shore and only discharged if they can be treated to less than 1% oil on cuttings for new drilling rigs and 6.9% for existing drilling rigs. For older drilling rigs, technically and financially feasible techniques, including the installation of thermo-mechanical cutting cleaning systems to meet the guidelines for new facilities should be considered for implementation, in relation to the number of wells included in the development drilling programme and/or to potential impacts on critical habitats. For offshore discharge of Water Based Drilling Fluid (WBDF) and NADF the EPA and IFC also require no free oil, limits on mercury (max 1 mg kg^{-1}) and cadmium (max 3 mg kg^{-1}) concentrations in stock barite.
Completion and Workover Fluids	Discharge to sea of oil and grease is not to exceed 40 ppm daily maximum and 29 ppm monthly average, in accordance with EPA Guidelines (2011) and Pecan Energies Project standards. 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 and IFC EHS Guidelines.
Produced Water	Oil in water not to exceed 40 ppm daily maximum and 29 ppm monthly average, in accordance with EPA Guidelines (2011) and Pecan Energies Project standards. This is slightly lower than the 42 mg l^{-1} daily maximum as per IFC EHS Guidelines for Offshore Oil and Gas Developments (2015).
Produced Sand	No discharge unless residual oil less than 1% by weight on dry sand as per EPA and IFC 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 0.5 mg l^{-1} as per MARPOL Resolution MEPC 159(55).
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, as per IFC guidelines.

3.11.2 Emissions to Air

Key provisions of the IFC EHS guidelines for offshore oil and gas developments relating to air emissions are outlined in Table 3.7. There are no equivalent EPA standards for offshore operations.

Table 3.7 Applicable Standards for Point Source Air Emissions

Source	IFC EHS 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 combustion processes fired by gaseous or liquid fuels designed to deliver electrical or mechanical power, steam, heat, or any combination of these with a total rated heat input capacity above 50 MegaWatt thermal input is provided in the IFC's Environmental, Health, and Safety Guidelines for Thermal Power Plants. Emission guidelines for combustion turbines[1] using natural gas are as follows. • Nitrogen oxides: 51 mg Nm^{-3} (25 ppm). • Dry gas, excess oxygen content: 15%. Emission guidelines for combustion turbines using fuels other than natural gas are as follows. • Particulate matter: 50 mg Nm^{-3} (non-degraded airshed) 30 mg Nm^{-3} (degraded airshed). • Sulphur dioxide: Use of 1% or less sulphur fuel non-degraded airshed); Use of 0.5% or less sulphur fuel (degraded airshed). • Nitrogen oxides: 152 mg Nm^{-3} (74 ppm). Technological differences (for example the use of Aeroderivatives) may require different emissions values which should be evaluated on a cases-by-case basis through the EA process but which should not exceed 200 mg Nm^{-3}. • Dry gas, excess oxygen content: 15%. 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 combustion processes (including turbines, reciprocating engines or boilers) using liquid fuels these are as follows. • Particulate matter: 50 mg Nm^{-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 mg Nm^{-3} if bore size diameter less than 400 mm (up to 1,600 mg Nm^{-3} if justified to maintain high energy efficiency) and 1,850 mg Nm^{-3} if bore size diameter more than 400 mm. These normalised gas concentrations equate to approximately 711, 779 and 901 ppm respectively. • Dry gas, excess oxygen content: 15%. For gas-fired combustion processes (including turbines, reciprocating engines or boilers) these are as follows. • Nitrogen oxides: 200 mg Nm^{-3} for spark ignition, 400 mg Nm^{-3} for dual fuel and 1,600 mg Nm^{-3} for compression ignition. • Dry gas, excess oxygen content: 15%.
Greenhouse Gases	Significant (more than 25,000 tonnes CO_2 equivalent per year) greenhouse gas (GHG) emissions from all facilities and offshore support activities (direct emissions and indirect from electricity use) should be quantified annually as aggregate

[1] Separate emissions guidelines for reciprocating engines and boilers are detailed in Tables 6(A) and 6(C) of the IFC's Environmental, Health, and Safety Guidelines for Thermal Power Plants respectively.

Source	IFC EHS Guideline
	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.
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 2007) defer to the World Health Organisation (WHO) air quality guidelines standards (WHO 2005). These were updated in 2021 (WHO 2021).

The Ghanaian and WHO ambient air quality standards are set out in Table 3.8. The WHO (2021) guideline standards apply to onshore and offshore locations. The Ghanaian air quality standards apply at onshore locations, such as at the port location.

Table 3.8 Applicable Standards for Air Quality

Pollutant	Averaging Period	Guideline Value/Standard (µgm^{-3})		
		WHO	Ghana	
			Residential and rural	Industrial/ commercial
SO_2	1-year	-	50	80
	24-hour	125 (Interim target-1) 50 (Interim target-2) 40 (guideline)	50	100
	1-hour	-	700	900
NO_2	1-year	40 (Interim target-1) 30 (Interim target-2) 20 (Interim target-3) 10 (guideline)	-	-
	24-hour	120 (Interim target-1) 50 (Interim target-2) 25 (guideline)	60	150
	1-hour	-	200	400
PM_{10}	1-year	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (Interim target-4) 15 (guideline)	-	-
	24-hour	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (Interim target-4) 45 (guideline)	70	70
$PM_{2.5}$	1-year	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (Interim target-4) 5 (guideline)	-	-
	24-hour	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (Interim target-4) 15 (guideline)	-	-
CO	24-hour	7,000 (Interim target-1) 4,000 (guideline)	-	-
	8-hour	-	10,000	-
	1-hour	-	30,000	-

4. Project Description

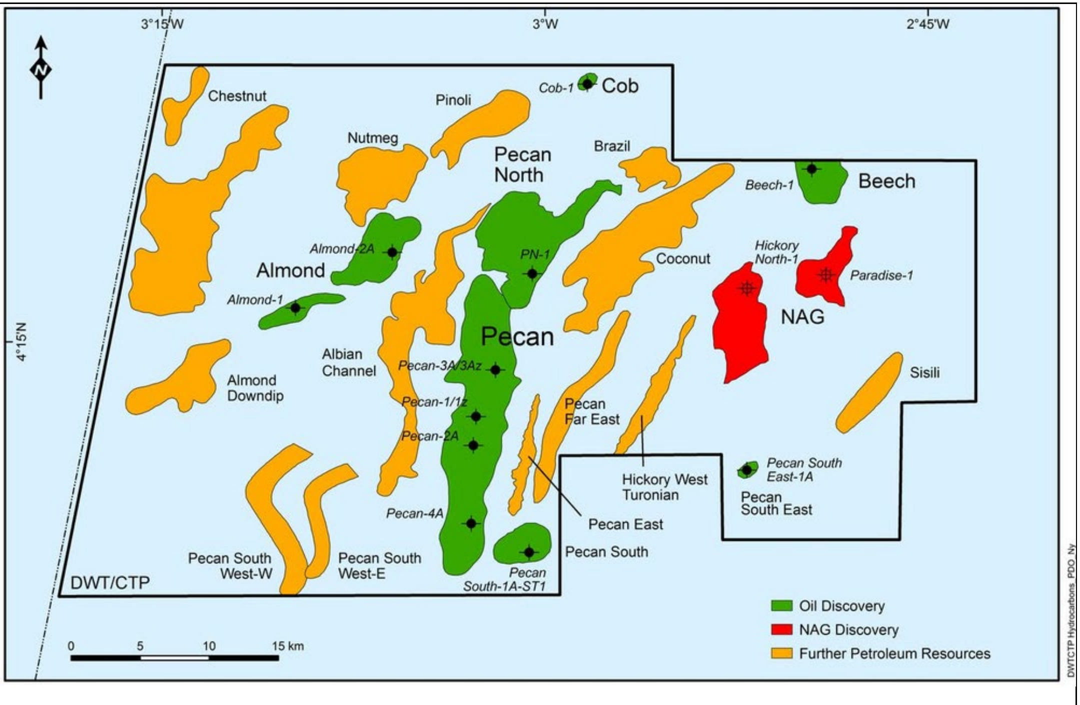
4.1 Pecan Development Concept

The description of the proposed development is based on the Deep Water Tano / Cape Three Points Plan of Development (April 2023) that was approved by the Ghana Ministry of Energy in June 2023.

A phased development of the resources in the Contract Area will start with the development of the Pecan Field, as Phase 1, based on a Floating Production Storage and Offloading vessel (FPSO) as a field processing and crude export centre.

Phase 1 will have a total of 14 subsea horizontal wells (seven producers and seven Water Alternating Gas (WAG) injectors) to be developed over two sub-phases: Phase 1a and Phase 1b. Phase 1a will have seven wells (three producers and four WAG injectors) with one producer and one WAG injector ready at production start-up (scheduled for 36 months after Final Investment Decision - FID). Phase 1b will have seven wells (four producers and three WAG injectors) with the first of the Phase 1b producers ready three years after first oil.

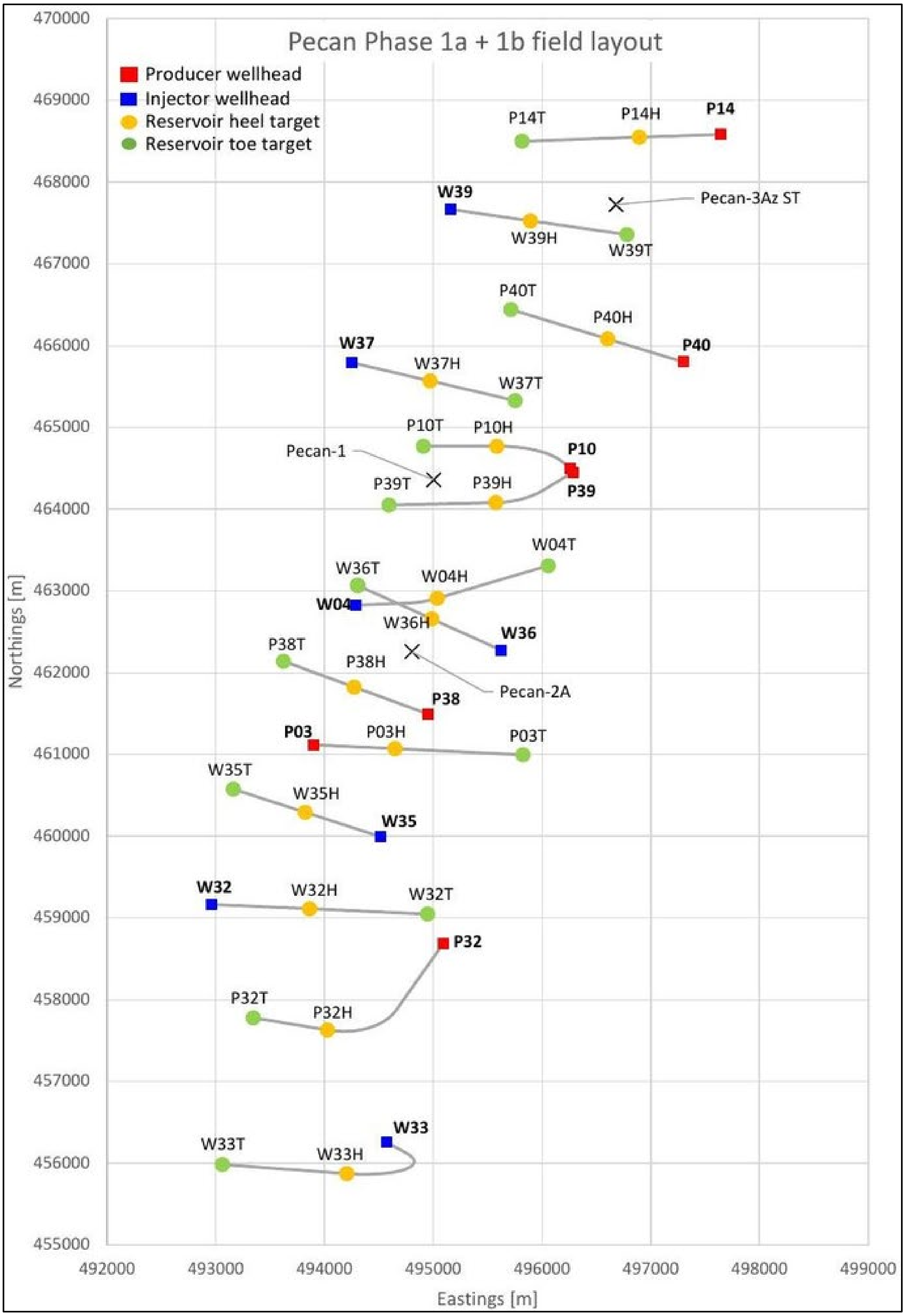
The DWT/CTP block consists of four declared commercial oil discoveries – Pecan, Beech, Almond and Pecan North and two gas condensate discoveries – Paradise and Hickory from wells drilled between 2011 and 2019 within the Contract Area are shown in Figure **4.1**. Figure **4.2** presents an overview of the overall field development.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 4.1 DWT CTP Contract Area with Discoveries

The subsea layout has been established based on an iterative process with considerations made to Reservoir Management, Subsea Production Systems (SPS) infrastructure constraints, well construction risks and life-of-well risks. Seabed locations for both production and injection wells are distributed in a North-South direction along the field, ensuring reservoir targets can be reached with non-complex well trajectories (see Figure **4.3**).



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 4.2 Pecan Phase 1 Field Layout / Wellbore trajectories

With channelled reservoir sands in the North-South direction, the wells are placed horizontally in the East-West direction with Producers and Injectors spaced about 1.5 km apart North-South. To accelerate production and acquire geological information at an early stage, pre-drilling will commence about 12 months prior to production start-up.

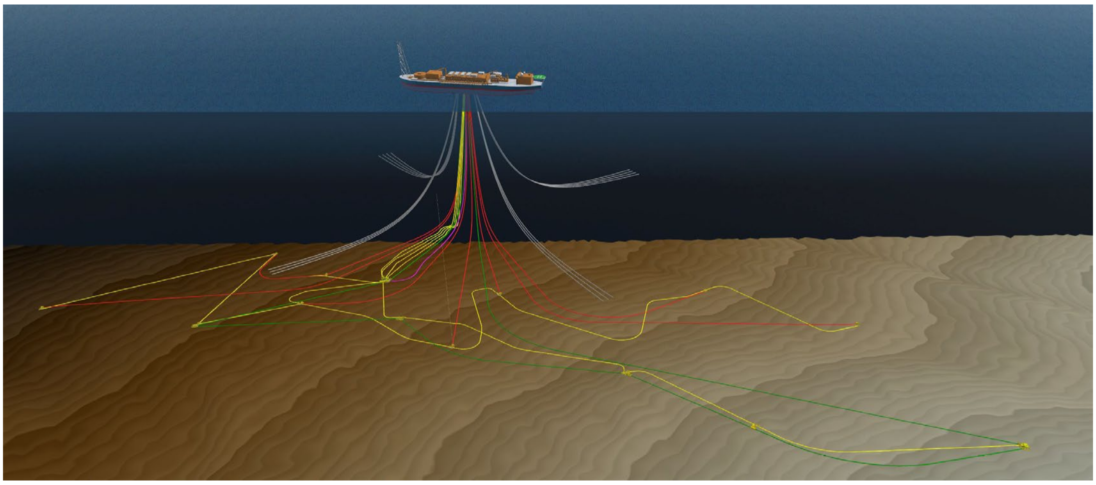


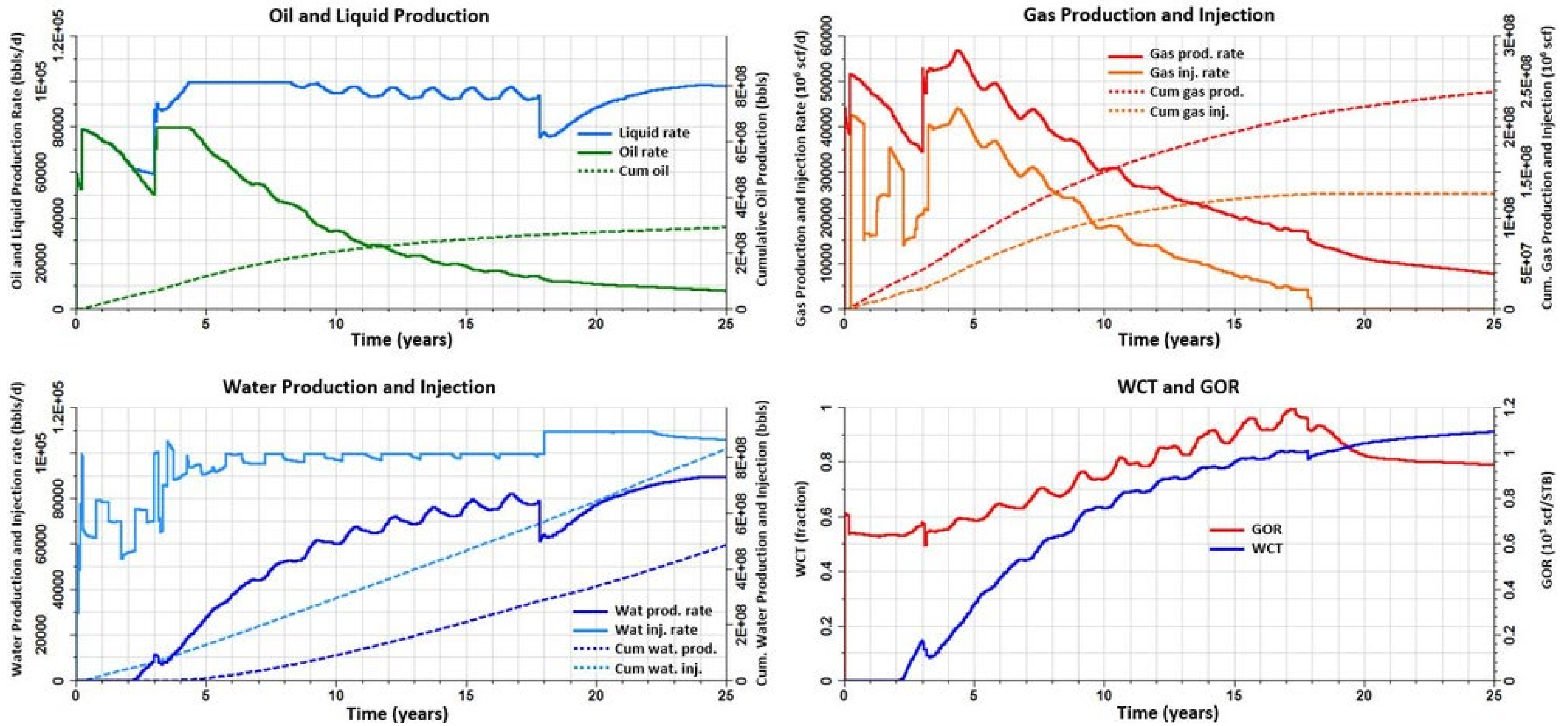
Figure 4.3 Pecan Phase 1a and 1b illustration

The proposed well drilling sequence and locations of the top hole of each well are presented in Table 4.1.

Table 4.1 Well Sequence and Top-Hole Locations

Well Name	Well type	Drill Sequence	Easting (m)	Northing (m)	Water depth (m)	Well Clean up
Phase 1a						
P38	Oil Producer	1	494947	461497	2566	MODU
W32	WAG Injector	2	492959	459166	2651	MODU
W36	WAG Injector	3	495628	462273	2540	MODU
P39	Oil Producer	4	496285	464452	2476	MODU
W37	WAG Injector	5	494254	465792	2514	MODU
W35	WAG Injector	6	494512	459997	2600	MODU
P03	Oil Producer	7	493900	461119	2597	FPSO
Phase 1b						
W04	WAG Injector	8	494288	462828	2559	MODU
P32	Oil Producer	9	495091	458686	2619	FPSO
P40	Oil Producer	10	497299	465801	2422	FPSO
P14	Oil Producer	11	497643	468585	2365	FPSO
W39	WAG Injector	12	495157	467668	2459	MODU
P10	Oil Producer	13	496263	464504	2476	FPSO
W33	WAG Injector	14	494569	456258	2675	MODU

The three Phase 1a oil producers give an initial production of approximately 70,000 to 80,000 barrels per day (bbls/d). Well P39 will be on pressure control from day one while P38 and P03 will be on pressure control after approximately 0.5 and 1.5 years respectively. The field production starts to decline to approximately 50,000 bbls/d before a stable plateau production of 80,000 bbls/d is reached after three years when Phase 1b commences. The plateau production lasts for approximately 1.5 years. The decline for the first four years is related to increased water cut and the MPP liquid capacity constraint of 100,000 bbls/d. Thereafter, the oil production is limited by the well potential (see Figure 4.4).



Source: Pecan Energies, DWT/CTP – Plan of Development 2023

Figure 4.4 Oil Production and Average Field Pressure Model Simulation-Reference Case

4.2 Project Alternatives

4.2.1 Base Design

The Project development location was defined based on the geophysical data and subsequent exploration and appraisal well drilling. Results of well testing indicated accumulations of oil and gas within the DWT/CTP Contract Area.

The potential development and production concept is based on the results of the exploratory and appraisal drilling and is designed to optimise the extraction of hydrocarbons in the most efficient and cost-effective manner. An FPSO was selected given the water depths and the need to offload to oil tankers for international export as Ghana does not have the facilities and capacity to receive the oil for processing. The location of the FPSO also considered the location of the proposed oil and gas production wells with the design intended to minimise the distance between wells and the production facilities, and to optimise potential for later phase developments with tie-back to the FPSO.

The technical, operational and economic factors associated with various development approaches were evaluated by Pecan Energies. Oil industry experiences in similar fields, including developments offshore Ghana, were used to define the approach. Based on an evaluation of production operational risks, Project cost, environmental and social factors, and schedule risks associated with installation and risks arising from major accidental hazards, the option involving one ship-shaped FPSO was determined to have the lowest risk for both Project installation and operational phases.

Similar to decision making for the option with one FPSO, several factors were considered to determine the best approach for subsea infrastructure design, including location, water depth, reservoir depth, and aerial extent of the fields.

The Project base design goal would be to use proven subsea production and control systems tied back to the FPSO, utilising proven processing equipment. The proposed approach has been used successfully at the Jubilee Field, TEN Field, Sankofa Field and elsewhere in West Africa and other deep-water locations around the world.

4.2.2 Engineering Design Alternatives

The Project considered several platform concepts, such as a spar, Tension Leg Platform, semi-submersible and round FPSO. A ship shaped FPSO design was selected as the best option. Pecan Energies evaluated detailed design alternatives, based on safety, engineering, technical, financial, environmental, and social considerations, to determine the optimum field development design.

A deployment of a ship-shaped FPSO has been selected for the Pecan field centre based on the following merits.

- Suitable for ultra-deep waters with favourable motion characteristics.
- Local oil storage and offloading.
- Flexibility for potential future topside expansions and tiebacks.
- High availability of production and utility systems in combination with water and gas injection to maximise Pecan field recovery.
- Track records in other African offshore fields.

Mooring with external or internal turret have been evaluated, this allows the FPSO to rotate with the wind and currents around the turret. However, based on local environmental conditions and the high number of risers and umbilicals, the concept with a spread moored fixed positioned FPSO was selected as the best option.

Offloading of the cargo crude will be approximately every ten to fourteen days to export tankers, when on plateau production. Offloading via an external offloading buoy connected with a hose to the FPSO was assessed versus offloading directly from the FPSO to the export tanker through an offloading hose that is on a reel when not in use. The direct offloading concept, also called tandem offloading, was selected as the best option.

Drainage strategies based on vertical/slanted wells versus horizontal wells have been evaluated for different development schemes. The reservoir configuration on Pecan with relatively thin net reservoir thickness and moderate to low flow properties favour long horizontal producers for maximising the oil production. Similarly, the optimum orientation for the majority of the injectors was concluded to be horizontal. The full field drainage strategy for the Pecan Field was optimised during 2020 to a 14 wells development scheme (7 producers and 7 injectors) targeting the crest of the Pecan field to reduce capital costs and improve the Project economics leading to the decision to develop the Pecan field in two phases, Phase 1a with seven wells in the first drilling campaign, followed by Phase 1b with seven wells in a second drilling campaign three years later.

A drainage strategy concept based on water injection only was considered to have high uncertainties related to early availability of predictable and commercial gas export/off-take solutions and the fact that a pure water injection scheme is evaluated to give a 3% units lower oil recovery after 25 year of production (i.e. about 36 million bbls lower) than for the combined water and Water Alternate Gas (WAG) injection strategy for a full field development scheme. A drainage strategy concept based on water injectors and dedicated gas injectors in the northern and southern part of field was also considered. This drainage strategy had higher risk for gas re-cycling, greater potential for asphaltene precipitation and reduced potential for Increased Oil Recovery (IOR). The selected injection strategy is that all injection wells have WAG injection. The water and gas switching will be at the FPSO.

4.3 Facilities Description

4.3.1 FPSO

The FPSO is based on the conversion of the Suezmax tanker Polar Alaska. The tanker was built in San Diego US in 1979 and had been operating on the west coast of US up to 2005, when it was taken out of service and subsequently converted into the Dhirubhai-1 (DB-1) FPSO (Figure 4.5). The DB-1 FPSO then operated off the east coast of India from 2008 to 2018.

Photo credit: Ghana FPSO Company

Figure 4.5 Photograph of FPSO Dhirubhai-1

The DB-1 has a double bottom and single side hull and a cargo storage capacity of 1,285,000 bbls. For the Pecan Project the FPSO hull will be modified with a Sandwich Plate System (SPS) at starboard side, that does not have the riser balcony and where PSVs will be adjacent to the hull for cargo handling, as an added layer of protection.

The SPS compact double hull (CDH) system is a sandwich plate system, which consists of a 30 mm composite core and a 15 mm top steel plate. These two plates are bonded with a polyurethane elastomer core and fitted onto the outer shell. The performance has been verified by detailed analysis using industry-standard engineering software and proven by a range of full-scale tests. It has been proven to have an equivalent protection of a double hull. The strength of the CDH exceeds the impact resistance requirements of MEPC 311 (73) 2018 Guidelines for Application of MARPOL Annex I Requirements to FPSOs and FSUs.

The SPS-CDS solution has been approved by American Bureau of Shipping (ABS), Det Norske Veritas (DNV) and Lloyd's Register. All three Class Societies have confirmed their interpretation of the specified design requirements and acceptance criteria. The existing turret and swivel system will be removed and a new spread mooring system and a riser balcony on port side will be installed to support the umbilicals and flexible risers connecting the wells to the FPSO. The modifications required for the Pecan Phase 1 Project are illustrated in Figure 4.6.

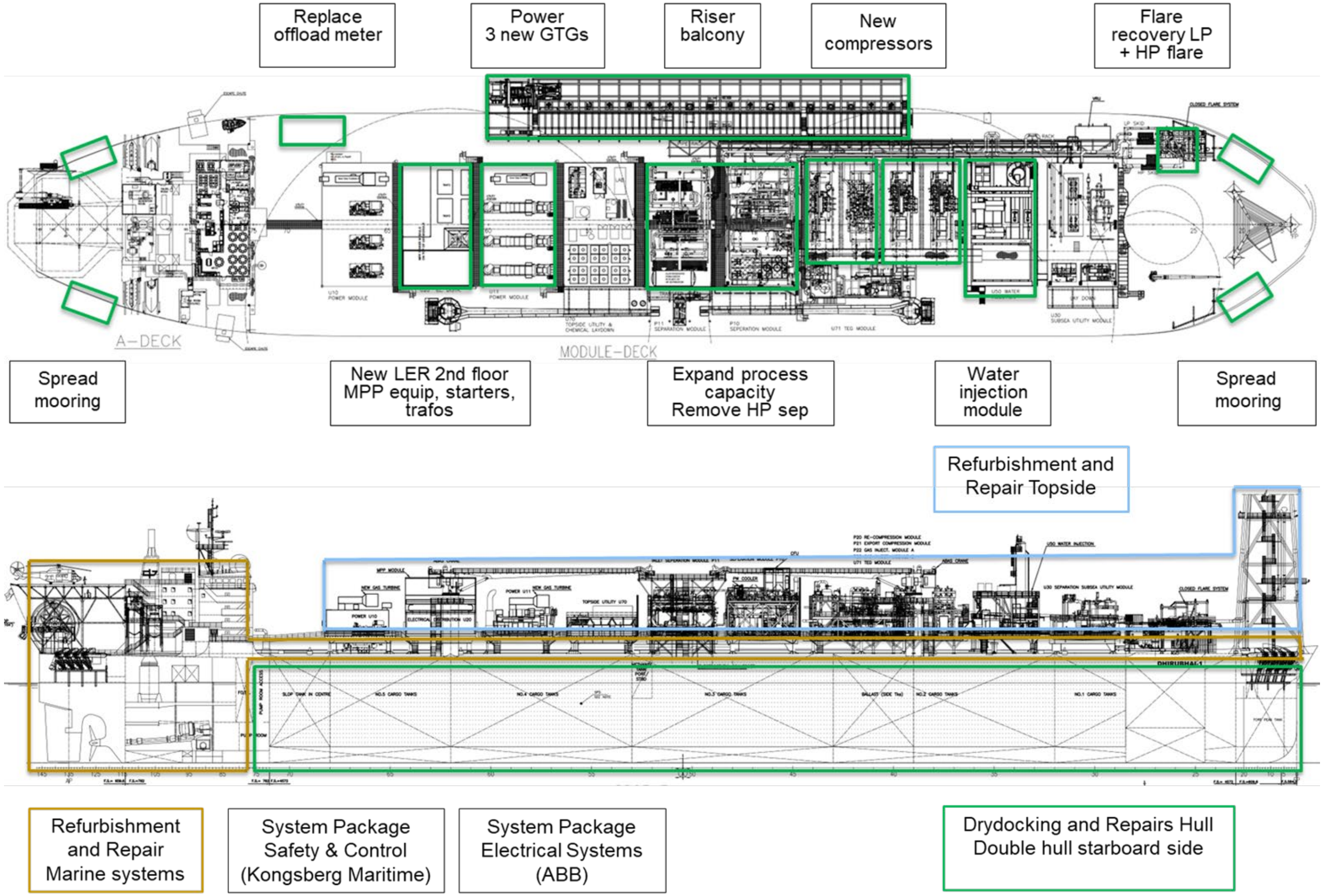
The FPSO topside system is designed to handle crude oil, gas and water from subsea wells. The FPSO will receive well fluid from subsea wells and will have production facilities to process and stabilise the fluids and separate up to 80,000 bbls crude oil per day, produced water and natural gas. Processed oil will be stored in the vessel cargo tanks, metered, and offloaded to export tankers via a tandem offloading system on the stern. The offloading capacity is 6,000 m^3/h (1 million bbls in 26.5 hours).

The associated gas that is produced will be compressed, treated, and used as fuel gas and for injection for Increased Oil Recovery (IOR). Assessment of optimal gas management strategy is described in Annex D.

For explosive atmosphere management and volatile organic compound (VOC) emission control, the crude oil tanks will be blanketed with hydrocarbon gas during normal operations. The cargo blanketing gas will be captured via a vapour recovery unit (VRU) and processed in the topside process system. When required, inert gas (IG) for cargo tank blanketing will be provided from a dedicated IG generator. The system will allow each storage tanks to be blanketed with IG or purged of gas for tank entry as required. All valves will have a lock open/lock close system.

Produced water will be treated (hydrocyclone and flotation cell) and disposed of overboard. Seawater for IOR will be treated and injected into the reservoir. The FPSO will have oil storage capacity (excluding slop tanks, drain tanks, etc.) to provide sufficient oil inventory on board after offload of a one million bbls parcel to effectively manage draft and trim. Allowance will be provided for buffer capacity for a minimum of three and up to five days of offloading delays. The FPSO will be capable of production operations during any ten-year environmental event.

The FPSO topsides will be equipped with three-phase separators (high pressure (HP) for oil/gas/water separation), compressors for gas injection, gas turbines and steam turbines for power production, pumps and valves. Gas will be water dried (gas dehydration) and as much hydrocarbon liquid as possible will be removed from the gas through a natural gas liquid (NGL) recovery system.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023

Figure 4.6 Plan View Showing Planned Modifications to FPSO Dhirubhai-1

The FPSO will have a closed flare system capable of flaring during an emergency, equipment breakdown or plant upset conditions based on the maximum gas processing capacity or maximum gas compression. Flaring will occur during start up and ramp up of production (commissioning) until stable production and gas injection has been achieved. To mitigate risk for asphaltene precipitation in the injection wells, the wells have to be injected with water for up to three months prior to injecting gas. Therefore flaring of produced gas from the first wells can last up to three months.

During normal operations, there will be no cold venting or flaring. In the event of an emergency or equipment breakdown, or plant upset conditions, excess gas will be sent to an efficient flare gas system to avoid cold venting.

If flaring is necessary for process safety reasons, then steps will be taken to reduce emissions through implementation of best practices and new technologies. Technical requirements to the flare system will follow the requirements set out in the EPA Guidelines on Environmental Assessment and Management for Offshore Oil and Gas Development in Ghana. This includes use of efficient flare tips and optimisation of number of burning nozzles to maximise the flare combustion efficiency.

The FPSO will have an integrated control and safety system (ICSS) that includes the following:

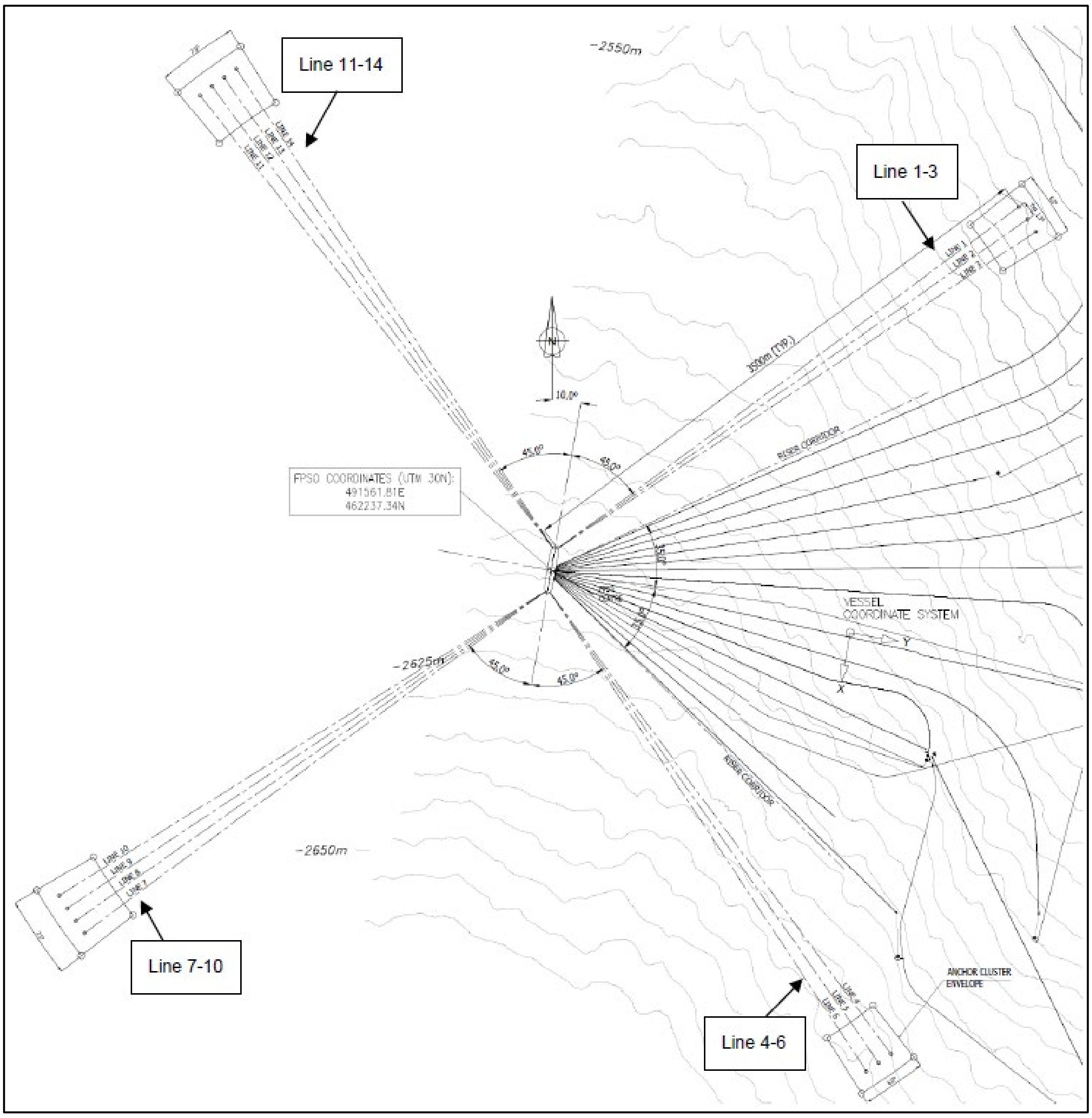
- Process Control System (PCS), Process Shutdown System (PSD), Emergency Shutdown (ESD) System and Fire and Gas (F&G).
- Subsea control.
- Marine systems control.
- Interfaces with unit control panels.
- Power distribution control / power management system.
- The FPSO design capacities are presented in Table 4.2.

Table 4.2 FPSO Design Capacities

Parameter	Unit	Design Capacity July 2021
Total Liquid	Barrels of liquids per day (BLPD)	110,000
Water Injection	Barrels of water per day (BWPD)	110,000
Oil production	Barrels of oil per day (BOPD)	80,000
Gas flow to FPSO (including gas lift)	Million standard cubic feet per day (MMscfd)	70
Gas Injection	MMscfd	55
Produced water	BWPD	90,000
Storage Capacity	Barrels (BBL)	1,285,000
Total power capacity (approx. at ISO conditions)	MW (Mega Watts)	Number of Gas and Steam Turbine Generators plus 1 spare: 44.2 MW
Power available for Multi Phase Pumps	MW	11.8

The FPSO shall be spread moored in a heading towards the south-south-west (190° relative true north) at approximately 2,700 m water depth.

The mooring system will consist of polyester rope with chain segments on each end with the seabed chain attached to suction pile anchors. The mooring layout consists of four anchor clusters positioned in a NE, SE, SW and NW direction with a horizontal radius of approximately 3,500 m between the FPSO fairlead and the anchors (as shown in Figure 4.7). The mooring system shall be equipped to measure mooring line tension on a continuous basis and will include sufficient capacity to allow one mooring line to fail in any corner without an impact on safety or operation.



Source: Ocean Operations AS 2021 Mooring system design brief (PECAN1-OCO-J-FD-0001)

Figure 4.7 FPSO Mooring Spread

4.3.2 Seafloor Footprint

The subsea infrastructure installed on the seabed will occupy an area of approximately 0.36 km^2 within an overall seabed development area of approximately 50 km^2 (i.e. the area within which all the subsea infrastructure, including the anchor lines and piles will be located). Table **4.3** provides a breakdown to the dimensions of the different types of seabed infrastructure and the area of seabed occupied. The MODU will be dynamically positioned so will not have anchor mooring lines.

Table 4.3 Seafloor Footprint

System	**Area in m^2**
Prodution systems	7,582
Service systems	2,722
Water Alternating Gas Injection	5,766
Gas Line	1,067
Dynamic umbilical	1,880
Static umbilical	3,825
Xmas trees	700
Pipelines	1,260
Umbilicles	650
Anchors	30,2210
Moorigs	35,829
Total m^2	**363,490**
Total km^2	**0.3635**

4.3.3 Drains System

A closed drain system and a hazardous and non-hazardous open drain system is provided. The open drains will be isolated from the closed drain so that no mixing of fluids occurs.

Hazardous Drains

Areas which may be contaminated with hydrocarbons (i.e. around process modules) will drain to the hazardous drain system. To assist managing potential hydrocarbon contamination of deck drainage, drip pans will be provided under areas of potential hydrocarbon leakage (pumps, exchangers, filters, etc.). Drains will be provided with removable covers to prevent debris from entering the system. Hydrocarbon contaminated fluids will be routed to a hazardous drain tank with oil/water separation. The hazardous drain tank will be heated, as necessary, to aid oil / water separation and there will be provision for treatment with small volumes of biocide. Process fluids sent to the hazardous drain tank will not be recycled into the process unless approved. To manage the volume of fluids in the system, the main deck scuppers (holes to allow drainage) will have plugs that are typically opened manually during heavy rains to allow excess water to be discharged to sea.

Non-Hazardous Drains

The non-hazardous drainage system will take run-off from areas unlikely to be contaminated by hydrocarbons and drain to a non-hazardous drain tank. Non-hazardous drains will be provided with removable covers to prevent debris from entering the drains systems. The system will have provision for biocide treatment. Processed fluids sent to the non-hazardous drain tank will not be recycled back to the process unless approved.

Closed Drains

Closed drains are used to mitigate fugitive emissions, they collect hydrocarbons from process equipment keeping them out of contact with the atmosphere. The closed drains will comprise pipe connections for routing drained liquids to a vented closed drain drum that will be connected to the flare system to avoid cold venting of fugitive emissions. There will be at least one closed drain provided on the FPSO. Liquids from the closed drain system will be routed to the slop tank and one cargo tank.

4.3.4 Water Alternating Gas Injection

There will be a system for alternating Seawater and Gas injection in the injection wells. Facilities for switching from seawater to gas will be installed topside at the FPSO, and seawater/gas will be routed to the well head X-mas trees in separate risers and flow lines for each injection well.

Seawater for injection will be routed from the cooling water outlet. A seawater treatment module consisting of coarse and fine filters, a vacuum deaeration unit and three 50% seawater booster pumps will be provided. Oxygen scavenger will be injected into the deaerated seawater before the injection pumps. Depending on the seawater injection capacity of the wells, there might be some overcapacity of the injection pumps that will lead to discharge of the treated seawater into the sea. This is mitigated by designing with three 50% injection pumps instead of two 100% pumps. Further, partly chocking of the valve downstream the injection pump will also allow for injection rate reduction. Discharge volumes will be measured during operation and kept at a minimum level by optimal use of injection pumps and valves.

All gas that are not used for gas turbine fuel or artificial gas lift, will be injected in the reservoirs through the injection wells. The gas will be dried and compressed to gain sufficient injection pressure through a single low pressure compressor train, and a two 100% high pressure compressor.

4.3.5 Subsea, Umbilical, Risers and Flowlines

The Subsea Production Systems (SPS) and Subsea, Umbilical, Risers and Flowlines (SURF) infrastructure is designed as a hybrid flow loop tied back to the FPSO using steel catenary risers (SCR) and umbilical/power risers. The subsea infrastructure is designed for WAG operations with dedicated lines per injection well combining gas, MeOH injection and water service. The production flowlines and service lines will be designed for round trip pigging. Pigging is the process of pipe cleaning and checking using a unit called a ‘pig’ that is propelled along the inside of the pipe/flowline. It is launched and retrieved via a Pig Launcher Receiver (PLR) access chamber within the flowline system.

There will be one combined production loop for Phase 1a and 1b, where the Phase 1b wells will be connected to the production loop at the later stage than the Phase 1a. A combined water alternating gas injection system will be used for reservoir pressure support and increase oil recovery (IOR). The subsea system will be designed to cater for the base case of seven producers and seven injectors with the additional capacity for contingency wells.

The subsea facilities for Phase 1a loop will be as follows.

- Vertical Subsea X-mas tree (XMT) on Wellhead.
- Production In-line structures, including:
- Pipeline Termination (PLT), In Line Structures (ILS)
- Pipe End Manifold (PLEM)
- Mud line gas lift manifold (Functionality for mudline gas lift connected downstream the Phase 1b multi-phase pump stations).

- Subsea Distribution Unit (SDU)

Dedicated riser and flowline system for:

- Production flowline and riser
- Service line flowline and riser
- Water and Gas injection flowline and riser
- Umbilical for chemicals, controls and power and communication distribution
- Gas lift riser

The additional subsea facilities for Phase 1b will be as follows.

- Artificial lift with multi-phase pumps located at seabed.
- Vertical XMT on Wellhead.

Dedicated riser and flowline system for the following.

- Water and Gas injection flowline and riser.
- Umbilical for chemicals, controls and power and communication distribution.
- Umbilical for chemicals control and high voltage power distribution.

The design life for the subsea facilities is presented in Table 4.4

Table 4.4 Subsea Facilities Design Life

Description	Design Life in Years
Subsea Production System	25
Wellhead system	30
Production X-mas tree (XMT)	25
Injection X-mas tree (XMT)	25
Multi-phase pump system	25
Flowlines and risers (production, gas injection, MEG, water injection, gas lift)	18
Umbilical	25

MeOH will be used as the primary hydrate prevention fluid for the WAG system, distributed from the topside process system. Dead oil circulation (oil at low pressure with no dissolved gas) will be the primary hydrate prevention method for production flowlines, in combination with MeOH for flushing the XMTs (collection of wellhead valves and gauges), well jumpers (short sections of flexible pipes connecting pipeline/flowlines with subsea infrastructure) and multi-phase pumps (can handle oil, gas and water). MeOH will be used at a high flowrate for displacement of hydrocarbons in all production XMTs and jumpers, and stabilised oil pumped from the FPSO through the service line will be used to displace the production fluid content of the pipelines during shut-downs.

4.4 Drilling

The development strategy for the Pecan Project consists of two main types of wells.

- Horizontal Oil Producers (OP)
- Horizontal Water Alternating Gas (WAG) Injectors

The mobile offshore drilling unit (MODU) will be a 6^{th} or 7^{th} generation, high performance, deep water, dynamically positioned vessel (either a drill-ship or semi-submersible).

4.4.1 Well Design and Control

Safe wells are achieved through a combination of the well design, construction and maintenance standards for all equipment, well-developed drilling procedures and competent personnel performing the planning and execution of the work. The following well design and control requirements will be implemented during the drilling campaign.

- Designing wells and drilling procedures based on lessons learned from analysis of offset well data (i.e. data from previously drilled wellbores close to a proposed well) and integrated pore pressure prediction.
- Planning drilling fluid densities to control reservoir pressure.
- Installing a blowout prevent (BOP) as a secondary well control mechanism.
- Provision of specialised training, equipment and procedures that meet or exceed regulatory requirements.
- Utilising multiple well flow monitoring devices to maximise the likelihood of detecting and shutting in on a hydrocarbon influx prior to surface release.

The hydrostatic pressure of the drilling fluid in the well is adjusted by adding weighting agents such as barite to ensure that it is greater than the formation pressure to prevent the undesired influx of formation fluids (oil, gas, water) into the wellbore (see left image in Figure 4.8). Pressure monitoring is undertaken during drilling to ensure that fluid influxes are avoided or managed to prevent escalation into a blowout.

Blow Out Preventers (BOPs) are designed to shut in a well if control of the well using the hydrostatic head of the drilling fluid is lost, by means of rams and annular preventers that physically close off the well aperture. Once closed, pressure in the borehole and the natural formation pressures will equalise. The density of the drilling fluid can then be increased to restore ‘over balance’, drilling fluid pressure greater than the formation pressure, and after carefully displacing any formation fluid out of the well in a controlled manner, the BOPs can be opened and drilling continued. During the drilling of each well, once the surface casing and wellhead has been installed and cemented in place, a BOP and well control system complying with international industry standards will be installed on the wellhead. It will remain installed and will be routinely tested until the well has been either permanently abandoned or suspended. An example schematic of a BOP is provided in Figure 4.8 (right image).

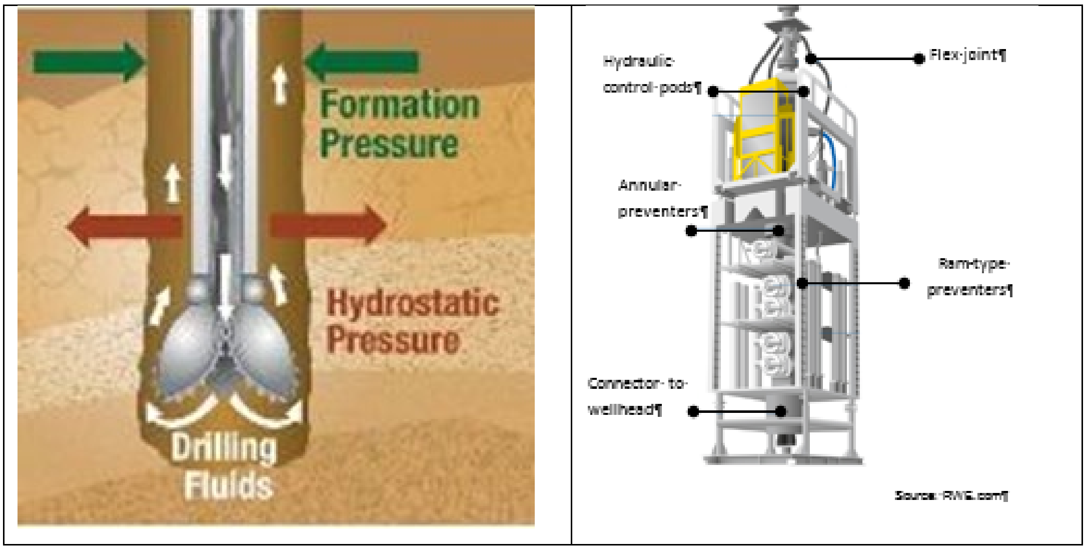
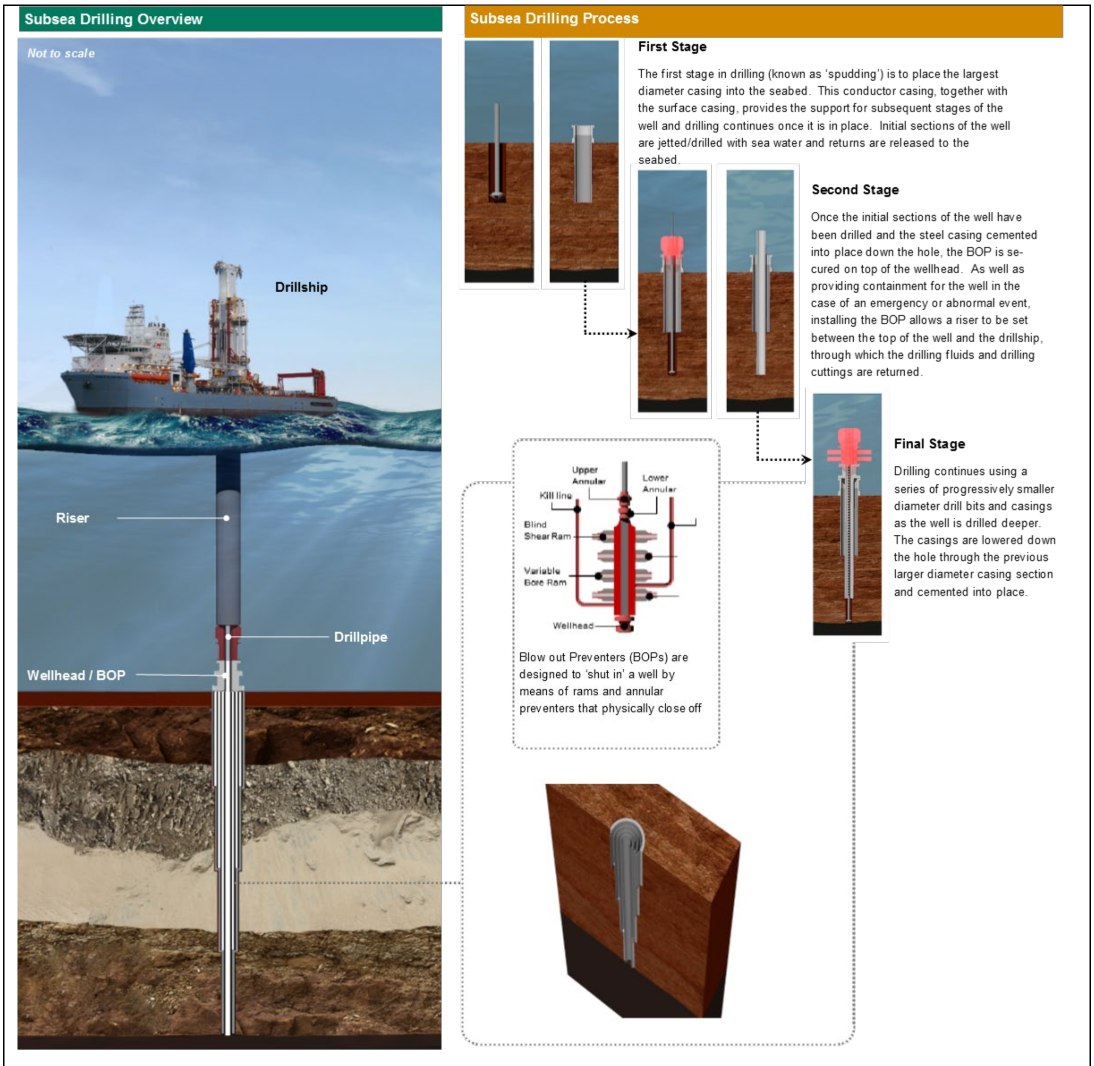


Figure 4.8 Hydrostatic Pressure and BOP Schematic

Once the MODU is on location the well can be drilled. This is achieved using a rotating drill bit attached to the end of a drill pipe (known as the ‘drill string’) to bore into the subsoil under the seabed to reach the target depth of the identified prospects (likely to be approximately 2,000 to 2,500 m below the seabed surface). Subsequent wells may be drilled deeper or shallower depending upon the geology encountered at the well location. The rotating drill bit breaks off small pieces of rock (called drill cuttings) as it penetrates rock strata (see

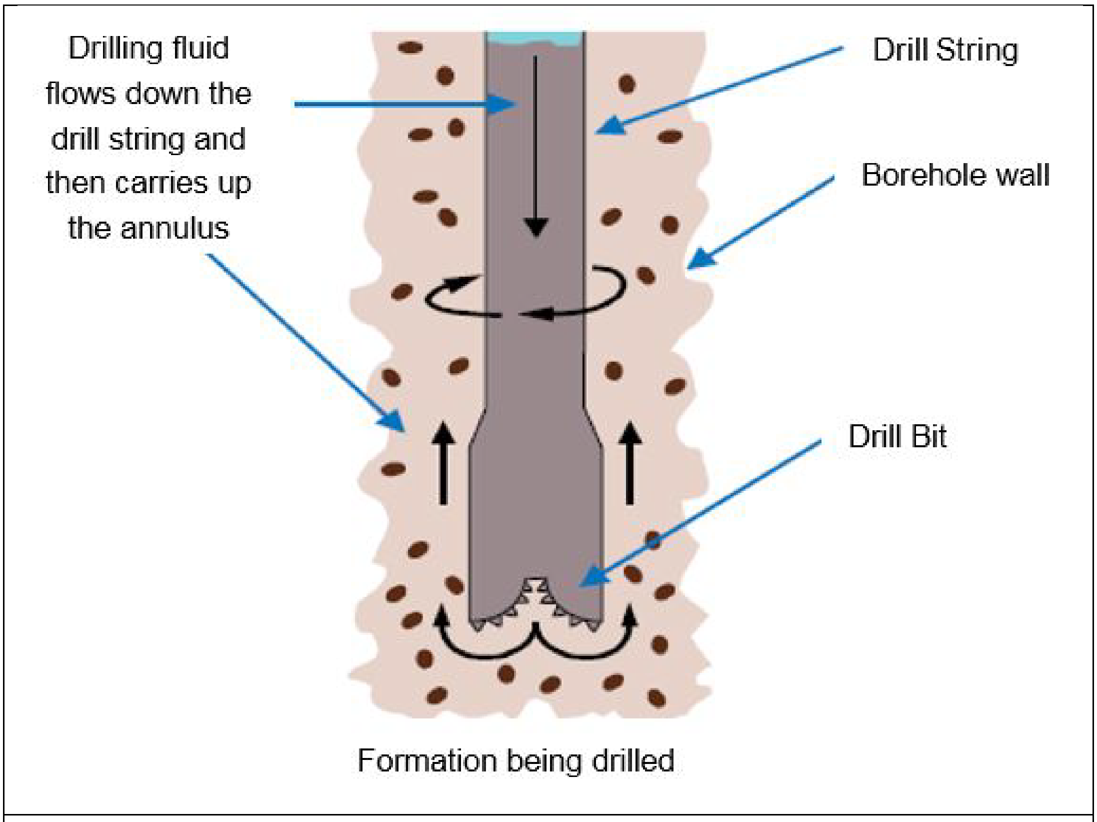
Figure 4.9). The cuttings typically range in size from grains of clay to pieces of coarse gravel and its composition will vary depending on the types of sedimentary rock penetrated by the drill bit.



Source: ERM

Figure 4.9 Typical Drilling Operations using a Drill Ship

Weighted drilling fluids are pumped down the drill string and exit via nozzles in the drill bit 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 (see Figure 4.10).



Source: OGP, 2003

Figure 4.10 Circulation of Drilling Fluid during Drilling

The first stage in drilling (known as 'spudding') is to install a 36-inch (c 91 cm) diameter conductor (steel casing) approximately 85 m below the seabed. This first section is commonly 'jetted' into place, by running the conductor pipe with a preinstalled concentric drill bit and drill-string inside it. In that way the conductor is jetted to its final depth, where the soft seabed sediments are allowed to bond to the conductor pipe to keep it in place. Subsequently the drill string is released from the conductor and the next well section is drilled. Each of these subsequent well sections of the well are drilled to the well design depth and then lined with metal casing that is cemented in place. Cement will return to the seabed from those sections drilled before the BOP is installed and any excess cement and cuttings return to the MODU through the riser. The following sections are then drilled using a progressively smaller drill bit and the casing, cementing and drilling process is repeated until the target depth is reached. After each cementing operation, the cement unit must be thoroughly cleaned to ensure that it is fit for use when needed (i.e. to prevent cement setting in the system).

4.4.2 Drilling Fluids and Cuttings Management

Two types of drilling fluids are typically used: Water Based Muds (WBM) for the upper well sections; Non Aqueous Drilling Fluids (NADF) for the lower well sections.

Typically, WBM can be used for shallow hole sections but are often technically not suitable for deeper hole sections where NADFs are used (to improve wellbore stability, ensure appropriate lubrication and minimise the risk of stuck pipe).

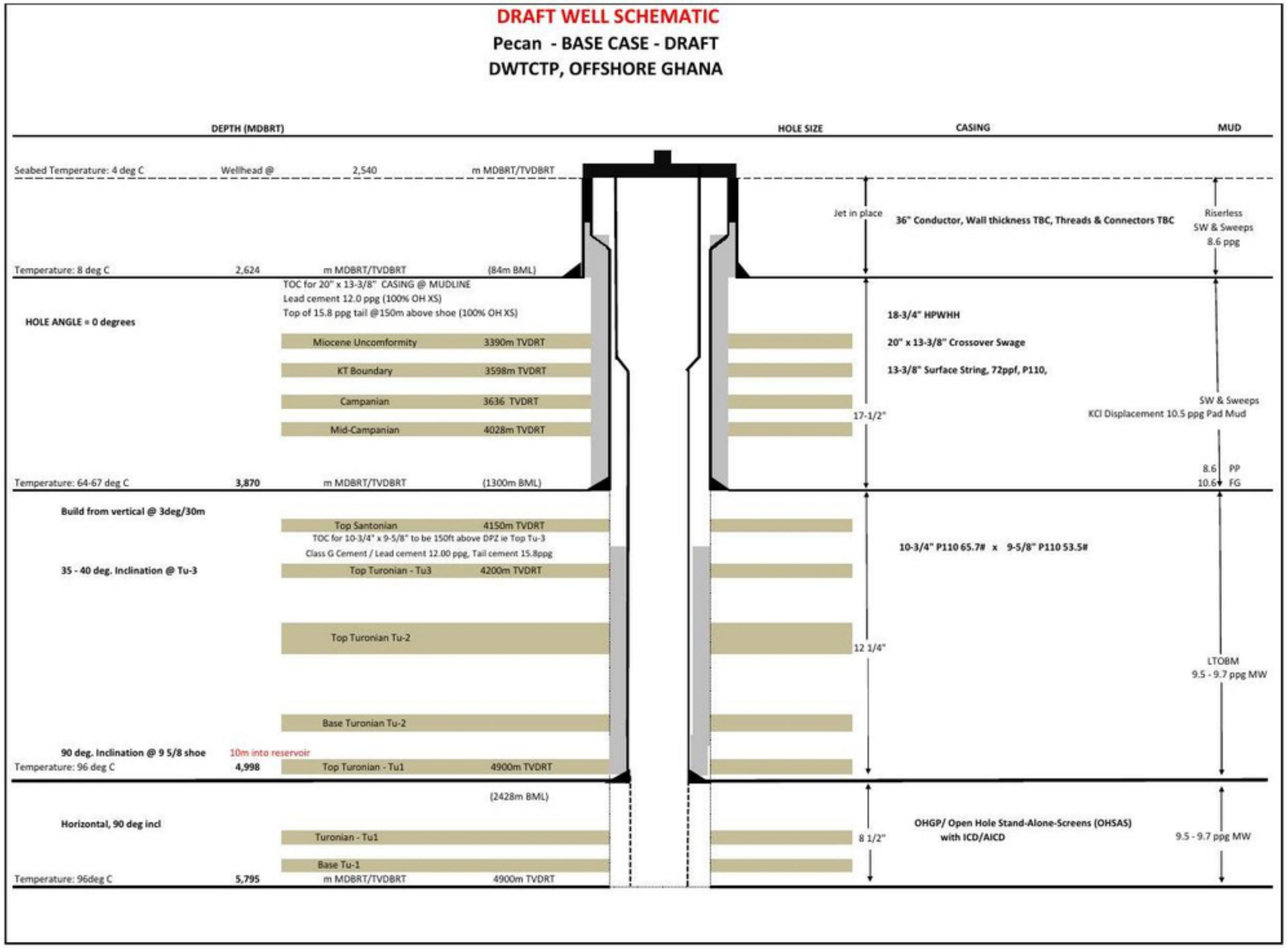
The additives generally used in drilling fluids include the following.

- **Fluid loss control additives.** These form a layer, or 'mud cake', that accumulates on the wall of the wellbore and retards the passage of liquid into the surrounding rock formation. Bentonite is the principal material for fluid loss control in WBMs although additional additives, such as starch and cellulose, both naturally occurring substances, are also used.
- **Lost circulation additives.** Predominantly naturally occurring fibrous, filamentous, granular or flake materials used to stop lost circulation when the drill bit enters a porous or fractured formation. Typical materials include ground-nut shells, calcium carbonate and mica.
- **Lubricity additives.** Added as required to prevent the drill string from becoming stuck or to help free it if it has become stuck in the hole (e.g. glycerol).
- **pH control additives.** Caustic soda and lime are used to control the alkalinity of the fluid to a pH of 9 to 10. This ensures the optimum performance of the polymers in the fluid, controls bacterial activity and prevents corrosion of the drill string components.
- **Pressure control additives.** Barite is generally used as a weighting agent to control the hydrostatic pressure that the drilling fluid exerts on the formation.

Figure 4.11 presents the wellbore schematic, and drilling mud based on current development plans, and it adopts a slim bore, 3-string casing design which includes 20 inch (c 51 cm) by 13⅜ inch (c 34 cm) surface casing.

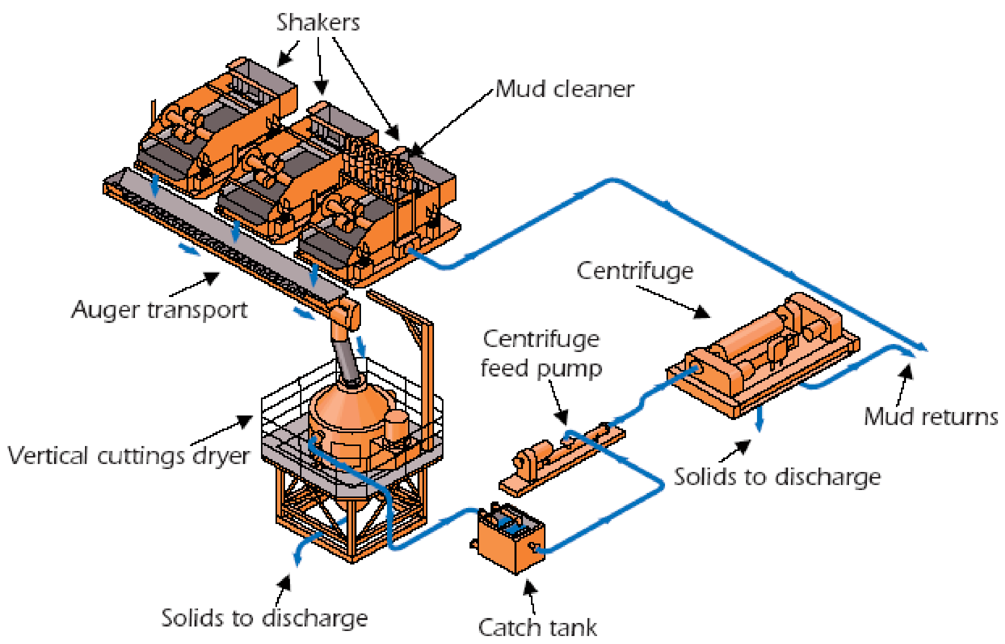
For the initial two hole sections, the 36 inch conductor and 20 inch by 13⅜ inch surface casing will be jetted into place using seawater and viscous sweeps (high viscosity drilling fluid that aid the transport of drill cuttings out of the well bore). WBM will be used, and both the fluid pumped and the drilled cuttings will be discharged onto the seabed because there isn't connection with the surface facilities through the marine riser. Once the conductor and surface casing are in place, the MODU's BOP and marine riser will be installed from the MODU to the wellhead on the seabed. This provides a closed fluid circulating system, which enables drilling fluid to be pumped down the drill string and returned to the MODU, along with entrained drill cuttings and excess cement via the casing and marine riser. On the MODU, the drill cuttings are separated from the NADF using solids control equipment involving shale shakers, cuttings dryers and centrifuges prior to final disposal to sea as per the local legislation. Figure **4.12** illustrates an advanced solid control system used by the industry.

The solid controls process to clean cuttings and recover the drilling fluid for reuse is a well-established process following a Standard Operating Procedure (SOP), which includes ongoing monitoring, frequent sample testing and reporting.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 4.11 Well Bore Schematic



Source: IOGP (2016)

Figure 4.12 Advanced Solid Control System Including a Secondary Treatment

4.5 Completions

After wells have been drilled a process known as 'well completion' is undertaken to prepare the well for its operational function (i.e. producing well or water injector well) and to install a number of safety and operational controls, such as flow valves and sand filters.

The completion designs all include some form of mechanical sand control, and have been standardised to two key completion designs:

- Open Hole Gravel Pack (OHGP) for the horizontal oil producers, and
- Open Hole Stand Alone Screens (OH-SAS) completion for the WAG injectors.

4.5.1 Lower Completions

The oil producers are currently planned as horizontal OHGP through the sand-face. The OHGP design was chosen to minimise the risk of sand and debris production through the subsea multi-phase pumps and to the FPSO, thereby reducing risk of subsea and topsides equipment failure and production downtime.

4.5.2 Upper Completions

The upper completions will provide reservoir surveillance, chemical injection and safety systems to ensure safe and compliant operations for the life-of-field. The wells will be designed to minimise the need for interventions during the well life, however, the designs will facilitate through tubing interventions such as wireline, tractor or coiled tubing, if they are required. The upper completions will include a Tubing Isolation Valve (TIV), a Safety Valve, Down Hole Pressure Gauges (DHPG) and Chemical Injection Mandrels (as required).

4.5.3 Well Clean-up

The well clean-up plan is to flow the first producer well to the MODU prior to first oil and to flow back all of the Phase 1a injector wells. The backflow liquid and gas will be flared at the MODU. The well clean-up philosophy is based upon a requirement to understand well performance and/or assurance on formation damage removal prior to injection. All other producing wells will be cleaned-up to the FPSO. All Phase 1b injector wells are planned for Direct Injection techniques, rather than well flow-backs. This reduces the amount of gas and liquid that will have to be flared at the MODU over the Project life.

4.5.4 Casing Design

The wells are designed to withstand the expected load cases and the production environment over the life of the well. The casing objectives for the Pecan wells are summarised in Table 4.5.

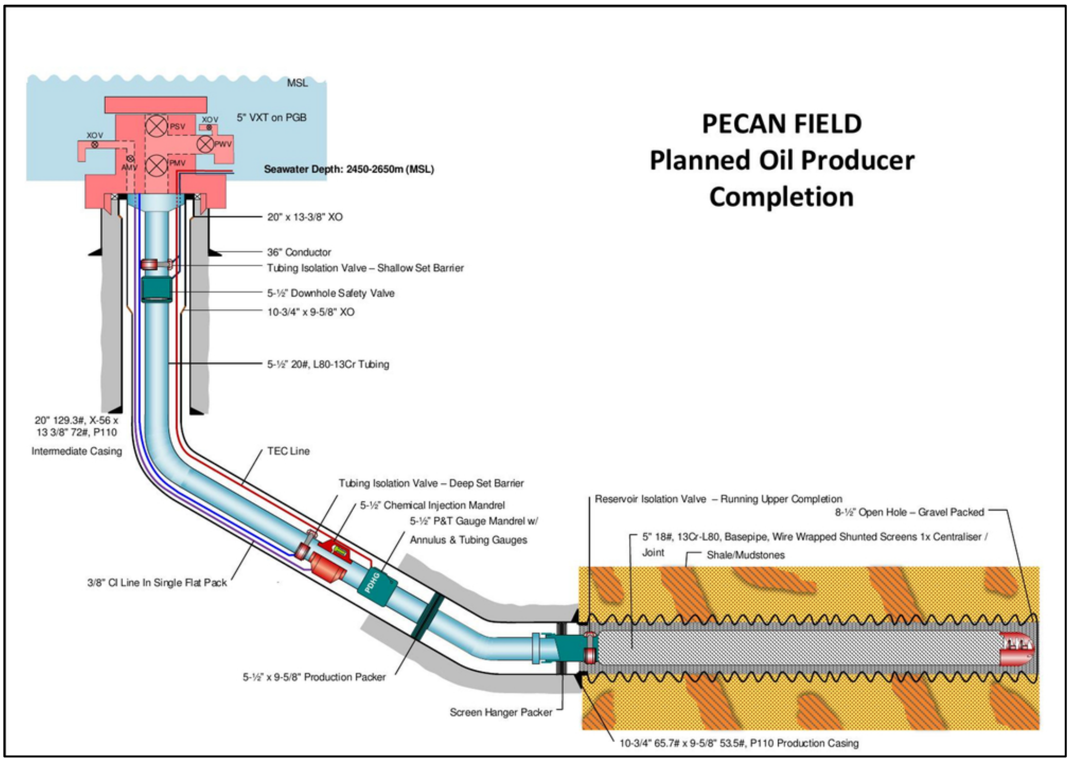
All planned wells will be cemented and isolated in accordance with industry good practice and Ghanaian guidance. Detailed cementing plans will be developed during the planning phase in cooperation with the selected service provider.

Table 4.5 Pecan Wells Casing Summary

Hole Size	Casing	Objective	Depth m TVDSS
36”	36”	Provide adequate axial and lateral support for wellhead, BOP & XMT Minimise wellhead movement – Provide sufficient fatigue life	±2,585
26”	20”	Planned for one well only Provide axial and lateral support - Provide sufficient well-head fatigue life Competent shoe to allow for sufficient mud weight / kick tolerance to drill the next section	±3,550
17 ½”	13 3/8”	Provide axial and lateral support - Provide sufficient well-head fatigue life. Allow an open hole blowout to be killed via relief well intersection at the shoe. Competent shoe to allow for sufficient mud weight / kick tolerance to drill the next section.	±3,800
12 ¼”	10 ¾” x 9 5/8”	Barrier against the Tu-3 formation DPZ (Distinct Permeable Zone) Casing cement provide primary barrier during production Casing above packer to provide secondary barrier during production Minimise shale exposure for the lower completion	±4,500
8 ½”	Open hole gravel pack with shunt screens (Producers) or Stand Alone Screens (Injectors)	Maximise access to reservoir sands Provide mechanical sand control	

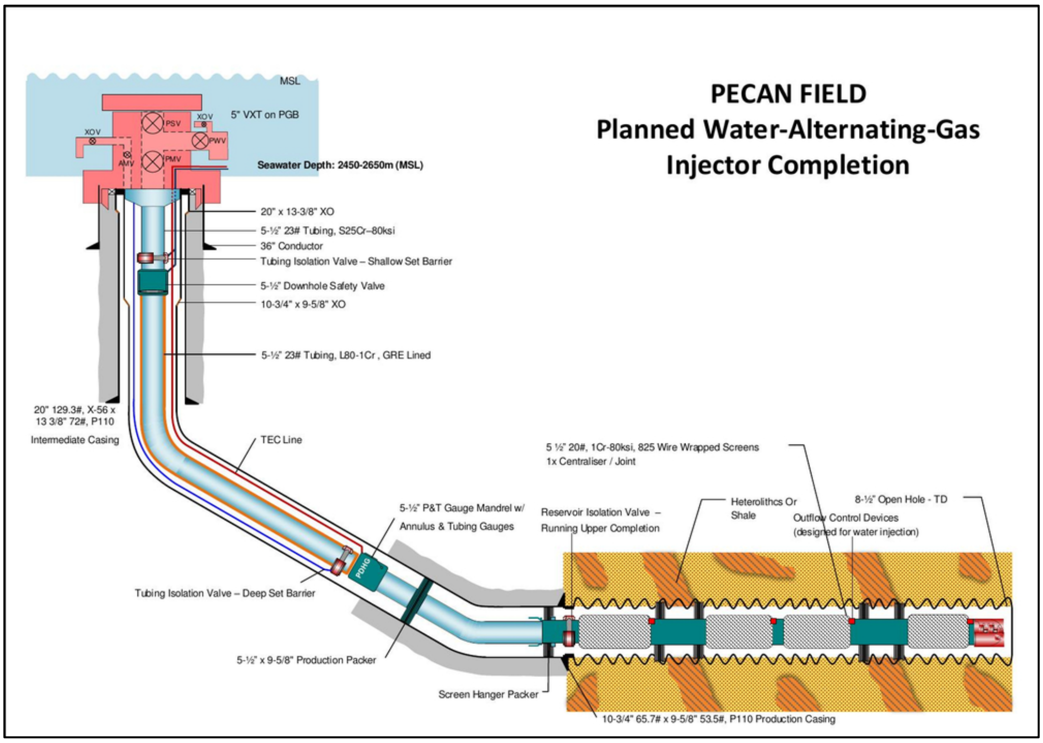
Source: Pecan Energies, DWT/CTP – Plan of Development 2023. Note: Only one of the wells is planned with a 4-string casing design. However, if difficult subsurface conditions are encountered, the other wells might also need to use the conventional 4-string design.

Figure 4.13 and Figure 4.14 illustrate the planned well completion schematics addressing the principal completion objectives for Producer and Injector wells, respectively.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 4.13 Oil Producer Completion



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 4.14 WAG Injector Completion

4.6 Infrastructure Installation

Installation of the FPSO mooring suction piles will be performed prior to FPSO arrival. The mooring clusters position and final FPSO location depend upon the field layout determined during the Project detailed design phase. The FPSO would sail under its own power or be towed from the conversion yard to the installation site.

Subsea Production Systems and flowlines, umbilicals and risers will be installed as a part of the subsea infrastructure. The risers and flowlines will either be installed with reel lay, S-lay or J-lay method. The umbilicals will be installed by a construction vessel with a tiltable or fixed vertical lay system (TLS and VLS, respectively) from a basket carousel. Large structures, jumpers and other infrastructure will be installed with lifts using construction vessel cranes.

The flowlines and subsea equipment will be hydrotested and flushed with potable or treated seawater prior to commissioning. The chemical lines and hydraulic lines in the umbilicals will arrive with storage fluid and the lines will be flushed and cleaned using a subsea system and all storage fluids routed into the flowlines and to the FPSO prior to discharge. The specific chemicals and additives that would be used would be in line with the Harmonized Offshore Chemicals Notification Format (HOCNF) to ensure the least hazardous available chemicals are used.

4.7 Commissioning

Pre-commissioning, and commissioning of the subsea system are expected to involve the following main activities.

4.7.1 Oil System

To ensure the system is pre-commissioned and ready for the introduction of first oil a certain sequence of activities is required both Pre-and Post FPSO arrival and hook-up.

Pre-FPSO

Once installation of production and service flowlines is complete, each line will be flooded, cleaned and gauged (FCG) with filtered and treated seawater (treated with chemicals comprising biocide, oxygen scavenger, corrosion inhibitor and leak tracer dye and hydrotested using a subsea pre-commissioning unit.

Flooding will be performed with a pig to remove all entrapped air. Interconnecting spools will be installed before the arrival of the FPSO and hydrotesting performed where possible using a subsea pre-commissioning unit.

Post–FPSO

All risers will be pulled in and connected to the permanent system onboard the FPSO. Following riser pull in, risers will be flooded with treated seawater from subsea to surface connection. After completion of free-flooding operations, risers will be topped-up from the FPSO and pigging operations may commence. A single multi-purpose pig will be propeller from FPSO and recovered via a receiver/pig catcher located on the main hub of the associated Pipeline End Terminal (PLET). Hydrotesting of the risers will be performed against closed valve on riser base PLET utilising a testing spread located on the FPSO.

Flowline and Well Jumpers

Flowline jumpers will be installed with treated and filtered water. Following jumper tie-in, a back seal test will be performed on each connection. Following the final connection of the FPSO riser spool piece to the FPSO piping, leak tests will be performed to confirm the integrity of these flange connections including the seaboard flange of the Emergency Shutdown Valve.

Well jumpers will be flushed with MeOH. Fluid in the well jumper will be discharged in the production loop pipelines. Once well jumpers have been flushed with MeOH, diesel will be introduced in the production flowline. Treated seawater will be initially discharged overboard. At a given stage of the dewatering (e.g. 95% of the total volume pumped) the flow will be routed to the production manifold / FPSO process equipment.

4.7.2 Water Alternating Gas Injection System

Water Alternating Gas (WAG) Injection Risers and flow lines will undergo FCG using treated seawater in a similar manner as detailed for the flowline jumpers. To mitigate potential asphaltene precipitation, WAG injection wells have to be injected with water for three months prior to introducing gas injection.

The gas compressor train will be commissioned and certified ready for hydrocarbon. There will be need for flaring of excess produced gas, associated gas not used for gas turbine fuel, during the first three months of operation after first-oil. The flaring will last until the first WAG well is ready for gas injection.

Switching from water injection to gas injection is conducted topside on the FPSO, and the same risers and flow lines are used for both water and gas injection. The process is closer described in section 4.6 Operation Phase.

4.8 Operation Phase

The FPSO will be operated by the FPSO Owner according to an Operation & Maintenance (O&M) agreement with Pecan Energies. The FPSO operator will operate the subsea and subsurface infrastructure and system on behalf of Pecan Energies, through a Subsea Life of Field (SLF) contractor. To allow the Contractors to function efficiently there will be bridging of Management Systems of all companies which will be facilitated by Pecan Energies. The bridging documentation will cover aspects of Operating Procedures, Standards, Manuals, HSSE Policies and Emergency Response.

Contract with external vendors will include the following.

- Shore base facilities and storage areas.
- Quayside /berth area.
- Helicopter transportation and booking services.
- Marine operations:
    - Supply vessel[1] transport services between shore base and offshore facility
    - MPV subsea service vessel;
    - Offload operation support vessels; pullback tug (100 bollard tonnes) and a line handling boat;
    - Security guard boat, policing 500m safety zone.
- Production and injection chemicals.
- Diesel and fresh water.
- Waste handling services

Flow Assurance (FA) strategies shall be developed to ensure efficient and effective flow of fluids through the entire production system during steady state and transient conditions. FA evaluations will be done throughout the operation phase to optimise production and prolong field life, e.g. hydrate management, well start-up sequence and any special scenarios. All systems (facilities, wells, risers, etc.) shall have appropriate mitigation measures to prevent degradation due to erosion, corrosion, scale and hydrates.

During plateau production, offloading is scheduled to take place monthly in phase 1A, and fortnightly in phase 1B. The offloading plans and logistics planning will be undertaken by Pecan Energies. During offloading, the O&M operator will manage and perform the offloading operation with Pecan Energies supervision. The O&M operator shall develop and maintain an FPSO offloading report. Offloading will be performed from the FPSO to the oil offtake tanker in tandem mode. Tug vessels will assist to secure tanker position. The offloading and ballasting shall be controlled from the FPSO and crude oil samples shall be analysed on the FPSO during offloading.

4.9 Decommissioning Phase

4.9.1 Abandonment and Removal of Installations

At the end of economic life of the Pecan Field, the Field facilities and wells will be decommissioned and/or abandoned in accordance with the Petroleum Agreement, applicable Ghanaian Acts and Regulations and relevant international petroleum industry practices. An outline Decommissioning and Abandonment Plan (DAP) is presented in Chapter 8. This will be developed further by the Project for submission to the EPA prior to commencement of production from the FPSO, as required by the Environment Assessment Regulation (1999) LI 1652. A detailed DAP will be submitted to the Ghana EPA between two and five years prior to the planned cessation of production operations, as required by the Petroleum Agreement. The Project Waste Management Plan will also be updated to address wastes from the decommissioning process.

The DAP will be undertaken in accordance with applicable laws and regulations in force at the time, including criteria for which parts of the installations that need to be removed or may be left on the seabed.

At this stage it is expected that:

- the FPSO and mooring lines will be removed;
- the mooring lines will be cut on the seabed as close to the anchor pile as possible;
- the steel catenary risers and pipelines will be cleaned, filled with seawater, disconnected and left on or self-buried on the seabed; and
- removal of subsea structures will be evaluated in view of the ultra-deep water and other activities, and as for the riser, pipelines and cables, they may be left on the seabed.

4.9.2 Plug and Abandonment of Wells

Wells are planned to be individually decommissioned, and permanently Plugged and Abandoned (P&A) using a MODU and a light well intervention vessel, depending on the requirements. For each well cement and mechanical plugs will be installed to prevent hydrocarbon release to the environment, in accordance with recognised industry practices and Pecan Energies policies and procedures. The P&A programme for each well will be developed as part of the detailed DAP.

A summary of the currently planned P&A operational steps are as follows.

- Flush the well of hydrocarbons and close down the well from a MODU or FPSO.
- Suspend the well with bridge plugs and cut the drill pipe at seabed level.
- Remove the X-Mas tree.
- Recover the production tubing.
- Set and test mechanical and first cement plug.
- Set and test second cement plug.
- Set and test third cement plug at wellhead, if required.

4.10 Emissions, Discharges and Waste Generation

4.10.1 Emissions to Air

Emissions to air will result from the combustion of fuels, such as marine gas oil, gas and aviation fuel consumed to support field development (MODU, field support vessels (PSV) and construction support vessels (CSV)) and production operations (FPSO and PSV engines, FPSO topsides equipment and helicopters). These will result in emissions of greenhouse gases and pollutants such as carbon dioxide (CO_2), methane (CH_4), volatile organic compounds (VOCs), carbon monoxide (CO), oxides of nitrogen (NOx) and sulphur (SOx), and particulate matter (PM). Emissions will be subject to standards, as discussed in Chapter 2: Section 2.12. The existing gas turbine generators (GTGs) on the FPSO are being replaced by low NOx DLE GTGs (Titan 130) resulting in approx. 65% reduction in NOx emissions from this source.

Emissions will also result from the flaring of associated gas during the commissioning phase. Prior to commissioning of the FPSO, the initial wells will be cleaned-up to the MODU. This requires that the hydrocarbons and other completion fluids (e.g. diesel, methanol) are flared. This will be performed using an efficient test burner.

During normal FPSO operations, vent streams will be routed back to the gas injection system. Associated gas will be used for fuel on the FPSO or for WAG reinjection. In case of planned production shut-downs on the FPSO (e.g. during routine turnarounds for major maintenance) there will be a need for flaring during shut-down and start up sequences. Flaring during upsets and maintenance will be applied for in the Operations Production permit application.

The main factors contributing to planned flaring from the FPSO are as follows.

- Well clean-up. It is assumed that during well clean-up to FPSO, oil will be routed to cargo tanks and associated gas is flared for three days.
- FPSO commissioning. It is assumed that all associated gas is flared and that the FPSO is fuelled by diesel during commissioning. There is a requirement to inject water for three months prior to introducing gas injection necessitating gas flaring during this period.
- Downtime of the gas injection system.

Hydrocarbon blanket gas in the oil storage tanks will be recovered in a VOC recovery unit. The recovered VOC will be introduced into the gas handling system for mixing with produced gas.

Emissions to air have been estimated for the Project and are presented in Appendix J. The main sources are presented with emissions of NOx and SOx presented for Phase 1a and Phase 1b for each year over the duration of the Petroleum Agreement (15 years from First oil). Emissions data are derived from a number of sources including plant and equipment suppliers (e.g. Cat and Perkins vessel engines), USEPA AP-42 (1) and Alberta Environmental Sustainable Resource Development (ESRD) (2), as listed in Annex I.

(1) http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s05.pdf,
https://www.epa.gov/sites/default/files/2020-10/documents/c03s01.pdf,
https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-a-aviation
http://www.epa.gov/ttnchie1/ap42/ch13/final/c13s05.pdf
(2) https://www.aer.ca/rules-and-regulations/directives/directive-060

The flaring volumes are based upon the Pecan production profile and were conservatively estimated with 95% availability of gas compression (minimum requirement as per FPSO functional specification).

Annual greenhouse gas (GHG) emission in CO_{2e}, including marine and aviation transport, varies from 271,056 to 573,439 tonnes, with an annual average (over 15 years) of 366,160 tonnes CO_2e (see Annex I). The estimated flaring volumes excludes flaring due to depressurisation of equipment/systems during planned maintenance or blowdown due to unforeseen events e.g. emergency shutdown. The emission factors used were from the API Compendium [(1)].

Figure 4.15 and Figure 4.16 provide an illustration of the amount and origin of pollutant species per year from the Project. Figure 4.17 provides an estimation of the total energy use by source.**Error! Reference source not found.** provides an estimate of the CO_{2e} emissions profile for the Project in tonnes a year over 15 years.

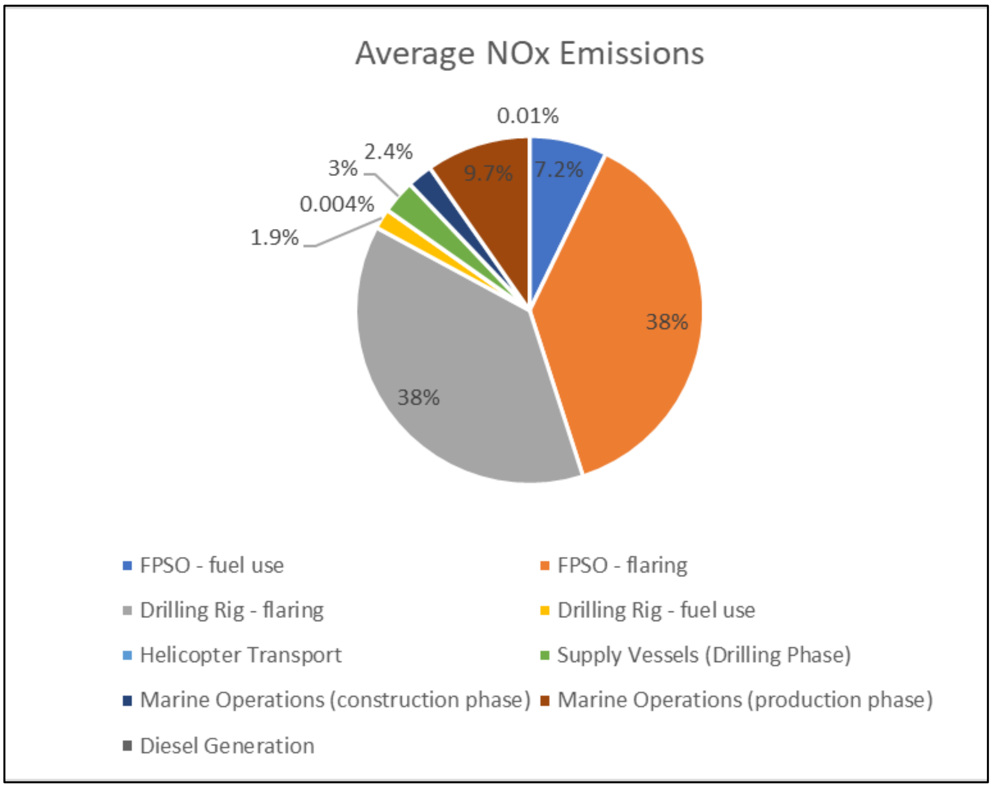


Figure 4.15 Average Emissions of NOx per year as a Percentage of 6,922 Tonnes a Year

(1) https://www.api.org/~/media/files/ehs/climate-change/2009_ghg_compendium.ashx

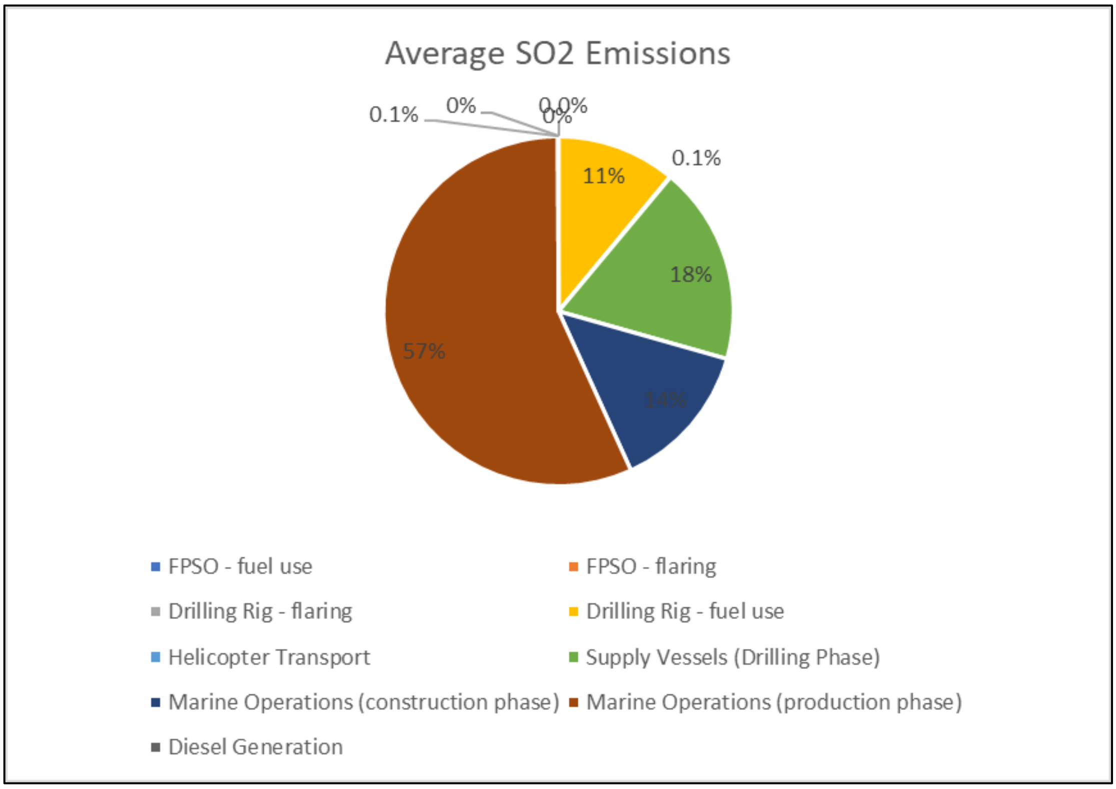


Figure 4.16 Average Emissions of SOx per year as a Percentage of 181 Tonnes a Year

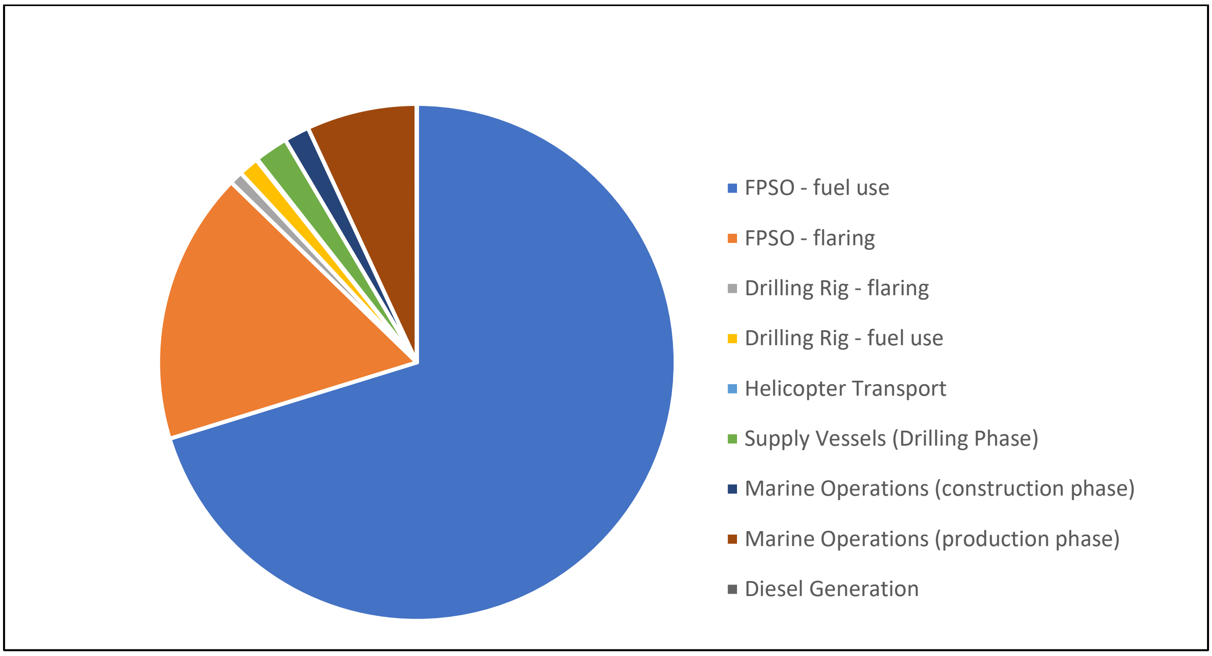


Figure 4.17 Average Project Energy Use by Main Sources as Percentage of 85,833 Terra Joules per year

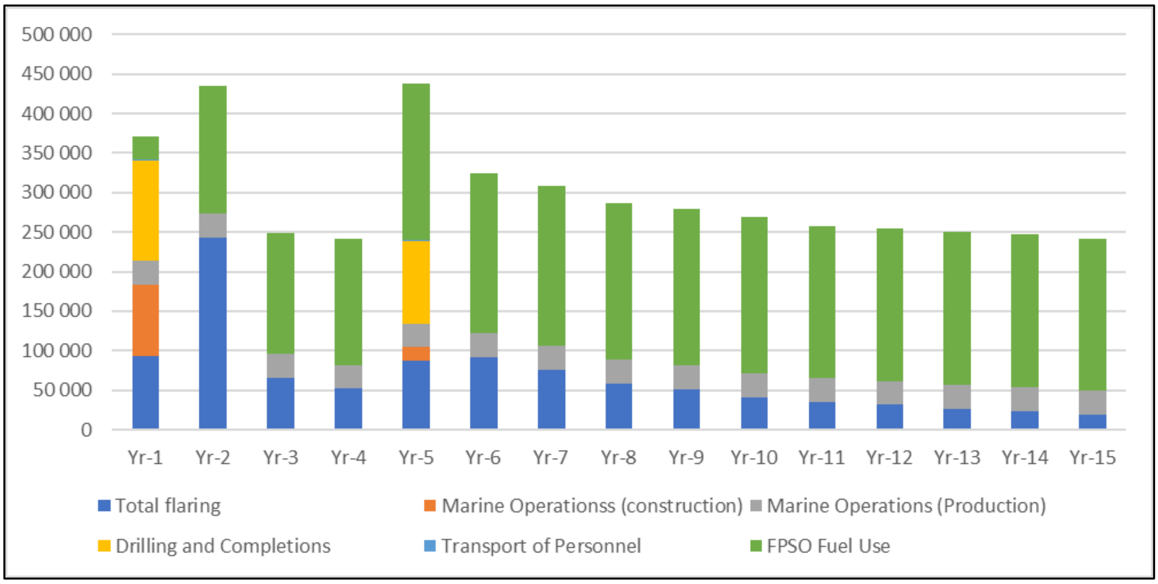


Figure 4.18 Predicted Project CO_{2e} Emissions

4.10.2 Light

Offshore activities will require 24 hr operations therefore light is required to maintain a safe working environment on the MODU, FPSO and support vessels. Onshore operations will require some 24 hr working, for example at the port, and adequate lighting will be required for safety and security.

4.10.3 Discharges

MODU and support vessel operations during well drilling will result in routine discharges to sea (i.e. sewage, grey water, food waste, bilge water, ballast water and deck drainage. Discharges to water are subject to standards as discussed in Chapter 2: Section 2.11. Discharges will be from the following main activities.

Drilling

Drilling process discharges will include drill cuttings and drilling fluids. WBF (seawater and sweeps) 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 and separate drilling fluid from the cuttings prior to disposal. Initial treatment will be by shale shakers and a vertical cuttings dryer to reduce residual oil on cuttings (OOC) The vast majority of the drilling fluids are separated from the cuttings and re-used after mixing with chemicals to obtain correct quality and properties.

A Best Available Technique (BAT) assessment has been undertaken of the following drill cuttings treatment options.

- Offshore thermal treatment to average of <1% OOC and offshore disposal.
- Offshore thermal treatment to average of <1% OOC, with intermediate storage on support vessel, and offshore disposal.
- Offshore cuttings dryer to average of 2-5% OOC over the entire volume of NADF drill cutting and disposal offshore.
- Skip and ship with onshore thermal treatment and disposal.

Modeling of the fate and impact of drill cuttings and mud was conducted as basis for the BAT assessment (Appendix B). The results showed no difference in water column or sediment contamination between 1% OOC and 4% OOC over the entire volume of NADF drill cuttings per well. See the Impact Assessment in Chapter 5 for discussion of the results.

Option 1 above, offshore thermal treatment is not technically feasible as the footprint of Thermal Desorption Unit (TDU) and cuttings storage tanks (pre treatment) are too large for the MODU.

Option 2, offshore thermal treatment with intermediate storage on PSV has a significant increased safety risk due to increased number of lifting operations. It has increased energy consumption and carbon emission due to the extra vessel and the TDU energy need. Further, it has a significant increased cost of over ten times higher cost than for Option 3.

Option 4, onshore treatment for large bulk cuttings handling is not feasible with the existing infrastructure in Ghana.

Option 3, offshore cuttings dryer has the lowest energy consumption of the options, is technically well proven, has the lowest safety risk, the lowest cost per well and the environmental impact of discharge is at the same level as for the other discharge options. Thus, Option 3 is considered as the Best Available Technique for the Pecan Project.

As stated in the applicable standard for effluent discharges overview in Table 3.6, the limit for discharge of cuttings with low toxicity NADF is 2 %. However, the conditions of the environmental permits for the previous drilling activities are that discharges of cuttings (from sections drilled with NADF) with average OOC of 2-5% and 5-10% can be compensated with an administrative surcharge while discharge over 10% OOC is prohibited. Similar conditions are expected for the Pecan drilling operations as the option with discharge of 2-5% OOC is assessed to be the best available technique option.

Typical volumes of drilling fluid and cuttings generated per well are provided for the three-string slim design wells in Table 4.6 and the conventional 4-string design wells in Table 4.7. The total volumes of drill cuttings for each drill section for all Phase 1 wells are presented in Table 4.8.

Table 4.6 Estimated Cuttings, WBM and NADF Volumes for the Slim-Well Design (Per Well)

Hole Size in	36"	17.1/2"	Total	12.1/4"	8.1/2"	Total
Drilling Fluid System	WBM	WBM	**WBM**	NADF	NADF	**NADF**
WBM	145 t	637 t	**782 t**	-	-	
WBM Cuttings	134 t	588 t	**722 t**	-	-	
NADF (5% retention)	-	-		-	-	**19 t**
NADF Cuttings	-	-		294 t	81 t	**375 t**
Discharge Location	Seafloor	Seafloor	**Seafloor**	Surface	Surface	**Surface**

Note: Estimates are based on well section length for an average Pecan development well. 30% additional contingency added to volumes. Rock density assumed 2.4 t/m^3. 5% NADF adherence on cuttings. Volumes are indicative and will vary 2depending on the final well design. One of the wells in Phase 1b is currently planned with one additional drilling section (26") and has been included in Table *4.8*.

Table 4.7 Estimated Cuttings, WBM and NADF Volumes for the 4-String Design (Per Well)

Hole Size in	**36"**	**26"**	**Total**	**17.1/2"**	**12.1/4"**	**8.1/2"**	**Total**
Drilling Fluid System	WBM	WBM	**WBM**	NADF	NADF	NADF	**NADF**
WBM	145 t	770 t	**915 t**	-	-	-	
WBM Cuttings	134 t	711 t	**845 t**	-	-	-	
NADF (5% retention)	-	-		-	-	-	**32 t**
NADF Cuttings	-	-		278 t	273 t	81 t	**632 t**
Discharge Location	Seafloor	Seafloor	**Seafloor**	Surface	Surface	Surface	**Surface**

Table 4.8 Total Cuttings and NADF Volumes for Phase 1a and 1b

Hole Size in	**36"**	**26"**	**17.1/2"**	**Total**	**17.1/2"**	**12.1/4"**	**8.1/2"**	**Total**
Drilling Fluid System	WBM	WBM	WBM	**WBM**	NADF	NADF	NADF	**NADF**
WBM	2032 t	770 t	8285 t	**11086 t**	-	-	-	
WBM Cuttings	1876 t	711 t	7647 t	**10233 t**	-	-	-	
NADF (5% retention)	-	-	-		-	-	-	**275 t**
NADF Cuttings	-	-	-		278 t	4092 t	1132 t	**5502 t**
Discharge Location	Seafloor	Seafloor	Seafloor	**Seafloor**	Surface	Surface	Surface	**Surface**

Well Construction

The 36’’ conductor will be jetted in place, therefore no cementing is planned. The $13^3/_8$” (or alternative 20” casing) will be cemented to seabed for structural integrity and load bearing capacity. Excess cement forced out of the top of the initial surface casing at the seabed will be circa 8 m^3 per well.

At startup of the cementing, there will be discharge of a cement test slurry, approximately 8 m^3 per well. After the cement job is completed there will be need for clean-up of the equipment causing discharge of approximately 10 m^3 cement dissolved with washdown water.

Completions

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.

Well testing and clean-up

As outlined earlier (Section 3.5), the planned welltest-cleanup strategy includes the flowback of the wells listed in Table 4.9.

Table 4.9 Pecan Phase 1a Well Clean-Up Strategy

Well Type	Well Clean-Up to Rig	Well Clean-Up to FPSO	Direct Injection	Well Injectivity Tests	Fluid in Reservoir Section	Tubing Fluid	Fluid below DHSV after Clean-Up
Horizontal Oil Producer	1	2	0	0	OBM Filter Cake / Breaker / Brine	Base Oil	HC / Base oil
High Angle WAG Injector	4	0	0	4	OBM Filter cake / Breaker / Brine	Base Oil	Inhibited brine

For Phase 1a, the estimated flared volumes from Drilling Unit welltest operations is presented in Table 4.10.

Table 4.10 Estimated Well Cleanup Flared Volumes (Phase 1a)

Welltest	Producer	Water Injector
Clean-Up Rate	12,000 bbl/day	12,000bbld/d
GOR	650scf/bbl	650scf/bbl
No. Of Clean-ups	1	4
Estimated full-flow duration	2 days	1.5 days
Total Phase Estimated Oil Flare	**24,000 bbls**	**72,000 bbls**
Total Phase Estimated Gas Flare	**16 MMscf**	**47 MMscf**

As mentioned earlier in Section 3.4, in Phase 1b there shall be no clean-up operations to the Drilling Unit.

Chemical Selection

Drilling and completion chemicals will be chosen to have minimum impacts on the aquatic environment. The *Guidelines on Environmental Assessment and Management in the Offshore Oil and Gas Development* in Ghana (EPA 2011) define four categories of chemicals as shown in Table 4.11. Permitting conditions for the previous offshore oil and gas developments in Ghana stipulated that, chemicals (which were to be discharged into the sea) in the red and black categories shall only be chosen if they are necessary for technical and safety reasons.

Table 4.11 EPA Categorisation of Chemicals

Category	Description
Black	Black category consists of chemicals on the following lists. 1. OSPAR List of Chemicals for Priority Action 2. 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) • Substances that are detrimental in a mutagenic or reproductive way
Red	Red category consists of substances with the following ecotoxicological properties. 1. Inorganic substances which are acutely toxic (EC_{50} or LC_{50} at 1 mg l^{-1}) 2. Organic substances with a low biodegradability (BOD_{28} <20%) 3. 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 Poses Little or No Risk (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 to ensure that it is below the specification for discharge (i.e. less than 15 ppm oil and grease, maximum instantaneous oil discharge monitor reading). If the TOG content is greater than the specification then the returned fluids will be retained on the vessel in tote tanks or similar closed vessels, where this is practical, and shipped for onshore disposal.

Completions will be undertaken from the MODU and this process will take approximately 30 days per well.

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 Guideline for Offshore Oil and Gas Development (2011).

Black and Grey Water

There will be vessel discharges of black water and grey water (defined below). Discharges are estimated in Table 4.12, based on monitoring data for similar FPSO facilities with a similar number of persons on board (PoB).

Black water (i.e. 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 0.5 mg l^{-1} and no visible floating solids or oil and grease. Grey water (i.e. 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.

Food Waste

Ensure that Organic Food Waste is macerated to less than 25mm (<25mm) and discharged to achieve no floating solids or foam in compliance with MARPOL.

Deck Drainage

Deck drainage will be managed via the open non-hazardous and hazardous drains systems as described in *Section 0.*

Bilge Water

Support vessels will occasionally discharge treated bilge water. These vessels will comply with the requirements of Annex H 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

Any ballast water discharges that may be required for Project vessels entering Ghanaian waters will be subject to MARPOL 73/78 requirements. MARPOL 73/78, Annex H, 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 nm 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 discharges that may be required.

Pre-Commissioning, Testing and Line Flushing Fluids

Liquid discharges will result from flowlines, umbilicals and the water treatment facilities during hydrotesting and pre-commissioning activities at the offshore location. Pre-commissioning fluids for subsea infrastructure and production flowlines will use treated seawater (filtered to a minimum quality with suspended particles no larger than 50 μm) and dosed with a blend of corrosion inhibitor, biocide and oxygen scavenger to allow for protection of pipelines and components. A dye will also be added to assist with leak detection. Pre-commissioning chemicals will be selected based on the following criteria: technical function; lowest toxicity; lowest bioaccumulation potential; and highest biodegradation.

The discharge will be subsea, except for the production flowline volumes that will be produced back to the FPSO and discharged from surface. In addition, deoxygenated and filtered seawater will be pumped through the subsea flowlines and manifolds to flush the subsea system. Gas injection pipelines will be dewatered (i.e. water is pumped out), flushed with MEG to remove any remaining water and then dried with nitrogen (left *in situ* under pressure). MEG will be discharged to sea.

Production risers will be left *in situ* with inhibited seawater. During commissioning, the flowline circulation tank on the FPSO will be filled with diesel that will be used to displace the seawater. Residual diesel will be contained on board the FPSO.

Workover Fluids

In general, workover fluids are similar to completion fluids (listed in Table 4.12) and will be re-used, re-injected into the formation or remain downhole. Some fluids will be returned to the surface for disposal to sea after testing, or taken to shore and returned to the supplier for disposal.

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 hydraulic fluid that is biodegradable with low toxicity and minimal impact to the marine ecosystem rated yellow according to the Ghana Guideline on Environmental Assessment and Management (EPA 2011). Small volumes of hydraulic fluid will be vented from the control system equipment when given a command to close. The testing or operation of the subsea BOP would also result in small volumes of hydraulic fluid being discharged, e.g. 8 litres of hydraulic fluid from BOP testing.

4.11 FPSO Production Operations

FPSO operation discharges will include produced formation water (PFW). Details of the chemicals likely to be used and remain in PFW and therefore be discharged overboard can be found in Table 4.13. The OSPAR hazard category provided for each type of chemical is based on a preliminary enquiry to a potential supplier. The actual chemicals selected will be from those available from the selected supplier, therefore some chemicals may be of a lower or higher hazard category. It is noted that de-foamer products are generally silicon based and not readily biodegradable so have a red rating. However, discharge of this chemical will not be frequent.

Table 4.12 Summary of Discharges and Treatment

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Black Water from vessels, MODU and FPSO	Treat with approved sanitation unit. Maceration and Chlorination	Single; holding tank storage; discharge overboard (above sea surface)	Variable depending on number of personnel. Estimated discharge rate of 151 l per POB per day. Max POBs: FPSO: 104 personnel = 15,704 l d^{-1} MODU: 180 personnel = 27,180 l d^{-1} Multipurpose offshore support vessels (MOSV): 70 personnel = 10,570 l d^{-1} PSV: 25 personnel = 3,775 l d^{-1} Pipelay: 140 personnel = 21,140 l d^{-1}	Intermittent	Achieves no visible floating solid No discolouration of surrounding water < 0.5 mgl^{-1} chlorine concentration	EPA (2011) Annex IV MARPOL
Grey Water from vessels, MODU and FPSO	Remove floating solids	Single; holding tank storage; discharge overboard (above sea surface)	Variable depending on number of personnel. Estimated discharge rate of 385 l per POB per day. Max POBs: FPSO: 104 personnel = 40,040 l d^{-1} MODU: 180 personnel = 69,456 l d^{-1} MOSV: 70 personnel = 27,011 l d^{-1} PSV: 25 personnel = 9,647 l d^{-1} Pipelay: 140 personnel = 54,021 l d^{-1}	Continuous	No visible floating solids or discoloration of surrounding water	EPA (2011) Annex IV MARPOL
Food Waste from vessels, MODU and FPSO	Macerate to acceptable levels	Single; holding tank storage; discharge overboard (above sea surface)	Variable depending on number of personnel. Estimated discharge rate of 1 kg per POB per day. Max POBs: FPSO: 104 personnel = 104 kg d^{-1} MODU: 180 personnel = 180 kg d^{-1} MOSV: 70 personnel = 70 kg d^{-1} PSV: 25 personnel = 25 kg d^{-1} Pipelay: 140 personnel = 140 kg d^{-1}	Intermittent	Ground to pass through a 25-mm mesh Discharge more than 12 nautical iles from land	EPA (2011) Annex V MARPOL

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Deck Drainage from vessels and MODU	Oil-water separation	Single, discharge overboard	Deck drainage water generation variable, depending upon facility and vessel characteristics, rainfall amounts. Discharge volumes variable.	Intermittent	No free oil 15 mgl^{-1} instantaneous reading oil water threshold	EPA (2011) Annex I MARPOL
Bilge Water from vessels, MODU and FPSO	Bilge water separator	Single, discharge overboard (above sea surface)	Bilge water generation variable, depending upon facility and vessel characteristics. Estimated discharge rate variable FPSO: 1,200 l d^{-1}. MODU: 1,700 l d^{-1}.	Intermittent	No free oil 15 mgl^{-1} instantaneous reading oil water threshold	EPA (2011) Annex I MARPOL
Ballast Water from vessels	None	Single; Discharge overboard (above sea surface)	Dependant on vessel trim requirements and size of vessel.	Intermittent	No free oil 15 mgl^{-1} instantaneous reading oil water threshold	MARPOL Annex I IMO (2004)
Drill cuttings and fluid from MODU	WBF Drilled Section : No treatment – discharge to seafloor. Unused fluid will be returned to supplier NADF Drilled Section: Mud recycled using solid control equipment. Unused retuned to supplier	WBF Drilled Section : Discharge to seafloor. NADF Drilled Section: Option for treatment and disposal of cuttings will be evaluated.	Estimated discharge per well (based on generic three string Pecan producer well): Total mass of cuttings: 15,736 t. Cuttings drilled with WBF: 10,233 t Cuttings drilled with NADF: 5,502 t WBM: Up to 11,086 t. NADF: Up to 275 t of residual NADF entrained on cuttings based on 5% oil on cuttings.	Intermittent	Use of low toxicity (Group III) NADF Hg 1 mg kg^{-1} dry wt in stock barite Cd 3 mg kg^{-1} dry wt in stock barite Target Limits: Discharged to sea with level range of 2-5% OOC based on the entire volume of NADF drill cuttings[1]. Maximum Limit: Discharged to sea with level below 9.4% OOC based on the entire volume of NADF drill cuttings.	IFC (2015), EPA (2011)

[1] The cuttings treatment solutions have been assessed to be best available technique for the drilling operation.

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Cement (returns) from MODU	None	Discharged at the seabed when cementing initial surface casing.	Excess cement forced out of the top of the initial surface casing at the seabed (circa 8 m^3 per well).	Intermittent	N/A	N/A
Cement slurry and washdown water from MODU	None	Discharge 5-20 m below seawater surface via caisson	Cement test slurry, washdown water (typically 1 part water, 20 parts cement) from cleaning the cement unit following cement jobs, and excess cement. Estimated quantities per well: Cement slurry: 8 m^3 Washdown water 10 m^3 Excess cement: 8 m^3	Intermittent	N/A	N/A
Completion fluids from MODU	Oil-water separation. Any acids used will be neutralised to pH 6-7 by addition of soda ash or similar prior to discharge	Discharge 5-20 m below seawater surface via caisson	Brine options to be consiuderred the following chemistry or mixture; NaCl, KCl, NaBr. Operational plan full brine discharge at the end of drilling operations per well. Total estimated brine volume discharges equals 890 m^3 per well. Potential additives might be corrosion inhibitor, biocide and oxygen scavenger blend at low concentrations and shall be compliant with discharge regulations.	Intermittent	Oil in water not to exceed 40 ppm daily maximum and 29 ppm monthly average, in accordance with EPA guidelines and Pecan Energies Project standards. Any spent acids will be neutralised (to attain a pH of 6 or more) before testing and disposal.	EPA (2011) Pecan Energies Standard EPA (2011)
Pre-commissioning - treated seawater from FCG, hydrotest and leak tests.	No treatment prior to discharge.	Subsea at Pig Launcher Receiver (PLR)	Seawater typically treated with corrosion inhibitor, biocide and oxygen scavenger blend at 500 ppm and tracer dye at 100 ppm.	Intermittent	No limits defined – chemical selection and use subject to EPA guidelines	EPA (2011)

Discharge and Source	Treatment	Discharge Point (s) and Location	Volume	Frequency	Limit	Standard
Pre-commissioning - gas system dewatering fluids – treated seawater and MEG.	No treatment prior to discharge.	Subsea at PLR	Seawater typically treated with corrosion inhibitor, biocide and oxygen scavenger blend at 500 ppm and tracer dye at 100 ppm. Discharge volume estimated as 120% of system volume. MEG, dosed with tracer dye at 100 ppm, used in dewatering fluids.	Intermittent	No limits defined – chemical selection and use subject to EPA guidelines	EPA (2011)
Production system commissioning fluids from FPSO – treated seawater, diesel or crude.	Treated water processed on FPSO via oil in water (OIW) treatment system.	Treated water discharge from FPSO at surface. Diesel / crude will be routed to the crude oil stock tanks.	Discharge volume estimated as 120% of system volume.	Intermittent	Oil in water not to exceed 40 ppm daily maximum and 29 ppm monthly average, in accordance with EPA Guidelines Pecan Energies Project standards.	EPA (2011) Pecan Energies Standard
Produced water from FPSO	Electrostatic coalescer	Caisson at least 2 m below water surface	Discharge of 1,224 m^3 per hr based on a maximum design capacity of 60,000 bbls/day.	Continuous	Oil in water not to exceed 40 ppm daily maximum and 29 ppm monthly average, in accordance with Pecan Energies Project standards.	EPA (2011) Pecan Energies Standard

Table 4.13 Chemicals to be used during the Pecan Project

Application	Dosage Based On	Typical Dosage Range (ppm)	Dosage Used for Calculation (ppm)	Estimated Usage L/yr	OSPAR Category
	Subsea				
Corrosion Inhibitor	Total fluids	10-250	20	127,666	Yellow
H_2S Scavenger (future if needed)	Gas / H_2S / Efficiency	50% efficiency	8	460,630 (max over life)	Yellow
Paraffin Inhibitor (contingency)	Oil	150-1000	250	0	Yellow
Asphaltene Inhibitor (future if needed)	Oil	20-500	50	319,166	Yellow
Scale Inhibitor (future if needed)	Water	5-20	2.5	15,958	Yellow
	Topside				
Paraffin Inhibitor (contingency)	Oil	150-1000	250	0	Yellow
Demulsifier	Total	10-200	30	382,999	Yellow
Scale Inhibitor (contingency)	Water	5-20	5-20	0	Yellow
Corrosion Inhibitor (contingency)	Water	10-250	20	0	Yellow
Polyelectrolyte	Water	1-5	5	31,917	Yellow
Water Clarifier	Water	5-15	10	63,833	Yellow
De-foamer	Water	5-50	30	191,500	Red
Biocide	Water	300 ppm / 2 hr week	300	22,735	Yellow
	Sea Water Injection				
Biocide	Seawater	300 ppm / 4hr week	300	68,205	Yellow
Polyelectrolyte	Seawater	0.5	0.5	4,787	Green
Antifoam	Seawater	5-10	5	47,875	Yellow
Oxygen Scavenger	Seawater	1-10	5	47,875	Green
Scale Inhibitor	Seawater	50 ppm first 1MM bbl/well	50	95,392	Yellow
Scale inhibitor (over treat)	Seawater	50 ppm first 1MM bbl / well	50	1,313,676,	Yellow
Scale inhibitor (over treat)	Seawater	50 ppm first 1MM bbl / well	50	1,313,676,	Yellow
	Hydrate Management				
Methanol	Water	2 m^3 per well	2000	~2.1 MM	Green

4.12 Accidental Releases

Accidental releases of chemicals and / or hydrocarbons may occur. Barriers to prevent spill to sea are the primary measures to reduce risk for accidental releases.

The main well control barriers during drilling operation will be:

- Primary Well Control, a conditioned and monitored drilling fluid is the primary means of well control in all well construction operations.
- Secondary Well Control is the Blowout Preventer (BOP) that will shut down the well flow in case of loss of primary well control.
- Tertiary Well Control will be needed in case both primary and secondary well control is compromised and will be deployment of a capping stack at the well head or drilling of a relief well.

The FPSO will be designed with a separate drainage system for areas with risk for spill of chemicals or hydrocarbons.

The secondary measure will be oil and chemical spill response. As per MARPOL, the FPSO and MODUs will have oil and chemical spill response equipment to contain and recover small spills onboard the installation. In the unlikely event of a large oil spill, there will be an oil spill response according to the Project's oil spill contingency plan (OSCP). The OSCP, part of the Project's Emergency Response Plan (ERP), will be developed, based on input from an oil spill risk assessment and an oil spill contingency assessment, giving requirements for response capacity and capability.

4.13 Underwater Noise

The MODU and installation vessels and support vessels will introduce sound into the marine environment during their operation. Underwater vessel noise is primarily attributed to propeller cavitation and propulsion engines (i.e. noise transmitted through the vessel hull). Underwater noise will also be produced from drilling activities and during operational equipment installation 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(s)). Sound from propellers and thrusters is predominantly caused by cavitation around the blades whilst moving at speed or operating thrusters under load to maintain a vessel's position (i.e. dynamic positioning). The sound produced is typically broadband noise, with some low tonal peaks.
- Machinery Sound. 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, i.e. 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, e.g. 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. Sound produced will tend to be relatively low for drill casing, but likely higher for sub-sea valves.

Indicative underwater sound levels that may be produced by Project activities are included in Table 4.14

Table 4.14 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
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.

4.14 Waste Generation and Management

Pecan Energies will develop and implement a waste management plan (WMP) for the Project. All waste materials including hazardous wastes (i.e. liquid and solid wastes) will be transported to Takoradi Harbour for onward transfer, disposal or recycling at an approved facility. To monitor all wastes transported by supply vessels, a waste management register shall be maintained by the Operator.

Waste generated offshore for disposal onshore will be suitably contained and documented prior to transfer by the supply vessel. All wastes to be sent onshore must be properly labelled with the appropriate codes, including for hazardous wastes. Prior to loading any wastes for shipment to shore, a final check must be made of the requirements for packaging, labelling and documentation. The FPSO and MODU operators will provide all relevant documentation including Waste Transfer Notes and Hazardous Waste Consignment Notes.

On arrival at the quayside, the Operator will ensure all documentation is completed prior to offloading and transportation to the waste management contractor for onward disposal and/or treatment. For onshore disposal, all waste materials will be documented and tracked, segregated from other waste streams and stored in suitable containers. The Operator will ensure all documentation is transferred to the Waste Management Contractor who will arrange road transport for onward disposal at an approved onshore disposal site.

Any temporary storage at Takoradi port should be in suitable bunded areas, with impermeable floor and bunds to prevent waste leakage into the ground in the event of a leak.

Wastes generated offshore will be recorded monthly by the Operator. Table 4.15 details the likely waste streams for the Project and Table 4.16 details the criteria for the Hazardous Waste.

Pecan Energies will develop a Naturally Occurring Radioactive Material (NORM) material management plan as part of the Waste Management Plan. Ghana is a member of the International Atomic Energy Agency (IAEA); NORM-containing sludge, scale, or equipment should be treated, processed, isolated and/or disposed of according to guidelines from IAEA

(2013) Management of NORM Residues. If NORM[1] is found during well drilling or production, it can be disposed through:

- canister disposal during well abandonment;
- injection into the annular space of a well;
- shipment to shore for disposal in a landfill within sealed containers; or, depending on the type of NORM, and
- discharge to sea with the drainage effluent.

The Ghana Atomic Energy Commission, the regulator in charge of regulating NORM waste in Ghana shall be consulted if NORM occurs at any stage of the development and production operations.

[1] The geologic formations that contain oil and gas deposits may also contain naturally-occurring radionuclides, which are referred to as NORM. As oil and gas production processes concentrates these naturally occurring radionuclides and expose them to the surface environment and human contact, wastes containing these are classified as Technologically Enhanced Naturally Occurring Radioactive Material (TENORM).

Table 4.15 Typical Waste Streams likely to be generated from the FPSO

Waste Stream	Rig / Platform	Vessels	Shore	Onshore Disposal Requirements
Office Waste	Segregated for reuse/recycling where possible. Placed in Non- Hazardous waste skip for disposal onshore	Placed in Non- Hazardous waste skip for disposal onshore	Segregated for reuse/recycling where possible	All general waste arising from office activities shall be appropriately segregated at source for recycling. Where non-hazardous waste cannot be recycled /reclaimed/reused it shall be sent by the Waste Management Vendor to a municipal landfill site for final disposal.
Scrap Metal or wire ropes	Placed in scrap metal waste skip for reclamation/disposal onshore	Placed in scrap metal waste skip for reclamation/disposal onshore	Scrap metal skip for reclamation/reuse/ recycling or disposal	All metal waste will be recycled /reclaimed /reused where possible. All oil contaminated metal wastes shall be considered hazardous waste and disposed as such.
Glass	For safety reasons, glass waste should be segregated and returned in a designated container.	For safety reasons, glass waste should be segregated and returned in a designated container.	For safety reasons, glass waste should be segregated and in a designated container.	All glass bottles (with metal removed) shall be adequately cleaned at source and recycled where possible. Where it cannot be recycled /reclaimed/reused it shall be sent to the municipal landfill site for final disposal.
Aluminium Cans	Segregated and placed in non-hazardous waste sacks for recycling onshore	Segregated and placed in non-hazardous waste sacks for recycling onshore	Segregated and placed in non-hazardous waste sacks for recycling	Where cans cannot be recycled /reclaimed/reused it shall be sent to municipal landfill site for final disposal.
Lumber including pallets	Segregated for reuse/recycling where possible.	Segregated for reuse/recycling where possible.	Placed in the non-hazardous timber waste skip	All timber shall be adequately cleaned at source and recycled where possible. Where it cannot be recycled /reclaimed/reused it shall be sent to municipal landfill site for final disposal.
Packaging / containers for mud cement mix chemicals	Empty packaging / containers will be back loaded in sealed containers and returned to mud / cement company. Full/ half-full packaging / containers re-sealed as necessary and at end of well back loaded in sealed containers and returned to	None	Wherever possible empty packaging / containers returned to mud / cement company. Full/ half-full packaging / containers re-sealed as necessary and returned to mud / cement	Where empty packaging cannot be returned to the mud/cement company it shall be sent to Waste Management Vendor for final disposal.

Waste Stream	Rig / Platform	Vessels	Shore	Onshore Disposal Requirements
	mud / cement company accompanied by detailed manifest.		company accompanied by detailed manifest.	
Packaging /containers for other non-hazardous chemicals (full, half-full or empty)	Sealed as necessary and placed in non-hazardous waste skip for disposal onshore	Sealed as necessary and placed in non-hazardous waste skip for disposal onshore	Sealed as necessary and collected as domestic refuse	Where empty packaging cannot be returned to the supplying company it shall be sent to the Waste Management Vendor for final disposal.
Packaging / containers for hazardous chemicals (full, half-full, or empty)	If not reusable for storing the same chemical, they will be sealed as necessary and placed in hazardous waste skip.	If not reusable for storing the same chemical, they will be sealed as necessary and placed in hazardous waste skip.	None	Waste hazardous containers /packaging will be stored at the shore base, in accordance with Material Safety Data Sheet requirements, prior to final disposal by the Waste Management Vendor.
Waste Oil	Stored in holding tank on MODU. Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore recycling/disposal.	Stored in holding tank on vessel. Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore recycling/disposal.	None	Waste oil shall be stored at the shore base prior to final disposal by the Waste Management Vendor.
Cooking Oil	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore recycling/disposal.	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore recycling/disposal.	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore recycling/disposal.	Cooking oil shall be stored at the shore base prior to final disposal by the Waste Management Vendor.
Sanitation and Clinical Waste/Bins and Sharps Containers	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore disposal.	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore disposal.	None	Medical waste shall be disposed of by Waste Management Vendor
Milling Cuttings	Placed in scrap metal waste skip for reclamation/disposal onshore.	None	None	If contaminated with oil, obtain skips prior to the milling operation, if contaminated, it is Hazardous Waste and shall be sealed as necessary and placed in hazardous waste

Waste Stream	Rig / Platform	Vessels	Shore	Onshore Disposal Requirements
				skip, identified and accompanied by detailed manifest for final disposal.
Tank Washings	Supply detailed information on the type of mud and brine to the Logistics Superintendent.	Supply detailed information on the type of mud and brine to the Logistics Superintendent.	None	Supply detailed information on the type of mud and brine to the Logistics Superintendent. Classified as Hazardous Waste and shall be sealed as necessary and identified and accompanied by detailed manifest for final disposal.
Batteries	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore disposal	Placed in suitably sealed containers, identified and accompanied by detailed manifest for appropriate onshore disposal	Placed in suitably sealed containers, identified and accompanied by detailed manifest.	Liquid from acid or alkali batteries can be removed and sent ashore separately in plastic drums. Otherwise batteries should be packed to prevent spillage. Empty acid or alkali batteries and the battery liquid are Special Waste, and will need appropriate handling by waste management vendor.
Shot Blast	If not contaminated. Placed in non-hazardous waste sacks for disposal onshore.	None	None	Return in a hopper if a recovery system is available. Otherwise, bag in woven polypropylene sacks. Sacks should be placed in the general waste skip or in a designated skip for larger quantities. If contaminated with lead-based paint, it is considered as hazardous waste and subject to packing, labelling and manifesting requirements.
Fire extinguishers/ gas cylinders	Do not treat as waste. Return to Supply Base along with a Job Card to await confirmation that the extinguishers or cylinders are for disposal. Secure in a container.	Do not treat as waste. Return to Supply Base along with a Job Card to await confirmation that the extinguishers or cylinders are for disposal. Secure in a container.	Do not treat as waste. Return to Supply Base along with a Job Card to await confirmation that the extinguishers or cylinders are for disposal. Secure in a container.	Onshore local contractor for reuse. Where Fire extinguishers/gas cylinders are damaged or fail a test/inspection, they will be sent to shore and finally disposed by the Waste Management Vendor.
Aerosols	Sealed as necessary and placed in hazardous waste skip, identified	Sealed as necessary and placed in hazardous waste skip, identified and	Sealed as necessary and placed in hazardous waste skip, identified and	To be sent to shore and finally disposed by the Waste Management Vendor

Waste Stream	Rig / Platform	Vessels	Shore	Onshore Disposal Requirements
	and accompanied by detailed manifest.	accompanied by detailed manifest.	accompanied by detailed manifest.	
Special resins and Coatings	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest.	To be sent to shore and finally disposed by the Waste Management Vendor
Oily Rags and Filters	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for disposal.	To be sent to shore and finally disposed by the Waste Management Vendor
Paint Thinners	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest.	To be sent to shore and finally disposed by the Waste Management Vendor
Paints – Flammable	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	Not to be mixed with other paint waste. Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest.	To be sent to shore and finally disposed by the Waste Management Vendor
Paints – Peroxide	Not to be mixed with other paint waste. Check the IMO International Maritime Dangerous Goods (IMDG) code (2020) for shipping instructions. Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	None	None	To be sent to shore and finally disposed by the Waste Management Vendor

Waste Stream	Rig / Platform	Vessels	Shore	Onshore Disposal Requirements
Products containing polychlorinated Biphenyls (PCBs)	Prior notice of consignment is required. Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed for onshore disposal.	Prior notice of consignment is required. Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	None	To be sent to shore and finally disposed by the Waste Management Vendor
Lead Paint	Not to be mixed with other paint waste. Check the IMDG code for shipping instructions. Sealed as necessary and placed in hazardous waste skip, identified and accompanied by detailed manifest for onshore disposal.	None	None	To be sent to shore and finally disposed by the Waste Management Vendor
Other Non-hazardous Waste	Segregated for reuse/recycling where possible. Non-recyclable wastes placed in non-hazardous waste skip for disposal onshore	Collected for later disposal onshore	Collected as domestic refuse	Where non-hazardous waste cannot be recycled /reclaimed/reused it shall be disposed of by the Waste Management Vendor
Other Hazardous Waste/ unidentified waste	Retain offshore until the waste has been identified. Sealed as appropriate and placed in hazardous waste container identified and accompanied by detailed manifest for disposal onshore.	Sealed as appropriate, loaded onto MODU, and placed in hazardous waste container accompanied by detailed manifest for disposal onshore.	None anticipated	To be sent to shore and finally disposed by the Waste Management Vendor

Table 4.16 Hazardous Waste Criteria

Waste Stream	MODU	Vessels	Shore	Onshore Disposal Requirements
Sewage	Treated and discharged to sea	Treated and discharged to sea	Discharged to sewers	In accordance with MARPOL requirements
Food Garbage	Macerated and treated for disposal offshore. Weight and time of discharge recorded within the Waste Transfer Notes	Where viable, macerated and treated for disposal offshore	Collected as domestic refuse	Vessels without MARPOL compliant macerators or at locations <12 nm from a land base: food wastes will be stored in a skip or bagged, frozen and returned to shore for treatment by Waste Management Vendor.
Surplus Mud Chemicals	Reused within the mud system wherever possible.	None	None	Where not possible, stored and sent to shore for appropriate waste disposal.
Drilling Cuttings	Discharged offshore in line with Ghanaian Legislation and accepted oil and gas industry practice.	None	None	Discharged offshore in line with Ghanaian Legislation and accepted oil and gas industry practice.
Cement Slurry	Unused cement slurry will be sent to shore for disposal.	None	None	Unused cement slurry will be sent to shore for disposal.
Dry bulk waste e.g. dry cement	Unused dry cement will be sent to shore for other uses or appropriate disposal if necessary.	None	None	Unused dry cement will be sent to shore for other uses or appropriate disposal if necessary.
Machinery Space Drainage	Discharged offshore after treatment (<15 ppm hydrocarbons) or stored in MODU holding tank for later transfer to shore for disposal.	Discharged offshore after treatment (<15 ppm hydrocarbons) or stored in holding tank for later transfer to shore for disposal.	None	Oily slops to be sent to shore and finally disposed by the Waste Management Vendor.
Deck /Hardstanding Drainage Water	Treated by Deck Drainage System prior to discharged directly to sea.	Discharged directly to sea.	Discharged directly to sewer.	N/A

4.15 Local Content

Pecan Energies has determined a series of strategic local content objectives for the Project. These are summarised in Table 4.17.

Table 4.17 Strategic Local Content Objectives

Scope	**Local Content Strategic Objectives**
Local Infrastructure	To require local presence of Pecan Energies and subcontractors through establishment of Local Infrastructure such as Country Office, Onshore Supply Base and other facilities to support the Project activities and operations.
Supply Chain	To first consider locally produced goods and services where they meet specifications of the petroleum industry as established by the Standards Authority and internationally acceptable standards. To progressively increase utilization of locally procured goods and services over the Project's lifetime. To facilitate participation of Ghanaian companies in the supply chain, either directly with Pecan Energies, or through international subcontractors, by using procurement and contracting strategies that implies work scope and services suited for participation and development of local companies. To promote the establishment and development of Joint Ventures (JVs), channel partnerships or strategic alliances between international companies engaged in the Pecan field development Project and Ghanaian companies. To require subcontractors to commit to a local content plan in compliance with applicable regulations.
Employment and Training	To develop a plan for recruiting, employment, training of local personnel in Ghana, and succession of expatriates, with the overall aim to localise Contractors and subcontractors' workforce in Ghana.
Technology Transfer and Development	To promote technology transfer and development related to the building of the oil and gas industry in Ghana through: Day-to-day transfer of skills, technology and knowledge in operations. Cooperation with other Operators and industry participants in Ghana with Ghanaian companies, and with research and development institutes and organisations. Supporting training and educational institutions in Ghana that are either directly or indirectly related to the Petroleum industry. Facilitating for development and transfer of technology to Ghana through Pecan Energies and subcontractors' procurement and employment practices.
Professional Services	To comply with the insurance requirement in country and the use of the Ghana oil and gas insurance pool (GOGIP). To adhere to the approved procurement procedures for the use of legal and financial services and use Ghanaian legal and financial services related to Ghanaian Law and in-country contracts as required by relevant regulations.
Local Content Reporting	To develop and implement Key Performance indicators (KPIs) for reporting, review and measurement of the performance and results of in-country spend and development and capacity building versus the goals and requirements set forth by the Ghanaian Authorities and by both Pecan Energies and subcontractors. To ensure mandatory local content reporting to relevant Petroleum Commission and other Ghanaian Authorities.

The achievement of the local content strategic objectives will be facilitated through the implementation of the Pecan Local Content Plan (PLCP). Actions required for implementation of the plan have been identified and outlined for Pecan Energies and subcontractors respectively to fulfil the intentions and requirements of the *Petroleum (Local Content and Local Participation) Regulations, LI 2204 (2013) and LI 2435*.

Pecan Energies, Accra and Takoradi offices, Takoradi port base, related facilities, buildings and other physical structures in Ghana, referred to as Local Infrastructure, shall be established and administered by Pecan Energies and subcontractors with the aim to manage, support and supervise the local activities of the Project. Pecan Energies is committed to ensure that establishment and continued operation of Contractors and subcontractors' Local Infrastructure adhere to the local content guidelines set forth in the PLCP and to the applicable Local Content regulations.

With respect to local content in contracting and procurement activities, Pecan Energies will comply with the DWT CTP Procurement Process, applicable requirements and commitments to achieve the purpose of the local content regulations while adhering to the obligations and rights under the Petroleum Agreement and the related conditions for safe, predictable and timely Project execution.

Pecan Energies will use a step-wise procurement and contracting methodology to maximise local supplier participation. Some key activities in the procurement process include;

- Mapping and segmentation of local industry.
- Establishment of a list of potential local suppliers.
- Scope definition for Local Content.
- Pre-qualification and Supplier Engagement.
- Invitation to tender, evaluation, negotiation and award of contract.
- Supplier development and performance management.

In addition, all subcontractors will be required to outline their proposed Local Content Plan in their bid documents with the expectation that, if selected, their plan will be incorporated in the corresponding Contract. International (non-Ghanaian) subcontractors shall, consistent with the applicable requirements of local content regulations in Ghana, incorporate a Joint Venture with a Ghanaian contractor or form channel partnerships and/or strategic alliances with fully indigenous Ghanaian entities. Subcontractor's Local Content Plan and structural set-up shall be consistent with Pecan Energies Local Content Plan.

Based on the above methodology for procurement and contracting, Pecan Energies will define packages for in-country scope for Facilities (FPSO, SPS, and SURF), Operations & Maintenance and Drilling & Wells. These packages, which are outlined in the PCLP, will facilitate local suppliers to participate in the delivery of the Project and enable expansion of the local petroleum industry.

Pecan Energies has developed guidelines on recruiting and employment practices, training and succession practices, and reporting of training and employment activities, to ensure compliance with applicable requirements and to achieve Pecan Energies strategic local content objectives. Initiatives to train and build local capacity through the Project include the following.

- Educational Sponsorship.
- National Service Placement.
- Secondment Agreement with GNPC.
- Recruitment of Ghanaians.
- Pecan Energies Ghana Intern-ship Programme.

Through its activities in Ghana, Pecan Energies is committed to contribute to the building of local petroleum related technology and knowledge in Ghana by the transfer of technology, knowledge, and skills. Initiatives to enable this include the following.

- Operational Technology Transfer.
- Procurement Promotion of Local Technology.
- Technology Transfer Plans.

With respect to professional services, Pecan Energies and its subcontractors ensure that Insurance, Legal and Financial Services conform to applicable requirements in the local content regulations, including the following.

- Insurance related to the Pecan Energies and subcontractors' activities and assets in Ghana would utilize GOGIP where applicable.
- Retainment of legal services to the extent possible and practicable from Ghanaian legal practitioners or firms of Ghanaian legal practitioners with local presence in Ghana.
- Using financial services of Ghanaian institution(s) or organisation(s) or seeking required approvals to utilise financial services of a foreign entity or entities, maintain a bank account with an indigenous Ghanaian bank and transact business through banks with local presence in Ghana.

Facilitated by its Stakeholder Engagement Plan (SEP), Pecan Energies will seek to develop strong partnerships with government agencies, traditional authorities, district assemblies, youth groups, non-governmental organisations (NGO), community-based organisations (CBO), civil society, fishing communities and other relevant stakeholders. Pecan Energies will adopt a proactive approach to sharing information with stakeholders and gathering feedback on potential issues arising. In its CSR projects, Pecan Energies will seek to actively engage affected stakeholders and local communities throughout the project cycle, from project identification through to project design, implementation and monitoring. This will ensure Pecan Energies CSR projects are well-aligned with communities' self-identified needs and will increase local ownership of projects, which increases the chances of projects becoming sustainable beyond the first project cycle.

A strategy for community development and Corporate Social Responsibility (CSR) will be prepared. The strategy will seek to ensure that:

- Contractors (Pecan Energies Service Providers) delivering projects are constructive contributors to sustainable socially-responsible economic growth in Ghana; and
- Contractors delivering projects plays a significant role in building up the Ghanaian oil and gas industry.

Pecan Energies has prioritised project areas in Ghana will be:

- Education;
- Sustainable Environments;
- Health a& Wellbeing'; and
- Socio-economic/Livelihood Investments.

These prioritised areas, together with the Pecan Energies business operations, will contribute towards the delivery of the United Nations' Sustainable Development Goals (SDGs) 1 –No Poverty, 3 –Good Health and Wellbeing, 4 - Quality Education; 6 –Clean Water and Sanitation, 7 –Affordable and Clean Energy and 10 – Reduce Inequalities.

The approach to CSR projects will be through stakeholder engagements in the project design and implementation phases, and subsequent detailed monitoring and reporting of project performance.

To date stakeholder campaigns have been held in the Western Region and workshops have been held with fishermen and regional authorities to discuss the Pecan Project, potential community challenges and mitigation measures and solutions. Pecan Energies has employed fulltime CLOs that are engaged with the local communities on a regular basis. They are one of the means for collecting and reporting grievances and for direct communication with the communities. In addition, there will be Fishery Liaison Officers employed for the Pecan Project that will have a main duty to communicate with fishermen to avoid conflicts and vessel incursions of the exclusion zone around drilling rig, installation vessels and the FPSO.

Specific social investment programs, some of which are ongoing and others in the planning phase, include the following.

- Pecan Energies Tertiary Program- Coverage for fees, lodging, stipends, project work, clothing, transport etc.) Pilot phase complete with 20 beneficiaries.
- Fisherfolk recruitment and onboarding as Fishing Liaison officers on Pecan Energies offshore vessels

Upcoming Projects include:

- Expansion of Aker Tertiary program (reach and scale) with projected target of 600 beneficiaries by 2026 in variety of disciplines including Technical/Vocational education training.*
- Pecan Energies Clean Communities Initiative: addresses critical water and sanitation issues in target communities
- Socio-economic investments to address developmental gaps (incl. Legacy Projects, health, multi-sector approach).
- Health and Wellbeing improvement programs to address critical health gaps
- Fishers Enhancement Programs (support for fishing trade and value chain).

In 2021, Pecan Energies' High School Scholarship Program which provided textbooks, stipends, notebooks, provisions, mentoring and counselling to 1000 beneficiaries. was phased out and replaced with a tertiary scholarship program.

Pecan Energies intends to support the Ghanaian government's 'Accelerated Oil and Gas Capacity Programme'.

This programme consists of four main areas as follows:

- training individuals in various technical and vocational areas;
- building the capacity of educational institutions to be able to train students and provide internationally recognised training certificates;
- providing business and management training for small- and medium enterprises (SMEs); and
- ensuring the continuous professional development of various public institutions connected to the oil and gas industry.

4.16 Fabrication Sites, Onshore Facilities and Support Services

4.16.1 Fabrication Sites

The selected FPSO will undergo conversion work at a yard outside of Ghana. Elements that may be fabricated at other locations include the following.

- Hydrocarbon Modules.
- Utility Modules.
- Chemical Injection Module.
- Waste Heat Recovery Units.
- Electrical, Instrumentation and Control, and Telecommunications Systems.

Fabrication of items such as suction piles, supporting engineering services, and installation activities may be undertaken within Ghana, subject to capacity and contractual agreements.

4.16.2 Onshore Facilities

Pecan Energies currently operates an office in Accra. It is anticipated that expansion of that office and the establishment of an office in Takoradi will be required to support supply chain and project management functions. In addition, accommodation in Takoradi for Pecan Energies staff will be required.

Contractors providing services such as rental of drilling equipment and provision of drilling fluids will operate out of their own shore bases.

It is planned to use the expanded Takoradi Harbour facilities for office space, warehousing, laydown areas and quayside access. This would keep all the Pecan Energies facilities in one location, with most contractor companies and suppliers having their own shore base facilities.

The planned expansion of Takoradi Harbour is shown in Figure 4.19. The existing harbour is to the west with planned expansion over three phases to the east, however, the timing of the expansion is not confirmed. The planned harbour extension is not dependent on Pecan Energies use of the facilities and was subject to a separate EIA process.

Other than offices and access to port facilities, including some storage areas, Pecan Energies does not require to set up a separate shore base.

Quayside

Quayside access will be required to load and unload PSVs and CSVs during drilling and installation phases, and berthing of the field support vessels to operations during operations (up to 120 m length and up to 12 m draft). Access to single crane lift and direct pumping from storage silos and mud plant to PSVs of bulk material (cement, barite, and bentonite) and drilling and completion fluids will be required. Quayside based services would also include freight forwarding, and customs and permits.

Supply Vessels

Various requirements for the use of marine vessels in support of offshore activities will be required and include but are not limited to the following.

- Supply vessels to service MODUs and FPSO.
- Anchor handling vessels/tug boats to assist with tanker stability during cargo transfer.
- Multi-purpose vessels required to recover multi-phase pumps and carry out SPS inspection and equipment repairs.

- Security/guard vessels to assist in maintaining the security zone around MODUs and FPSO.

Supply vessels will meet all the requirements of a recognised Classification Society for the highest notation. The vessels will meet all current requirements of safety of life at sea (SOLAS), International Maritime organisation (IMO) and all relevant Flag State Governmental and International requirements for this type of vessel.

Land Transport

Transport required for transport of materials and personnel to and from office locations, shore bases and other sites will be by car, Light Goods Vehicles and Heavy Good Vehicles.

Source: Ghana Ports Handbook 2018-2019[1]

Figure 4.19 Planned Expansion of Takoradi Harbour

[1] https://ghanaports.gov.gh/page/index/20/55QF2TKE/Our-History-and-Future

Air Transport

Air transport will be required for the movement of personnel, and some materials, to the shore base and the offshore facilities. This would require the use of fixed wing planes and helicopters.

It is assumed that international personnel will fly into Accra and will take a fixed wing aircraft to Takoradi. National personnel will travel to Takoradi by fixed wing aircraft or road transport, depending on the location of their home bases. Transport offshore will be by helicopter from the heliport based within the Takoradi Air Force base.

4.17 Schedule

Figure 4.20 shows the indicative schedule for the Pecan Phase 1 Project up to the commissioning of Phase 1b. The schedule will be revised and communicated to relevant authorities prior to project execution. The key stages are as follows based on months after final investment decision (FID).

- Construction of the FPSO, with hull conversion, topside fabrication and integration is planned to start five months after FID and is expected to last for 24months. Sailaway from the yard to Ghana is planned for month 27.
- The drilling and completions for Phase 1a are planned to commence in month 21 and last for five years, with drilling and completion for Phase 1b being conducted during years 6 and 7.
- Subsea equipment installation would occur approximately in month 20 and last for 10 months.
- Hook-up of the FPSO with risers and umbilicals on the field, and pre-commissioning is expected to start in months 30 to 32 and last for three months until ready for first oil.
- First oil from Pecan field is estimated to be produced in month 35.

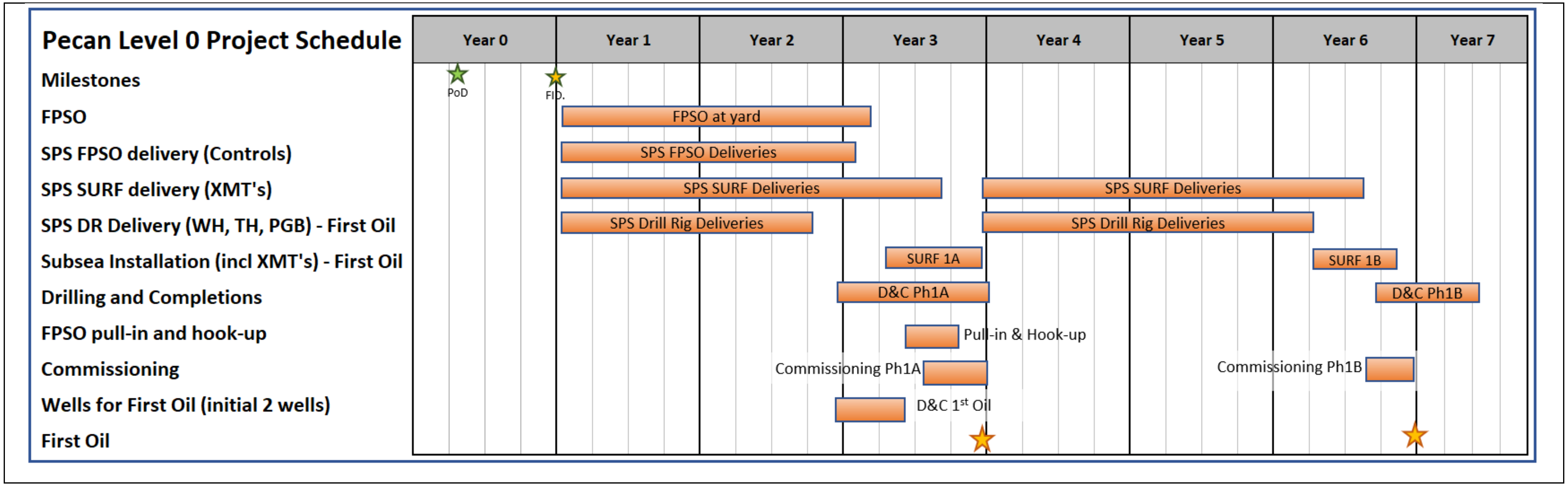


Figure 4.20 Pecan Phase 1a and 1b Execution Schedule with Construction, Drilling, Installation and Commissioning

5. Baseline

5.1 Introduction

This chapter provides a description of the environmental, social, health and heritage baselines against which the potential impacts of the Project have been assessed. The description covers the area in which the Project will take place as well as areas that may be directly or indirectly affected, as defined below.

5.2 Definition of Terms

The following terms have been used to describe different areas described in the environmental and social baseline.

- Contract Area refers to the broader DWT/CTP licence area to which Pecan Energies Ghana Limited and partners hold exploration rights. The term is also used when describing baseline conditions at a regional level.
- Project Area refers to the area immediately surrounding the installed Project components; i.e., the Project footprint as well as marine transit routes to and from Takoradi Harbour, the helicopter flight paths from the Air Force base to the FPSO/MODU and the road transport routes between supply bases and the port facilities.
- Area of Influence refers to the area likely to be affected by the Project directly (i.e. from activities at project sites directly owned, operated or managed by the Operator), from unplanned but predictable developments caused by the Project, and indirectly (i.e. on biodiversity or on ecosystem services upon which affected communities' livelihoods depend). This includes cumulative impacts from the incremental impact on areas or resources used or directly impacted by the Project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

The are no Associated Facilities related to the Project i.e. there are no non-Project funded facilities that would be constructed or expanded if the Project did not exist and without which the Project would not be viable (e.g. utilities, warehouses and logistics bases).

5.3 Sources of Information

The baseline description draws on a number of primary and secondary data sources.

The environmental baseline description also draws on primary data collected through studies and surveys commissioned for the Project. The following are the main sources used for this report.

- PECAN1-FUG-S-RA-0001 Deepwater Tano – Cape Three Points; Environmental Baseline Survey, Survey Period: 22 May to 28 June 2021, Fugro 2021.
- PECAN1-AKG-O-RS-0002 Pecan Geophysical Results Report. Fugro 2022.
- PECAN1-AKE-S-RA-0003 Environmental Baseline Survey Report, Deep Water Tano Cape Three Points, Survey Date December 2013 to January 2014, Gardline, 2014.
- PECAN1-AKE-Z-FD-0004 Metocean Basis of Design.
- PECAN1-FUG-Z-RA-0001 FUGRO Report Metocean Criteria for the Pecan Field 190805 1 R2 17 March 2020
- Stakeholder Consultations with Communities, Traditional Authorities and Public and Private Institutions. September 2021 – January 2022 and March 2023.

- Current Data Report, Ghana Deepwater Current Measurements Phase 4, Survey Date 24 August to 27 December 2014, Fugro, 2014.
- Metocean Modelling Data Report, Metocean Criteria for the Pecan Field, Fugro, 2014.
- 3D Seismic Survey Report. Cetacean and Sea Turtle Report. Hess Corporation. Deepwater Tano/ Cape Three Points, Ghana, EPI Group, 2014.

The baseline description draws on a number of publicly available secondary sources including the following.

- Environmental and Social Impact Assessment of the Jubilee Field Phase 1 Development, Ghana (prepared by ERM and ESL), Tullow Ghana, 2009
- Environmental and Social Impact Assessment of the Tweneboa, Enyenra, Ntomme (TEN) Development, Ghana (prepared by ERM, ESL and SRC), Tullow Ghana, 2014.
- Environmental and Social Impact Assessment of the Offshore Cape Three Points (OCTP) Phase 1 and Phase 2 Development Ghana (prepared by ERM and ESL), ENI Ghana, 2015.
- Fisheries Management Plan of Ghana 2022 to 2026. A National Policy for the Management of the Marine Fisheries Sector. Ghana Fisheries Commission, 2021.
- Independent Study of Marine Environmental Conditions in Ghana (prepared by Acorn International), Kosmos Energy, 2015.
- Information from international organisation including Food and Agriculture Organization (FAO), International Union for Conservation of Nature (IUCN), Fishbase, and Birdlife International.
- 2010 Population and Housing Census (published in 2013), District Development Plans, District Water and Sanitation Development Plans, District Annual Health Reports and the Ghana Living Standards Survey.
- 2021 Population and Housing Census (published in November 2021), Population of Regions and Districts, General Report Volume 3A, Ghana Statistical Service.
- Ghana Ports Handbook 2018 -2019, Ghana Ports and Harbour Authority, Tema.

Copies of the Gardline (2014) EBS and the Fugro (2021) sediment analysis reports are provided in Annex E and Annex F respectively,

5.4 Physical Environmental Baseline

5.4.1 Climate and Meteorology

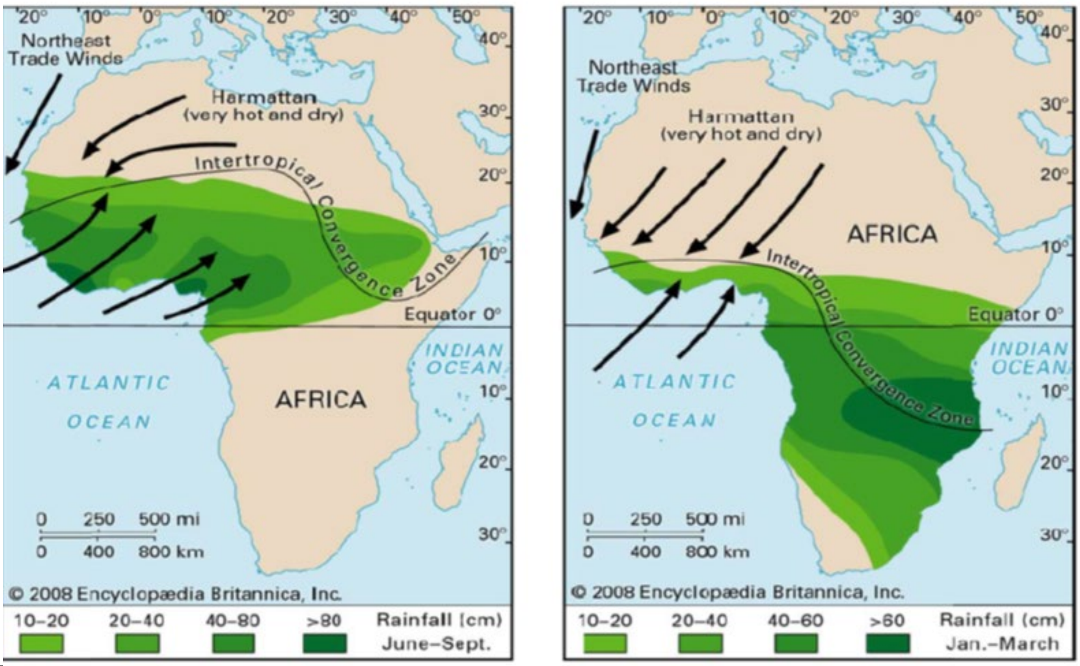
Overview

Regional climatic conditions are 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 movement of the ITCZ (see Figure 5.1). 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 (see Table 2.1). Climate variability is linked to changes in the movement and intensity of the ITCZ as well as variations in the timing and intensity of the West African Monsoon, which is influenced by the El Niño Southern Oscillation (ENSO). El Niño is connected to below normal rainfall in West Africa (USAID 2017).

Table 5.1 Climate and Meteorology in the Western Region of Ghana

Variable	Details
Wet season	From April to July and again between September and November
Dry season	From July to August and December to March
Annual rainfall	From 1,100 mm to 2,100 mm
Annual percentage rainy days	60%
Diurnal temperature range	26°C and 33°C
Annual variation in temperature ranges	2°C and 4°C

Source: USAID 2017



Source: Encyclopaedia Britannica Online, April 2011.

Figure 5.1 West Africa Monsoon

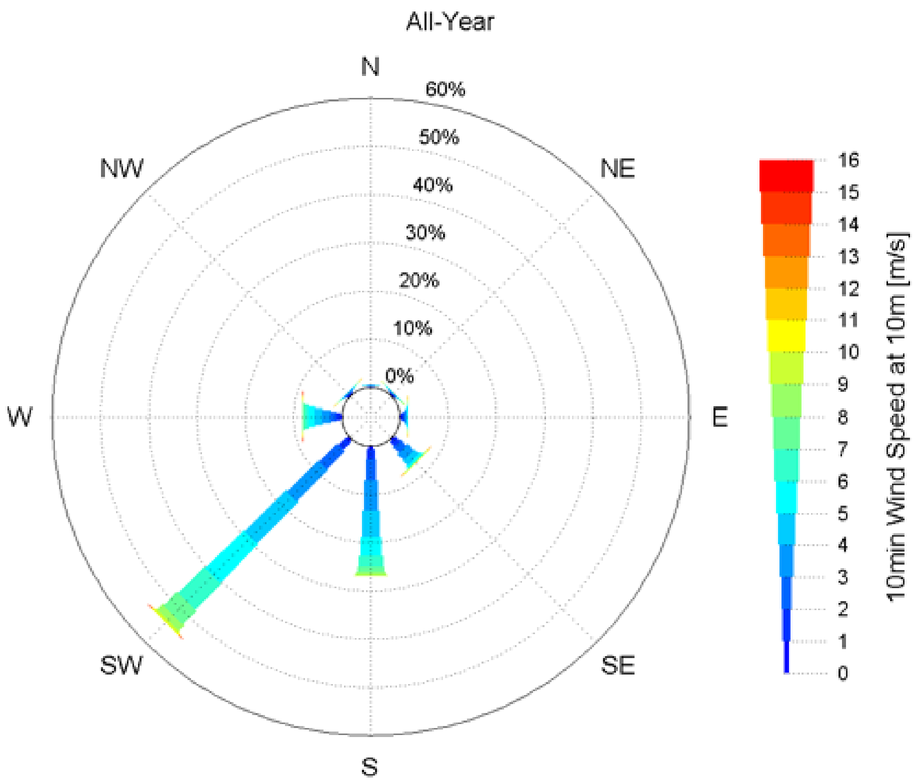
Offshore Winds

Surface atmospheric circulation in the region is influenced by north and south trade winds and the position of the ITCZ. The south-easterly winds, originating in the Southern Hemisphere cross the equator throughout the year extending to approximately 7° N during the boreal winter and approximately 15° N in the summer months. As the trade winds cross the equator, they are deflected to become south to south-westerly offshore Ghana. Light to moderate winds predominate although winds are stronger during the summer months. Strong winds are rare, but thunderstorms with associated violent, but generally short-lived, squalls do develop.

There can be a diurnal variation in the near-shore wind speed influenced by sea breezes. The diurnal variation tends to have a maximum during the night because of radiation cooling leading to instability in the surface layer. The diurnal variation is strongest during periods of reduced trade winds and clear skies.

The squall season offshore Ghana is closely tied to the seasonal movement of the Inter-Tropical Convergence Zone (ITCZ). Due to Ghana's proximity to the equator, the northward migration of the ITCZ and its corresponding southward return are separated by several months. As a result, Ghana has a less well-defined squall season than other parts of Africa. However, squall activity tends to reach a minimum in August and a maximum around March[1].

The prominent wind direction in the Project Area is from the south-southwest (Figure). Average wind speeds are between 5 ms^{-1} and 6 ms^{-1} and maximum wind speeds are approximately 12 ms^{-1}.



Source: Fugro (2020)

Figure 5.2 Wind Speed by Direction in the Project Area (All-Year)

5.4.2 Air Quality

The Project is located between 90 and 103 km from the coast of Ghana (locations of the closest and farthest away wells) and the FPSO location is approximately 98 km from the nearest coast. The Project is 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 in the proximity as well as vessels involved in oil and gas operations in the area including process emissions from the Jubilee Field FPSO and TEN Field FPSO to the north of the Contract Area, and combustion emissions from exploration

[1] NOTE: whilst thunderstorms and squalls are responsible for the strongest winds, they generate only weak currents and low wave heights due to the limited fetch and duration.

and appraisal well drilling in the vicinity. In general, the airshed in the Project Area offshore is considered un-degraded.

Onshore air quality in the Western Region of Ghana 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 Sekondi-Takoradi Metropolitan Assembly (STMA), due to combustion sources used for cooking and space heating, road traffic, local and industry.

The principal source of atmospheric pollution in urban areas in the region are from biomass burning, e.g., firewood for cooking and heating, and controlled burning for agriculture (Bailis et al., 2005; Barnes et al., 2005; Smith et al., 2004). Other sources of urban air pollution will be from transportation, industrial pollution and non-combustion sources.

5.4.3 Climate Change

A greenhouse gas (GHG) is any gas in the atmosphere that absorbs and re-emits heat, and thereby keeps the planet's atmosphere warmer than it otherwise would be. The main greenhouse gases include carbon dioxide, methane, nitrous oxide, chlorofluorocarbon, hydrofluorocarbon, sulphur hexafluoride and nitrogen trifluoride.

According to the IPCC (2014) during the period 2000 to 2010, CO_2 (carbon dioxide) remained the major anthropogenic GHG accounting for 76 percent of total anthropogenic GHG emissions, followed by CH_4 (methane) with 16 percent, N_2O (nitrous oxide) with 6.2 percent and fluorinated gases with 2 percent (Blanco et al 2014).

Concern over increasing amounts of greenhouse gases in the atmosphere and their potential to influence global climate change has produced a number of initiatives, including the United Nations Framework Convention on Climate Change (UNFCCC). The stated objective of the UNFCCC is to achieve stabilisation of the concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The Ghana Government ratified the UNFCCC in September 1995 (Republic of Ghana, 2015).

The Environmental Protection Agency calculated the GHG emissions for Ghana that have increased from 25.34 MT CO_{2e} in 1990 to 42.15 metric tonnes (Mt) CO_{2e} in 2016 (EPA, 2019).

Long Term Climate Trends

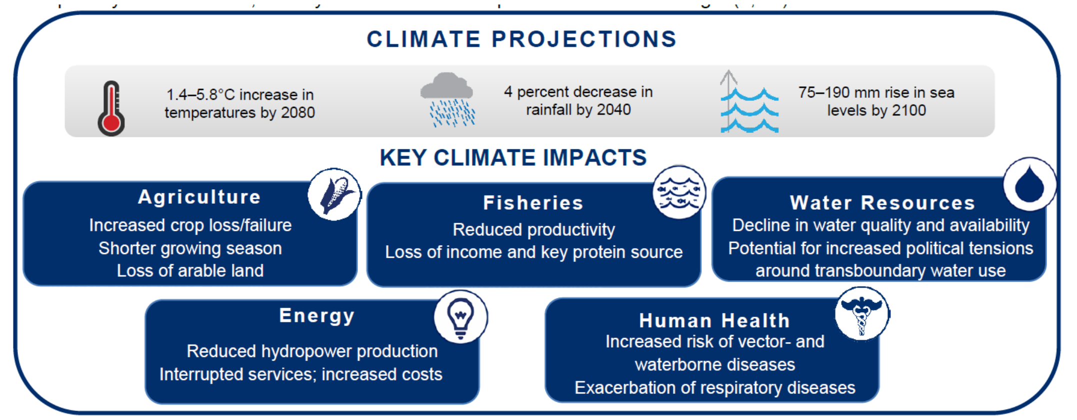
Countries with a dependence of the majority of the population on agriculture, particularly rain-fed agriculture as well as widespread poverty that reduces the population's ability to withstand climate stress are vulnerable to the effects of climate change. A USAID study (2017) modelled and forecast the future changes in temperature and precipitation in Ghana until 2080. The results of this are summarised in **Box 5.1**. One-quarter of the population lives along the coast and 45 percent of the workforce depends on rain-fed agriculture.

Drought, higher temperatures, erratic rainfall and rising sea levels negatively impact hydropower production, infrastructure, food security and coastal and agricultural livelihoods (Institute of Statistical, Social and Economic Research, 2014; USAID, 2011). Figure 5.3Figure 5.8 Mean Wave Direction in the Project Area (All-Year) illustrates the key impacts in Ghana from climate change (USAID 2017).

Box 5.1 Summary of Modelled and Forecast Climate Change

Historical Climate	Future Climate
Climate trends since the 1960s. Increase in average annual temperatures of approximately 1°C (an average increase of 0.21°C per decade). Increase in the average number of 'hot' nights per year (73), with the rate of increase most pronounced from September to November. Although interannual and interdecadal rainfall levels were highly variable, overall rainfall saw a well-defined cumulative reduction of 2.4 percent per decade. Increase in sea surface temperatures (precise data are not available). Rise in sea level of 63 mm over the past 30 years. Average coastal erosion of 1.13 m per year.	Projected climate changes include: Increase in average annual temperatures between 1.4–5.8°C by 2080, with the greatest increases in the north. Increase in the frequency of hot days and nights of 18–59 percent by 2060. Decrease in overall rainfall of 4.4 percent by 2040. More erratic and intense rainfall during the wet season and lower precipitation levels during the dry season; larger decreases in the south. Rise in sea surface temperatures by approximately 2–4°C. Sea level rise of 75–190 mm by 2100. Average coastal erosion and shoreline loss of 0.38 m per year.

Source: USAID, 2017



Source: USAID, 2017

Figure 5.3 Summary of Climate Change Projections and Key Impacts in Ghana

5.4.4 Hydrology and Oceanography

Tides, Currents, and Waves

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 oceanic gyral currents (Fontaine *et al* 1999, Merle and Arnault 1985).

Surface water temperatures are warm (24ºC to 31ºC) with the daily sea surface temperature cycle showing annual variability (Fugro 2014). Hydrographic data collected in the Gulf of

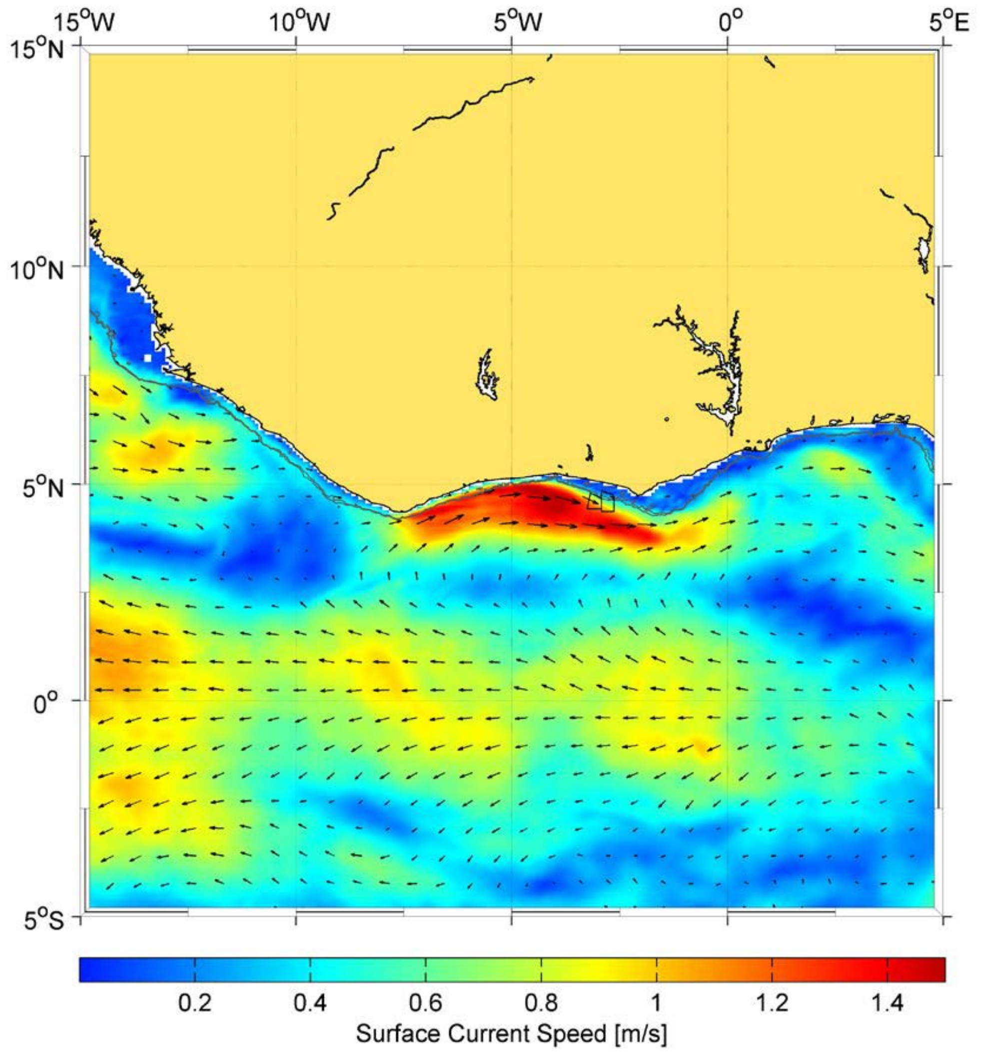
Guinea indicate that a thermal cycle occurs only in the upper two elements of the water column which together comprise the tropical surface water mass.

The oceanic gyral currents of the North and South Atlantic Oceans produce a counter current, the Equatorial Counter Current that flows in an eastward direction. This becomes known as the Guinea Current as it runs from Senegal to Nigeria.

The offshore waters of Ghana are dominated by the Guinea Current, which is an offshoot of the Equatorial Counter Current and is typically confined to the upper 40 to 50 m of the water column (Figure 5.4) (Fugro, 2014). Currents are typically aligned along the continental slope likely due to topographic steering. However, reversal of the current does occur, predominantly during the less severe winter months. The Guinea Current, like other eastern ocean boundary currents, is characterised by areas of upwelling, and cooler surface waters during the boreal summer are typically associated with the intensification of the current (Fugro, 2014).

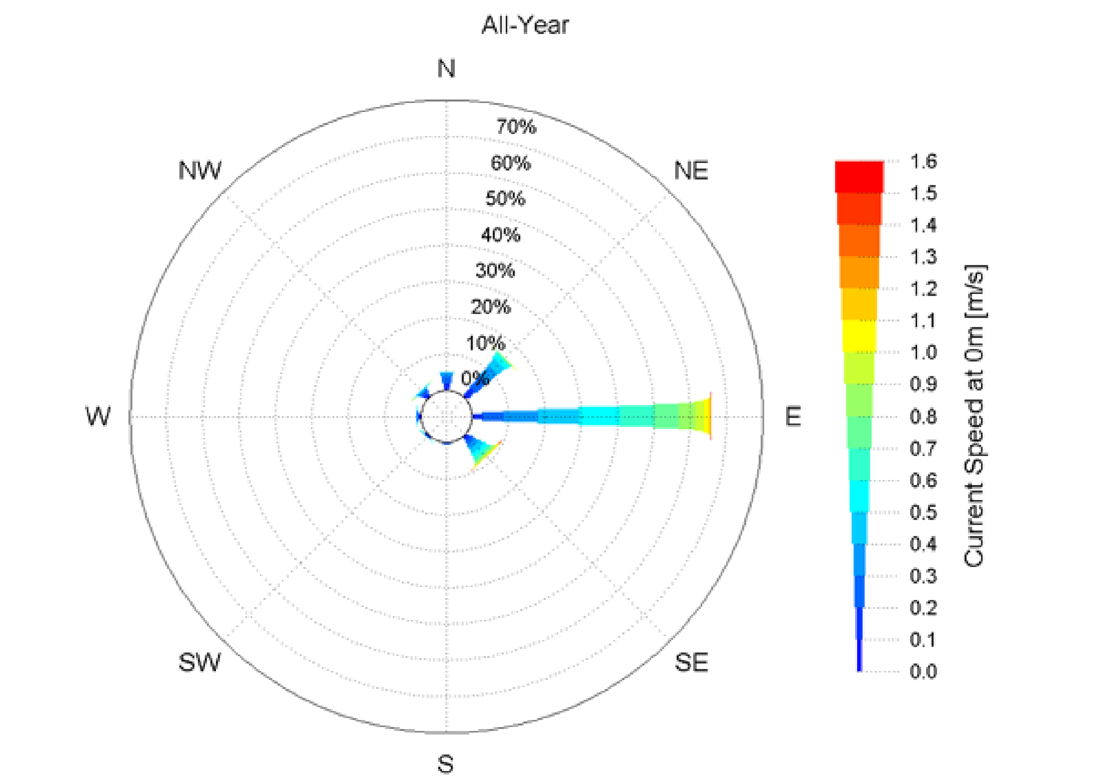
Figure 5.5, Figure 5.6 and Figure 5.7 show the variation in water current speed and direction with depth at the sea level, mid water and near seabed, respectively. Maximum currents speeds at 4 m below mean sea level were 0.90 ms^{-1} and seabed current speeds are weak (0.15 ms^{-1}) (Fugro, 2020). Maximum current speeds with water depth is shown in Figure 5.9 (Fugro 2020).

The tides in the Gulf of Guinea and specifically in the coasts of Ghana are regular and semi-diurnal of two almost equal high tides and two low tides each day (Noble-Denton 2008). 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). Wave heights are generally between 0.9 m and 1.4 m and rarely greater than 2.5 m. Occasionally, during swells, the wave amplitude may increase to five or six metres, though the periodicity of such events is about 10 to 20 years. The swell wave direction is usually from the south (see Figure 5.8). The maximum recorded significant wave height measured during field surveys was 5.0 m and the minimum recorded significant wave height was 0.9 m (Fugro 2014).



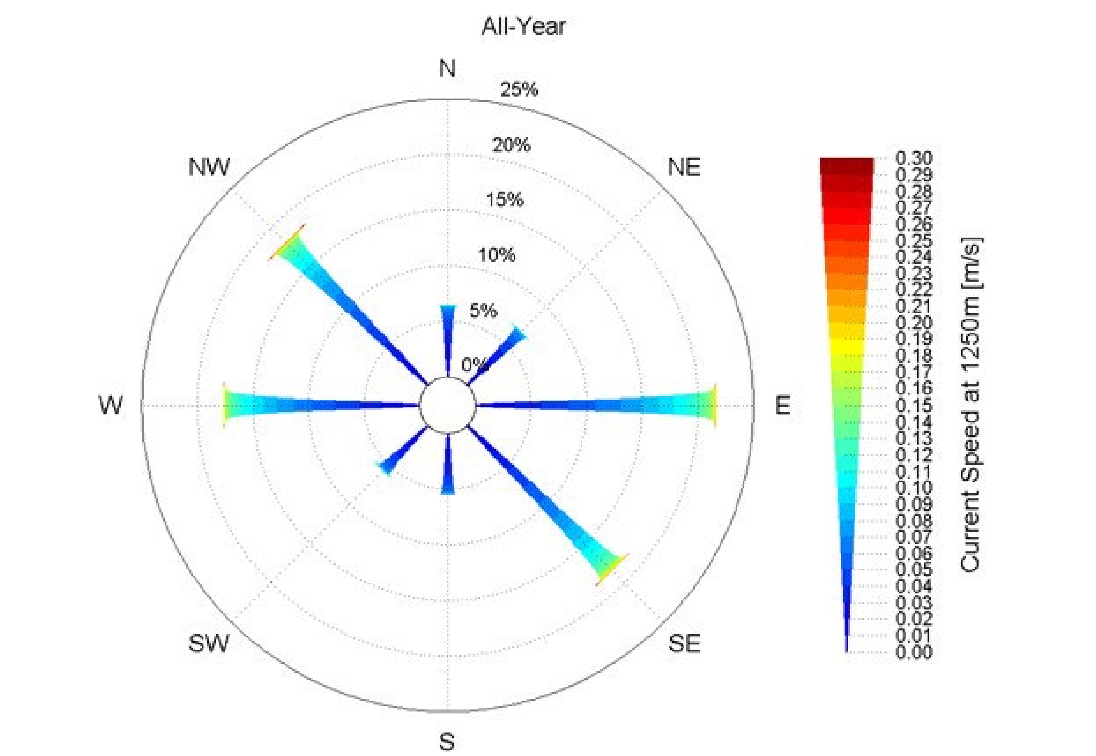
Source: Fugro (2014)

Figure 5.4 Surface Current Speed in the Guinea Current



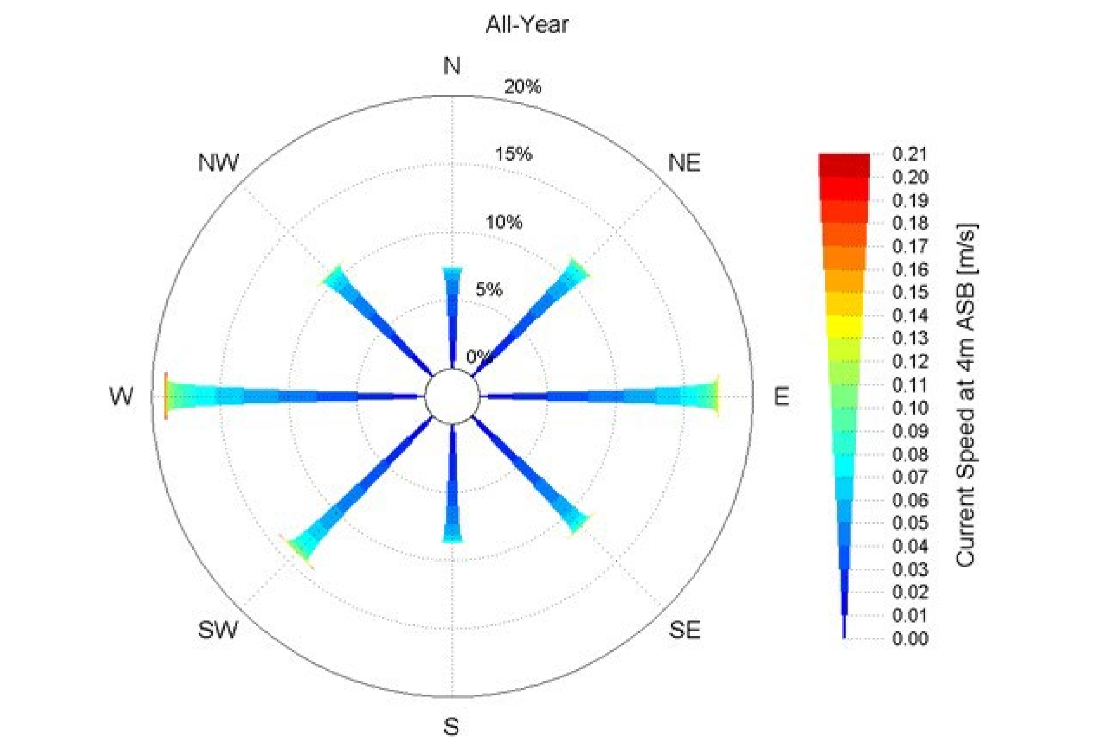
Source: Fugro (2020)

Figure 5.5 Current Speed and Direction at Sea Level in the Project Area (All-Year)



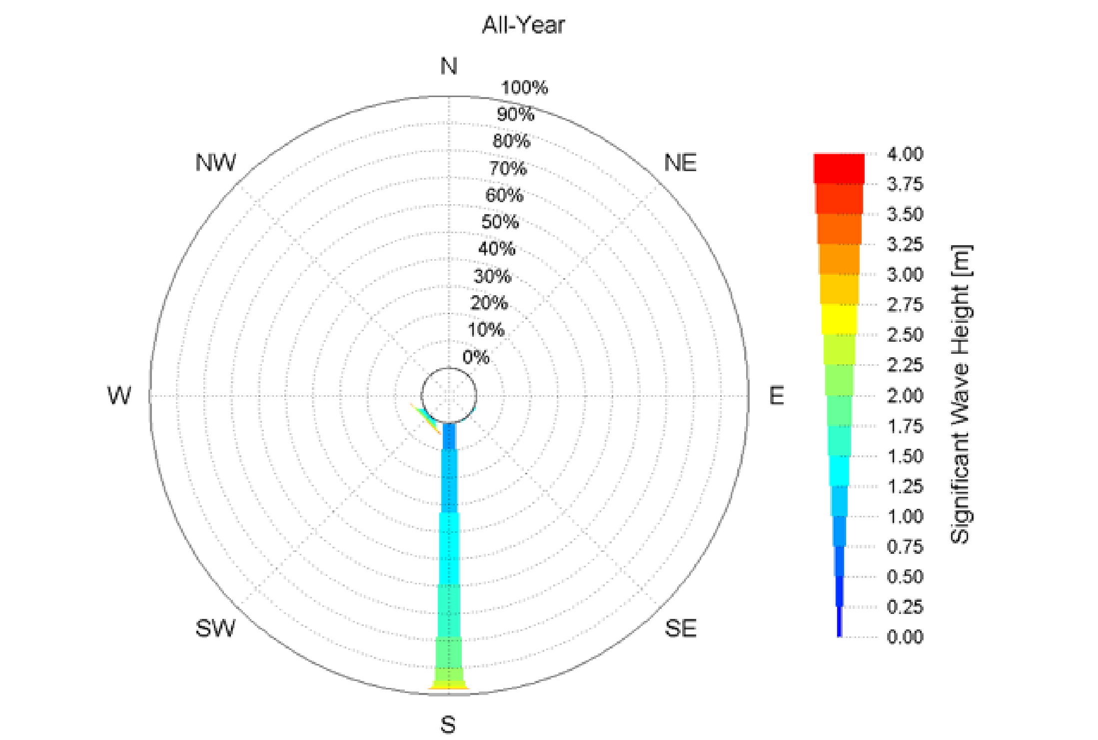
Source: Fugro (2020).

Figure 5.6 Current Speed and Direction at 1250 m in the Project Area (All-Year)



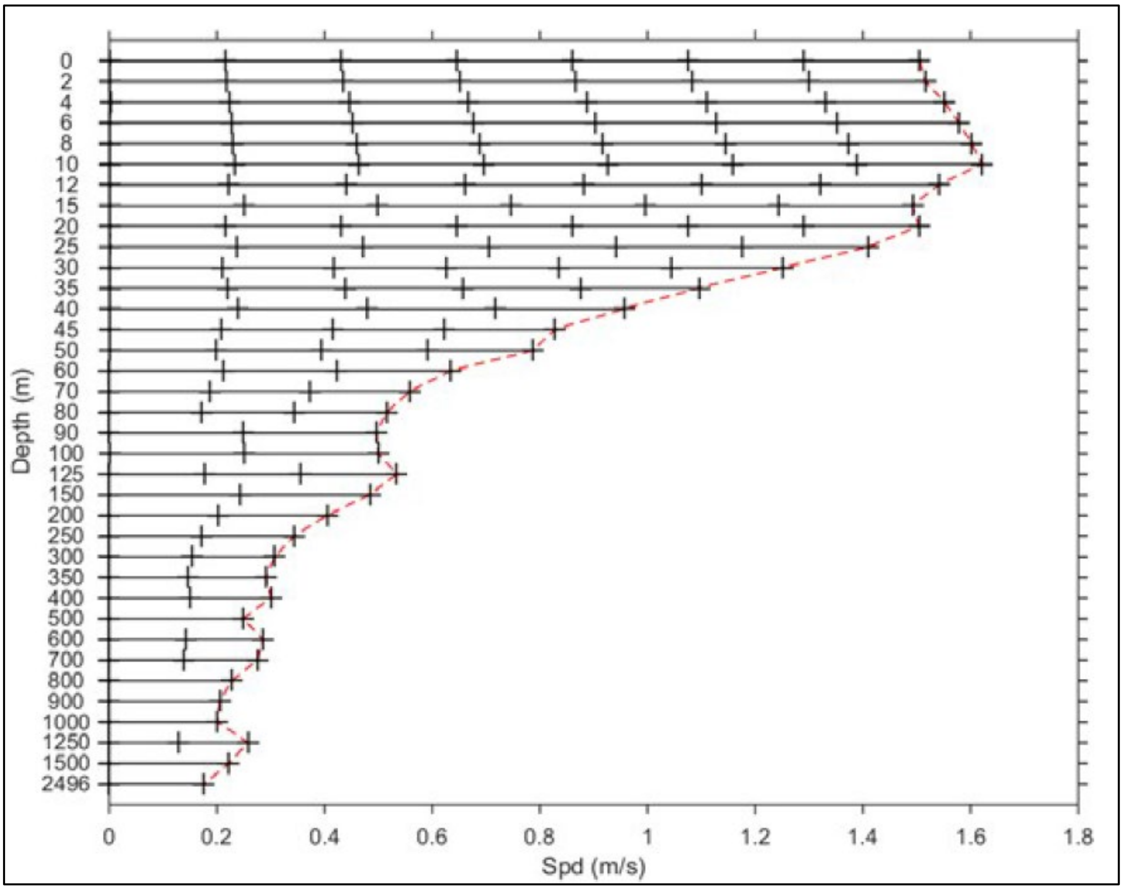
Source: Fugro (2020)

Figure 5.7 Current Speed and Direction at 4 m Above Seabed in the Project Area (All-Year)



Source: Fugro (2020)

Figure 5.8 Mean Wave Direction in the Project Area (All-Year)



Source: Fugro (2020)

Figure 5.9 Maximum Current Speed at each Water Depth

Upwelling

There are two seasonal coastal upwellings each year offshore Ghana, one major and one minor, with differing durations and intensities (Mensah and Koranteng, 1988). The major upwelling event normally occurs between July and September and the minor upwelling event normally occurs anytime between December and March. The upwelling is known to have considerable influence on local and sub-regional fisheries.

The upwelling influences the migratory patterns of pelagic fishes and is linked with the marine fish catch in Ghana (Armah and Amlalo 1998). The abundance of small pelagics in Ghana waters is related to the high plankton production in this area, which in turn is caused by upwelling of nutrient-rich water (USAID 2017). Landing values during the major upwelling are always higher than those in the minor upwelling (USAID 2017).

Water Quality

An Environmental Baseline Survey (EBS) was undertaken in December 2013 to January 2014 (Gardline 2014). Water quality samples were collected at four sites across the Contract Area: Almond-A, Almond-B, Pecan-A and Pecan-B (see Figure 5.10).

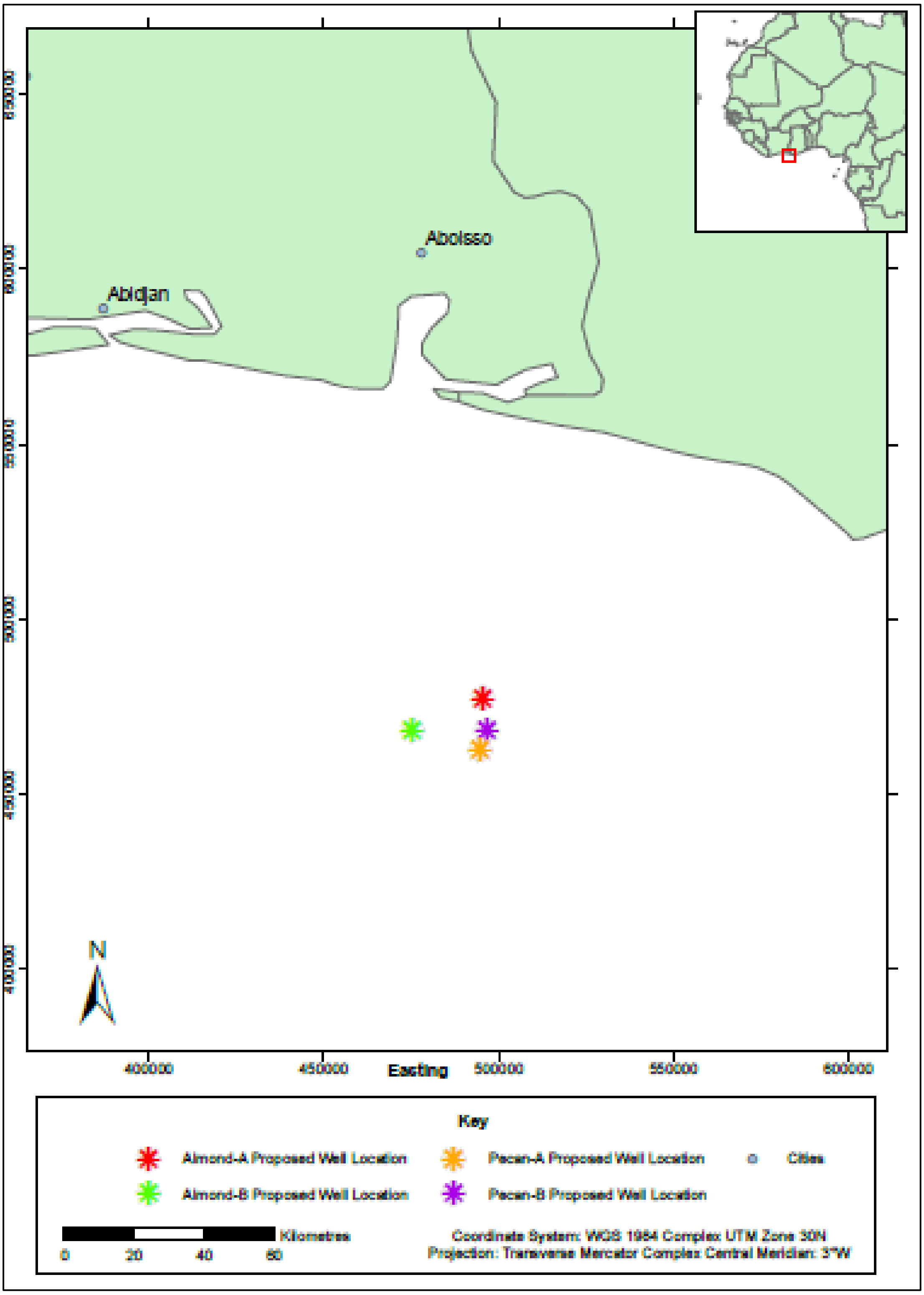
The results of water column profiles were similar at all four sites. Temperature of the surface waters ranged from 28 to 29°C and salinity ranged from 34.4 to 34.8 Practical Salinity Units (PSU). A prominent thermocline was present at approximately 40 m water depth with another zone of cooling around 300 m depth. Temperature above the seabed was 3°C and salinity was 35 PSU. Turbidity decreased with depth from 6.9 Formzine Transference Units (FTU) at surface and 5.9 FTU near seabed. Dissolved oxygen decreased from a maximum 120 percent at surface to 25 percent at 250 m to 300 m water depth.

Fugro (2020) also compared the measured maximum seawater temperature profiles with depth from measured data from Long Current Moorings (LCM) (2013-2015) and modelled data (HYCOM 1996-2004) and found that they were generally in good agreement. The water temperature is shown to decreases from surface temperatures above 25°C to below 5°C near the seabed (Figure 5.11).

Values for pH peaked in surface waters with a typical seawater pH of around 8.2, before decreasing slightly near the thermocline at 40 m. Minimum pH values of 7.7 to 7.8 pH occurred at approximately 440 m depth. Thereafter pH rose slightly and stayed constant to seabed (Gardline 2014).

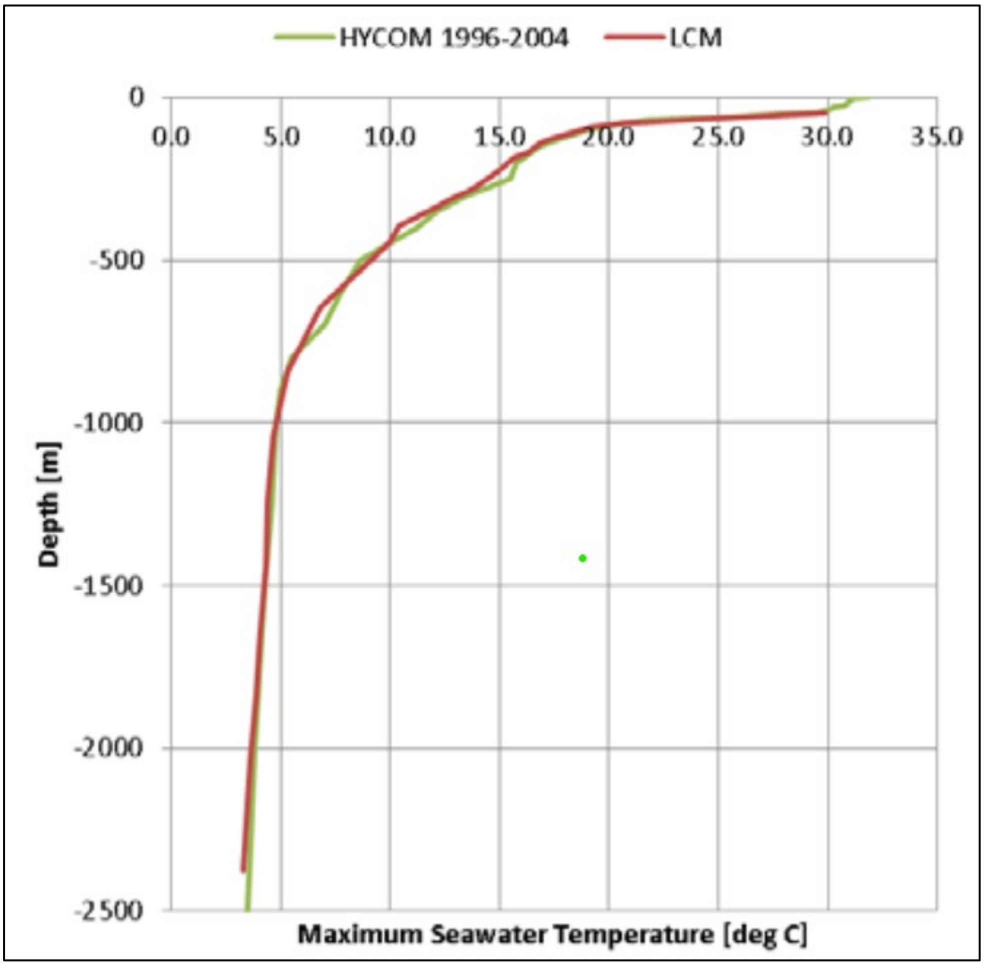
Water column profiles during the survey indicated an oligotrophic environment, absent of notable upwelling. The chlorophyll-a, suspended solids, nitrites and phosphate were below the level of detection for the majority of the samples. Nitrate concentrations were variable across the five sampling depths at each site, ranging from below the Limit of Detection to 0.8 mgl^{-1}. There was no indication of hydrocarbon contamination in the water column (Gardline 2014).

There was little variation in dissolved metal concentrations within the water column. Cadmium, mercury and lead were below the limit of detection, with little or no variation in chromium, copper, nickel and between samples. Zinc and arsenic recorded the highest concentrations of all metals within the survey areas but were low at less than 0.020 μgl^{-1} in almost all samples with the majority recording comparable values across depths within each site (Gardline 2014).



Source: Gardline (2014)

Figure 5.10 2014 EBS Sample Locations



Source: Fugro (2020)

Figure 5.11 Seawater Temperature Profiles

Bathymetry and Topography

The continental shelf at about 200 m water depth off the coast of the Western Region of Ghana is at its narrowest off Cape St Paul in the east (20 km wide) and at its widest between Takoradi and Cape Coast in the west (113). The continental slope is steep, and the depths increase sharply from approximately 100 m on the shelf and drop to approximately 1,600 m at the deepest part of the slope. The Project Area is located on the deeper portion of the continental slope in water depths ranging between 1,600 to 2,700 m (Gardline 2014, Fugro 2022). Figure 5.12 illustrated the bathymetry at the Pecan Field within the Contract Area (Fugro 2022).

Sediments

Down to a depth of approximately 30 m off the coast the sediment is mainly soft and muddy after which it changes into mixed substrate, and is generally rocky in a carbonated, muddy fine sand matrix between 75 m and 120 m, although the western areas of coastline remain relatively soft down to depths of more than 100 m (AECOM, 2014).

Sediment samples analysed from the EBS (Gardline 2014) showed that sediments across the Contract Area were found to be generally similar. These sediments were determined to be poorly to very poorly sorted and either fine or medium silt. Total Organic Matter (TOM) ranged between 9.5% and 14.2% and Total Organic Carbon (TOC) ranged between 1.48% and 2.36%. The Total Petroleum Hydrocarbons (TPH) concentrations ranged from 5.9 $\mu g g^{-1}$ to 18.4 $\mu g g^{-1}$.

Fugro (2021) undertook an EBS to obtain further physical and chemical data from the Pecan field. The survey was undertaken between 22 May and 28 June 2021. In total 18 stations were sampled for geotechnical evaluation and from 4 of these stations, samples were also collected for physical and chemical analysis.

The following analysis was undertaken on the sediment samples.

- Sediment particle size distribution
- Sediment Total Organic Matter (TOM) and Total Organic Carbon (TOC)
- Total hydrocarbon content (THC)
- 2 to 6 ring aromatic hydrocarbons (US EPA 16 priority PAHs);
- Suite of metals (Aluminium, arsenic, barium, cadmium, chromium, copper, iron, mercury, lithium, nickel, lead, vanadium and zinc).

The results of the analysis showed that the sediment within the survey area were similar to the wider regional area being dominated by fine silts (>90%), with a smaller proportion of sand. The low variability observed in the sand and fines fractions suggests the presence of a relatively homogenous sediment type throughout the survey area. The sediment characteristics were broadly comparable to previous surveys at the Almond and Pecan fields in 2013 (Gardline, 2014) suggesting no obvious temporal changes in the physical sediment characteristics. Low variability was observed in the total organic matter (TOM) and total organic carbon (TOC) content, with no spatial patterns observed.

The total hydrocarbon content (THC) values displayed low variability between stations and were broadly comparable to the previous surveys in the area. The PAH concentrations from sediment samples were similar and typical of background levels, as indicted in the Gardline (2014) survey. The majority of PAHs were interpreted as coming from pyrolytic sources. Such sources are often associated with fuel emissions, i.e., from vessel engines.

The variability in metals concentrations was low for the majority of analytes and concentrations were generally comparable to the 2014 survey, suggesting these were typical of the wider area.

The data from the 2014 and 2021 surveys indicate a stable environment, as would be expect for deep water location. The distribution and diversity of benthic species associated with these sedimentary habitats are therefore expected to be similar to those identified from the previous 2014 survey.

Noise, Vibration, Light

Existing noise, vibration and light levels in the Project Area will be from natural sources (such as water movement, weather events and natural light cycles) as well as from marine traffic (see Figure 5.52 in Section 4.6.12 for vessel traffic intensity in the Project area).

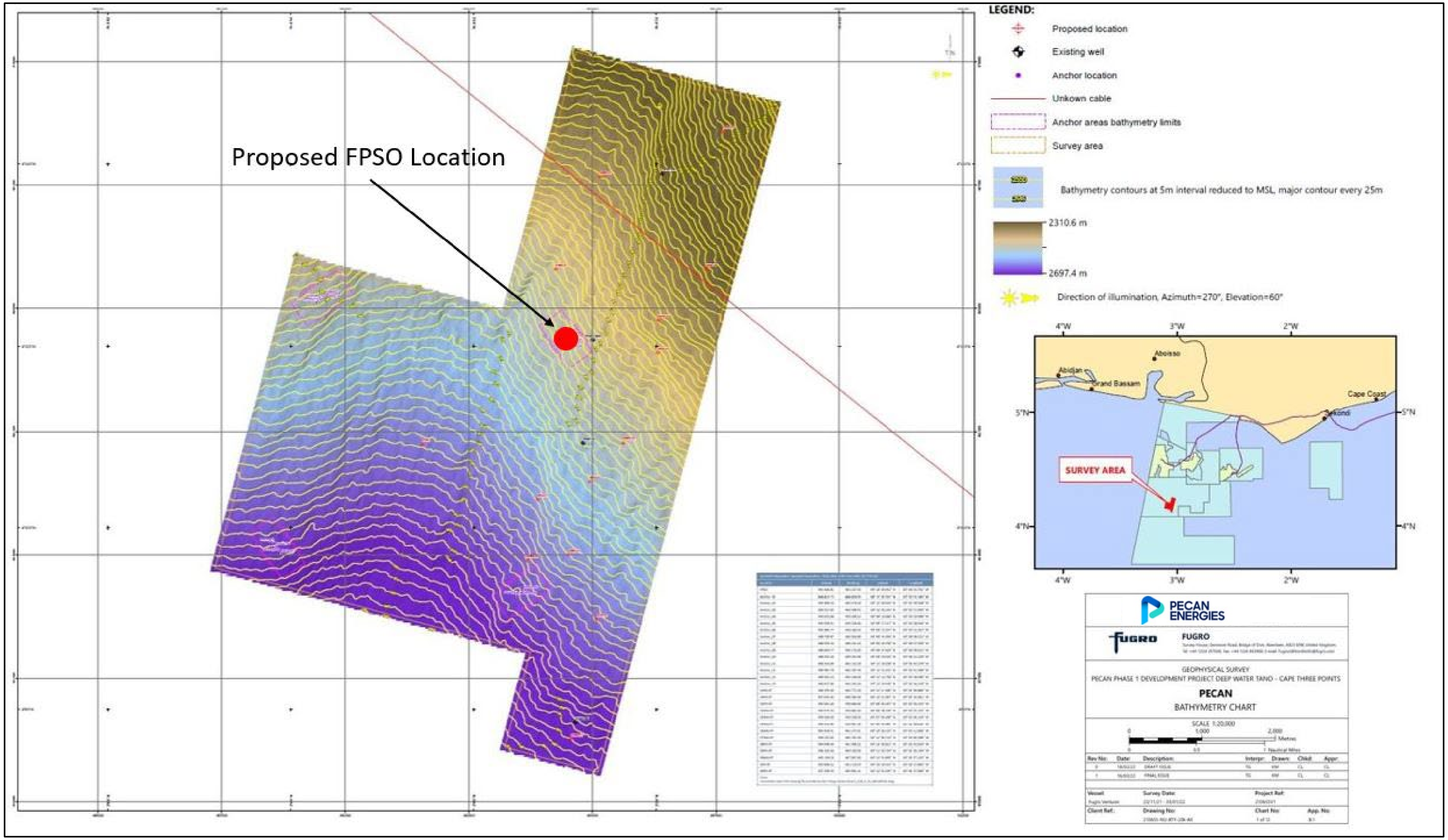


Figure 5.12 Bathymetry of the Project Area

5.5 Biological Baseline

5.5.1 Plankton, Invertebrates and Fish

Phytoplankton

The plankton, including phytoplankton and zooplankton, constitutes the basis of trophic chains in marine ecosystems. Phytoplankton organisms are microscopic and range between 30 µm and 60 µm in size, and their abundance increases with increased nutrient availability because of an upwelling event.

The composition and abundance of plankton is variable throughout the year and depends mainly on water circulation patterns, light, temperature, salinity and nutrients (Nybakken 1992 and Odum 1971). However, the main limiting factor influencing the development of phytoplankton is the presence of nutrients, especially nitrate and phosphate (Nybakken 1992). In the coasts off Ghana, it is known that phytoplankton abundance increases during upwelling events when nutrient availability increases.

The EBS found the abundance of phytoplankton in the Contract Area to be low during the survey period which means that there was limited evidence of any upwelling event during the survey (December and January) (Gardline 2014). Previous studies have determined primary production in the Gulf of Guinea to be about 4,305 to 5,956 mg Cm^{-3} per day as seen in Figure 5.13 (Sea Around Us Project 2008).

Green algae blooms of non-toxic marine green algae (*Enteromorpha flexuosa*) occur seasonally and are expected to be a result of over fertilisation of soils alongside rivers draining into the sea, as well as the outflow of untreated sewage into rivers and the sea (CRC-URI, 2010). These blooms usually appear between August and October and may remain in the inshore region during several months or even a year, with impacts on local fishing activities.

In recent years, Ghana has experienced an unprecedented increase in the presence of seaweed known as *Sargassum* (a genus of free-floating algae). The *Sargassum* has been particularly present in the Western Region where it has affected livelihoods of fishers and other community members (Ghana EPA 2014b). The increase in *Sargassum* along Ghana's shores is part of a regional and global trend. The reason for the migration of *Sargassum* from the Gulf of Mexico may be related to climate change, changes in Atlantic current patterns and changes in the productivity of marine habitat on a regional scale. This issue is discussed in more detail in Section 4.6.9.

Zooplankton

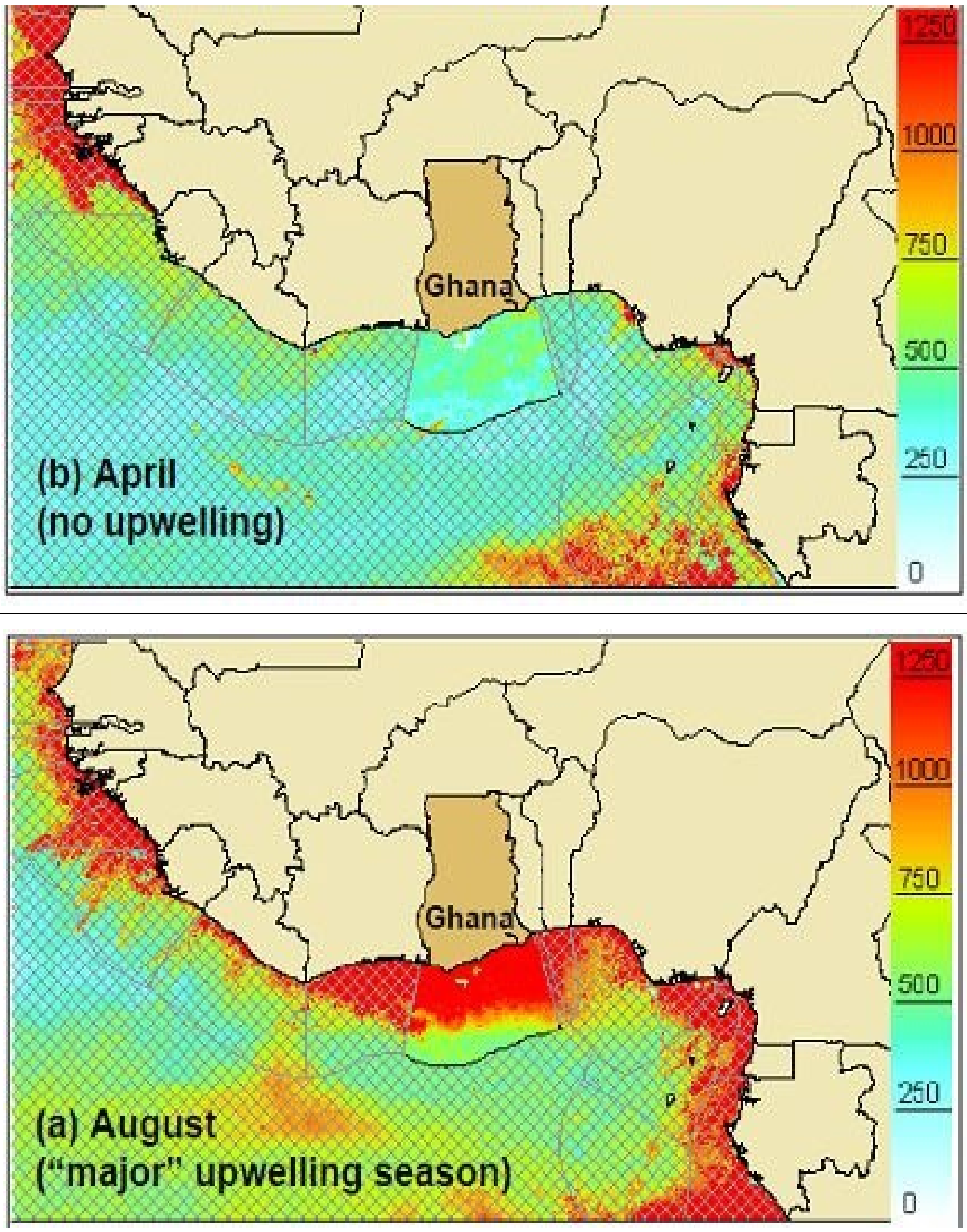
Zooplankton organisms are heterotrophic and rely on phytoplankton as a food source, becoming the first consumer in the food chain. Zooplankton includes a range of organism sizes including small protozoans and large metazoans. It includes holoplanktonic organisms, whose complete life cycle lies within the plankton, as well as meroplanktonic organisms that spend only part of their lives in the plankton (e.g., fish eggs).

Offshore Ghana zooplankton assemblages are generally dominated by copepods, followed by Ostracods[1], Appendicularians[2] and Chaetognaths[3].

- Maximum zooplankton abundance usually takes place during the major upwelling event (June to October) and to a minor extent during the minor upwelling event (December to February) following the increase in primary productivity by phytoplankton. The EBS conducted in the Contract Area found high numbers of zooplankton in the top 200 m of

[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.

the water column. The zooplankton community was dominated by copepods with the predominant species the cyclopoid copepod *Oncaea* (Gardline 2014).



Source: Sea Around Us Project 2008.

Figure 5.13 Primary Productivity (mg Cm^{-3} per day) Offshore Ghana during August and April

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.

Benthic fauna are relatively long-lived and sedentary and they exhibit different tolerances to stress, making them useful indicators of environmental conditions. The macrobenthos of offshore Ghana has not been extensively studied, particularly in deeper waters.

The Gardline (2014) EBS found that the macrofaunal community in the Contract Area has a low abundance but proportionally high diversity. Many of the sites exhibited a high level of bioturbation indicating burying fauna. Polychaetes, arthropod, crustaceans and molluscs dominated species composition and abundance, with relatively few echinoderms or other taxa present in the samples (Figure 5.14).

The results indicate an absence of contamination, under which circumstances only a few tolerant and highly abundant taxa might be expected to be present. No potentially sensitive or threatened species were observed during the survey (Gardline 2014).

Fix: 282 E: 495808 N: 462264 Depth: 2546	Fix: 286 E: 495801 N: 462271 Depth: 2546
Fix282: Silt with occasional shell fragments, Echinodermata (Scotoplanes sp.)	*Fix286: Silt with occasional shell fragments Mollusca (Scaphopoda), Bioturbation*
Fix: 343 E:494285 N:462266 Depth: 2575	Fix: 343 E:494285 N:462266 Retention: MFA
Box Core: Fine silt with clay, no visible live fauna	*Sieve: Sand, shell fragments and small clay aggregates Fauna, no visible live fauna*

Source: Gardline (2014).

Figure 5.14 Sampling and Seabed Photograph from Pecan-A (ENV 4)

Corals

Corals have very restricted ranges due to their requirements for specific thermal regimes, salinities, water depths, sedimentation and other physical and chemical characteristics. True coral reefs do not occur along the West African coast or in the vicinity of the Gulf of Guinea archipelagos, although mature coral communities are found at some discrete locations such as the oceanic islands and rocky mainland coasts; Cape Verde Islands, Gulf of Guinea Islands, Ghana, Gabon and Cameroon (Wells and Bleakley 2003). Deep water corals, dominated by the cold-water coral *Lophelia pertusa*, but also potentially including other cold-water corals (*Madrepora oculata*) have been recorded in the West African coast (Rogers, 2004).

During the R/V Dr Fridtjof Nansen survey in 2013 of the DWT Block, north-west of the TEN Project Area, a deepwater area offshore Ghana, a zone of coral was identified at a depth of approximately 500 m (IMR, 2010 and 2012). No corals were observed in the 2014 Gardline EBS (2014) and in the detailed seabed mapping by Fugro in 2021, which is to be expected in deep water offshore fine sediment environments.

Molluscs and Crustaceans

A variety of molluscs and crustaceans are known to be present within the Deep Water Tano (DWT) and West Cape Three Points (WCTP) blocks (ERM 2009). These mostly occupy the closer to shore, shallower waters and are not found in the water depths at the Pecan field, however, are described here due to their importance to coastal fisheries. 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*).

Further details of these key species are provided below, principally from the online FAO Marine Resource Fact Sheets on each species, 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.

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.

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.

The common octopus occurs 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.

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).

Demersal Fish

Demersal fish species are those that live on or near the seabed. They are usually found over the continental shelf and the continental slope. Their distribution and composition is influenced by oceanographic conditions and specifically by the upwelling that results in changes of the bathymetric extension suitable for different species.

This can also be observed by the differences recorded between the communities found above the thermocline, above 40 m depth and dominated by sciaenid species, and those living below (Koranteng, 1998). The density of demersal species is higher on shallower waters up to 50 m depth.

Trawl surveys conducted between 1956 and 1992 have shown that demersal fish are widespread on the continental shelf along the entire length of the Ghanaian coastline (Koranteng, 2001). Species composition is a typical tropical assemblage including the following families.

- Porgies or Seabreams (Sparidae) (e.g. bluespotted seabream Pagrus caeruleostictus, Angola dentex Dentex angolensis, Congo dentex Dentex congoensis, Canary dentex Dentex canariensis and pink dentex Dentex gibbosus).
- Grunts (Haemulidae) (e.g., bigeye grunt Brachydeuterus auritus and to a lesser degree, sompat grunt Pomadasys jubelini and bastard grunt Pomadasys incisus).
- Croakers or drums (Sciaenidae) (e.g., red pandora Pellagus bellottii, Cassava croaker Pseudotolithus senegalensis).
- Goatfishes (Mullidae) (e.g., West African goatfish/red mullet Pseudupeneus prayensis).
- Snappers (Lutjanidae) (golden African snapper Lutjanus fulgens, Goreean Snapper Lutjanus goreensis).
- Groupers (Serranidae) (e.g., white grouper Epinephelus aeneus).
- Threadfins (Polynemidae) (e.g., lesser African threadfin Galeoides decadactylus).
- Emperors (Lethrinidae) (e.g., Atlantic emperor Lethrinus atlanticus).
- Triggerfish (e.g., grey triggerfish Balistes capriscus).

The demersal species that are most important in terms of catch volumes are Sparidae or porgies (mainly *Pagellus bellottii*, *Dentex canariensis* and *Pagrus caeruleostictus*), Haemulidae or grunts, (e.g., *Pomadasys jubelini* and *Brachydeuterus auritus*); Sciaenidae or croakers (e.g., *Pseudotolithus* spp. or cassava croaker) and Lutjanidae or snappers (e.g., *Lutjanus fulgens*). Others are Mullidae or mullets, (e.g., *Pseudupeneus prayensis*);

Serranidae or groupers (e.g., *Epinephelus aeneus*) and Polynemidae or threadfins (e.g., *Galeoides decadactylus*, Nunoo et al, 2014).

Deep Sea 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 and higher layer of the seabed. Of these deepwater species, 89 were from 28 families, including Alepocephalidae, Gonostomatidae, Myctophodae and Stomiidae, that are likely to be found in Ghanaian waters over at depths over 1,000 m have been reported to have been found within the depth range in the Pecan (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 around the TEN FPSO and around other oil and gas structures 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 the TEN field octopus (*Muusoctopus* sp and cirrate), comb jellies (ctenophores), eelpout (Zoarcidae) and blobfish (*Psychrolutes* sp) have been observed. In Nigerian waters, sharks (Squalidae), chimaeras (Chimaeridae), grenadiers (Macrouridae), rays (Rajidae) and jellynose (*Guentherus altivela*) of the Ateleopodidae family, have been observed in deep water. In Angola, 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.

Pelagic Fish

The pelagic fish are those that live in the water column and consist of species exploited commercially. The distribution and quantity of each population largely depend on hydrological conditions, with each species distributed according to the optimum temperature and salinity required for growth and reproduction.

Most of the fish species discussed below have spawning grounds offshore Ghana and spawning of different species takes place throughout the year, typically with a peak from April to November.

The commercially important small pelagic fish in the coastal and offshore waters of Ghana include round sardinella (*Sardinella aurita*); flat sardinella (*S. maderensis*); European anchovy (*Engraulis encrasicolus*); and chub mackerel *(Scomber japonicus*). These species are important commercially as they represent approximately 80 percent of the total catch landed in the country (FAO 2010 and USAID 2017). In terms of biomass, acoustic surveys have shown that the two sardinella species and the European anchovy represent almost 60 percent of the total biomass in Ghanaian waters (FAO 2010).

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*) (FAO 2010). 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 predators and prey, as well as providing an important commercial resource for industrial fisheries.

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

[1] SERPENT Project website. Available at www.serpentproject.com [Accessed August 2022].

Ghana, with the main species caught being blue shark (*Prionace glauca*) and hammerhead shark (*Sphyrna* spp) (FAO, 2010).

Protected or Endangered Species

The sensitive fish species in offshore Ghana according to the IUCN Red List (IUCN 2022) and in the Project's Area of Influence according to the IBAT database are presented in Table 5.2. Main fish species of concern are angle sharks as they are considered as critically endangered and shortfin mako, longfin mako and whale sharks as they are endangered.

Other species are subject to commercial fishing and to international regulations and monitoring, as is the case of all tuna species by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Sharks are one of the groups most represented within the list.

Local enforcement of protection programmes for fish is through the Fisheries Commission that monitors and inspects fish catch. Tuna fishing is monitored through on-board fishing inspectors that monitor activities in accordance with The International Commission for the Conservation of Atlantic Tunas programme requirements.

Table 5.2 IUCN Red Listed Fish Species That Could Occur in the Project's AOI

Scientific Name	Common Name	Red List Category	Range
Carcharhinus longimanus	Oceanic Whitetip Shark	Critically Endangered	One of the most widespread of shark species, ranging across entire oceans in tropical and subtropical waters, usually found far offshore between about 30°N and 35°S in all oceans.
Squatina oculata	Smoothback Angelshark	Critically Endangered	Although historically this species occurred throughout the west coast of Africa and the Mediterranean Sea, it has undergone severe declines since the mid- 1980s. FAO records confirm the continued occurrence of the species in Ghana.
Manta birostris	Giant Manta Ray	Endangered	Circumglobal in tropical and temperate waters, this species has a widespread distribution.
Centrophorus granulosus	Gulper Shark	Endangered	*Centrophorus acus* is a poorly known deepwater shark with a limited understood distribution in the Western Pacific. It is also nominally recorded from the Western Central Atlantic and the relationship between these forms needs taxonomic resolution when more specimens are available.
Isurus oxyrinchus	Shortfin Mako	Endangered	The Shortfin Mako is a large pelagic shark, widespread in temperate and tropical oceans to depths of 888 m.
Isurus paucus	Longfin Mako	Endangered	The Longfin Mako is a large widely distributed but infrequently encountered, pelagic oceanic shark. It usually occurs to depths of 760 m, but has been reported to 1,752 m.
Rhincodon typus	Whale Shark	Endangered	Found in all tropical and warm temperate seas except the Mediterranean. Their core distribution is between approximately 30°N and 35°S, with occasional seasonal penetration to the north and south. Whale Shark distribution is likely to be temperature limited, as they are rarely sighted in surface temperatures of less than 21°C.
Epinephelus itajara	Goliath Grouper	Vulnerable	Found in the Atlantic Ocean in the west from northeastern Florida, south along the U.S., throughout the Gulf of Mexico and Caribbean Sea, and along South America to Santa Catarina, Brazil (Hostim-Silva et al. 2005) and in the east along West Africa from Senegal to Cabinda, Angola.

Scientific Name	Common Name	Red List Category	Range
Epinephelus marginatus	Dusky Grouper	Vulnerable	Found in the northeastern Atlantic Ocean from the southern English Channel, south along the coasts of western Spain and Portugal, throughout the Mediterranean Sea and Macaronesian islands and south along West Africa to southern Angola and possibly northern Namibia at the Cunene River. In the southwestern Atlantic Ocean, it is distributed from the mouth of the Rio Doce in the state of Espírito Santo in Brazil south to northern Patagonia in Argentina. Its depth range is zero to 300 metres.
Thunnus obesus	Bigeye Tuna	Vulnerable	Distributed globally in tropical and temperate seas, except the Mediterranean.
Alopias superciliosus	Bigeye Thresher Shark	Vulnerable	A highly migratory, oceanic and coastal species found circumglobally in tropical and temperate seas.
Alopias vulpinus	Common Thresher Shark	Vulnerable	Found circumglobally, with a noted tolerance for cold waters.
Carcharhinus falciformis	Silky Shark	Vulnerable	Found circumglobally in tropical waters.
Carcharodon carcharias	Great White Shark	Vulnerable	Found in most seas and oceans with concentrations in temperate coastal seas. It is principally known as a pelagic dweller of temperate continental shelf waters, but also ranges into the open ocean far from land and near oceanic islands, the cold boreal and austral (sub-Antarctic) seas and the coastal tropics. It is found from the surf-line and the intertidal zone to offshore, and from the surface down to depths over 250 m.
Dalatias licha	Kitefin Shark	Vulnerable	Found on continental and insular shelves and slopes in warm-temperate and tropical areas. This species is found in the western and eastern Atlantic, western Indian Ocean, western Pacific and around the Hawaiian Islands. The Kitefin Shark has a widespread yet patchy distribution in the Atlantic and Indo-West and Central Pacific Oceans. It has been recorded on continental and insular shelves and slopes at depths of 37 to 1,800 m, but mainly >200 m.

Scientific Name	Common Name	Red List Category	Range
Kajikia albida	White Marlin	Vulnerable	Found throughout warm waters of the Atlantic from 45°N to 45°S including the Gulf of Mexico, Caribbean Sea, and Mediterranean.
Epinephelus aeneus	White Grouper	Near Threatened	Found throughout the southern and eastern waters of the Mediterranean Sea, the southern Atlantic coasts of Portugal and Spain, and southwards along the Atlantic coast of West Africa as far as southern Angola, including the islands of the Gulf of Guinea. Its depth range is 20 to 200 metres.
Prionace glauca	Blue Shark	Near Threatened	One of the widest ranging of all sharks, being found throughout tropical and temperate seas from latitudes of about 60°N'50°S. It is oceanic and pelagic, found from the surface to about 350 m depth; occasionally it occurs close inshore where the continental shelf is narrow. The Blue Shark prefers temperatures of 12-20°C and is found at greater depths in tropical waters.
Thunnus albacares	Yellowfin tuna	Least Concern	Found worldwide in tropical and subtropical seas.
Pseudocarcharias kamoharai	Crocodile Shark	Least Concern	An oceanic and circumtropical species that occurs at the surface to at least 590 m depth, usually found offshore and far from land but sometimes occurring inshore and near the bottom.

Source: IUCN 2022

5.5.2 Marine Mammals

The water of the Gulf of Guinea and offshore Ghana are considered favourable to the presence of marine mammals, especially due to the seasonal upwelling, which boosts productivity and therefore ensures food availability for these species. However, there is a lack of knowledge on the distribution, population estimated and ecology of cetaceans in the region. The majority of data are based on opportunistic sighting, incidental catches and strandings and species abundance in the Gulf of Guinea (Van Waerebeek et al 2009; Weir 2010; and ERM, 2015a). Marine mammal species observed in the waters surrounding Ghana and potentially to occur within the Project Area, are listed in Table 5.3. The main marine mammals of concern are sei whale as they are considered as endangered and sperm whale, as they are classed as vulnerable.

During a seismic survey of areas in the *Contract Area* carried out from November 2013 to April 2014, marine mammal observations were recorded by Marine Mammal Observers (MMO) accompanying the survey vessels (EPI Group 2014). The following species were recorded: sperm whale, Bryde's Whale, short-finned pilot whale, clymene Dolphin bottlenose dolphin, melon-headed whale, Fraser's dolphin, spinner dolphin and pantropical spotted dolphin.

Table 5.3 Whales and Dolphins of Ghana, IUCN Conservation Status

#	**Species**	**IUCN Status**
Delphinidae		
1	Common bottlenose dolphin (*Tursiops truncatus*)	Least Concern
2	Clymene dolphin (*Stenella clymene)*	Least Concern
3	Spinner dolphin (Stenella longirostris)	Data Deficient
4	Pantropical spotted dolphin (*Stenella attenuate)*	Least Concern
5	Atlantic spotted dolphin (*Stenella frontalis*) (G. Cuvier, 1829)	Least Concern
6	Long-beaked common dolphin (*Delphinus capensis*)	Data Deficient
7	Fraser's dolphin (Lagenodelphis hosei)	Least Concern
8	Rough-toothed dolphin (*Steno bredanensis*)	Least Concern
9	Risso's dolphin (*Grampus griseus*)	Least Concern
10	Melon-headed whale (*Peponocephala electra*)	Least Concern
11	Pygmy killer whale (*Feresa attenuata*)	Least Concern
12	Short-finned pilot whale (*Globicephala macrorhynchus*)	Least Concern
13	Killer whale (*Orcinus orca*)	Data Deficient
14	False killer whale (*Pseudorca crassidens*)	Near Threatened
Ziphiidae (beaked whales)		

#	Species	IUCN Status
15	Cuvier's beaked whale (*Ziphius cavirostris*)	Least Concern
Kogiidae (pygmy sperm whales)		
16	Dwarf sperm whale (*Kogia sima*)	Data Deficient
Physeteridae (sperm whales)		
17	Sperm whale (Physeter macrocephalus or Physeter catodon)	Vulnerable
Balaenopteridae (rorquals)		
18	Humpback whale (Megaptera novaeangliae)	Least Concern
19	Sei whale (Balaenoptera borealis)	Endangered
20	Bryde's Whale (Balaenoptera edeni)	Least Concern

Source: IUCN (2022)

5.5.3 Marine Turtles

Relatively little is known about the migration patterns, genetic variation, or nesting behaviour of sea turtles along the approximate 560 km long coast of Ghana (Tanner 2013). Currently, olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles are known to nest in Ghana regularly, and hawksbills (*Eretmochelys imbricata*) are thought to have nested historically along the coast (Doak 2009) (see Table 5.4).

Table 5.4 Sea Turtles Nest Site Records in Ghana

Author, year	Leatherback	Olive Ridley	Green
Amiteye, 2002	46	412	32
Agyemang, 2005	30	190	10
Allman, 2007	418	134	0
Agyekumhene, 2009	74	103	0
Average	142	210	21

There are records of loggerhead turtles (*Caretta caretta*) nesting on one beach. Over the last 30 years, two loggerheads were observed in December 1998 and a single loggerhead was observed nesting in January 2013 (Allman, Barbour and Agyekumhene, 2015). It is noted that consistent nesting surveys were only conducted on this beach from August 1998 to April 2000.

The IUCN Red List classifies hawksbill turtles as Critically Endangered, green turtles and loggerhead turtles as Endangered and olive ridley and leatherback turtles as Vulnerable (IUCN, 2019). These species are also listed as protected species under the Convention on

International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS).

In Ghana, coastal habitat is favourable and turtle nesting may occur all along the sandy coast of the country, including the beaches from Keta to Half-Assini that are important nesting areas for marine turtles. Approximately 70% of Ghana's coastline is found suitable as nesting habitat for marine turtles (Armah *et al* 1997; Amiteye 2002). The olive ridley is the most abundant nesting marine turtle species in Ghana. The nesting period stretches from July to December, with a peak in November (Armah *et al,* 1997) (ERM, 2015a).

During a seismic survey of areas in the *Contract Area* carried out from November 2013 to April 2014, sea turtle observations were recorded by Marine Mammal Observers (MMO) accompanying the survey vessels (EPI Group, 2014). The following species were recorded: leatherback turtle, olive ridley turtle and hawksbill turtle.

Seabirds

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 (*e.g.,* 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 (*e.g.,* 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*).

5.5.4 Protected Areas

Several coastal habitats are important for their biodiversity as well as for rare and endangered species. However, only five coastal areas are currently protected within the country. These areas are all located inland 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 are located with exposure to the Atlantic Ocean.

Table 5.5 Coastal Ramsar Sites in Ghana

Name and Site Number	Location and distance from Project area	Area (km^2)	Comments
Muni-Pomadze (563)	5°23′N, 0°40′E 250 km	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 300 km	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 375 km	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 450 km	511.33	Closed lagoon with high salinity, and a large mudflat with scattered mangroves.
Keta Lagoon Complex (567)	5°55′N, 0°50′E 550 km	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 established any marine protected areas. There are five coastal Ramsar sites designated as protected areas for their ecological importance. Several coastal lagoons with their associated mangrove stands serve as breeding and nursery areas for a wide variety of marine species. However, none of these lagoons are under any protection by national legislation, except for those found in the Ramsar sites.

Traditional methods of conservation exist for a number of lagoons and wetlands within the country. These lagoons are considered as deities, and this affords the lagoons and their resources protection. The traditional protection methods include days, periods and seasons of closed fishing, and restrictions on fishing methods, gear and fishers.

Six Important Bird Areas (IBAs) are located along the coastline of Ghana (see Figure 5.16), that are, from the west to the east coast (Birdlife International, 2022):

- Amansuri Wetland;
- Muni-Pomadze Ramsar Site;
- Densu Delta Ramsar Site;
- Sakumo Ramsar Site;
- Songor Ramsar Site; and
- Keta Lagoon Complex Ramsar Site.

Five of these are designated Ramsar sites, however, only one site, the Amansuri Wetland, is located in the Western Region. The Amansuri Wetland is the largest stand of intact swamp-forest in Ghana, with large portions of the wetland still in a relatively pristine condition. The wetland is classified as a blackwater area, and as such, the fauna on the site is species-poor, but distinctive.

Coastal Zone

The Ghanaian coast can be divided into three areas with definitive characteristics (COWI, 2004).

- West of Cape Three Points the coastline comprises sheltered, gently sloping, wide beaches, backed by coastal lagoons. The wave heights are generally low.
- Between Cape Three Points and Tema the coast consists of rock headlands and sandbars (or spits) enclosing coastal lagoons, embayed coast, subject to medium to high wave energy. The wave heights often exceed 1 m. The south-westerly prevailing winds cause oblique wave approach to the shoreline, which generates an eastward littoral sediment transport.
- East of Tema, the shoreline is sandy and characterised by the eroding Volta delta. Wave and sediment dynamics are similar to those between Cape Three Points and Tema.

A series of coastal sensitivity maps have been drawn up based on information provided in the Ghana Coastal Sensitivity Atlas (Armah *et al* 2004; EPA 2020). These are presented as follows.

- Figure 5.15: International Bird Areas.
- Figure 5.16: Sensitive bird habitats.
- Figure 5.17: Turtle nesting beaches.

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 outcrops alternating with sandy bays. These shores support a wide variety of species of macro algae, barnacles and snails. Ecologically, algae mats on rocky shores serve as important micro-habitats for epifauna (crustacean, macro-invertebrates) and fish. In the Western Region, rocky shores are restricted to the area between Axim and Tema, supporting a wide range of organisms in the intertidal zone.
- 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. The amount of annual rainfall has an important effect on the nature of the coastal lagoons. Westwards from Takoradi, where the rainfall higher, all the coastal lagoons have a permanent opening to the sea. East of Takoradi, only four rivers the Pra, Kakum, Densu, and the Volta, have a sufficient volume of water at all seasons to maintain a permanent outflow from the coastal lagoons at their mouths. Lagoons of importance in the Western Region are Tano/Aby/Ehy Lagoon (410 km2) and Amanzule Lagoon (2.5 km2) near Benyin both in Jomoro District. The latter has been proposed for designation as a Ramsar Site.

There are also a series of freshwater wetlands in the Western Region (Finlayson et al, 2000)

- Estuaries are present along the Ghanaian coastline where large rivers enter the sea. The main rivers in the west of Ghana are the Tano, Ankobra and Pra rivers. The estuary and wetlands of Ankobra estuary, in the west of Ghana, supports in excess of 1,000 km2 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 are an important nursery habitat for fish and feeding areas for waterfowl. Red mangroves (Rhizophora harrisonii, Rhizophora mangle and Rhizophora racemosa) with their distinct prop roots are common in these estuarine wetlands where there is mixing of fresh and saline waters (USAID, 2010).

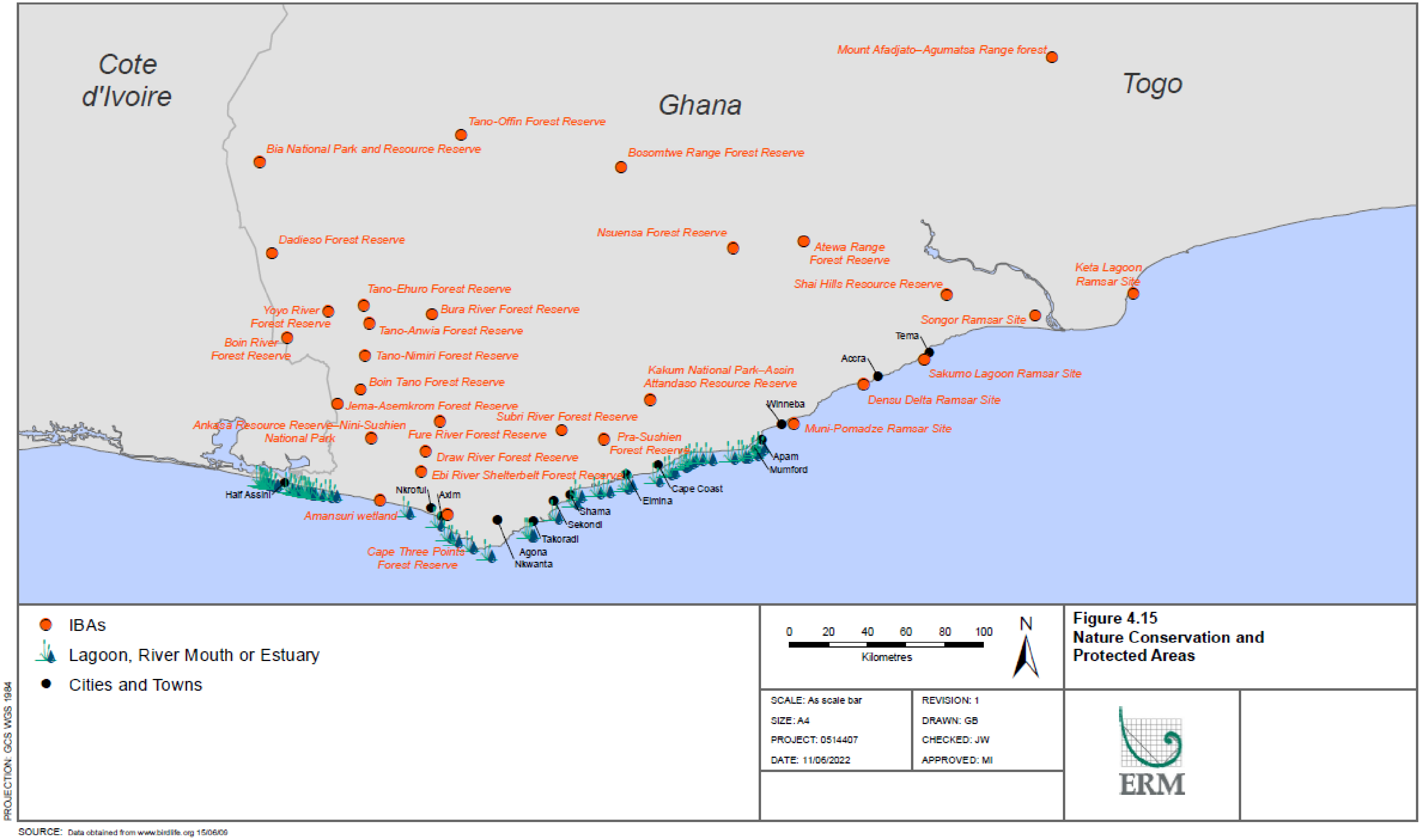


Figure 5.15 Nature Conservation, International Bird Areas and other Protected Areas

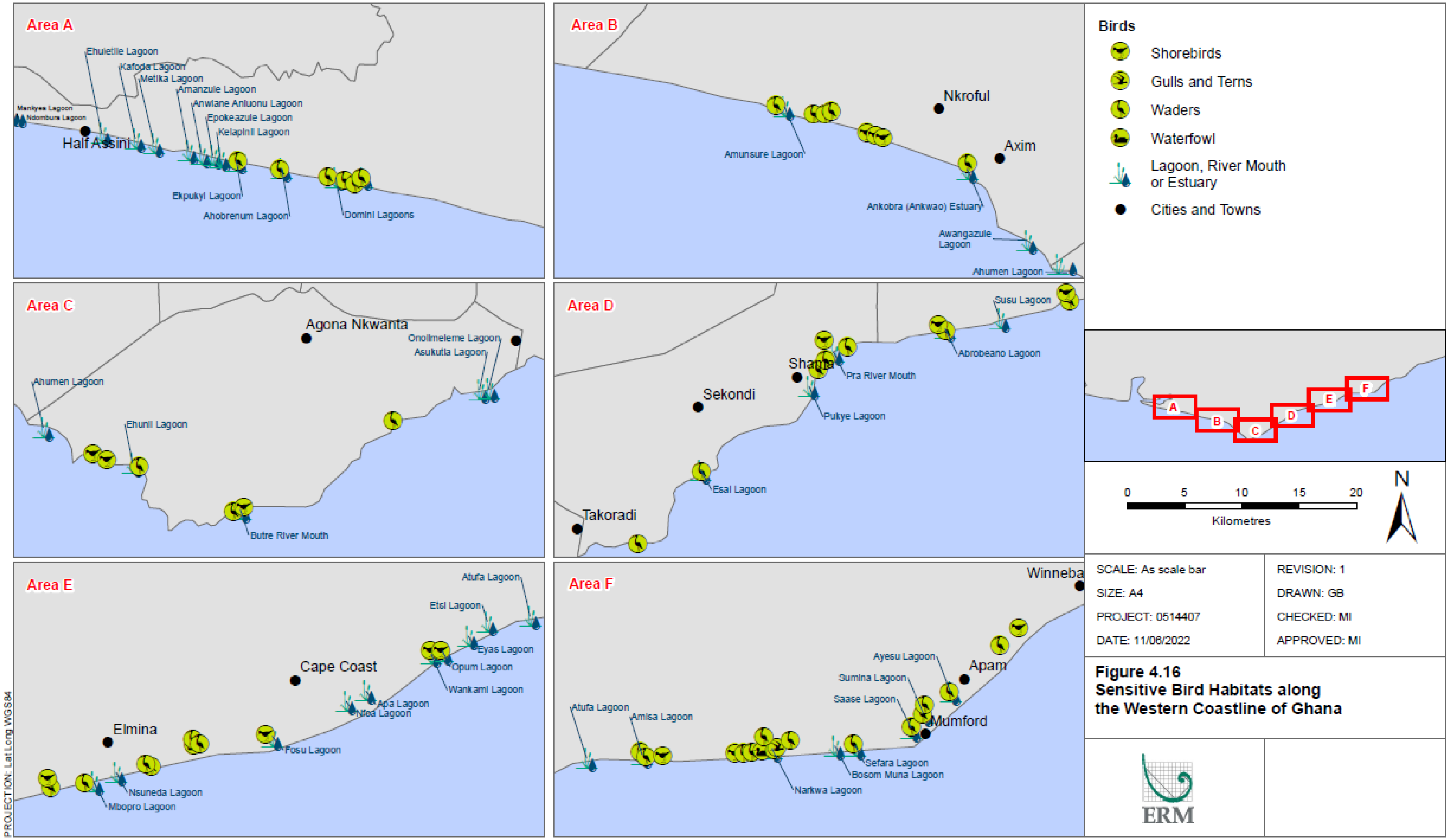


Figure 5.16 Sensitive Bird Habitat along the Western Coastline of Ghana

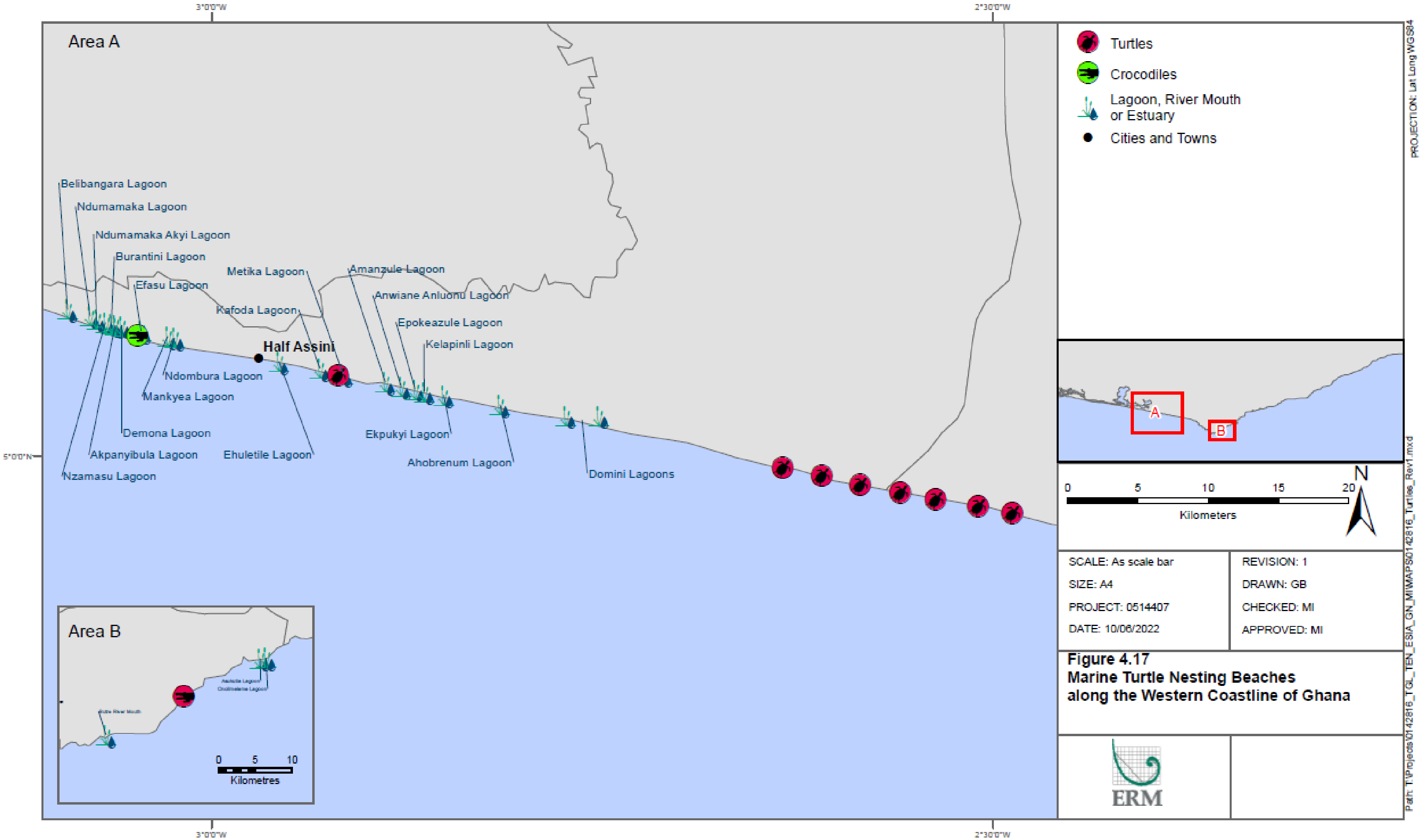


Figure 5.17 Marine Turtle Nesting Beaches along the Western Coast of Ghana

5.6 Socio-Economic and Health Baseline

5.6.1 Introduction

This section provides a description of the relevant baseline socio-economic, health and human rights baseline conditions in the socio-economic Area of Influence (AoI) defined for Pecan Energies Pecan offshore development in the Western Region of Ghana. This is intended to support the identification of key socio-economic sensitivities to inform the assessment of social impacts related to the Project.

Information presented in this section has been collected from available secondary data, including the following main sources.

- Ghana Statistical Service (2019). Ghana Living Standards Survey (GLSS) Round 7, Main Report, June 2019. The data collection was over a period of 12 months (22nd October 2016 to 17th October 2017) when Ghana was still organised in 10 regions.
- Final Draft 2018-2021 Medium-Term Development Plans of the coastal districts (Jomoro, Ellembelle, Nzema East, Ahanta West, Sekondi-Takoradi Metropolitan Assembly, Shama) in the Western Region of Ghana1.
- District Analytical Reports (Jomoro, Ellembelle, Nzema East, Ahanta West, Sekondi-Takoradi Metropolitan Assembly and Shama) developed based on the 2021 Population and Housing Census (General Report Volume 3A) partial results by the Ghana Statistical Service, November 2021.
- Coastal District Profiles published by the Western Regional Coastal Foundation (WRCF)2.
- Kennedy Atong Achakoma et al: Labour Migration Study in Ghana, 2016. ISBN: 9988-572-71-93.
- Sam B and Buckle F 2017. The Implications of Infrastructure Investments on Land and Livelihoods- Experience from the Western Coastal Region of Ghana, Paper prepared for presentation at the 2017 World Bank Conference on Land and Poverty; The World Bank - Washington DC, March 20-24, 2017.
- Charlie J. Gardner, Opportunities for Oil & Gas Corporate Social Investment in the Fisheries Sector of Ghana's Western Region, Full Scoping Report, Western Region Coastal Foundation, December 2016.
- Ghana Country Report on Human Rights Practices for 2018, United States Department of State Bureau of Democracy, Human Rights, and Labour4.

Information is presented, as available, at various geographic levels, with particular focus at district level, and covers the following aspects.

- Administrative Structure;
- Planning and Development;
- Human Rights Context;
- Demographics;
- Land Tenure and Use;
- Economy and Livelihoods;
- Education;
- Health Care
- Utilities, Infrastructure and Services; and

[1] Information presented in these Development Plans were not systematically presented so certain types of data and information are not consistently described for all the districts. The Development Plans are yet to be updated
[2] available at http://wrcfghana.org/archives/publication-category/information -about-the-western-region, accessed on 9 March 2020
[3] available at http://www.fesghana.org/index.php?page=new-publications, accessed on 9 March 2020
[4] Available at https://www.state.gov/wp-content/uploads/2019/03/Ghana-2018.pdf, accessed on 1 April 2020

- Community Cohesion and Conflict.

5.6.2 Overview of Districts in the Area of Influence

The Project socio-economic AoI includes the local fishing communities that operate in the six coastal districts located within the Western Region, as these are located nearest to the offshore Pecan Field (the closest well site is approximately 92 km from the nearest coast). The coastal districts include, from west to east, Jomoro Municipal, Ellembelle District, Nzema East Municipal, Ahanta West Municipal, Sekondi-Takoradi Metropolis and Shama District[1]. A new administrative unit, the Effia-Kwesimintsim Municipal which has no coastline, was carved-out from Sekondi–Takoradi Metropolitan Assembly as one of the 38 newly created and upgraded District Assemblies in 2018.

Prior to coming into existence as a Municipal Assembly, Effia-Kwesimintsim was a Sub - Metro under Sekondi-Takoradi Metropolitan Assembly (STMA).

Figure 5.18 presents an overview of the Western Region, including the six coastal districts and some fishing communities in the AoI.

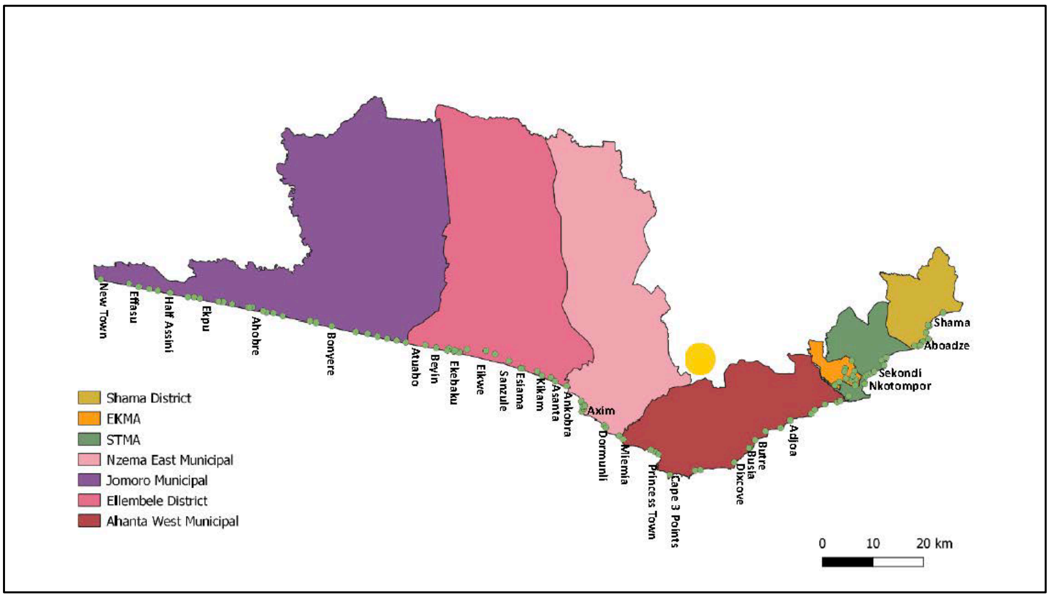


Figure 5.18 Map of the New Western Region of Ghana and its Districts and Towns

5.6.3 Administrative Structure

There is a dual system of governance in Ghana made up of formal government structures and traditional leadership structures. These systems of authority are recognised as complementary structures with different responsibilities. The decentralised government in Ghana, referred to as the Local Government System, comprises three levels of administrative authorities, namely national, regional and district.

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. Under these fall the Sub-Metropolitan District Council, Zonal Council and Urban/Town/Area/ Councils, as well as Unit Committees (Figure 5.19).

[1] The term 'District' is used in this report to cover all three types of administrative area.

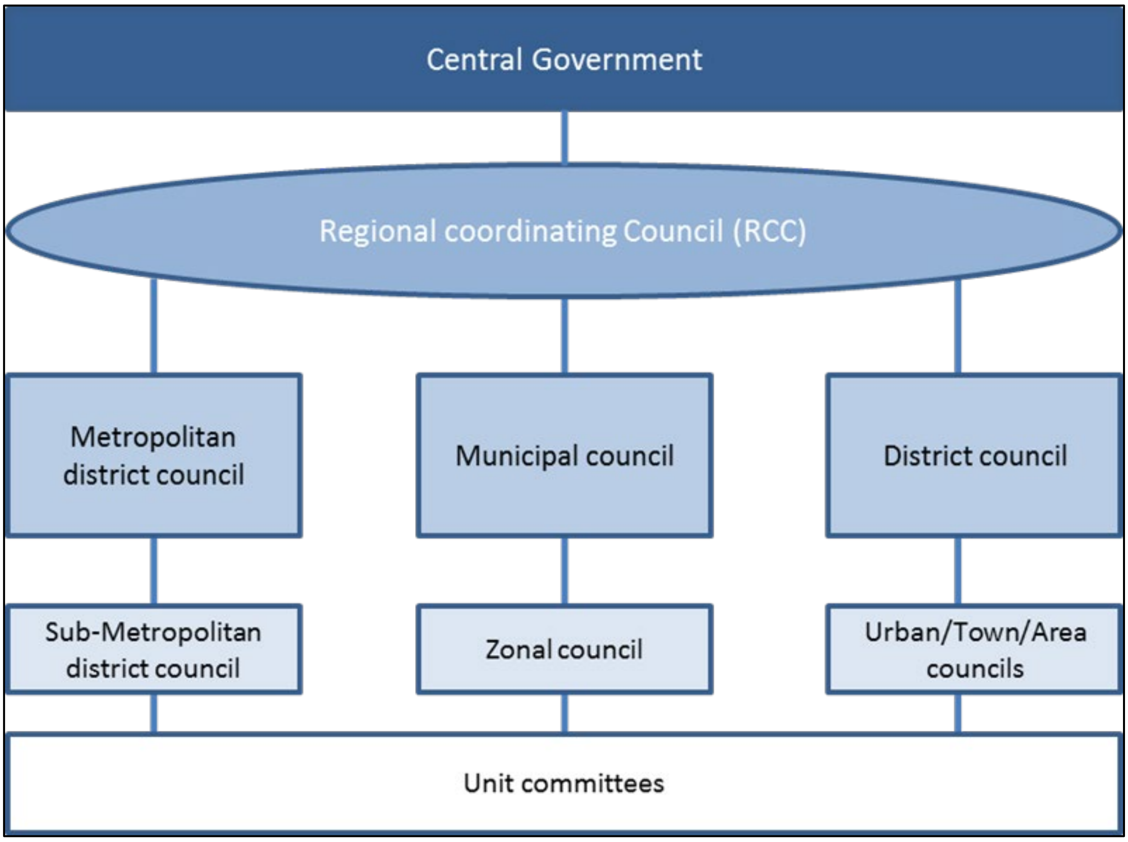


Figure 5.19 The Governance Structure in Ghana

Formal Structures

Following a Referendum on 27th December 2018 and the establishment of Constitutional Instrument (C.I) 117 dated 15th February 2019, the number of administrative regions in Ghana increased from 10 to 16[1].

Figure 5.20 illustrates the 16 regions created and their capitals following the 2018 referendum.

The new regions are Oti, Western North, North East, Ahafo, Savannah and Bono East Regions. The six new regions were carved from four already existing regions, namely Brong Ahafo, which has been split into three; Northern Region, also split into three; Western Region and Volta Region., Oti Region was carved from Volta, Bono East and Ahafo from Brong Ahafo, and Savannah and North East from Northern Region. The new Western North Region was carved from the former Western Region[2]. The Districts of Ghana are the second-level administrative subdivisions of Ghana, below the level of region. There are currently 260 districts[3], out of which 6 are Metropolises, 109 are Municipalities and 145 are Districts.

[1] Ghana Districts, available here http://www.ghanadistricts.com/Home/AllDistricts and accessed on 16 June 2022
[2] Online article, Ghana now has 16 regions, published on 16 February 2019, at https://www.modernghana.com/news/916140/ghana-now-has-16-regions.html and accessed on 16 June 2022.
[3] Ghana Districts, available here http://www.ghanadistricts.com/Home/AllDistricts and accessed on 16 June 2022.

Source: Ghana Districts (2019), http://www.ghanadistricts.com/Home/LinkData/718

Figure 5.20 Map of Ghana's 16 Administrative Regions and Capitals

The key factors which determine an Assembly to be a Metropolitan, Municipal or District are the population size and settlement characteristics of the area. The Act stipulates the classification as follows.

- A metropolis is a local government unit or area with a minimum population of 250,000 people.
- A municipality is a single compact settlement with a minimum population of 95,000 people.
- A district is a local government unit or area with a minimum population of 75,000 people.

A District Assembly is established by the Minister of Local Government and serves as the highest political authority in each district. It is made up of:

- the District Chief Executive, appointed by the President of the Republic;
- one person from each electoral area within the district elected by universal adult suffrage[1];
- the member or members of Parliament from the constituencies that fall within the area of authority of the District Assembly; and
- other members that shall not exceed thirty per cent of the total membership of the District Assembly appointed by the President in consultation with the traditional authorities and other interest groups in the district.

As the political and administrative authorities of the districts, the primary function of District Assemblies is to promote local economic development. According to the Local Government Act of 2016, District Assemblies also have the following tasks.

- Formulate and execute plans, programs and strategies for the effective mobilization of the resources necessary for the overall development of the district.
- Promote and support productive activity and social development in the district and remove any obstacles to initiative and development.
- Sponsor the education of students from the district to fill particular work force needs of the district especially in the social sectors of education and health, making sure that the sponsorship is fairly and equitably balanced between male and female students.
- Initiate programs for the development of basic infrastructure and provide municipal works and services in the district.
- Be responsible for the development, improvement and management of human settlements and the environment in the district.
- In co-operation with the appropriate national and local security agencies, be responsible for the maintenance of security and public safety in the district.
- Ensure ready access to courts in the district for the promotion of justice.
- Act to preserve and promote the cultural heritage within the district.
- Initiate, sponsor or carry out studies that may be necessary for the discharge of any of their duties.

The new Western Region has Sekondi-Takoradi maintained as its capital and is made up of one Metropolis, eight Municipal Assemblies and five District Assemblies, illustrates the status and district capitals in the newly created Western Region after reorganisation.

[1] Universal Adult Suffrage is the right of citizens in a given society who are entitled to vote in an election to select, at periodic intervals when these elections are called, a government to represent them.

Table 5.6 Districts and Capitals of the New Western Region[1]

District	Status	Capital
Jomoro*	Municipal	Half Assini
Ellembelle*	District	Nkroful
Nzema East*	Municipal	Axim
Ahanta West*	Municipal	Agona Nkwanta
Sekondi-Takoradi*	Metropolis	Sekondi-Takoradi
Shama*	District	Shama
Amenfi Central	District	Manso Amenfi
Wassa Amenfi East	Municipal	Wassa-Akropong
Amenfi West	Municipal	Asankrangwa
Mpohor	District	Mpohor
Prestea Huni Valley	Municipal	Prestea
Tarkwa Nsuaem	Municipal	Tarkwa
Wassa East	District	Daboase
Effia Kwesimintsim** (formerly part of STMA until 2018)	Municipal	Kwesimintsim

*Coastal Districts that form part of this study in bold.
** Effia-Kwesimintsim has no coastline but included because it was formerly part of STMA
Source: Ghana Districts (2019), www.ghanadistricts.com

Traditional Structures

There is a dual system of governance in Ghana, with traditional government structures alongside the formal government ones. These systems of authority are recognised as complementary structures that have different responsibilities. There is a decentralised formal and traditional government in Ghana with three levels of administrative authority, namely national, regional and district in both systems.

The Ministry of Chieftaincy and Religious Affairs in Ghana is the national official body responsible for ensuring linkages between the Government of Ghana and the traditional authorities in the country.

The vision of the Ministry is to preserve, sustain and integrate the regal, traditional and cultural values and practices to accelerate wealth creation and harmony for total national development.

Organisations under this Ministry include:

- Houses of Chiefs, organised into national, regional and traditional councils;
- National Commission on Culture;
- Bureau of Ghana Languages;
- Ghana Museums and Monuments Board and others.

The National House of Chiefs is the highest body in Ghana that unites all traditional rulers, chiefs and kings.

At the regional level, the Regional Houses of Chiefs represent the regional government and their function is to express a cultural, historical and/or ethnic point of view on public policies. 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

[1] Ghana Districts (2019), http://www.ghanadistricts.com/Home/LinkData/718 accessed on 16 June 2022

administrative structures; however, it should be noted that the traditional stool boundaries do not align exactly with the formal administrative boundaries. Below the Paramount Chiefs are Chiefs and sub-chiefs. Each Chief has a Traditional Council composed of the elders who carry out the instructions of the Chief and safeguard traditional customs and local knowledge for future generations. Traditional structures are intended to be politically impartial as they are responsible for supporting all members of the community, irrespective of political affiliation. The Chiefs 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 district belongs to a traditional council that assists the Paramount Chief to administer his area of jurisdiction. The Council is typically comprised of the Paramount Chief, the Queen Mother, divisional chiefs, various family heads and the linguist. The Council is the supreme organisation of the stool and must approve all decisions taken by the Chief.

An overview of chieftaincy structures in the six coastal districts is provided below.

- Jomoro. The district falls under the traditional jurisdiction and paramountcy of the Western Nzema Traditional Council, with its seat at Benyin. Benyin is literally the traditional as well as cultural capital from which the Omanhene, Awulae Annor Adjaye II exercises traditional authority over his people. The jurisdictional interest of the paramountcy stretches from Ekabaku, near Atuabo in the east, to Newtown, in the extreme west, along Ghana's frontier with La Cote d'Ivoire[1]. The 2018-2021 Medium-Term Development Plan indicates that although the district is said to be peaceful, there are chieftaincy disputes at Bonyere, Newtown and a few other areas.
- Ellembelle. The district has one Paramount Chief - the Eastern Nzema Traditional Council - that is situated at Atuabo. The jurisdictional interest of the paramountcy stretches from Ankobra to Atuabo.
- Nzema East. With the splitting of the old district into two (Nzema East Municipality and Ellembelle District), the Municipality still has five Paramountcies, out of which two in Axim (Lower and Upper Traditional Councils), the Nsein Traditional Council in Nsein, the Ajomoro Traditional Council in Apataim and the Gwira Traditional Council in in Bamiankor.
- All the Traditional Councils present in the three districts of Nzema East, Ellembelle, and Jomoro constitute the Nzema Manle Council[2].
- Ahanta West. There are three Paramountcies namely, Ahanta, Upper Dixcove and Lower Dixcove with Otumfuo Nana Baidoo Bonsoe XIV as the Ahantahene. These Paramount Chiefs have their respective Divisional and Sub-Chiefs under their jurisdiction[3].
- Sekondi-Takoradi Metropolis (including Effia-Kwesimintsim Municipal). STMA traditionally can be classified into Paramountcies namely, Sekondi, Essikadu and Takoradi. The traditional councils are made up of various sub chiefs and the councils meet regularly to discuss various issues related to the development of the traditional areas[4].

[1] Jomoro District Analytical Report (based on the 2010 Population and Housing Census), Ghana Statistical Service, October 2014.
[2] Ellembelle District Analytical Report (based on the 2010 Population and Housing Census), Ghana Statistical Service, October 2014.
[3] Ahanta West Municipal Draft Medium-Term Development Plan 2018-2021.
[4] STMA District Analytical Report (based on the 2010 Population and Housing Census), Ghana Statistical Service, October 2014.

- Shama. The Shama Traditional Area (STA) is governed by the Shama Traditional Council (STC) headed by a Paramount Chief with jurisdiction over three main Chieftaincy Divisions and several sub chiefs.

In addition, each fishing community has a Chief Fisherman. This person is in charge of all matters pertaining to fishing, either on the community or on the landing site level (in the case of communities with more than one landing site). He also represents the local fishers at the fishers' association at the district level. The Chief Fisherman works with a council of elders, which represent descent groups and/or representatives of gear groups and may or may not have to report back to other community leaders. Chief Fishermen are elected, but they typically come from a certain clan or family. Fishmongers in each fishing community have a female leader known as the Konkohemaa.

5.6.4 Planning and Development

Development Policies

Eradication of poverty and reduction of inequalities in the rural and deprived communities is the prime focus of the National Development Planning Commission[1]. Development is structured around four key pillars that include the following.

- Social Development. This is the core of 'national development' and refers to human development and welfare. The long-term objective of social development is to create safe, peaceful and sustainable communities where, in accordance with the Constitution, Ghanaians can live productive, prosperous, and fulfilling lives, in freedom and in peace[2].
- Economic Development. This deals as much with growth (the expansion in goods and services) as it does with opportunities for citizens to participate in the very process that generates that growth. With a dominant informal sector that accounts for 80-90% employment but only about 40% of economic outputs, policies are essential to transform the sector into efficient hubs of production and productivity.
- Environmental Development. In Ghana, environmental development refers both to the 'built environment' (largely reflecting spatial planning and the various infrastructure that define it) and the 'natural environment' (made up principally of land, water bodies and the atmosphere) and how they influence the process of social and economic development. In early 2015, the first National Spatial Development Framework was developed to harmonise land use and spatial planning in the country. This legislation, along with others such as the Ghana Urban Development Policy and its Action Plan, complement policies on the natural environment to form a strong and coherent basis for incorporating 'environment' into Ghana's national development.
- Institutional Development. 'Institutions' generally comprise that network of laws, policies, regulations, organisations, cultural practices, belief systems and attitudes that, although abstract, play a critical role in attaining tangible results from national development efforts. Institutional development therefore forms a critical part of Ghana's evolving strategy for long-term national development and socio-economic transformation.

A number of development policies exist at a national, regional and district level. These policies have been formulated in response to key political and development milestones in Ghana's history and are summarised in Table 5.7.

[1] Ghana National Development Planning Commission, http://www.ndpc.gov.gh/
[2] http://www.ndpc.gov.gh/four-pillars/#social

Table 5.7 Development Policies Relevant to the Project

Policy	Key Aspects
National Level Policies	
Long Term National Development Policy Framework (LTNDPF) 2018-2057	• The LTNDPF which has a vision of a just, free and prosperous nation with high levels of national income and broad-based social development has been mainstreamed with the Sustainable Development Goals (SDGs), African Union Agenda 2063 and the Paris Climate Change Agreement (COP21). • It has the following five main Goals which spans throughout the 40 years and are phased out in a series of ten 4-Year medium-term development plans (MTDPs): – Build a Prosperous Society; – Create Opportunities for All; – Safeguard the natural environment and ensure a resilient built environment; – Maintain a stable, united and safe society; – Strengthening Ghana's role in the international affairs.
Co-ordinated Programme of Economic and Social Development Policies (CPESDP), 2017-2024	• The CPESDP reflects the President's development program as required by the constitution from a newly elected government. • It sets out a vision for agricultural modernisation, industrial diversification, and youth employment; embeds national strategies to localise and achieve the Sustainable Development Goals; and articulates a pathway to economic transformation and inclusive growth. • Priority interventions include: – Revitalising the Economy; – Revamping Economic and Social Infrastructure; – Transforming Agriculture and Industry; – Social Development; – Reform the Delivery of Institutions of Governance; – Leveraging on Science, Technology and Innovation for Development.
Medium-Term National Development Policy Framework (MTNDPF) 2018 – 2021	• The MTDF has been developed by the National Development Planning Commission (dated May 2017) and it outlines the government's medium-term priorities for Ghana. • The MTDF focuses on five broad thematic areas namely: (i) economic development, (ii) social, (iii) environment and infrastructure, (iv) governance and, • (v) international relations, to optimise key sources of growth and enhance the economy's resilience to shocks by focusing on transformation and value addition in agriculture and industry. • The development dimensions under the MTNDPF are: – Economic, – Social Development, – Environment, Infrastructure and Human Settlements, – Governance, Corruption and Public Accountability and – Ghana's Role in International Affairs.
Ghana Education Strategic Plan (ESP) 2018–2030	• The ESP 2018–2030 puts Ghana on the road towards meeting the Sustainable Development Goals (SDGs) and represents a deliberate reorientation towards this aim, as it replaces the previous ESP 2010–2020. • Under the plan every sub-sector of the education system has a strategic goal and is based on three policy objectives: • Improved equitable access to, and participation in, inclusive education at all levels; • Improved quality of teaching and learning in science, technology, engineering, and mathematics (STEM) at all levels; and • Sustainable and efficient management, financing, and accountability of education service delivery.

Policy	Key Aspects
Ghana's Education Sector Medium-Term Development Plan 2018-2021	• This plan sets out the vision and the policies for transforming Ghana into a 'learning nation'. • It recognises the strengths and weaknesses of the current system and describes strategies to address the challenges to give every Ghanaian child the opportunity to contribute to national development.
Ghana National Spatial Development Framework (NSDF), 2015-2035, Volume II: Overall Spatial Development Strategy	• The NSDF aims to: – strengthen national development planning, including medium and long term, by articulating the spatial dimensions of social, economic, environmental and other policies at the national level; – establish a national spatial framework that gives policy direction to land use planning and management at the national level, to guide the preparation of other lower hierarchy plans, such as regional, sub-regional and district spatial development frameworks, structure plans and local plans – make explicit the spatial information from sectoral agencies -- including their plans, projects, resources and assets -- to enable coordinated decisions and aligned policies as well as reduced duplications, conflicts and overlaps; – provide spatial policies to help ensure sustainable development as well as mitigating and adapting the natural environment and human settlements to climate change. • The spatial strategy is based on the following pillars: – emphasise balanced polycentric development; – improve regional, national and international connectivity; – Strengthen the metropolitan city regions of Accra and Kumasi; – Promote development in secondary cities; – Ensure sustainable development and protect ecological assets.
Regional Level Policies	
Western Region Spatial Development Framework (WRSDF), October 2012, under the Ghana-Norway Agreement of Strengthening the Environmental Management of the Oil & Gas Sector in Ghana	• The oil and gas industry has and will generate many economic activities that has and will continue to influence land use, human settlements, the environment and transportation. The industry has and will present challenges to land users and holders, owing to changing land use. In recognition of this, development partners and the government developed a Western Region Spatial Development Framework with the objective to 'ensure a spatially balanced, diversified and environmentally friendly economy that brings sufficient employment and social services for its people and the nation, based on sustainable use of the natural resource endowment'. It presents a spatial plan for the integration of social, economic and environmental development for the Region. • Zones the Region into three spatial zones. • Identifies the Project Area within Zone 3: Coastal - Industrial Districts. • Recognises the discovery of oil and gas as a key driver of development in the Region and the AoI. • Considers the following Millenium Development Goals as pivotal for the development of the Region and defines targets under the following goals: – Goal 1: Eradicate extreme poverty and hunger; – Goal 7: Ensure environmental sustainability; – Goal 8: Develop a global partnership for development.
District Level Policies	
Jomoro Municipal Assembly Final Medium-Term Development Plan (MTDP) 2018-2021	• The broad development goal of the Jomoro District is to achieve accelerated and sustainable growth and reduced poverty through effective collaboration with the • private sector for agriculture transformation, human and institutional capacities development and job creation. • The MTDP builds on the development dimensions defined in the MTNDPF (see above).

Policy	Key Aspects
Ellembelle District Medium-Term Development Plan (MTDP) 2018-2021 (Prepared November 2017)	• The District Medium Term Development Plan (DMTDP) under the National Medium-Term Development Policy Framework (NMTDPF) 2018 – 2021 is driven by the Long Term National Development Policy Framework (LTNDPF) 2018-2057 and builds on the five thematic goals defined by the Framework. • The district development goal is to achieve accelerated and sustainable growth and development, poverty reduction, promotion of gender equity, protection and empowerment of the vulnerable and excluded within a decentralised democratic environment. • The main objective of the plan is to put in place a road map, which in the medium term would guide the district to pursue a course of sustainable development by reducing the generally high level of poverty and improve the living conditions of the people in the district with considerable emphasis on growing the informal sector for accelerated local economic development.
Nzema East Municipal Draft Medium-Term Development Plan (MTDP) 2018-2021	• This MTDP, in the context of the current development focus, will reflect development priorities and goal within the framework of the five thematic goals defined at national level. • Specific areas of priority include but not limited to: – Revenue mobilization and management: (development of market and industrial enclaves as satellite points for high commercial activity and hence revenue accessible points. This is directly linked to the enhancement of human and technological capacity to manage revenue systems); – Private sector participation in development; – Local economic development (aquaculture development, enhancement of artisanal skills, etc.); – Unveiling the tourism potentials in the Municipality; and – Social infrastructure and amenities: education, health, water and sanitation, transportation.
Ahanta West Municipal Assembly Medium-Term Development Plan (MTDP) 2018-2021	• The District Development Focus for the planned period 2018-2021 aims at ensuring that all hindrances to development are removed to pave the way for a rapid socio-economic development of the District thus preparing the grounds for the take off. • The Economic Development Focus aims to: – embark on aggressive Local Economic Development; – take stock of existing opportunities and carry out activities to boost the local economy; – provide needed infrastructure and support to artisans in the district; – local revenue mobilization, street naming and property addressing, efficient and prudent revenue management system to support local economic development; – promote an efficient agricultural sector capable of feeding the District and exporting to neighbouring markets; – take advantage of existing tourist potentials in collaboration with the private sector; and – foster strong collaboration with the private sector for job creation. • The Social Development Focus aims to ensure that people have access to quality basic social services such as health care, quality education, potable water, provide support to the aged children women and other vulnerable groups in the society, all efforts aimed at rapid growth and development. • The Environment, Infrastructure and Human Settlements focus aims to ensure: – Decent housing with clean environment; – Construction of drains; – Liquid and solid waste management; – Application of sanctions and intensive education to bring about needed behavioural change. • Under Governance, Corruption and Public Accountability, the focus is to: – Provide needed office and residential accommodation; Encourage the participation of the citizenry in decision-making processes and strengthening and transforming established institutions.

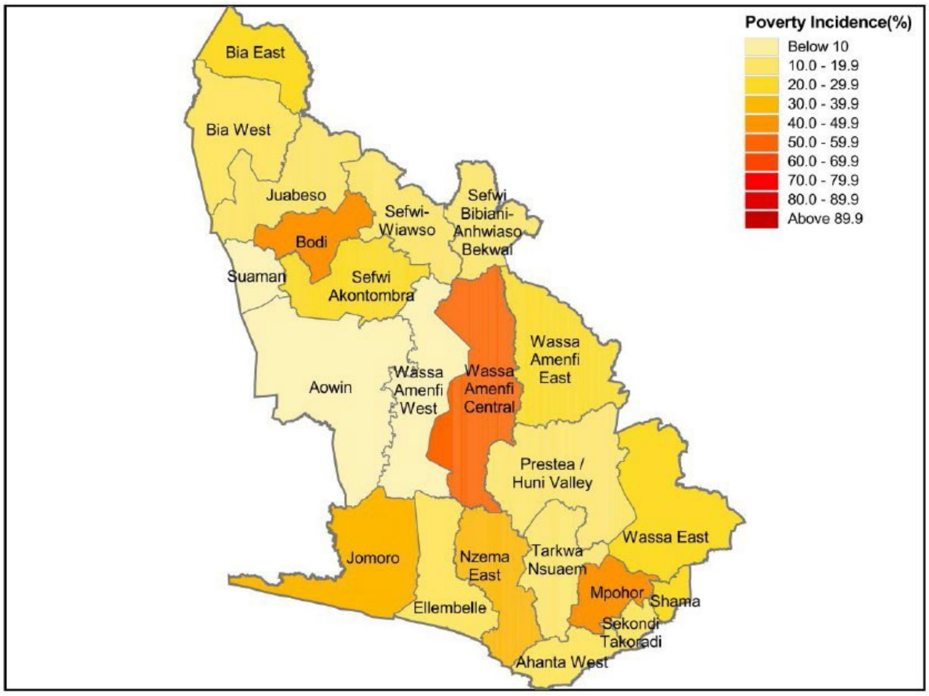
Policy	Key Aspects
Sekondi-Takoradi Metropolitan Assembly, Final Draft Medium-Term Development Plan (MTDP) 2018-2021	• According to Section 1.2.4.5 of the Plan, there is a twenty-year period plan to make Sekondi Sub-Metro (one of the three Sub-metropolitan areas of the Metropolis) the Administration hub of the Metropolis with Takoradi being the main Commercial centre and Essikado-Ketan Sub Metro earmarked for industrial purposes and also serving as a bulk breaking centre to support the commercial function of Takoradi Sub Metro. Effia-Kwesimintsm will serve as the food basket of the Metropolis.
Sekondi-Takoradi Metropolitan Assembly Spatial Development Plan (referred to in the Ghana National Spatial Development Framework (NSDF), 2015-2035, Volume II: Overall Spatial Development Strategy)	• The STMA plan adopts a 'structured continuity' concept that: – promotes re-development of existing areas and extension of already-developed areas, and – restricts peripheral development not served by existing infrastructure. • The plan also advocates a 'two-centre city'—the Takoradi CBD and the Secondi port. It defines four, nested, growth zones: zone 1 comprises the two city-centres; zone 2 is the old residential areas including fishing villages as well as public and commercial facilities; zone 3 includes new residential areas, farms and vacant land; and zone 4 is mainly farm and parks. • Key spatial recommendations, which are endorsed by NSDF, include the following: – a green belt to preserve existing open space, including wetlands; – central business districts strengthened with upscale offices and retail; – upgraded historic core areas to include improved housing; – sub-centres developed as activity nodes; – mixed-use development along main radial corridors; – public transport to reduce urban sprawl and reliance on private vehicles; – land allocated for small and medium scale enterprise; and – redeveloped derelict and vacant land and properties.
Effia-Kwesimintsim Municipal Assembly Draft Medium-Term Development Plan (MTDP) 2018-2021	• Similar to the other MTDP, it is developed under the Medium–Term National Development Policy Framework Agenda for Jobs: Creating Prosperity and Equal Opportunity for All. • Development Priorities and Intervention Areas relevant to the Plan include: – Private sector development; – Agriculture development; – Local Economic Development; – Roads and Transport; – Health; – Education; – Revenue Mobilisation; – Social protection; – Slum upgrading; – Water and Sanitation; – Waste Management.
Shama District Assembly Medium-Term Development Plan (MTDP) 2018-2021 (Prepared September 2017)	• For the period 2018-2021, the goal of the district is to ensure that all the people have access to basic social services while creating an enabling environment for economic growth, job creation, improved security and poverty alleviation in an inclusive society. • The Plan contains 30 programs with 55 projects translating into 700 activities at an estimated cost of approximately 110 million Ghana Cedis.
District Spatial Development Plans	• District assemblies have spatial development plans to guide land use decision- making and land allocation for different uses. However, traditional leaders and landowners give out large areas of agricultural land without regard to these spatial plans, especially when economically attractive land use options are available, offering important sums of money. The result is that spatial development plans have not been effectively implemented.

Poverty and Vulnerability

Poverty levels in the six coastal districts are varied. Shama, Sekondi-Takoradi Metropolis and Ahanta West (Ahantas) Districts are urban with a lower poverty ratio compared to the Nzema East, Ellembelle and Jomoro Districts (Nzemas) that are peri-urban and rural. A Community Perception and Social Economic Survey (CPSES), conducted by WRCF in 2016, found the average poverty incidence for the districts to be Jomoro 28.2%, Ellembelle 26.2%, Nzema East 26.8%, Ahanta West 25%, STMA 11.4% and Shama 22.7%. Some of the very large oil and gas infrastructure is located in the last three districts. Furthermore, the offshore oil rigs are within the seas bordering these districts (e.g., FPSO Kwame Nkrumah). The Ghana Gas plant and Eni's gas infrastructure are in the Ellembelle District.

These infrastructures have brought opportunities in the districts including the service sector (hotels), markets, rental accommodation, factories, which are dotted along the towns in the districts and improved road networks in some towns, among others (Sam and Buckle 2017).

According to the 2015 Ghana Poverty Map, Sekondi Takoradi Metropolis (68,482), Jomoro (44,662) and Wassa Amenfi Central (35,095) are the districts with the highest number of poor persons in the region. Suaman (1,206) and Wassa Amenfi West (6,207) districts have lower number of poor persons[1]. Figure 5.21 illustrates the incidence of poverty in the Western Region of Ghana. The map shows the Western Region prior to the 2018 administrative reorganisation and therefore includes data for the current Western North and Western Regions.



Source: Ghana Poverty Mapping Report, Ghana Statistical Services (2015), reporting data by the former 10 regions of Ghana

Figure 5.21 Poverty incidence in the Western Region[2].

[1] Ghana Poverty Mapping Report, Ghana Statistical Services, May 2015, available at https://www.statsghana.gov.gh/gssmain/fileUpload/pressrelease/POVERTY%20MAP%20FOR%20GHANA-05102015.pdf and accessed in June 2022

[2] The map shows the Western Region area according to the administrative structure of Ghana comprising 10 regions (prior 2019).

According to the 2017 District Profiles published by the WRCF, the following percentage of the population in the coastal districts live in severe poverty[1]:

- Jomoro: 22%;
- Ellembelle: not specified;
- Nzema East: not specified;
- Ahanta West: 27%;
- Sekondi Takoradi Metropolitan Assembly: 31%;
- Shama: 24%.

Vulnerable individuals or groups are understood as those that are less able to cope with change due to a pre-existing condition that limits their ability to access social, economic, technological, institutional and cultural resources. Vulnerable groups that may be present in the coastal districts include:

- low-income households;
- female-headed households;
- households with a high number of dependents;
- households with limited or no access to land;
- households with limited or no alternative livelihood activities other than fishing;
- households with elderly and/or disabled individuals; and
- people with HIV/AIDS.

5.6.5 Human Rights Context

This section presents an overview of the human rights context in Ghana, based on a desktop analysis of publicly available information on the situation in the country.

The Human Rights Context section is divided into two parts. In the first part, it sets out the institutional framework at the national and international levels. In the second part, it presents the human rights situation in the country in practice, with an emphasis on labour rights and welfare.

National Human Rights Institutional Framework

Since the introduction of the Constitution of Ghana in 1992, fundamental and basic rights, namely human rights of every human being have been recognised. It is the responsibility of the government of Ghana to enforce and uphold these human rights. The Commission on Human Rights and Administrative Justice (CHRAJ)1 of Ghana has a mandate to protect universal human rights and freedoms, especially those vested in the 1992 Constitution, including civil, political, economic, social, and cultural rights. Specific mandates concerned with the protection of human rights are stated in Article 218 (a), (c) and (f) of the 1992 Constitution and Section 7 (1) (a) (c) and (g) of the CHRAJ Act.

The CHRAJ investigates complaints about how public institutions and their staff carry out their everyday executive and administrative functions.

The CHRAJ is also one of the State agencies with power to promote integrity in public service and combat corruption in Ghana. The Commission contributes to the promotion of high ethics and integrity in Public Service, and enforces compliance with the ethical standards contained in the Code of Conduct for Public Officers.

[1] The poverty line was revised in 2015—since then, a person is considered to be in extreme poverty if they live on less than 1.90 international dollars (int.-$) per day.

International Human Rights Framework

Ghana has acceded to only part of the United Nations human rights treaties, specifically treaties on the elimination of discrimination against women, racial discrimination and the protection of the rights of the child. A full list of the UN human rights treaties signed and/or ratified by Ghana are included in Table 5.8.

Table 5.8 Ghana Human Rights Conventions

Human Rights Instruments (Date into force)	Signature/ Ratification Dates
Convention against Torture and Other Cruel Inhuman or Degrading Treatment or Punishment: 1987	Signature: 7 September 2000. Ratification/Accession: 7 September 2000.
Optional Protocol of the Convention against Torture	Signature: 6 November 2006. Ratification/Accession: 23 September 2016
International Covenant on Civil and Political Rights	Signature: 7 September 2000. Ratification/Accession: 7 September 2000.
Second Optional Protocol to the International Covenant on Civil and Political Rights aiming to the abolition of the death penalty	Signature: NA. Ratification/Accession: NA
Convention for the Protection of All Persons from Enforced Disappearance	Signature: 6 February 2007 Ratification/Accession: NA
Convention on the Elimination of All Forms of Discrimination against Women: 1979	Signature: 17 July 1980. Ratification/Accession: 2 January 1986.
International Convention on the Elimination of All Forms of Racial Discrimination: 1969	Signature: 8 September 1966. Ratification/Accession: 8 September 1966.
International Covenant on Economic, Social and Cultural Rights: 1966	Signature: 7 September 2000. Ratification/Accession: 7 September 2000.
International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families: 1990	Signature: 7 September 2000. Ratification/Accession: 7 September 2000.
Convention on the Rights of the Child: 1990	Signature: 29 January 1990. Ratification/Accession: 5 February 1990.
Optional Protocol to the Convention on the Rights of the Child on the involvement of children in armed conflict: 2002	Signature: 24 September 2003. Ratification/Accession: 9 December 2014.
Optional Protocol to the Convention on the Rights of the Child on the sale of children, child prostitution and child pornography: 2002	Signature: 24 September 2003. Ratification/Accession: NA
Convention on the Rights of Persons with Disabilities: 2008	Signature: 30 March 2007. Ratification/Accession: 31 July 2012

Source: Office of the High Commissioner of Human Rights (OHCHR), Ghana Country Profile, Status of Ratification, accessed in April 2020 at https://tbinternet.ohchr.org/_layouts/15/TreatyBodyExternal/Treaty.aspx?CountryID=67&Lang=EN

Ghana joined the International Labour Organisation (ILO) in 1957 and has ratified 51 ILO Conventions (see Chapter 2: Section 2.5)

Labour

The Ministry of Employment and Labour Relations is mandated to formulate policies on Labour and Employment issues, develop sector plans, coordinate Employment and Labour related interventions across sectors, promote harmonious labour relations and workplace safety, monitor & evaluate policies, programmes/projects for accelerated employment creation for national development.

The National Labour Commission (NLC) is established under Section 135 of the Labour Act, 2003 (Act 651). The function of the Commission includes the settlement of industrial dispute through negotiations and other effective alternative methods of disputes resolution, such as mediation and arbitration. Others are the NLC's Regulations (2006), Legislative Instrument (LI) 1822 and the Labour Regulations (2007), LI 1833. The Commission, a tripartite body, is composed of seven members under Section 136 of Act 651 as follows: A chairperson and six others, two representatives each from

Government, employers' organization and Organised Labour. The Members of the Commission are all part-timers[1].

The Labour Department is one of the major arms of the Ministry of Employment and Labour Relations. It exists to carry out functions subject to ILO Convention No. 150 concerning the Labour Administration system, ratified by Ghana in 1986. The Convention defines Labour Administration as ''public administration activities in the field of national labour policy''. Accordingly, Section 1 of the Labour Act 2003 (Act 651) provides for the establishment and functions of the National Employment Service. Section 12 of the Act also mandates the Department to conduct labour inspections of workplaces[2].

The primary law and regulations that govern employment relationships in Ghana are the Labour Act 2003 (Act 651) and the Labour Regulations. The Labour Act stipulates that an employer cannot discriminate against a person on the basis of several categories, including gender, race, ethnic origin, religion, social or economic status, or disability, whether that person is already employed or seeking employment. However, discrimination in employment and occupation does occur with respect to women, persons with disabilities, HIV-positive persons, and LGBTI persons[3].

Child Labour

According to the Constitution of Ghana (1992) and the Children's Act (1998), the minimum age for employment is 15 years and the minimum age for engagement of child in light work is 13 years. Light work is the work that is not likely to be harmful to the health or development of the child and does not affect the child's attendance at school or the capacity of the child to benefit from education. The minimum age for apprenticeship is 15 years or after completion of basic education. The minimum age for hazardous work is 18 years. Hazardous work (which poses a danger to the health, safety and morals of a person) includes the following activities: going to sea; mining and quarrying; carrying and transporting of heavy loads; manufacturing industries where chemicals are produced or used; work in places where machines are used; and work in places such as bars, hotels and places of entertainment where a person may be exposed to immoral behaviour. No person may engage a child in exploitative labour, the labour that deprives a child of his health, education and development. A child may not be engaged for night work (between 08:00 p.m. and 06:00 a.m.)[4].

According to ILO Committee notes from a report of 2017, a significant number of children below 18 years of age are engaged in hazardous conditions of work in the agricultural sector, with an estimated 10 per cent of them working in cocoa- specific hazardous activities. The ILO Committee also reports information from a study carried out by ILO–

[1] National Labour Commission, http://www.melr.gov.gh/national-labour-commission/
[2] Labour Department, http://www.melr.gov.gh/labour-department/
[3] Ghana 2018 Human Rights Report, Country Reports on Human Rights Practices for 2018, United States Department of State, Bureau of Democracy, Human Rights and Labor available at https://www.state.gov/wp-content/uploads/2019/03/Ghana- 2018.pdf and accessed on 16 June 2020
[4] As above

IPEC that children are engaged in hazardous fishing activities and are confronted with poor working conditions. Among the children engaged in fishing activities, 11 per cent were aged 5–9 years and 20 per cent were aged 10–14 years. Furthermore, 47 per cent of children engaged in fishing in Lake Volta were victims of trafficking, 3 per cent were involved in bondage, 45 per cent were engaged in forced labour and 3 per cent were engaged in sexual slavery[1].

In Ghana, fishing is an important economic activity operated by artisanal, small- and large-scale fishers who operate in marine waters (sea and lagoons) and inland waters (lakes, rivers and reservoirs but most significantly in the Lake Volta).

Empirical evidence points to the fact that, especially in the artisanal and small-scale fisheries sector, children are engaged to work and many are trafficked from one location to the other to engage in fishing.

The USAID Ghana Sustainable Fisheries Management Project (SFMP) conducted studies into the prevalence of child labour and trafficking in fisheries in 2015 and had confirmed the existence of the problem and the need to address it, not only as part of the overall project strategy but most importantly the problem requires government action. In view of this, the Netherlands Development Organisation, SNV, an implementing partner of the project was given the task of supporting the Fisheries Commission of Ghana to develop a national policy on child labour and trafficking in fisheries. Hence, a technical working group was established which was made up of relevant anti-child labour and trafficking agencies with a Terms of Reference (TOR) to develop an appropriate policy document. In December 2015, the team held an initial meeting to discuss the dimensions of CLaT (Child Labour and Trafficking) in fisheries. Stakeholders were consulted which included representatives from the Ministry of Gender, Children and Social Protection, the anti-Human Trafficking Unit of the Ghana Police, the representatives of the Ghana National Canoe Fishermen Council, amongst others.

In Ghana's marine and inland fishing sector, children work on board vessels and boats, unloading catches, preparing nets and baits, feeding and harvesting fish in aquaculture ponds, and sorting, processing and selling fish. At the upstream level of the fishing supply chain, or other business sectors linked to fishing, child labour occurs in areas as net-making and boat building.

The first nationwide survey indicating the occurrence of Child Labour undertaken in 2001 (GSS, 2003) found that more than 49,000 children were engaged in fishing (boys being the majority) and over 126,000 were active in mining and quarrying. The survey found that 1.3 million children were involved in Child Labour. The 2005 Multiple Indicator Cluster Survey (MICS), which investigated the prevalence of child labour, found that 34 percent of children aged 5-14 years were involved in child labour at any particular point in time.

In 2015, the USAID/Ghana SFMP survey of 36 coastal communities of the Central Region assessed the severity of CLaT with the purpose of identifying the root causes of CLaT. The survey indicated that among children from households engaged in the fisheries value chain, only 30 percent attended school on regular basis. These children engaged in fishing-related activities after school as well as during holidays. The remaining 70 percent that did not attend school on a regular basis engaged in fisheries activities full-time.

The Child Labour situation is worse in the fishing sector, because seasonal fluctuations, the hazardous conditions, and high fuel prices contribute to high poverty levels. Many parents see child labour as something positive, because they think that their children are learning a useful trade.

[1] https://mywage.org/ghana/labour-law/fair-treatment-at-work/child-labour

There is an increased awareness of the perils of child labour and trafficking in the fisheries sector, and recently, Ghana has prioritised the issue of child labour and trafficking as a major socioeconomic and socio-political concern. The Government of Ghana has addressed children's welfare and taken measures towards eliminating CLaT. The Children's Act, 1998 (Act 560) was a move by government to reform and consolidate laws relating to children (defined as people below 18 years of age). It provides for the rights of the child and regulates child labour and apprenticeships.

The existing Fisheries Act, 2002 (Act 625) and the Fisheries and Aquaculture Policy framework, (2008) makes provisions for the regulation and management of fisheries, development of the fishing industry and sustainable exploitation of the fisheries resources and for the regulation of the marine and inland fisheries activities respectively, yet neither addresses CLaT. Figure 5.22 below illustrates children involved in fishing related activities.

Source: CLaT PRA Report (2015)

Figure 5.22 Children Engaged in Fishing Related Activities on the Beach

Other governmental initiative to improve the welfare of children include such specific social protection programs as the Free Compulsory Basic Education (fCUBE), Capitation Grant, School Feeding Program, the Livelihood Empowerment against Poverty (LEAP) and the National Health Insurance Scheme (NHIS).

The integrated National Anti-Child Labour and Trafficking in Fisheries Policy takes into account national and international plans and programs across sectors—aiming to combat child labour and trafficking of children with particular reference to the fisheries sector. This Ant-CLaT in Fisheries Policy is structured around the 5 P's framework namely Policy, Prosecution, Protection, Prevention, and Partnership. The Policy is intended to include all Metropolitan, Municipal and District Assemblies (MMDAs) to incorporate CLaT issues in their plans with budget lines to reduce challenges associated with implementation of CLaT reduction activities.

Forced Labour

The Constitution (1992) prohibits all forms of forced labour. The Labour Act (2003) also prohibits all forms of forced or bonded labour. In addition, employers are prohibited from employing a trafficked person or a victim of trafficking as defined by the Human Trafficking Act, 2005.

The Government of Ghana has made significant efforts to eliminate trafficking by validating and implementing a national anti-trafficking action plan and expending funds allocated for the plan; prosecuting and convicting labour and sex traffickers under the Human

Trafficking Act; increasing inter-agency cooperation in efforts to remove child victims from trafficking situations; adopting systematic procedures for identifying and referring trafficking victims for services; and conducting and providing support for anti-trafficking public awareness activities. The 2005 Human Trafficking Act, amended in 2009, criminalised sex and labour trafficking. However, the government reported initiating 113 total investigations into suspected human trafficking during the calendar year 2017, compared to 138 investigations in 2016. Of the 113, the Ghana Police Service (GPS) Anti-Human Trafficking Unit (AHTU) reported conducting 91 investigations of potential trafficking crimes, compared with 118 investigations in 2016. Of these 74 were labour trafficking investigations, most of which were

trafficking within Ghana, and 17 were sex trafficking investigations, all of which involved cross border trafficking[1].

Fair Treatment and Equal Pay

The annual report compiled by Hays Oil and Gas and Oil and Gas Job Search, on average annual salaries in the global oil and gas industry for the year 2013, indicated that Ghanaian workers in that industry were among the least paid in the world at that time. The 2013 report looked at 24 industry disciplines, sampled more than 7,200 employers and 24,000 other respondents in the industry across 53 countries. It showed that oil and gas companies in Ghana paid the locals US$26,800 on average every year, which compared unfavourably with the US$128,500 that their expatriate counterparts got every year. This indicated a disparity of 379.48%.

At that time, tensions had been reported among local workers on various offshore facilities who were complaining against generally low salaries and pointing accusing fingers at offshore vessel owners and recruitment agencies as short-changing the locals. This resulted in an initiative by the Ghana Petroleum Commission to develop guidelines on salaries and remuneration in the upstream oil industry[2].

Summary of Human Rights Issues

An overview of the situation in the country, based on the information in the Ghana 2018 Human Rights Report[3] is provided below.

- Discrimination. The Constitution and law provide for the same legal status and rights for women as for men under family, labour, property, nationality, and inheritance laws. While the government generally has made efforts to enforce the law, predominantly male tribal leaders and chiefs are empowered to regulate land access and usage within their tribal areas. Within these areas, women were less likely than men to receive access rights to large plots of fertile land. Widows often faced expulsion from their homes by their deceased husband's relatives, and they often lacked the awareness or means to defend property rights in court.
- Education: The Constitution provides for tuition-free, compulsory, and universal basic education for all children from kindergarten through junior high school. In September 2017, the government began phasing in a program to provide tuition-free enrolment in senior high school, beginning with first-year students. Girls in the northern regions and rural areas throughout the country were less likely to continue and complete their education due to the weak quality of educational services, inability to pay expenses

[1] United States Department of State, 2018 Trafficking in Persons Report - Ghana, 28 June 2018, available at: https://www.refworld.org/docid/5b3e0b364.html [accessed in June 2022]
[2] http://www.reportingoilandgas.org/ghanaian-oil-industry-staff-among-lowest-paid-in-the-world-report/
[3] Ghana 2018 Human Rights Report, Country Reports on Human Rights Practices for 2018, United States Department of State, Bureau of Democracy, Human Rights and Labor available at https://www.state.gov/wp-content/uploads/2019/03/Ghana 2018.pdf and accessed in June 2022

related to schooling, prioritization of boys' education over girls', security problems related to distance between home and school, lack of dormitory facilities, and inadequate sanitation and hygiene facilities.

- Freedom of Expression. The constitution and law provide for freedom of expression, including for the press and the government generally respected this right. The government did not restrict or disrupt access to the internet or censor online content, and there were no credible reports the government monitored private online communications without appropriate legal authority.
- Freedoms of Peaceful Assembly and Association. The constitution and law provide for the freedoms of peaceful assembly and association, and the government generally respected these rights.
- Freedom of Movement. The constitution provides for freedom of internal movement, foreign travel, emigration, and repatriation and the government generally respected these rights. In an effort to curb human trafficking, however, the government in 2017 imposed a ban on labour recruitment to Gulf countries after increased reports of abuse endured by migrant workers. Media investigations during the year revealed some recruitment agencies continued their operations despite the ban.
- Torture and Other Cruel, Inhuman, or Degrading Treatment or Punishment. While the constitution and law prohibit such practices, there were credible reports police beat and otherwise abused detained suspects and other citizens. Victims were often reluctant to file formal complaints. Police generally denied allegations or claimed the level of force used was justified.

According to the Ghana 2018 Human Rights Report[1], human rights issues included arbitrary or unlawful killings by the government or its agents; harsh and life-threatening prison conditions; corruption in all branches of government; lack of accountability in cases of violence against women and children, including female genital mutilation/cutting; infanticide of children with disabilities; criminalization of same-sex sexual conduct, although rarely enforced; and exploitative child labour, including forced child labour. The government took some steps to address corruption and abuse by officials, whether in the security forces or elsewhere in the government. This included the establishment of the Office of the Special Prosecutor (OSP).

5.6.6 Demographic Profile

National Level

The current population of Ghana is 30,832,019 (2021). Ghana's land mass is almost the same as the United Kingdom's (92,099 square miles/238,535 km^2), giving the country has an overall population density of 335 people per square mile, or 129 people per square kilometre. The 2021 Ghana Population and Housing Census indicated there was a big difference between the rate of growth of the urban and rural population in Ghana, reflecting a shift of the population from rural to urban localities while at the same time portraying that some rural localities have become urban over time[2]. As of 2020, the urban population in Ghana was 57.35%, the highest percentage over the past 60 years[3].

At the time of the 2010 Census, the percentage of the female population was slightly higher (51.24%) than that of the male population (48.67%). In 2021 population and housing census, the female population was still greater (50.70%) than the male population

[1] CHRAJ website, https://chraj.gov.gh/human-rights/
[2] 2021 Ghana Population and Housing Census -Populations of Regions and Districts, General Report (Volume 3A), November 2021
[3] https://www.indexmundi.com/facts/ghana/urban-population, accessed June 2022

(49.30%) as in 2010. However, the female percentage of the population declined in 2021 (i.e., from 51.24% in 2010 to 50.70% in 2021), while the male percentage of the population appreciated by 0.63% (i.e., from 48.67% in 2010 to 49.30% in 2021).According to Ghana Statistical Service, in 2021 the average household size was 3.6, the lowest recorded in the last six decades, and decreased by one person (0.9) since 2010 (4.5)

The annual inter-censal growth rate between 2010 and 2021 was 2.1%, the lowest since independence. The modal growth rate was 2.0%, which was recorded in the Western Region and was the nineth (9th) on the annual inter-censal growth rate chart as shown below (Figure 5.23)

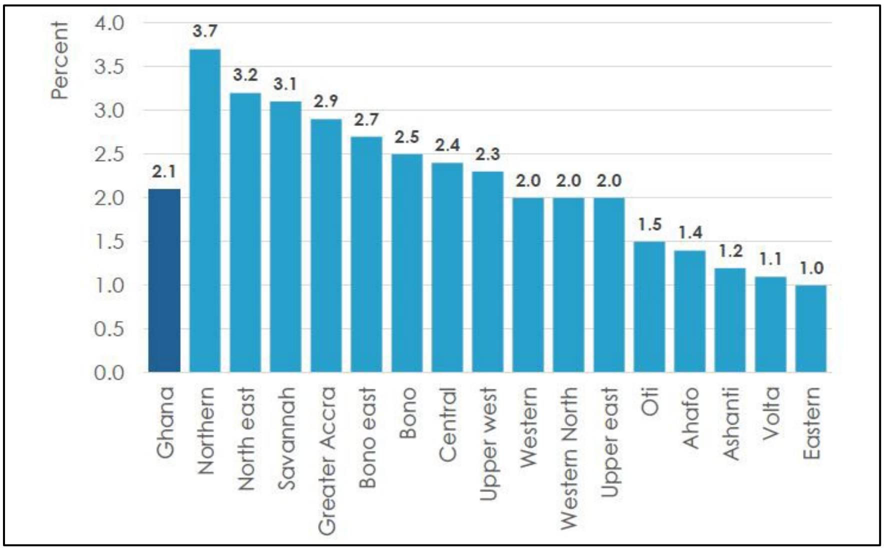


Figure 5.23 Annual Inter-Censal Growth Rate by Region

The birth rate per woman in 2020 was 3.8.[1] The life expectancy at birth for Ghana was 64 years[2] (both sexes combined), increasing from 46 years in 1960. The key human development indicators for Ghana, concerning demographics and life expectancy, are presented in Table 5.9.

Table 5.9 Key Human Development Indicators for Ghana

Human Development Indicator	Data
Sex ratio at birth (male to female births)	1.05
Urban population (%)	57
Young age (0-14) dependency ratio (per 100 people ages 15-64)	63.4
Old-age (65 and older) dependency ratio (per 100 people ages 15-64)	5.2
Net migration rate (per 1,000 people)	45.2
Median age (years)	21.5

Source: UNDP, Human Development Report, 2019[1]

[1] https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?locations=GH
[2] As above

Regional and Local Level

The new Western Region (formed after the 2018 administrative reorganisation) had a total population of 2,060,585 or 6.7% of the national population (Ghana Statistical Services, 2021[1]) as compared to approximately 1.6 million at the time of the 2010 Census.

Among the 14 Districts in the Region, the Prestea Huni Valley Municipal has the highest share of the population (11.1%), whilst Mpohor District has the lowest share at 2.5%[2].

Table 5.10 shows the six districts in the Project AoI and associated population by gender, according to the Ghana 2021 Population and Housing Census published by the Ghana Statistical Service.

In spite of the relatively similar number of males to females in the Region as a whole in 2010, there are variations in the sex ratio by District. All coastal Districts have sex ratios lower than 100.0 with Shama having the lowest (89.5).

Table 5.10 Population by Sex for the Coastal Districts, 2021

District	2021		
	Male	**Female**	**Total**
Jomoro	62,649	63,927	126,576
Ellembelle	60,586	60,307	120,893
Nzema East	48,590	46,031	94,621
Ahanta West	75,219	77,921	153,140
Sekondi Takoradi Metropolitan (including Effia-Kwesimintsim Municipal)	137,598	141,214	278,812
Shama	57,210	60,014	117, 224
Total population of the Western Region*	**441,852**	**449,414**	**891,266**

Source: Ghana Statistical Service (2021). Population refers to the Western Region after the 2018 administrative reorganisation.

In terms of population density, the highest density is in Sekondi-Takoradi Metropolis (1,847 people/km^2), which shows the metropolitan nature of this district. The following are Shama (379 people/km2), Ahanta West (180 people/km2), Jomoro (112 people/km2), Ellembelle (36 people/km2) and Jomoro (26 people/km2) at significantly lower densities[3].

Age

The population in the six districts in the Project AoI is relatively young, with a 40% share of the population under 15 in five districts[4]. In Sekondi Takoradi Metropolitan, 44.8% of the population is below the age of 14 with 51.9% between 15 and 64 while those above 65 are only 3.3%. The high proportion of youth leads to a relatively high dependency level in the Region. This dependency places a demand on the economically active sector of the

[1] 2021 Ghana Population and Housing Census -Populations of Regions and Districts, General Report (Volume 3A), November 2021

[2] As above

[3] 2010 Population and Housing Census, Western Region Analytical Report, Ghana Statistical Service, accessed in June 2022

[4] District Profiles published by the WRCF, available at http://wrcfghana.org/archives/publication category/information-about-the- western-region, accessed in June 2022

population and thus households have difficulties in maintaining and/or improving their standards of living.

Figures available in previous years' district profiles (2012) indicate that Ahanta West, Jomoro and Shama had >50% of their population aged between 15 and 64. More recent figures on the age distribution of the population in the Project AoI have not been available.

Urbanisation

According to the 2021 PHC, approximately, 51.6 % of the Western Region is urbanised and the remaining 48.4% is rural (the rural/urban classification of localities is population-based, with a population size of 5,000 or more being urban and less than 5,000 being rural). The six coastal districts in the AoI show differences in terms of the number of such urban centres and, naturally, associated populations.

An overview of the urbanisation levels of the six coastal districts in the AoI is provided below.

- Jomoro Municipal. The district is the largest and has the fourth highest population out of the six coastal districts. The district is typically rural with a population of 88,504 people living in rural areas. This represents approximately 69.9 % of the total district population.
- Ellembelle District. The district was carved out of the then Nzema East District, now Nzema East Municipal in December 2007 by Legislative Instrument (LI) 1918 and officially inaugurated in February, 2008. Ellembelle District is among the developing areas in the country. It is predominantly rural in terms of economy and demography and currently has two Onshore Gas Processing Facilities at Sanzule and Atuabo. The District's Medium Term Development Plan 2018 – 2021 indicates that the urban population has a ratio of only 28%. Most of the communities in the district lack basic services like potable water, health facilities, decent housing, clean environment and quality education facilities. The district has very poor road conditions, especially the northern part. However, the coastal areas have tarred roads
- Nzema East Municipal. Having the least population among the six coastal districts, Nzema East has approximately 75.4% of the population living in the rural areas whilst 24.6 % are in the urban areas. The district has a slightly male-dominant population made up of 48,590 males and 46,031 females. The district covers a total land area of 2,194 square kilometres, which forms about 9.8% of the total land area of the Western Region. The district is rich in tourist attractions although most of these are still underdeveloped.
- Ahanta West Municipal. This district ranks fourth in size and has the third largest population (70,862) among the six coastal districts. A large proportion of the population approximately 53.7% lives in rural settlements and thus Ahanta West is a rural district despite it being located adjacent to the Western Region capital of Sekondi – Takoradi. Communities along the main road from Takoradi –Agona Ahanta – Eluobo have a relatively higher population than those farther from the main road.
- Sekondi-Takoradi Metropolis (STM). It is the third largest city in Ghana and the Region's largest city. In December 2017, the STM was made up of four Sub-Metropolitan District Councils: Takoradi sub metro at Takoradi, Sekondi sub metro at Sekondi, Essikado-Ketan sub metro at Essikado and Effia-Kwesimintsim. In 2018, Effia-Kwesimintsim Sub Metro was elevated to Municipal Assembly; hence, the assembly comprises three Sub- Metropolitan District Councils Takoradi, Sekondi and Essikado- Ketan sub metros. Over the past 20 years, STM has been constantly expanding. The greatest urban expansion occurred in the Essikado-Ketan sub metro,

followed by the Sekondi Zone, while the least urban expansion occurred in the Takoradi Zone followed by the Effia-Kwesimintsim Zone (831.46 ha). The Takoradi Zone recorded the least urban expansion because this zone has no land for further expansion as they have expanded fully in the past2. About 90% of the total land area in Sekondi-Takoradi Metropolitan Assessment is the built environment. This comprises residential buildings, offices, industries, markets, educational facilities, health facilities and many others. Most of the buildings are sky-rise buildings, which indicates the high demand for land in the metropolis and the urgent need to make intensive use of the existing land. The 10% of the land area in the metropolis is used for urban agriculture. This portion is located in the northern part of the metropolis. There is a continual high demand for residential housing hence the agricultural land is decreasing as people extend to these areas to build housing facilities.

- Shama District. Just slightly larger in terms of area, than STMA, Shama District is the second most urban of the six coastal districts and one of the few urban districts in the country. The 2021 Population and Housing Census indicates that approximately 64.5% of the district population was living in urban settlements. Shama District is made up of 54 settlements, which are evenly distributed within the district's boundaries. However, the major settlements are located in the coastal areas, while the minor ones are in the inland part of the district. Based on the size of the population and the services rendered, there are five major settlements in the district: Shama, Abuesi, Aboadze, Inchaban and Komfueku. The cumulative population size of these communities makes up 54.5% of the total district population. Settlements such as Shama, Aboadze, Beposo, Inchaban and Supomu Dunkwa are classified as urban while semi-urban ones are Komfoeku, Beposo and Shama Junction.

Population Change

Many factors account for the movement of Ghanaians within and out of the country. Migration literature in Ghana has identified these at both the internal and international levels. Internally, the old north-south pattern continues which is fuelled by infertile soils and lack of local services in Ghana's northern sector. Accordingly, rural outmigration in northeast Ghana is for employment purposes and it is dominated by young people1.

According to the Ghana Statistical Service (2019), population migrating internally within Ghana was 40% and most of them (53.2%) were employed in agriculture, forestry and fishing (33.8%) and wholesale and retail, repair of motor vehicles and motorcycles (19.4%) sub-sectors. At national level, the percentage of male migrant population (36.9%) is lower than their female counterparts (42.9%). People born at their current place of residence and that have never stayed away for a year or more are classified as non-migrants. Close to two-thirds (63.1%) of the male population are non-migrants compared to their female counterparts (57.1%). Regionally, Upper West has the highest proportion (78.4%) of non-migrant population, followed by Northern (75.6%) and Upper East (74.6%) with the least being Greater Accra region (45.5%).

Oil-driven growth in the Western Region has led to high expectations among communities in the six coastal districts in the AoI that they will benefit from the industry. There is a population growth in anticipation of jobs and other economic opportunities associated with the oil and gas industry and a rapid increase in cost of living (Sam and Buckle 2017). Comparisons between the 2010 and 2021 Population Census indicated that Jomoro and Sekondi-Takoradi (STMA) saw a decline in population by 15.68% and 81.26% respectively. The creation of a new district out of STMA led to drastic reduction in the district's population. The decline in Jomoro's population could be attributed to socio-

[1] Kennedy Atong Achakoma et al: Labour Migration Study in Ghana, 2016. ISBN: 9988-572-71-9, available at http://www.fesghana.org/index.php?page=new-publications,

economic driven migration. The remaining coastal districts recorded population increments ranging from 38.16% to 55.56%

The expansion in communication, energy, transportation, water and sanitation, the social interactions of people and the development of the oil and gas industry over the past years, mainly based in Sekondi–Takoradi city (one of the districts in the AoI), function as a pull factor to attract migrants into the city from different parts of the country. This contributes to the attraction of skilled workforce, which allows the transfer of knowledge and skills in specialised sectors of the economy such as the oil and gas industry. Not many migrants return to the communities once they have left. However, as the development of the oil and gas sector off the coast continues, additional influx of employment seekers can be expected into the Region. While urban migration may not be a problem in itself issues may arise if individuals do not have the sufficient skills or funds to seek alternative livelihoods. Further, this increased demand for jobs needs to be met with sufficient opportunity for employment (Sam and Buckle, 2017).

The Western Region also attracts migrant labourers due to its active mining and manufacturing (cocoa and forest products processing) (cocoa plantation) sectors, which are also present in the coastal districts.

Nzema East Municipal and Ellembelle District have seasonal migration patterns, mainly attributed to seasonal fishing activities, as people migrate to key fishing areas during the fishing season and return to their crops for the farming season. Similarly, large proportions of fishermen migrate from other coastal Districts Ahanta West District during the major fishing season that is normally between July and September.

According to the 2021 Population and Housing Census Thematic Report on Migration released by the Ghana Statistical Service (GSS), the Western Region had a net gain of 3000 migrants in 2021. There is no readily available information on migration statistics for Western Regional Coastal Districts for 2021.However, an overview of migration patterns in the coastal districts in the AoI, based on the district reports analysing the 2010 Census data, is provided below.

- Jomoro. Out of the total approximately 51,000 migrants (26% of the district population) recorded in the district, approximately 59% of the migrants living in the district were born in another region while 41.1% were born elsewhere in the Western Region. Most of the migrants from other regions come from Central region (23.9) and outside the country (8.5%). Out of the total migrants in the district, 29.3% were resident between 1-4 years. About 22% had stayed in the district between 10 to 19 years and 18.3% had lived there for 20 or more years. With those born elsewhere in another region, the highest number of migrants came from Central Region and the second largest group was from the Volta Region. Comparisons between the 2010 and 2021 population census, however, indicated a general population decline of 15.68% in the district.
- Ellembelle. Out of the total approximately 19,000 migrants (16.6% of the total population) in the district, 33% had lived there for 1-4, while 16% had stayed for less than a year and 16% for more than 20 years. For the proportion of the migrants born elsewhere, in another region in the country, the highest proportion (22%) were born in the Central Region while the lowest proportion (5.4%) were born in the Greater Accra region. A significant number of the migrant population (16.2%) was born outside the country. This significant number may be attributed to the presence of refugees (from both Liberia and Cote d'Ivoire) in the district. The data also indicates that migrants who have lived in the district for between one year or less and 4 years constitute about 50 % and that may be attributable to the recent oil find located not too far from the district could have influenced this movement into the district. The current population based on

the 2021 Census indicates a total district population of 120,893 – a 38.16% increase from the 2010 Census.

- Nzema East. Out of the total population, approximately 17,000 (28%) are migrants. Of the migrant population, 14.4% have spent less than one year in the Municipality, 25.2% have spent between 1 and 4 years, 17.7% have spent between 5 and 9 years and 44.7% have spent over 10 years in the Municipality. Approximately 41% of the migrants were born elsewhere in the region, while 52.9% were born elsewhere in another region. Most of the migrants (33.1%) born elsewhere in another region were born in the Central Region. In 2021, the total population stood at 94,621 thus representing an increment of 55.56% when compared to the 2010 Census.
- Ahanta West. Out of the total approximately 30,000 migrants (21.7% of total population) in the district, 64.3% were born elsewhere in the Western region, while 30.7% born in another region. Out of the total number of migrants, 15.3% had lived there less than one year. Thirty-two percent have been residents for 1-4 years and 36% for more than 10 years. The Central Region has the highest proportion (38.1%), whereas migrants from the Upper West region (0.9%) are the lowest. The oil find in the district has attracted migrants in recent years, as total migrants in the district with less than 5 years stay constitute 47.1%. Based on the 2021 Census, the Ahanta West population has experienced a general increase of 44.18% when compared with the previous Census in 2010.
- Sekondi-Takoradi Metropolis (including Effia-Kwesimintsim Municipal). Approximately 59% of the migrants living in the Metropolis were born in another region while 41% were born elsewhere in the Western Region. The highest proportion (29.5%) of the migrants in the Sekondi-Takoradi Metropolis has lived there for 1 to 4 years. The lowest proportion (15.9%) has lived there for less than 1 year. The concentration of the migrants who have lived in the Metropolis between less than one year and 1-4 years could be attributed to the oil find in the region. For those who migrated from other regions in Ghana to live in the Sekondi-Takoradi Metropolis for 20 years and above, Central Region dominate with 27.7 percent followed by northern (26.8%), and Upper West and Upper East with 26.4 percent and 25.4 percent respectively, with the least (13.9%) coming from outside Ghana1. The current population for Sekondi-Takoradi based on the 2021 Census stands at 104,837 – an estimated 81.26% reduction from the 2010 Census. This is attributable to the exclusion of Effia-Kwesimintsim Municipal from the Sekondi-Takoradi Metropolis in the 2021 Census.
- Shama. Out of the total district population, about 26% are persons who have migrated to the District. There are more migrants from the Central region than any other region, probably due to proximity of location of the district. Of these migrants, 20.4% percent have lived in the district for 20 years and more. The region with smallest number of migrants in the district is the Upper West (46). The highest proportion (24.3%) of migrants who have lived in the Shama district for less than one year is from the Greater Accra Region. Most migrants (29%) have lived in the district for 1-4 years as compared to the other categories of years. Higher proportions of the migrants are from Volta (33.7%) and Central (25.9%) Regions and have lived in the district for twenty years and more. The proportions of migrants from outside Ghana who have lived in the district for less than one year and for twenty years and above are 11.1% and 18.1% respectively. Shama district indicated a general population increase of 43.02% as of the 2021 Census.

Ethnicity and Language

In Ghana, ethnicity is characterised by one's mother tongue language. The official language of Ghana is English and it is the main medium for teaching in schools right from creche to the tertiary level.

Other languages spoken in Ghana include Akan, Dagaare, Dagbani, Dangme, Ewe, Ga, Gonja, and Kasem. The dominant ethic group in Ghana is Akan, which is made up of a number of smaller ethnic groups, each of which has its own language.

According to the Ghana Statistical Service (2019), the majority of heads of households within the country are Akan (52.5%) followed by Mole-Dagbani (13.5%) and Ewe (12.8%) while the Mande (0.9%) constitute the smallest proportion.

The population in the Western Region consists predominantly of people from Akan decent (the largest ethnic group in Ghana), and is dominated by two ethnolinguistic groups: the Nzema primarily occupy the western coastline whilst the Ahantas occupy the eastern coastline of the region. In addition, the area hosts people of other ethnolinguistic groups who are more recent arrivals. These groups are fully integrated members of the communities, and are primarily of Ewe, Fante or Ga origin, all recognised large ethnolinguistic groups in Ghana. Akans in the region have a high degree of cultural homogeneity, have similar cultural practices and celebrate the same festivals.

An overview of ethnicity in six coastal districts in the AoI is provided below.

- Jomoro. The Jomoro District is predominantly Akan, which constitute 87.1% of the population. About 5.6% of residents in the district are Ewe, followed by the Mole-Dagbani (2.6%), Gurma (1.5%), Mande (0.6%), Ga-Dangme (0.5%), Grusi (0.4%) and the Guan (0.2%) ethnic groups. Other smaller ethnic groups in Jomoro account for 1.6% of the total population. Nzema is the major language spoken in the district1.
- Ellembelle. The 2021 Census indicated that the predominant ethnic group in the district is Akan representing 81. 2% of the population, followed by Mole-Dagbani (8.8%), Ewe (3.8%) and Ga-Adangme (1.9%) and the Guans (0.2%) .The major language spoken throughout the district is Nzema with other dialects like Evalue and Gwira, Fanti and Twi are also widely spoken2.
- Nzema East. The ethnic groups in the Municipality are mainly Nzemas and Gwiras. There are other minority groups such as Ahantas, Fantes and other smaller ethnic groups. The predominant ethnic group is Akan (78.0%). This is followed by Mole-Dagbani (12.7%), Ewe (2.8%), Ga Adangme (2.6%), Gurma (1.5%), Grusi (1.1%) Mande (0.5%) and Guan (0.2%). Other smaller ethnic groups in the Nzema East municipality account for 0.7% of the total population. The major language spoken all over the municipality is Nzema with other dialects like Evalue and Gwira, Fanti and Twi3.
- Ahanta West. The main ethnic group of the district is Akan (92.1%) followed by Ewe (3.75%) and Mole-Dagbani (1.37%). The main language spoken is Ahanta. However, Evalue is also spoken by the people of Egyambra, Princess Town and Princess Aketakyi, and Fante by the people of Adjua, Funkoe, New Amanful and Dixcove. Other ethnic groups in the Ahanta West district include Ga-Dangme (1%), Gurma (0.16%),

[1] Jomoro District Analytical Report (based on the 2021 Population and Housing Census), Ghana Statistical Service, accessed in November 2023
[2] Ellembelle District Analytical Report (based on the 2021 Population and Housing Census), Ghana Statistical Service, accessed in November 2023
[3] Nzema East Municipality District Analytical Report (based on the 2021 Population and Housing Census), Ghana Statistical Service, accessed in November 2023

Grusi (0.6%), Mande (0.3%), and others (0.7%). The Guans (0.2%) and Gurma (0.2%) are the least represented ethnic groups of the district's population1.

- Sekondi-Takoradi Metropolis. According to the 2021 PHC, the distribution of proportion of ethnic groups in the Sekondi- Takoradi Metropolis is as follows in descending order; Akan (83.6%), Ewe (5.8%), Mole-Dagbani (3.8%), Ga-Dangme (2.7%), Grusi (1.1%), Mande (0.8%), Guan (0.4%), and Gurma (0.3%). The proportion of the rest of the ethnic groups in Sekondi-Takoradi Metropolis is 1.5%. The majority of the population speak Fante, but the main local dialects are Ahanta, Nzema and Wassa 2.
- Effia-Kwesimintsim. The people of Effia-Kwesimintsim municipality are indigenously Ahantas. Majority of the people speak Fante but Ahanta is the main local dialect. English is, however, the official language
- Shama. The major ethnic groups in Shama are the Akan (87.7%), the Ewe (9.2%) and the Mole-Dagbani (0.89%). The least represented ethnic group in the district is the Gurma accounting for 0.1% of the district's population. Fante is the major language spoken in the district3.

Religion

The 1992 Constitution of the Republic of Ghana allows for freedom of worship; therefor, all persons have the right to join or not to join any religious organisation of their choice. The people's religious affiliation is expressed in the constitutional guarantee for freedom of worship. According to the 2021 government census, approximately 71 percent of the population are Christian, 20 percent Muslim, 3 percent adhere to indigenous or animistic religious beliefs, and 6 percent belong to other religious groups or have no religious beliefs. Smaller religious groups include Buddhists, Jews, Hindus, and followers of Shintoism, Eckankar, and Rastafarianism. According to the census data, Christian denominations include Pentecostals/Charismatics (44 percent of Christians), Other Protestants (24 percent), Roman Catholics (14 percent), and Others (18 percent). Muslim communities include Sunnis, Ahmadiyya, Shia, and Sufis (Tijaniyyah and Qadiriyya). There is no significant link between ethnicity and religion, but geography is often associated with religious identity. Christians reside throughout the country; a majority of Muslims reside in the urban centres of Accra, Kumasi, and Sekondi-Takoradi and in the northern regions. Most followers of traditional religious beliefs reside in rural areas. An overview of religion in the coastal districts in the AoI is provided below (PHC, 2021)

- Jomoro. Approximately 81.3% of the population are Christians (Protestants, Catholic, Pentecostal/Charismatic, and Other Christians). Pentecostal/Charismatic is the most common Christian denomination in Jomoro, accounting for 30.8% of the population. This is followed by Catholics (20.5%), Protestants (16.6%) and Other Christians (13.5%) respectively. Islam constitutes 8.3% of the district's population, while persons with no religious affiliation account for 6.8%. Traditional religion was the smallest religious group, accounting for 0.8% of the residents in Jomoro. Other religious affiliations (i.e., Buddhists, Hindus, Rastafarianism, etc) make up 2.9% of the district population.

- Ellembelle. 80.0% of residents in Ellembelle identify as Christians. Pentecostal/Charismatic Christians make up the largest percentage of Ellembelle's

[1] Ahanta West District Analytical Report (based on the 2010 Population and Housing Census), Ghana Statistical Service, accessed in November 2023
[2] STMA District Analytical Report (based on the 2021 Population and Housing Census), Ghana Statistical Service, accessed in June 2022
[3] Shama District Analytical Report (based on the 2021 Population and Housing Census), Ghana Statistical Service, accessed in November 2023

population (30.2%). This is followed by Protestants (21.4%), Catholics (15.0%) and Other Christians (13.3%) respectively. 12.7% of the district's population is Muslim, while 6.6% are not affiliated with any religion. Approximately 0.4% of Ellembelle's population practice traditional religion. 0.3% of the district's population is made up of people who practice other religions.

- Nzema East. Approximately 79.2% of the population are Christians. The Pentecostal/ Charismatic group constitute the highest proportion of Christians (37.0%) in the district. This is followed by Protestants (19.0%), Other Christians (13.7%) and Catholics (9.6%) respectively. The district's population is made up of 8.5% Muslims and 10.0% people who identify as non-religious. The traditional religion which makes up 0.3% of the population in Nzema East is the smallest religious group. 2.1% of the district's inhabitants identify as members of other religions.
- Ahanta West. The dominant religion in the district is Christianity with 82.6% of the population professing adherence to the Christian faith. Pentecostal/Charismatic Christianity is the most prevalent Christian denomination in Ahanta West, accounting for 35.2% of the population. This is closely followed by Protestants (21.3%), Other Christians (17.8%) and Catholics (8.3%) respectively. Islam accounts for 4.2% of the population, while those who do not profess to any religion account for 11.4%. The traditional religion was the smallest religious group, accounting for 0.5% of Ahanta West's population. Other religious affiliations account for 1.7% of the district's population.

- Sekondi-Takoradi Metropolitan Area (STMA). Christianity is the dominant religion in the district, and accounts for 88.8% of the population. Pentecostal/Charismatic Christians (38.1%) dominates in the Christian religious affiliation category followed by Protestants (23.0%), Other Christians (16.4%) and Catholics (11.3%). 7.4% of people living in STMA are Muslims, while 3.4% are not affiliated with any religion. Approximately 0.2% of the population living in STMA are traditionalists. 0.5% of the district's population is made up of people who practice other religions.

- Shama. The dominant religion in the district is Christianity with 84.0% of the population professing adherence to the Christian faith. Pentecostal/Charismatic Christianity is the most prevalent Christian denomination in Shama, accounting for 34.7% of the population. This is closely followed by Protestants (21.2%), Other Christians (19.5%) and Catholics (8.6%) respectively. Islam accounts for 8.6% of the population, while those who do not profess to any religion account for 5.6%. The traditional religion was the smallest religious group, accounting for 0.6% of Shama's population. Other religious affiliations account for 1.2% of the district's population.

5.6.7 Land Tenure

Ghana maintains a dual land tenure system, comprised of customary and statutory land tenure. Customary tenure is based on local practices and norms, which are flexible and vary according to location. This type of tenure is typically unwritten and managed by a traditional ruler (the paramount chief or local chiefs); a council of elders; or family or lineage heads. The principles stem from rights established through first clearance of land, conquest or settlement.

The National statutory land tenure system is based on officially documented statutes and regulations, formalised in a legal system that is rooted in colonial law. These laws define processes, acceptable behaviours and consequences for non-compliance. Government structures and individuals delegated with relevant authority deal with the administration of this legal system. The state-recognised land rights are allocated and confirmed through the issue of titles or other forms of registration of ownership.

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.

The customary owners, stools, skins, clans, families and tendamba, own about 78% of the total land area in Ghana. Of the remaining 22%, the state owns about 20% percent while the remaining 2% percent is held in dual ownership: the legal estate in the government and the beneficiary/equitable interest in the community (FAO, 2003). There are no comprehensive data on land ownership and defined boundaries for the 78 percent of the land held by the customary sector (FAO, 2003).

Under customary lands, there are three forms of right to land, and due to the nature of the land tenure system, an individual can hold multiple rights to one piece of land. The land use rights are described below.

- Use Rights: the right to use the land (conferred either to 'natives' or to 'settlers').
- Control rights: the right to make decisions on how the land should be used and to benefit financially from the sale of the crops etc.
- Transfer rights: the right to sell or mortgage the land; to convey the land to others through intra- community re-allocations or to heirs; and to reallocate use and control rights.

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, and if leased, the family and the lessee have to agree on the rent before the transaction is regarded as complete. The same applies if the person wants to buy the land and a selling price must be agreed upon. Once this transaction is completed, the buyer becomes the legal owner of the land.

Nzema land is owned by stools (Nzema East, Western and Eastern Nzema) while in the Ahanta areas (Shama, Sekondi Takoradi Metropolitan Assembly and Ahanta West) lands may be owned by stools or families. The system of inheritance in all the districts is matrilineal (mostly among Akan speaking ethnic groups), where family members belonging to the maternal line of inheritance have ownership and control rights. The practice is that community and family members are allocated portions of this communal land for farming. Though every family or community member has access to the land, control remains in the hands of the chief, or in the case of the family – with male leaders. In apportioning land for farming, males get larger acreage than females, therefore, men grow cash crops (coconut, oil palm) while women, owing to their smaller portions, grow subsistence crops[1]. There are tenant farmers (migrants) who farm on 'abunu' or 'abusa'[2] basis in which farm produce

[1] Females are not given control over land because when they marry, control of the land would go to their husbands who are considered 'outsiders'. However, some women own cash crops

[2] Abunu' (division by two) and abusa (division by three) are farming practices in which non-land owners are allocated land to farm sharing the farm produce or money derived from sale of produce with the land owner.

when sold is divided into two or three parts with the landowner receiving one part (Sam and Buckle 2017).

Ownership, access and control over land correlates with compensation received for lands acquired for oil and gas activities. Landowners who sell land get more money than those who sell crops. Usually, when the chief or family leaders get the compensation, they share among families that constitute the stool, or among the family members. A stool that receives compensation for land divides the money[1].

There is a legal obligation to distribute revenues from Stool Land (Article 267 of the Constitution and Section eight of the Stool Lands Act 1994) as follows.

- The first ten percent of the revenue accruing from Stool Lands shall be paid to the Administrator of Stool Lands to cover administrative expenses.
- The remaining revenue shall be disbursed in the following proportions by the Administrator;
  - 25% to the Stool through the traditional authority for the maintenance of the Stool in keeping with its status;
  - 20% percent to the traditional authority; and
  - 55% percent to the District Assembly within the area of authority in which the Stool Land is situated.

5.6.8 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), a rubber-processing factory in the Agona Junction and other factories in Takoradi and Shama.

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.

The current majority land use in Jomoro District is by the wetlands, subsistence farms, trees and forest. The Amanzule wetland spreads through Jomoro, Ellembelle and Nzema East and extends to the border with neighbouring Côte d'Ivoire. Industrial and residential areas are concentrated mostly along the coastal areas. Ellembelle district shares an extensive part of the Greater Amanzule wetland with Jomoro District to the west side. Large portions of the total land area of the district have forest vegetation cover (in the northern part) while the southern portion is mainly the coastline. Various settlements have spread through the entire district. Some of the very large oil and gas infrastructures are located in the Jomoro, Ellembelle and Nzema East districts.

In Ahanta West, most land in the Western Region outside forest reserves and other protected areas has been deforested and converted to agriculture. There has been an increase in demand for other land uses such as industries and housing in the District with the discovery and production of oil and gas in the Western Region. Large tracks of land are used for rubber and oil palm plantations.

In STMA, the largest land areas are dedicated to agricultural and residential use. Industrial land areas are mostly located in the northern part and in the coastal area. Figure illustrates the land use plan for the STMA until 2021 and Figure 5.25 illustrates the panned

[1] As above

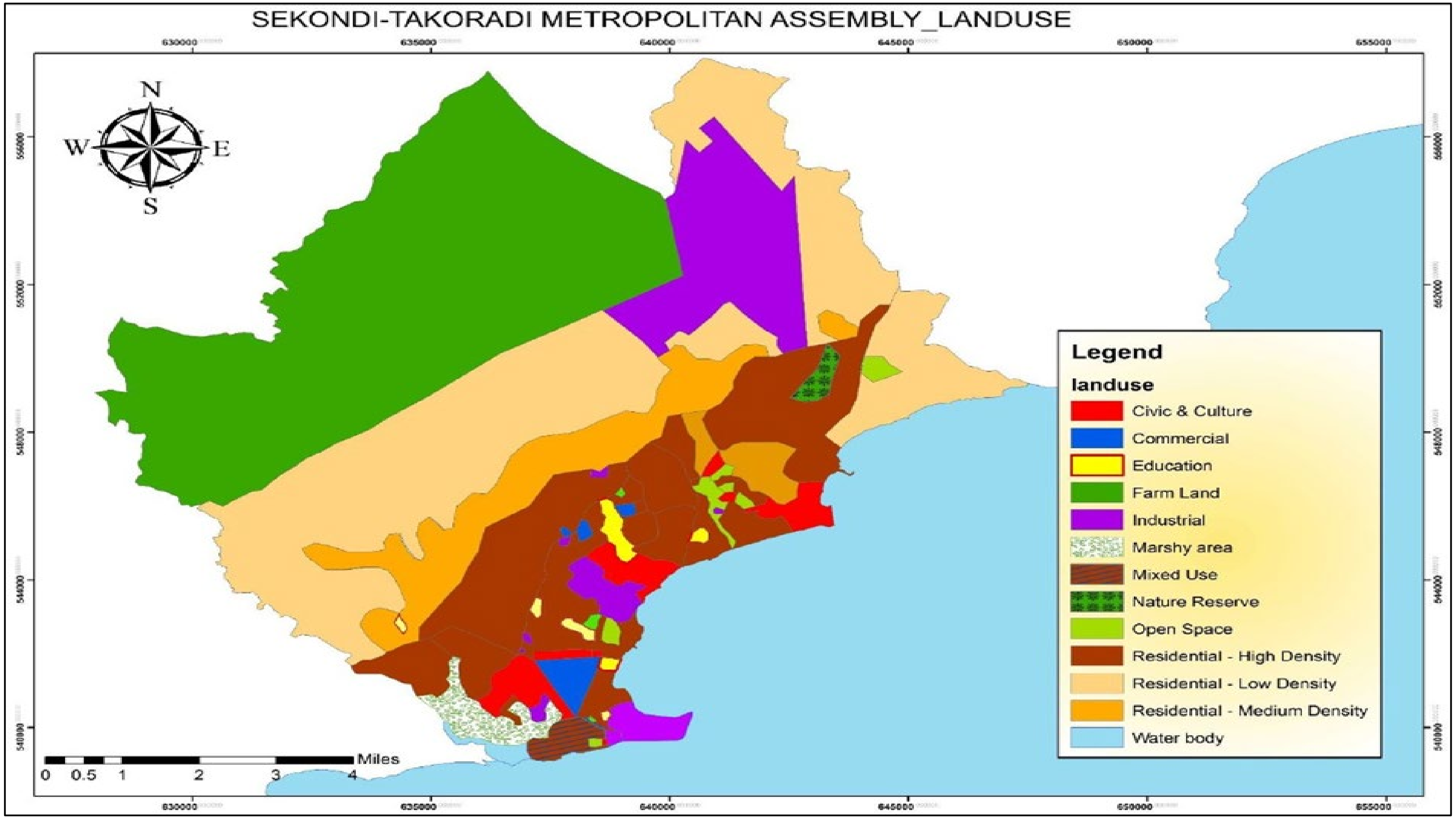
land use in 20 years. This projection shows an increase of industrial land use, which will be mostly concentrated in the coastal area. Residential areas will continue to expand, particularly towards the north of the Metropolis, significantly reducing farmland areas.

Issues related to Land Use

Discovery of commercial quantities of oil and gas off the coast of Ghana and their development for production has led to a high increase in infrastructure projects and investments in the Western Region, particularly the six coastal districts. Large tracts of land have been taken over for oil and gas infrastructure, businesses, pipelines, roads and areas for machinery repair. These huge investments have had big implications for the communities who live in these areas and for their livelihoods, particularly for those who rely on natural resources (Sam and Buckle, 2017).

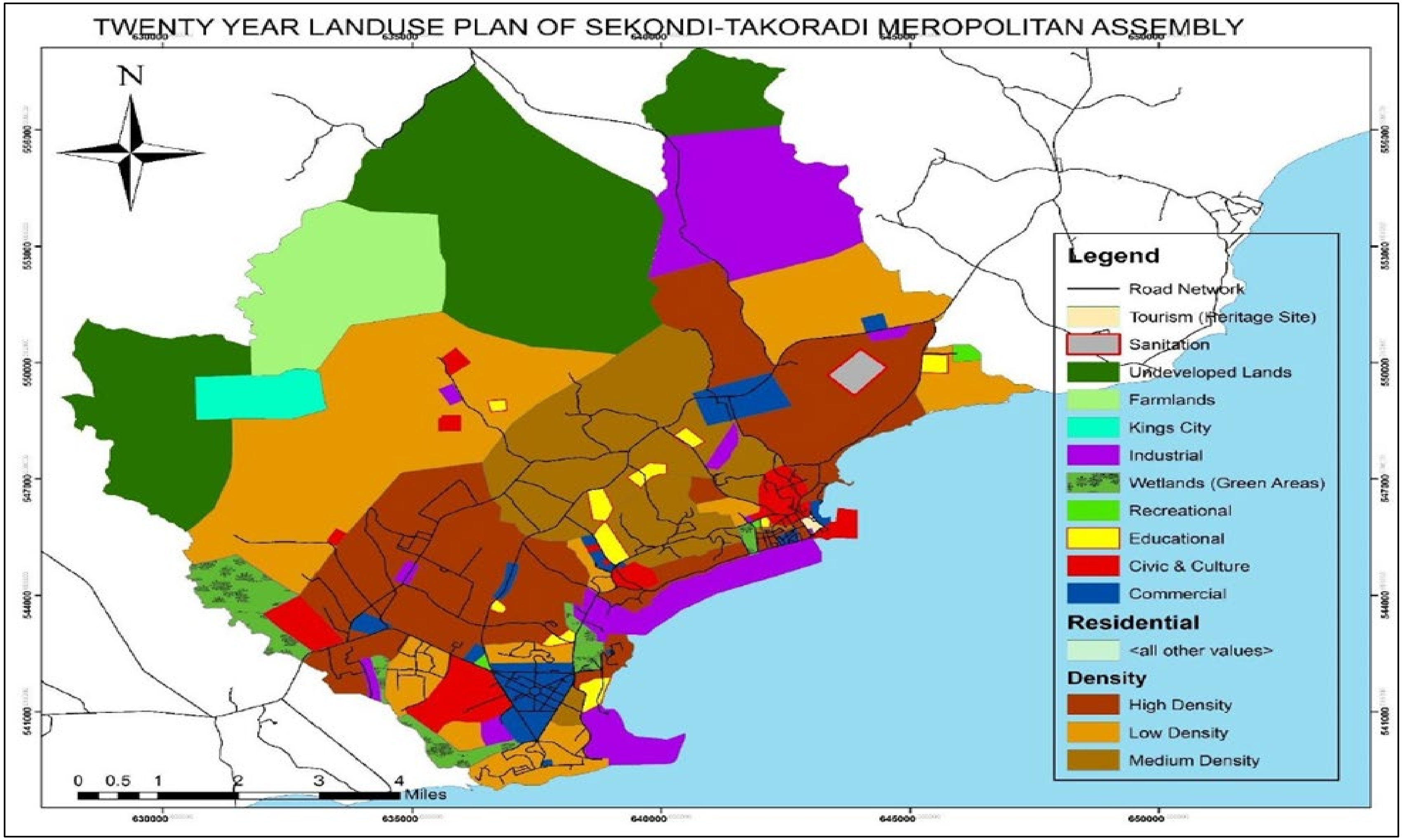
Speculative land purchases, construction of large infrastructure for oil and gas activities and allied services are rapidly changing the landscape of the six coastal districts. Rapid conversion of agricultural land for residential, commercial and industrial uses is displacing traditional agro-based livelihoods with negative implications for food security and overall resilience of ecosystems in the six coastal districts (Sam and Buckle, 2017).

According to a 2015 survey, between 1,500 and 4,500 acres of fertile agricultural land had been cleared for oil and gas companies, real estate or warehouses in Ahanta West district alone.



Source: Sekondi-Takoradi Metropolitan Assembly, Final Draft Medium-Term Development Plan 2018-2021.

Figure 5.24 Land Use Plan for Sekondi Takoradi Metropolitan Assembly



Source: Sekondi-Takoradi Metropolitan Assembly, Final Draft Medium-Term Development Plan 2018-2021.

Figure 5.25 Twenty Year Land Use Plan for Sekondi Takoradi Metropolitan Assembly

Construction of the Ghana National Gas Plant affected hundreds of coconut farmers in Atuabo (in the Ellembelle District) whose farms had been decimated by the Cape St. Paul Wilt disease. Gas pipelines stretching over 111 km through 85 communities across four districts have been laid. The Atuabo Freeport, covering 2000 acres of land, affected Anokye, Atuabo and Asemda, and Eni's gas activities affected the town of Sanzule. Of the 1,263 issues logged by WRCF in the 2016 round of community conversations, 49 land related issues were highlighted by community members across the six coastal districts of the Western Region. The issues related to compensation, livelihood, reinstatement and resettlement resulting from the activities of the oil and gas industry, mining, construction and plantation industry.

On compensation concerns, the Ellembele District discussed the most issues (#17, 46%) relating to their land as a result of it hosting of the Ghana Gas plant and its network of pipelines, construction of new highways and access routes to the plant, and the existence of mining or quarry operations. Communities such as Nkroful (Ellunibo, Tema and Ebanso) intensely elaborated on the oil, gas, and quarry operation's disproportionate compensation package compared to the loss of their farmland. In some cases, the compensation for land or houses affected have not been paid at all. In the Sekondi Takoradi Metropolitan area, most of the issues from Adientiem, Kansaworodo, Whindo and Ntankorful complained about the lack of compensation for landowners who have been affected by the laying of the gas pipelines (Sam and Buckle, 2017).

The issue of land acquisition, share cropping, land tenure, exploitation of non-timber forest products (NTFPs) and land development still pose constraints to agricultural development in the Municipality. Illegal mining (galamsey) and the absence of proper land tenure arrangements has led to the devastation of large acres of forestlands.

Loss of farmland and low compensation for crops has implications for women's economic opportunities and women's empowerment. Because their literacy rate is lower than men, women are less likely to take advantage of economic opportunities within the oil and gas industry. There is a loss of belongingness to family land where community members have to find new lands to farm on.

Furthermore, their bargaining power is weakened because having lost their land, many end up as tenant farmers with fewer rights on other people's land. Women are spending more to farm than previously. They sometimes must pay a token for these new farmlands. When previously women would walk to their farms, now they have to travel by car to new farms. In the Ahanta West District, women are travelling by car from their communities (Hotopo, Ewusiejo, Bokro) to Ayiem, a green zone area, to farm. Furthermore, women trek long hours to farms, which affects how much time they spend on household chores and family care, or where they put family care first, amount of time spent on the farm is affected, which in turn affects what they grow and how much they are able to sell (Sam and Buckle, 2017).

The degradation of the coastal environment affects livelihood and human settlements. Sand winning for construction has led to incursions of seawater into communities, leading to eroding coastlines and flooding that require construction of sea defence walls. Specifically, the Ellembelle District is affected with serious sea erosion along the beach, stretching from Ankobra community to Atuabo community, flooding in Ankobra community, depletion of the mangroves on the wetlands, endangering species in the sea, especially where the Ankobra River enters the sea.

Jomoro district is a relatively low-lying coastal district and is prone to flooding. A flooding event in 2014 affected 973 houses and 10 schools in 15 communities and destroyed crops such as cassava, tomatoes, plantain and groundnuts. Similarly, the STMA is also prone to flooding events.

Construction in flood prone areas leads to flooding of adjoining communities, calling for resettlement of communities in some districts, for example in Shama District. Due to high demand for accommodation, urban areas like Shama and the Sekondi-Takoradi Metropolis have seen development of unregulated housing projects (Sam and Buckle, 2017).

5.6.9 Economy and Livelihoods

National and Regional Economy

The Gross Domestic Product (GDP) in Ghana was 68.53 billion US dollars in 2020, according to official data from the World Bank and projections from Trading Economics. Per capita GDP in 2020 was 2,205.5 USD. The agricultural sector remains a major driving force in the development of the Ghanaian economy, despite being overtaken by the services sector in recent times. The sector continues to provide employment for almost 50% of employed persons in Ghana. However, the industrial sector, with average annual growth exceeding 10%, was a major driver of growth in the three years up to 2019[1].

The economy is expected to remain on a steady course of expansion in 2020. Focus Economics panellists project the economy will expand 6.1% in 2020 and 5.6% in 2021[2]. The impact of COVID-19 on the economy could possibly have affected these projections.

Main economic activities in Ghana and also largest contributors to the GDP, include:

- agriculture, which includes farming, fishing, and forestry;
- industry, including mining, manufacturing, energy production and construction; and
- services, covering government activities, communications, transportation, finance, and all other private economic activities that do not produce material goods3.

Agriculture, (including forestry and fishing) is the major industry in the Western Region (47.5%), accounting for the largest proportion of employed persons in all districts except Sekondi-Takoradi Metropolis. It is the largest producer of cocoa, rubber (including rubber processing) and coconut and one of the major producers of palm oil. Wholesale and retail, and repair of motor vehicles and motorcycles is the second largest industry in the Region and in 13 districts. It is the most important industry in the Sekondi-Takoradi metropolis employing about 1 in 3 persons. Mining and quarrying is the second largest employer in Tarkwa Nsuaem (22.6%) and Prestea/Huni valley (18.2%). The Western Region has considerable natural resources (minerals: gold, manganese, bauxite, forest reserves, timber, cocoa, oil palm, coconut and recently offshore oil), 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%. Other economic activities undertaken in the Region includes offshore oil & gas production, imports and exports, and, to a limited extent, tourism.

Employment Status: National and regional level

About 1,027,594 persons aged 15 years and older are estimated to be unemployed in Ghana, out of which 57.4% are females. About seven in every 10 (70.4%) of the unemployed are located in urban areas and 29.6% in rural areas. It is observed that 114,871 (or 11%) of the estimated unemployed persons are located in the Western Region, ranking third out of the sixteen regions, after Greater Accra and Ashanti regions. Out of the 114,871 people in the Western Region, 59% were women and 41% men. In

[1] https://tradingeconomics.com/ghana/gdp
[2] https://www.afdb.org/en/countries/west-africa/ghana/ghana-economic-outlook
[3] https://www.indexmundi.com/ghana/gdp_composition_by_sector.html

addition, more unemployed (69%) were present in urban areas compared to 31% in the rural areas (Ghana Statistical Service, 2019).

In terms of age, at national level, nearly three-quarters (74.1%) of the unemployed persons are within the age group 15-34 years. The unemployment rate is highest among the 20-24 years age group (19.9%) and lowest among the 55-59 years age group (3.0%). In urban areas, 72.2 % of the unemployed population are youthful compared to 78.4 % of their rural counterparts. However, for those residing in urban areas, the unemployment rate is highest among the 15-19 years age group (28.8%). Irrespective of sex and locality type, the 20-24 age group recorded large numbers of the unemployed population (Ghana Statistical Service, 2019).

The concept of time-related underemployment has been introduced to complement the statistics on unemployment. Time-related underemployed persons are those whose total actual hours worked were less than 40 hours and were willing and available to work additional hours on the job(s) in which they worked or wanted to change their work situation for different reasons. About 2.4 million persons 15 years and older, representing 21.4% of the employed population are estimated to be underemployed. Of this number, 59.3% are females and 40.7% are males. In addition, 59.3% of the underemployed are located in rural areas and 40.7% are in urban areas (Ghana Statistical Service, 2019). In terms of regional distribution, Northern Region ranks first out of the ten regions, with 16.1% underemployed persons, while Western Region ranks fifth with 10.7%. Slightly more women than men in the Western Region are underemployed; however, figures are comparable between urban and rural areas.

According to the 2021 Census, the total number of individuals who are 15 years of age or older in the Western region is 1,346,062 (PHC, 2021), with more of the population made up of men (50.97%) than women (49.21%). Out of the total population, 809,749 are economically active, constituting 60.16%. Out of the economically active population, 691,469 people (85.40%) are gainfully employed.

Employment Status: Districts the AoI

According to the 2021 Population and Housing Census, the population of individuals who are 15 years of age or older who are employed in the Western Region is 691,469 (51.37%). Of this population, 387,974 (56.11%) are males and 303,495 (43.98%) are females. The majority of the employed male population (38.91%) are into Agriculture (which includes forestry and fishing) as their main occupation. The Mining and Quarrying industry employs 10.02% of the male workforce, making it the second-largest sector in the Western Region. Similar to this, the majority of women (30.86%) in the Western region primarily work in agriculture, forestry, and fishing. Other female dominated working sectors in the Western Region include the wholesale and retail trade; repair of motor vehicles and motorcycles sector which constitutes 26.62% of the female working population, and the accommodation and food services activities which makes up 10.49% of the employed female population in the Western region.

An overview of employment in the coastal districts in the AoI, based on the District Analytical Reports of the 2021 Census results, is provided below.

Table 5.11 Economic Activity of Population (15 years and older) by, Geographic Area, and Gender

Districts	Total Population per District	Economic Active Population						Economic Inactive Population			
		Employed		Unemployed		Econact (Employed + Unemployed)	Econact %	Outside Labour Force		Outside Labour Force	Econinact %
		Male	Female	Male	Female	Total	%	Male	Female	Total	%
Jomoro Municipal	**160,976**	43,336	36,488	5,542	6,506	91,872	**57.1**	29,328	39,776	69,104	**42.9**
Ellembelle	**155,206**	40,440	30,700	7,474	7,042	85,656	**55.2**	29,306	40,244	69,550	**44.8**
Nzema East	**120,470**	38,694	27,092	4,304	3,914	74,004	**61.4**	19,518	26,948	46,466	**38.6**
Ahanta West	**194,736**	51,688	47,936	7,520	8,086	115,230	**59.2**	35,236	44,270	79,506	**40.8**
STMA	**340,950**	87,478	82,870	12,904	12,608	195,860	**57.4**	62,982	82,108	145,090	**42.6**
Shama	**148,112**	39,084	37,286	6,842	7,322	90,534	**61.1**	24,780	32,798	57,578	**38.9**

Source: Ghana Statistical Service (2021) *Econact: Economically Active, *Econinact: Economically Inactive

- Jomoro. The total population of people aged 15 years and older for economic activities in the Jomoro district is 160,976. Out of this, 91,872 people representing 57.1% of the population in the district are economically active while 42.9% are not economically inactive. Of the economically active population 86.9% are employed. The agriculture, forestry, and fishing industry employ the majority of people in the district (39.6%), with males (61.5%) greatly outnumbering females (38.5%) in the industry. The wholesale and retail trade: repair of motor vehicles and motorcycles is the district's second largest employer, accounting for 14.4% of the employed population. In the wholesale and retail trade: repair of motor vehicles and motorcycles industry, females outnumber males by 69.9% to 30.1%. Other female-dominated industries in Jomoro include manufacturing, which employs 11.5% of the population [Females (67.3%); Males (32.7%)] and the accommodation and food service industry, which employs 6.8% of the district's workforce [Females (84.7%); Males (15.3%)]. Male-dominated industries in the district include construction [Males (95.7%); Females (4.3%)], mining and quarrying [Males (85.1%); Females (14.9%)] and education [Males (64.9%); Females (35.1%)]. Private informal employment accounted for 84.0% of the population followed by the private formal sector (8.6%) and the public government sector (7.4%). There are more males (54.1%) in the private informal sector than females (45.9%). The employment characteristics in the district show that the employed population have low skills and they are mostly self-employed without employees. Residents of Jomoro who are self-employed without employees account for 63.9% of the employed population.

- Ellembelle. The Ellembelle district has a total population of 155,206 individuals aged 15 years and older who are engaged in economic activities. Among them, 85,656 people, accounting for 55.2% of the district's population are economically active, while the remaining 44.8% are not economically inactive. Out of the proportion of the economically active population, 83.1 % are employed, with the proportion of males (56.8%) slightly higher than that of females (43.2%). Agriculture, forestry, and fishing industry are the most common occupations in Ellembelle, accounting for 44.9% of the employed population, with male workers (62.8%) outnumbering female workers (37.2%). This is followed by the wholesale and retail trade: repair of motor vehicles and motorcycles industry (14.0%), other service activities industry (6.1%) and education (5.7%). The second largest occupation in the Ellembelle district is the service and sales workers who make up 21.5% of the working population. This is followed by craft and related trades workers (10.9%), plant and machine operators, and assemblers (7.3%), professionals (7.0%) and elementary occupation workers (6.1%). Also, Human health and social work activities (2%), public administration and defense; compulsory social security (0.9%), professional, scientific, and technical activities (0.6%) and electricity, gas, steam, and air conditioning supply (0.6%) accounted for the district's lowest represented industries. Persons self-employed without employees made up most of the district's employed population (67.9%) with males (51.7%) slightly outnumbering females (48.3%).

- Nzema East. In the Nzema East district, the total population of persons aged 15 years and older for economic activities is 120,470. From this total, 74,004 representing 61.4% of the district's population are economically active, compared to 38.6% who are not economically active. Among the economically active population, 88.9% are employed whilst only 11.1% are unemployed. Slightly more than half (51.7%) of the Municipality's employed population 15 years and older are skilled agriculture, forestry, and fishery workers. This is followed by service and sales workers (16.9%), elementary occupation workers (11.4%), and workers in craft and related trades (8.3%). Female-dominated industries in the municipality include the Manufacturing industry [Females (72.8%); Males (27.2%)], Wholesale and retail trade: repair of motor vehicles and motorcycles industry [Females (81.4%); Males (18.6%)] and Accommodation and food service activities [Females (86.3%); Males (13.7%)]. Aside from agriculture, forestry, and fishing, which employs more men (65.8%) than women (34.2%) in the municipality, other male-dominated industries in Nzema East include transportation and storage [Males (98.9%); Females (1.1%)], construction [Males (95.6%); Females (4.4%)] and education [Males (61.5%); Females (38.2%)]. Approximately 60,8% of residents in the municipality are self-employed without employees, with males (52.6%) outnumbering females (47.4%).

- Ahanta West. The overall population of people aged 15 years and older for economic activities in the district is 194,736. Out of this, 115,230 people (59.2% of the district's population) are economically active while 40.8% are not economically active. Among the economically active group, 86.5% are employed while 13.5 % are unemployed. Agriculture, forestry, and fishing are the main industries in the district that employs 28.6% of the workforce. This is followed by wholesale and retail; repair of motor vehicles and motorcycles with 19.0% of the working population, the manufacturing industry (10.4%) and other service activities (8.4%). The distribution by sex shows that more males (55.1%) than females (44.9%) are employed in the agriculture, forestry, and fishing industry while there are more females (79.1%) than males (20.9%) in the wholesale and retail trade, repair of motor vehicle and motorcycle industry. The majority of the population 15 years and older in the district are self-employed without employees (51.4%) followed by employees (34.0%), with the self-employed with employees and casual workers accounting for 7.2% and 4.2% respectively. In the district, females have a higher proportion of self-employment without employees (62.9%) than males (37.1%) in the same category.

- Sekondi-Takoradi Metropolitan Area (STMA). The total population of people aged 15 years and older for economic activities in STMA is 340,950. Out of this, 195,860 people representing 57.4% of the population in the district are economically active (51.2% are males and 48.8% are females), while 42.6% are not economically inactive. 87.0% of the economically active population in the metropolis [Males (51.4%); Females (48.6%)] are employed, whilst 13.0% are unemployed. The main industrial activities in STMA are wholesale and retail; repair of motor vehicles and motorcycles, which employs 23.6% of the workforce, other service activities (12.1%), manufacturing (9.5%), transportation and storage (8.0%) and education (8.0%) of the working population. Female-dominated industries in STMA include the wholesale and retail trade; repair of motor vehicles and motorcycles industry [Females (75.7%); Males (24.3%)] and accommodation and food service activities [Females (84.1%); Males (15.9%)] compared to male-dominated industries such as transportation and storage [Males (96.6%); Females (3.4%)], construction [Males (96.6%); Females (3.4%)] and electricity, gas, steam and air conditioning supply [Males (96.6%); Females (3.4%)]. Almost half (44.0%) of the working population in the Sekondi-Takoradi Metropolis is self-employed with no employees. Employees make up 44.4% of the employed population, while self-employed people with employees make up 7.2% of the working population in the entire metropolis.

- Shama. Shama has a total population of 148,112 people aged 15 years and older who are engaged in economic activities in the district. Out of this, 90,543 persons (61.1 % of the district's population) are economically active, while 38.9% are economically inactive. Of the economically active population, 84.4% are employed and 15.6% are unemployed. Agriculture (including forestry and fishing) employs the majority (24.6%) of the working population who are 15 years of age or older [Males (41.7%); Females (58.3%)]. The second largest industry in Shama, after agriculture, is the wholesale and retail trade; repair of motor vehicles and motorcycles which is made up of 15.4% of the workforce, with just 23.7% of men employed in the industry compared to 76.3% of women. The manufacturing sector makes up 14.8% of the working population, with more women (64.4%) than men (35.6%) employed in the industry. In the Shama district, women make up a higher proportion of people working in human health and social work (60.1%) than men (30.9%). Also, in the hospitality and food service industries, there are more women (91.3%) employed than men (8.7%). The construction sector employs only 8.1% of the working force in the district, with a higher proportion of males (97.5%) than females (2.5%). Other male-dominated industries in the district include transportation and storage [Males (99.5%); Females (0.5%)] and electricity, gas, steam, and air conditioning supply [Males (96.5%); Females (3.5%)].

Economic Activities: Agriculture

The 2010 Population and Housing Census indicated agriculture (which includes both fishing and farming) as the main economic activity practiced across the coastal districts, except for STM. Current information on agricultural activity for Western Regional Coastal Districts based on the 2021 Population and Housing Census is combined with Fishing and Forestry. An overview of the agriculture, forestry, and fishing industry of the coastal districts in the AoI, based on the District Analytical Reports of the 2021 Census results, is tabulated below (PHC. 2021)

Table 5.12 Industry employment (Agriculture, forestry, and fishing) of Population (15 years and older) by Locality, Geographic Area, and Gender

Districts	All Locality Types					Rural					Urban				
	Total	Male (M)	M (%)	Female (F)	F (%)	Total	Male	M (%)	Female	F (%)	Total	Male	M (%)	Female	F (%)
Jomoro Municipal	15,816	9,732	61.5	6,084	38.5	13,921	8,448	60.7	5,473	39.3	1,895	1,284	67.8	611	32.2
Ellembelle	15,969	10,030	62.8	5,939	37.2	14,788	9,257	62.6	5,531	37.4	1,181	773	65.5	408	34.5
Nzema East	17,538	11,533	65.8	6,005	34.2	15,269	9,643	63.2	5,626	36.8	2,269	1,890	83.3	379	16.7
Ahanta West	14,256	7,850	55.1	6,406	44.9	11,241	6,009	53.5	5,232	46.5	3,015	1,841	61.1	1,174	38.9
STMA	5,355	3,225	60.2	2,130	39.8	0	0	0.0	0	0.0	5,355	3,225	60.2	2,130	39.8
Shama	9,399	5,483	58.3	3,916	41.7	4,964	2,554	51.5	2,410	48.5	4,435	2,929	66.0	1,506	34.0

Source: Ghana Statistical Service, 2021

In rural areas, Nzema East has the largest percentage of males (63.2%) engaged in agriculture, forestry, and fishing, while Shama has the highest percentage of females working in the agriculture, forestry, and fishing industry. Similarly, in urban areas, the Nzema East district has the highest percentage of men (83.3%) involved in agriculture, forestry, and fishing, while STMA has the lowest at 60.2%. In contrast, STMA has the highest percentage of women (39.8%), while Nzema East has the lowest at 16.7%, showing a relatively lower female participation rate in the agriculture, forestry, and fishing industries in the Nzema East district.

Overall, Nzema East has the highest percentage of men (65.8%) working in the agriculture, forestry, and fishing industry among all locality types compared to Ahanta West, which has the lowest percentage of men (55.1%) engaged in agriculture, forestry, and fishing. Conversely, Ahanta West has the highest percentage of women (44.9%), while Nzema East has the lowest number of women (34.2%) working in agriculture, forestry, and fisheries.

The below section provides data on agriculture activity based on the 2010 Census results since there is no specific data on agriculture alone based on the 2021 PHC. Typical activities in the coastal districts are also shown in Figure 4.26.

- Jomoro. There are two main agricultural activities in the district namely, crop farming and livestock rearing. A high proportion of households are mainly engaged in crop farming (93.7%) in the district. These are engaged in growing cash crops like cocoa, coconut, oil palm and a range of food crops of which cassava and maize are the most notable. About 21% are engaged in livestock rearing while a small percentage are engaged in fish farming (0.7%) and tree planting (0.5%). In the urban areas 93% of agricultural households are engaged in crop farming and in the rural areas, the proportion of agricultural households engaged in crop farming is 94%. The proportion of urban and rural households engaged in livestock rearing was 14.3% and 23.7% respectively. The proportion of urban households (1.1%) engaged in fish farming is higher than for rural households (0.6%). Tree planting is the agricultural activity least engaged in by agricultural households in urban (0.6%) and rural (0.4%) areas.
- Ellembelle. Agriculture continues to be the bedrock of the economy of Ellembelle District and the soil supports the cultivation of many different crops. Agro-processing

cocoa has become the most predominant tree crop grown in the district because of the devastation of the coconut crop by the lethal yellowing disease (Cape Saint Paul's Wilt Disease). Other tree crops of economic importance include oil palm, rubber and citrus. Major food crops include cassava, plantain, and rice, vegetables such as garden eggs, and tomatoes as well as spices like pepper. Livestock includes cattle, sheep, goats, pigs, local poultry and ducks.

- Nzema East. More households (77.2%) in the rural areas are engaged in agriculture compared to the proportion of urban households (16.5%) who are into agriculture. Crop farming is the most common type of agricultural activity involving 94.7% of households in agriculture in the Municipality. Livestock rearing is also common in the Municipality engaging 33.3% of households involved in agriculture activities. Tree growing is not a common agricultural activity in the Municipality as only 0.3% of the households are engaged in this. Fish farming is a rare activity in the Municipality partly due to marine fishing, which is a major occupation for people in the Municipality. Only 0.2 percent of households in the Municipality engage in fish farming.
- Ahanta West. Out of the total district households, 47.2% are engaged in agriculture. Of the agricultural households, the majority (94.45%) are engaged in crop farming while 26.2% are into rearing of livestock. Tree planting is not common in neither urban nor rural areas, as only 0.2% of households are engaged in this activity. Only a few (0.2%) of the households are engage in tree planting. For the urban-rural distribution, 24.1% of urban households are into agriculture whereas 56.8% of rural households engage in agricultural activities. Crop farming is the main type of agricultural activity engaged in by households in both urban (87.2%) and rural areas (95.6%). This is followed by livestock rearing which engages 25.0% of urban households and 26.4% of rural households. The predominant cash crop is oil palm cultivated on a large-scale plantation by Norpalm Ghana Limited. This is followed by rubber cultivation that is on small scale by out growers to large sized plantations mostly owned by the Ghana Rubber Estate Limited (GREL). The major food crops produced include cassava, plantain, maize, yam, rice and vegetables such carrots, cabbage, tomatoes and pepper. Food crop production is generally on a subsistence level with output per yield substantially low in the district due to traditional methods of farming that is predominantly by slash and burn with little mechanization.
- Sekondi-Takoradi Metropolis (including Effia-Kwesimintsim Municipal). Only 9.6% of the households in the Sekondi-Takoradi Metropolis are involved in agriculture. This is because the Metropolis is predominantly urban and the main economic activities are in the service and administration sectors. Out of the agriculture households, approximately 80% are engaged in crop farming and 31% in livestock rearing (some households are engaged in both). The proportion of households involved in fish farming is the smallest (0.2%). This pattern is the same in the urban and rural areas of the Metropolis. For urban areas, the majority of household are engaged in crop farming as the dominant activity (79.1%) and fish farming households the least (0.2%). This situation is same in the rural areas, with crop farming households (87.9%), No household is engaged in fish farming in the rural communities. The most numerous livestock keepers are chicken keepers. They form 45.3% of all livestock keepers. Goat keepers are the second most numerous, forming 33.7% of all livestock keepers in the Metropolis.
- Shama. Out of the total households of the district, only 29% percent are engaged in agricultural activities. Agricultural activities by households in the rural areas of the district represent 76.4%, while in the urban areas they constitute 23.6%. Crop farming (92.7%) constitutes the major agricultural activity, with rural and urban proportions of

94.8% and 44.3% respectively. Livestock rearing accounts for 20.5%, tree planting constitutes 3.1% and fish farming is 0.2%. More households are engaged in tree planting in the urban areas (9.1%) than the rural areas (3.7%). The major agricultural activity in the urban areas of the District is crop farming representing 44.3%. Crop production is mainly on subsistence basis and very few farmers are medium scale producers. The major crops grown are cassava, plantain, cocoyam, maize, rice, oil palm and vegetables. Oil palm is the major cash crop produced in the district. Livestock rearing by households in the district is slightly higher in the rural areas (21.6%) compared to the urban areas (15.4%).

Plantain grown as food crops in Nzema

Cassava plants growing in Shama District

Coconut tree plantation in Jomoro

Rubber tree plantation in Ahanta West

Fish landing site in STM

Harvesting of wood for making charcoal

Source: ERM

Figure 5.26 Agricultural Activities in the Coastal Districts

Economic Activities: Fisheries

This section provides a brief overview of Ghana's fisheries sector from a perspective of its socio- economic and livelihoods contribution to the Ghana economy, based on information obtained from previous baseline descriptions and secondary literature review, including published data is from Lazar et al (2017) and from the Fish and Agriculture Organisation (FAO) up to 2016 (reported in FAO, 2019[1]).

In Ghana, marine fisheries have been the most important aspect of the fishing industry in terms of local fish production, delivering more than 80% of total fish supply. The fisheries sector contributes significantly to the local economy in the Western Region in terms of food security, employment and poverty alleviation. Nationally, the contribution of Ghana's fisheries sector amounts to 4.5% of the GDP, 12% of the agricultural GDP and 10% of the labour force (FAO, 2019).

The fishing industry in Ghana is based on resources from both marine and inland (freshwater) waters and from coastal lagoons and aquaculture (Quaatey, 1997; NAFAG 2007, FAO, 2019).

There is a long tradition of both artisanal and commercial fishing in Ghana. Ghana's marine fisheries are spread along 550 km of coastline and concentrated on its approximately 24,300 km2 of continental shelf between 75 and 120 m depth. These waters form part of the Gulf of Guinea Large Marine Ecosystem and are highly productive due to the Central West African Upwelling. This upwelling occurs twice a year: July-September (major), December-January (minor), and its strength is influenced by oceanic and atmospheric circulation. Therefore, this variability makes year-to-year fisheries productivity unreliable. The fish biomass is primarily composed of small pelagics: primarily round sardine, flat sardine, chub mackerel and anchovy. These species also support populations of larger predatory fish such as tuna, marlin, swordfish and sharks (collectively known as large pelagics). In addition to small and large pelagic fisheries, the upwellings support important demersal fisheries along the continental shelf.

The major commercial species landed listed below.

Small Pelagics

- Round sardinella (Sardinella aurita)
- Flat sardinella (S. maderensis)
- European anchovy (Engraulis encrasicolus)
- Chub mackerel (Scomber japonicus)

Large Pelagics

- Skipjack tuna (Katsuwonus pelamis)
- Yellowfin tuna (Thunnus albacares)
- Bigeye tuna (Thunnus obesus)
- Swordfish (Xiphias gladius)
- Atlantic blue marlin (Makaira nigricans)
- Atlantic sailfish (Istiophorus albicans)

Demersal Species

[1] http://www.fao.org/fishery/facp/GHA/en#CountrySector-SectorSocioEcoContribution

- Cassava croaker (Pseudotolithus senegalensis)
- Bigeye grunt (Brachydeuterus auritus)
- Red pandora (Pellagus bellottii)
- Angola dentex (Dentex angolensis)
- Congo dentex (Dentex congoensis)
- West African Goatfish (Pseudupeneus prayensis)

Shellfish Species

- Cuttle-fish (Sepia officinalis)
- Squid (Loligo vulgaris)
- Octopus (Octopus vulgaris)
- Lobster (Panulirus regius)
- Deep-sea rose prawn (Parapenaeus longistrostris)
- Shrimps (mainly Penaeus notialis, Penaeus kerathurus, Parapeneopsis atlantica)

The marine fisheries sector comprises four main fishing subsectors (Lazar et al 2017).

- Artisanal fisheries.
- Inshore fisheries.
- Industrial Trawl fisheries.
- Tuna or large pelagic fisheries.

These are described in the following sections:

Artisanal Fisheries

The artisanal fishery involves the use of canoes or dug-out wooden boats with inboard or outboard engines. The fishing gears are diverse, including beach seine nets, purse seine nets, set nets, drift gillnets, and hook and line[1].

The small-scale or artisanal subsector accounts for about half of the total marine catch in Ghana which makes it important for the sustainability of the fisheries sector. Within the continental shelf, fishing is carried out by an important artisanal sub-sector operating from about 186 fishing villages and 292 landing beaches along 26 coastal metropolitan, municipal and district assemblies in the four coastal regions of Ghana (Lazar et al, 2017).

Figure 5.27 shows a landing site located in the Western Region of Ghana.

[1] Article Determinants of Catch Sales in Ghanaian Artisanal Fisheries, published in January 2019, Sustainability 2019, 11, 298; doi:10.3390/su11020298, available at https://www.mdpi.com/2071-1050/11/2/298/ and accessed in June 2022

Source: ESL Consulting Ltd. (2021)

Figure 5.27 Fish Landing Site in the Western Region

Artisanal fishers operate anywhere in the Ghana Exclusive Economic Zone (EEZ), although most fishermen operate in the inshore, shelf waters and do not venture out into the deeper offshore waters. However, artisanal fishermen have been observed in deeper waters near drilling installations. This could be a result of the fishermen believing the lights around the MODU attract fish and reduce catch (Attah 2018). 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 it is reported that they do enter this zone, sometimes interfering with artisanal fishing activities (Lazar et al, 2017).

Artisanal fishers are mobile following the small pelagic fish stocks that in turn are dependent on the location of the upwelling, which can vary along the coast during the fishing season (Marquette et al 2002). The subsector is composed of multiplicity and high numbers of gears operated from a variety of sizes of dug-out canoes, powered by outboard motors with engines up to 40 hp (Lazar et al, 2017).

The 2016 fisheries statistical survey (known as a frame survey) estimated 11,583 active fishing canoes in the artisanal fisheries in Ghana. The artisanal fishery is open access with numbers fluctuating from 11,000 to 13,000 in the last 10 years due to migration and new entry, exit and regional migrations (Lazar et al, 2017). The government is trying to strengthen fisheries management and minimise overfishing through registration of all operation artisanal canoes.

Artisanal nearshore beach seine fishing uses locally constructed dugout canoes, paddles and nets. Equipment is purchased by a single boat owner and operated by a crew of between 30-40 individuals. Canoes are manned by a crew of between 9-15 individuals using paddles to travel between 200 m-800 m out to sea, before dropping nets and hauling them in by hand. Beach crews (often everyone including the boat crew) pull nets into shore using ropes, with between 30 and 50 individuals (including those that help with big catches) taking 4 to 7 hours to pull in a catch. Fishing is managed by a chief fisherman located in each village, responsible for determining where (beach segments and fishing grounds) and when (time slots) different fishing companies can fish, along with managing any disputes between fishing groups.

Artisanal offshore fishing uses the same type of dugout canoes (albeit slightly larger than beach seine canoes), but with an outboard motor. Offshore fishing is conducted 15 km from the shore at a bathymetric depth of 80 m but there are reports of offshore artisanal boats fishing around the MODU that is at distances of beyond 60 km from the shoreline. Offshore boats travel a distance of approximately 113 km along the coast, anywhere between Half Assini to the west of Ellembelle District to Cape Three Points and Princess Town in the east in Ahanta West District. Offshore crews of around five individuals per boat fish between 20 and 48 hours at a time. Offshore fishing companies do not appear to have specific fishing grounds and may land their catch anywhere depending on the currents.

The artisanal fishery plays an important role in coastal communities by providing employment, income, and a cheap source of protein. The major challenges they face are seasonality, small margins and low returns. The sector's performance is critical for the growth, economic development, and sustainability of the coastal communities. The returns accruing to artisanal fisheries are affected by several factors including limited value addition and consequent post-harvest losses, weak backward- forward market linkages, poor infrastructure, low bargaining power, as well as low and lack of variety of catch. Expenses associated with fishing activities include fuel, food, labour, taxes, and other variable overheads.

Women are important players in the small-scale fisheries subsector in developing countries. Their participation rate in pre- and post-harvesting activities is estimated at about 48%, and in Ghana, it is around 40%. Women participation in the subsector is higher if only post-harvest is considered. In particular, women in Ghana have a vital role in informal financing of fishing operations, partly due to lack of access to financial support from other channels like bank loans. The marketing system and remuneration for the artisanal fishery take a number of forms. A proportion of the catch goes to wealthy middle-women, often known as 'fish mothers' or 'fish mongers' to cover any pre-financing arrangements; a portion is sold or given to the boat owner to cover fixed costs (boat and fishing gear); hired labourers may receive a portion of the catch as wages; and smaller portions are shared. Thus, fish may be sold through fish mothers as well as other female fish value chain agents including fish processors, fish retailers, food vendors, relatives, and spouses. Some spouses may also be fish mothers. Selling fish catch to fish mothers has less risk as it is a cash market, and usually fish mothers can buy high volumes of fish landed. Fishers can obtain higher prices especially from fish mothers who primarily serve distant regional, or national, and in some cases international markets.

However, there are some disadvantages for selling to fish mothers. Fish mothers have often used their financing leverage to acquire and own fishing equipment used by the fishers and therefore control the production chain[1].

In-shore Fisheries

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 approximately 224 inshore vessels operating from seven landing centres. There are currently no shrimpers (Fisheries Commission, 2022).

These vessels are multipurpose and are used for both purse seining and bottom trawling. They operate as purse seiners during the upwelling periods and switch to bottom trawling

[1] As above

for the rest of the year. They tend to fish in the same coastal waters as the artisanal fleet during the upwelling seasons.

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 (e.g., golden African snapper, Gorean snapper), grunts (e.g. bigeye grunt), croakers (e.g. red Pandora, cassava croaker) and groupers (e.g. white grouper) (FAO, 2010). Bottom trawling is undertaken in waters greater than 30 m depth and less than 75 m depths.

Industrial Trawl Fisheries

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 registered and licensed number of industrial trawlers reached 90 in 2016[1] but there are 76 active vessels currently[2].

The industrial fleet has freezing facilities for preserving fish at sea and can stay for months at sea. 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, i.e., in waters greater than 30 m depth, but as they cannot trawl in depths greater than 75 m their operational area is limited (FAO, 2010).

The trawlers mainly exploit the valuable demersals, including sole and flounders, groupers (e.g., white grouper) and cuttlefish (e.g., common cuttlefish) as well as shrimps and pelagic tunas. They also target other species including porgies or seabreams, jacks (e.g., false scad), snappers, croakers (e.g., cassava croaker), goatfish (e.g., 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 to the Fishers Regulation 2010, Section 16, it is reported that not all these vessels use them (FAO, 2010).

Tuna or Large Pelagic Fisheries

There are 30 tuna fleet operating in Ghana, consisting of 14 bait boats and 16 purse seiners (Fisheries Commission, 2020). They are licensed by the Fisheries Commission

[1] The trawl fleet is mainly operated by the Chinese under joint venture arrangements.
[2] Fisheries Commission, 2020. Fisheries Management Plan of Ghana: A National Policy for The Management of the Marine Fisheries Sector. Ministry of Fisheries and Aquaculture Development.

and managed by the International Commission for the Conservation of Atlantic Tunas, ICCAT, and operate offshore.

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.

The tuna fishing vessels catch mainly yellowfin tuna, skipjack tuna and bigeye tuna. Most tuna vessels are operated on joint venture basis, with Ghanaian owners owning at least 50 percent of the shares, as required by the Fisheries Act 625 of 2002 (FAO, 2010).

Table 5.13 Ghanaian Fleet Exploiting Marine Resources in Ghana

Fleet	Vessel Type	Target Species	Gear	Number
Artisanal	Canoe up to 20 m	Small pelagics	Purse seine Gill nets	11,583
		Demersal	Hook and line, Bottom set net	
		Some large pelagic	Drift Gill Net	
Inshore	Small inboard boat (8-37 m)	Small pelagics	Purse seine	224
		Demersal	Trawl	
Industrial Trawl	Large Steel vessel	Demersal	Trawl	76
Tuna	Industrial vessels	Large pelagics	Purse seine	30
			Pole and Line	

Source: Fisheries Commission 2022

Illegal Unregulated and Unreported (IUU) Fishing in Ghana

There has been a decline in marine fish landings in Ghana impacting negatively on the livelihoods of fishing communities along the coast. A major contributing factor to the decline in fish stocks is illegal fishing practices in the fisheries sector as a result of weak law enforcement, competition among the fleet and perceived unequal treatment across the artisanal, semi-industrial, and industrial sectors. Illegal fishing is basically infringement of regulations by licensed or legal vessels, or fishing activities by unlicensed vessels in a managed location.

Ghana is faced with several forms of IUU fishing practices, including the use of illegal fishing gears, overexploitation, overcapacity, light fishing, fishing with explosives, and illegal transhipment at sea, locally called ‘saiko’.

Saiko is the practice where industrial trawlers target the staple catch of small-scale canoe fishers and transfer it to specially adapted larger canoes at sea for sale at the local markets. An estimated 100,000 MT of fish were sold at landing sites in the country from saiko activities in 2017, of which about 80 percent was reportedly landed at the Elmina fishing harbour in the Central Region. Locally registered vessels co-owned by the Chinese have been noted as the main offenders in illegal fishing activities.

The substantial catch of small pelagic fish through saiko is unreported and not included in marine fishery statistics. Juveniles make up a significant portion of the saiko catch, affecting the viability of the stock. Recent assessments suggest that Ghana's small pelagics fishery may collapse in the short term[1].

The transshipment of fish at sea from Ghanaian industrial fishing vessels to canoes is prohibited in Ghana's 2010 Fisheries Regulations. Lack of enforcement means that industrial trawlers lack the incentive to reduce their bycatch and artisanal fishers are demotivated to address their own destructive fishing practices. The saiko industry employs significantly fewer people than the artisanal sector, 1,500 versus two million in the artisanal sector[2]. An average saiko canoe lands in a single trip the equivalent of around 450 artisanal fishing trips. While the saiko industry has expanded rapidly, the catches of the artisanal fishery have been declining despite the increased fishing effort[3].

IUU has a regional dimension, and a regional approach and solutions are important to combat the problem. Besides national efforts by the Fisheries Commission, a regional fisheries organisation comprising Benin, Cote d'Ivoire, Ghana, Liberia, Nigeria and Togo, the Fisheries Committee for the West Central Gulf of Guinea (FCWC) was established in 2007 to facilitate cooperation in fisheries management between the member countries. The member States of the FCWC, within their national legal frameworks, have either banned transhipment at sea or require special authorisation. FCWC Conventions only permit transhipment at sea in emergency situations.

Fishing in the Six Coastal Districts in the Western Region

The two main types of fishing conducted in the villages in the six coastal districts in the AoI are nearshore beach seine fishing and artisanal offshore fishing. Commercial fishing and large vessels operating from the Sekondi-Takoradi Port can also be found in local waters. In addition to fishing, fishing-related activities such as fish processing and sale and coastal gathering are widely present in the coastal districts.

There is no readily available information on fishing activity for Western Regional Coastal Districts for 2021. However, an overview of fishing activity in the coastal districts in the AoI, based on the District Analytical Reports of the 2010 Census results, is provided below.

- Jomoro. Fishing plays an important role in the economy of the Jomoro District. It employs about 20% of its labour force and contributes to almost 50% of the total protein requirements. Active fishing activities occur in about 28 fish landing sites dotting the coast of Jomoro District. Fish landings have declined over the last 15-20 years, attributable in the first instance to simple increase in population leading to over-fishing.
- Ellembelle. The district has 31 landing beaches, out of 90 in the Western Region. The major marine fishing season is between July and September with the minor season occurring in November-January. The common types of fish landed include sardinella and tunas. Fishing in the district is seasonal. During the major fishing season, economic activities in the district become very brisk with a lot of in-migration into the district capital. However, during off-season period, there is recession in economic activities, thus, creating seasonal unemployment among the population, which adversely affects the revenue of the District Assembly.
- Nzema East. The Municipality is a major player as far as marine fishing in the country is concerned. Of the 90 landing beaches in the Region, 13 are found in the

[1] Lazar, N., et al. (2018). Status of the small pelagic stocks in Ghana and recommendations to achieve sustainable fishing 2017. Scientific and Technical Working Group. USAID/ Ghana Sustainable Fisheries Management Project (SFMP). Coastal Resources Center, Graduate School of Oceanography, University of Rhode Island.
[2] Stop Illegal Fishing, TM-Tracking, FCWC Secretariat (2022). Transhipment: Issues and Responses in the FCWC Region.
[3] Stop Illegal Fishing, TM-Tracking, FCWC Secretariat (2022). Transhipment: Issues and Responses in the FCWC Region.

Municipality. According to the 2016 Canoe Frame Survey (see Table 5.14), the Municipality had four fishing villages, 657 canoes, and 452 outboard motors. Comparison of data from previous years also indicates that the number of canoes in the Municipality is on the rise. This increase coupled with the use of unapproved fishing methods could lead to decline in fish catch and thus negatively affect the economic wellbeing of fishers. The major fishing season is between July and September with minor season occurring in November to January. The common types of fish landed are sardinella and tunas. Considering the critical role of marine fisheries in the Municipality, the 2018-2021 MTDP identified it will be beneficial to provide coastal infrastructure such as modern fish landings and processing facilities. During the major fishing season, there are high levels of economic activity in the Municipality, especially in Axim. However, during the off-season there is recession in economic activities and unemployment levels rise.

- Ahanta West. Fishing activities are also very important economic activities for the people of the coastal areas in the Ahanta West District. Dixcove village in this district is noted all over the Western Region for its catch in sharks, tuna and lobsters. It is one of the oldest and most well- known fishing communities in the country. Other important fishing communities include New Amanful, Funkoe, Butre, Princess Aketekyi, Akwidaa, Busua, Adjua, Asemkor, Egyambra, Miemia and Cape Three Points.
- Sekondi-Takoradi Metropolis. Approximately 6% of the population is engaged in fishing, which is the most important activity of the agricultural sector. Fishing infrastructure includes the Albert Bosomtwi –Sam Fishing harbour (built in 1999), which is managed as part of Takoradi Port. It is located in Sekondi, approximately 25 km West of Takoradi Port and just North of Sekondi Naval Base. The Fishing Harbour comprises of the Inner Fishing Harbour, the Canoe Basin and the Outer Fishing Harbour (see Figure 5.28).
- Shama. Fishing activities are clustered into eight main zones: Shama Apo, Shama Bentsir, Anlo Beach, Samanadze, Abuesi-Abuesi, Amena Ano, Kesewo Kan and Broni-Bema landing beach. However, Aboadze, Abuesi and Shama are the main landing beaches with 1,500 registered sea worthy canoes.

Source: ESL Consulting Ltd (2020)

Figure 5.28 Fish Landed at Sekondi Fishing Harbour

Table 5.14 Districts Summaries of 2016 Canoe Frame Survey

District	Fishing Village	Landing Beach	Pursing Nets	Beach Seine	Line	Set Nets	Ali Net	Drifting Net	One Man Canoe	Canoes	Total Motors	Fishermen
Shama	3	10	307	32	4	258	202	283	0	1,086	1,037	7,710
Sekondi-Takoradi	6	6	155	2	134	339	29	5	0	664	646	4,542
Ahanta West	20	20	174	26	112	400	68	264	63	1,107	794	6,031
Nzema East	4	13	176	13	119	224	22	66	37	657	452	5,405
Ellembelle	14	14	1	84	0	36	0	0	4	125	23	3,300
Jomoro	25	26	189	83	0	41	92	0	0	405	353	6,614
Sub-Total Western Region	**72**	**89**	**1,002**	**240**	**369**	**1,298**	**413**	**618**	**104**	**4,044**	**3,305**	**33,602**
Grand Total	**186**	**292**	**3,346**	**1,084**	**1,344**	**3,729**	**1,052**	**836**	**192**	**11,583**	**9,122**	**10,7518**

Source: Fisheries Commission, 2022

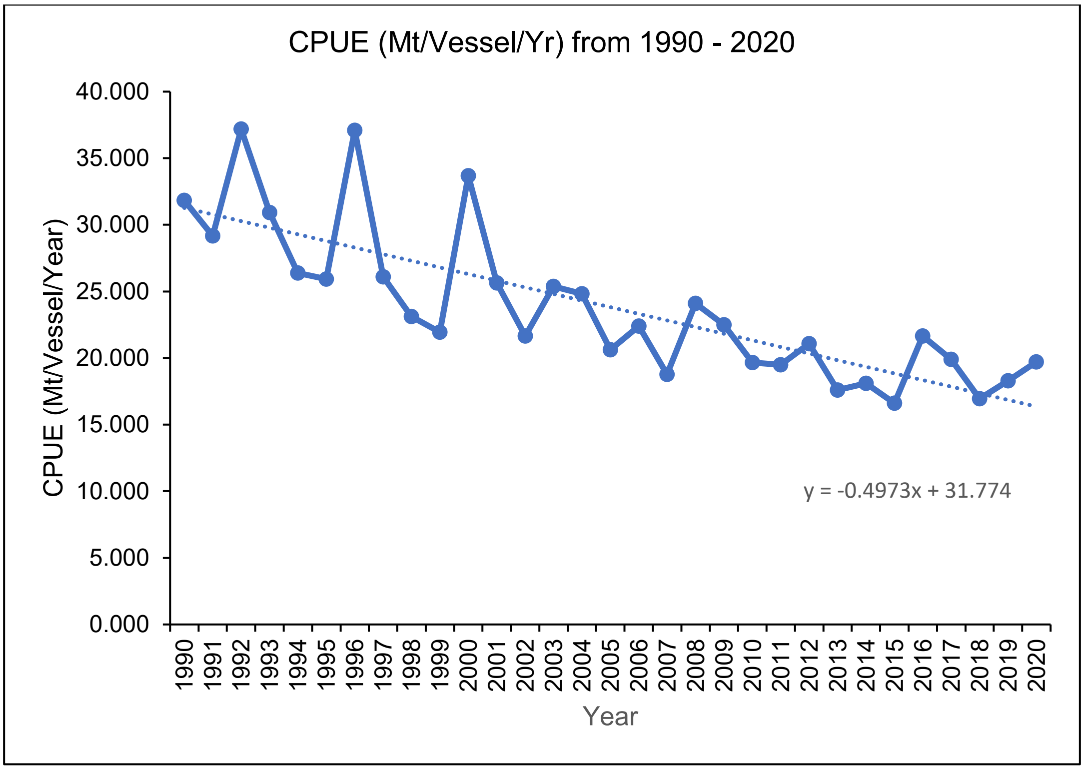
Fish Landings

Currently, the Ghanaian coastal fishing industry is plagued with declining fish stocks, overfishing, marine pollution, mangrove degradation, poor compliance and ocean acidification, and illegal, unregulated and unreported fishing ((Dovlo et al. 2016; Lazar et al., 2018). The decline in pelagic stocks is said to be caused by the open-access nature of the artisanal and semi-industrial sectors. Illegal fishing and transhipment, known as 'saiko', are also reported to contribute to the decline in the pelagic stocks. This catch is reported to consist of a high proportion of juveniles (Environmental Justice Foundation, 2020).

The marine fisheries sector is estimated to generate approximately US$1 Billion in total revenue each year (World Bank, 2013), however, its contribution to the nation's gross domestic product (GDP) has declined from 1.5% in 2015 to 0.9% in 2019 due to largely overexploitation of the fisheries resources (Ghana Statistical Service, 2020).

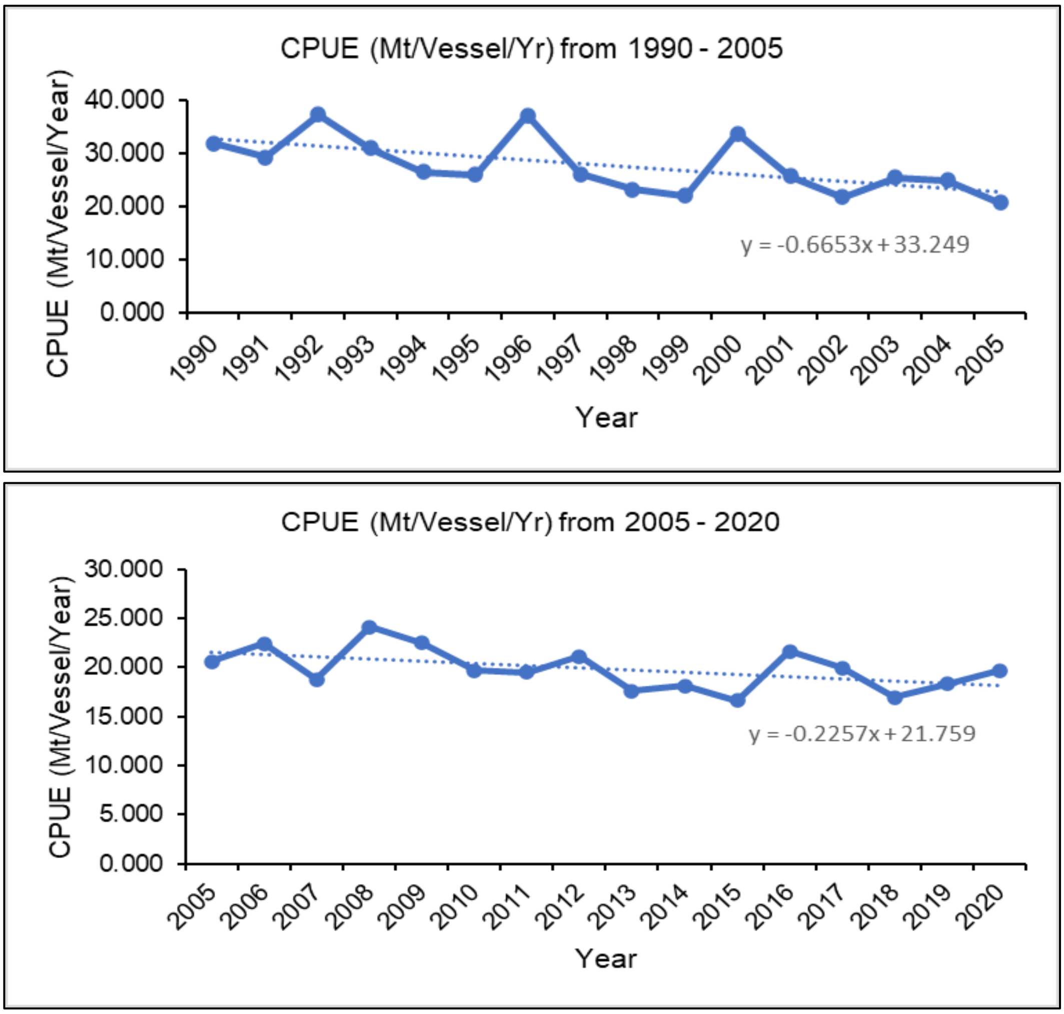
Of the 309,320 Mt of fish catch in 2019, catch from artisanal fisheries make up about 170,149 Mt which is about 55% of total marine capture fisheries. 44% of this is by motorised canoes while the remaining 11% is by non-motorised canoes. It is estimated that catch by motorised canoes is 10.60 Mt per vessel while the catch by non-motorised canoes is 23.85 Mt per vessel. (Fisheries Commission, 2020).

Figure 5.29 shows the Catch-Per-Unit-Effort (CPUE) from 1990 to 2020 from the Fisheries Commission of Ghana. It consists of the CPUE of the canoe, semi-industrial and industrial trawler sectors. The CPUE describes the catch in tonnes per vessel in a year. The figure shows a general decline in fish stocks over the past three decades (1990 - 2020). Wider fluctuations were evident during the first decade (1990 - 2000) compared to the latter two decades, indicative of diminishing stock due to overfishing. Figure 5.30 shows a rapid decline of stocks from 1990 to 2005 and a slower decline from 2005 to 2020.



Source: Fisheries Commission of Ghana, 2022

Figure 5.29 Catch-Per-Unit-Effort (CPUE) from 1990 to 2020



Source: Fisheries Commission of Ghana, 2022

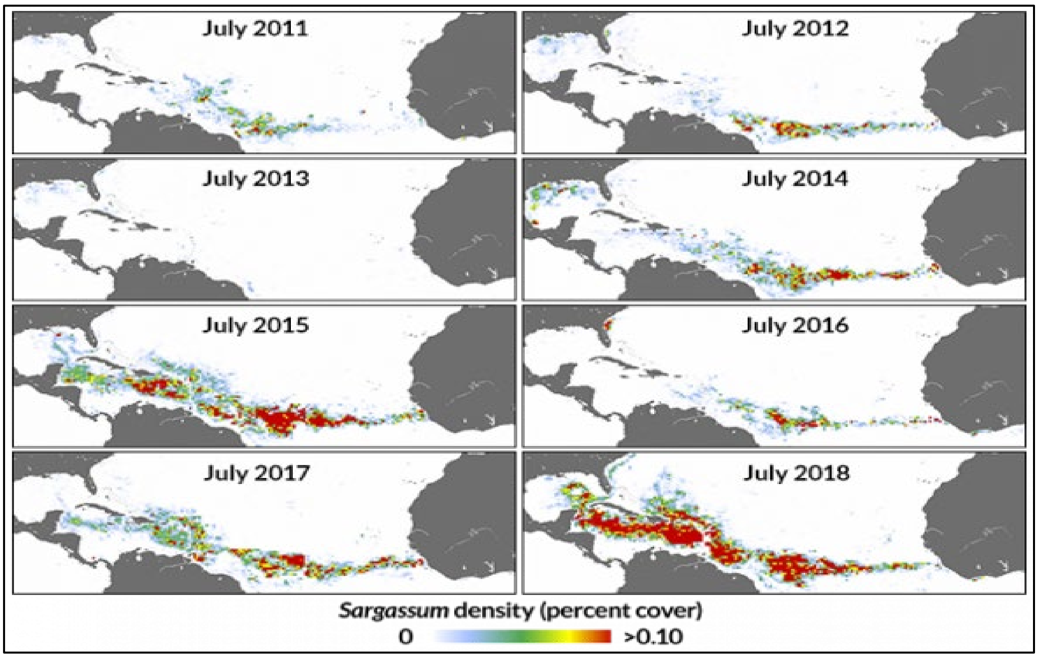
Figure 5.30 Varying Stock Declines from 1990 to 2005 and from 2005 to 2020

Presence of Sargassum and Perception of Fishing Communities

The arrival of Sargassum species on the beaches and in estuaries in the coastal regions of Ghana especially the Western Region was reportedly first recorded in 2009 (Addico & deGraft-Johnson, 2016). Since then, there have been several other incidents which have impacted negatively on biodiversity, tourism and the livelihoods of coastal communities, especially the fishing communities whose livelihoods are dependent on the fishing industry.

In Ghana, two indigenous rooted species of Sargassum have been recorded, namely *Sargassum vulgare*, and *Sargassum filipedula.* The species invading washing up on the coast are not rooted to the substratum but float in the open sea similar to those found in the Sargasso Sea in the Western Atlantic tropical region of the Northern Hemisphere (Szechy et al., 2012). The two exotic floating species of Sargassum have been identified as *Sargassum natans* and *Sargassum fluitans*.

Recent studies indicate that eutrophication of coastal waters off the Amazon Estuary leads to a disproportionate flourishing of the Sargassum sp. which are carried by the Euitorial Counter Currents in large quantities to the Western coast of Africa, in particular the Guinea coast (Figure 5.31).



Source: UNEP, 2021

Figure 5.31 Record of Sargassum Movement Across the Atlantic to West Africa from 2011 to 2018

Observations indicate that beaching of Sargassum are prevalent on gently sloping beaches, especially along the western coast of Ghana. The first large influx of sargassum was reported in 2011 and the largest to date was in 2021 (see Figure 5.32) with other reports of further large quantities beaching between 2021 and 2022. The beaching of sargassum on the shores of Ghana, especially the Western Region, does not appear to be seasonal and can occur several times a year.

Source: ESL, 2021

Figure 5.32 Sargassum on the Beach of a Village in the Western Region (ESL, 2021)

With the first large deposition of sargassum along the shorelines of Africa and Ghana occurring in 2011, few months after the start of commercial production of oil in Ghana, there was the perception amongst fishermen from villages in the coastal parts of the Western Region that these two events were linked. That perception still persists, and the fishing communities blame the oil and gas operators for the influx of sargassum on the shores of the coastal villages. The local fishermen believe the drilling activities scrape the seabed which dislodges attached seaweeds from the seafloor which are carried by the current waves to the shores.

Sargassum influxes negatively impact human well-being, activities, and livelihoods. Key areas that are impacted include livelihoods of people living on the coast, marine transport, fisheries and tourism. The large quantities of sargassum damage the aesthetic appeal of beaches and inhibit access to the nearshore fishing. Beach seining, being the dominant artisanal method of fishing in the Western Region (up to the West of Axim), is affected by beached sargassum. Fishermen are unable to go over the beached sargassum to set their nets and have no space to drag the net onshore.

Oil and Gas Activities

The discovery of oil and gas off the coast of Ghana's Western Region in 2007 greatly changed the country's development trajectory. Production began in 2010 and rapidly accelerated to reach 100,000 barrels per day in just four years[1]. Ghana's oil production is set to more than double over the next four years thanks to new fields coming on stream. Ghana's oil and gas industry is helping position it among the continent's fastest-growing economies[2].

Ghana has three offshore and one onshore petroleum basins, which comprise the Tano-Cape Three Points Basin/ the Western basin; the Saltpond Basin / central basin; Accra–Keta Basin / eastern basin and the onshore Voltaian Basin. The Western Basin is currently the most active of the four basins and includes the Deepwater Tano and Cape Three Point basin. The Jubilee Field straddles Tano and Cape Three Points, the TEN Fields are located in Tano, and the Sankofa Field is located in Cape Three Points. The Central Basin has Ghana's longstanding Saltpond field. The Eastern Basin includes both Accra and Keta Blocks, where exploration has been carried out without much commercial result to date. Lastly, the Voltaian Basin covers 40 per cent of Ghana's land mass and may have the potential for onshore petroleum extraction (Oxford Institute for Energy Studies 2018).

The country also has an active midstream and downstream oil and gas sector including a refinery at Tema and numerous storage and distribution systems for refined products. The Ghana National Gas Company operate a gas processing plant at Atuabo in the Western Region, which receives gas from the Tullow developments.

The Coastal Districts mainly have seen a development of oil & gas offshore exploration and production activities, with companies such as Eni, Tullow and Pecan Energies investing in this sector and supporting the economic growth.

In 2016, the oil and gas sector created 15.000 jobs with Ghanaians being 82.5%. Tullow Ghana Ltd built a technical training centre at the Takoradi Polytechnic to provide skills to young people so they can be employed. In addition, there is the USAID Ghana Supply Chain Development Program that provides capacity support to small and medium

[1] Western Region Coastal Foundation website, https://www.dai.com/our-work/projects/ghana-western-region-coastal-foundation-wcrf

[2] Online article By Patrick Kwabena Stephenson in Accra and Honoré Banda, Posted on 3 September 2019, updated on 8 October 2019, available at https://www.theafricareport.com/16814/ghana-oil-production-to-double-to-over-400000bpd-in-next- four-years/

enterprises and business service providers to participate in procurement tenders for contracts within the oil sector (Sam and Buckle 2017).

Mining

Large mining companies such as Gold Fields, Newmont, Kinross and AngloGold Ashanti are present in the mining sector of Ghana. There are five major gold mines in the Western Region namely Teberebie and Iduapriem, Prestea/Bogoso, Tarkwa and Aboso-Damang gold fields.

AngloGold Ashanti has two wholly-owned and managed operations in Ghana's Ashanti (Teberebie) and Western Regions (Iduapriem). The latter is located 80 km north of Takoradi, adjacent to Teberebie mine. In 2000, the operations of Iduapriem and Teberebie mines were merged by AngloGold Ashanti.

Prestea/Bogoso gold mine is in south-western Ghana, approximately 40 km from the Wassa Gold Mine. It is owned and operated by Golden Star Resources Ltd. Until 2018, production was being delivered from the Prestea Open Pits and the Prestea Underground Gold Mine. In the second half of 2018, Prestea became an underground-focused operation with an operational life of 5 years.

Tarkwa is one of the largest gold mines in Ghana and it is owned and operated by Gold Fields Limited. Its mine is located in the southwest of the country, in the Western Region, 10 km north of Iduapriem. The mine is served by the main road connecting to the port of Takoradi some 60 km to the south on the Atlantic coast. The Damang concession lies to the north of and joins the Tarkwa concession, which is located near the town of Tarkwa. The area is served by access roads with established infrastructure, and the main road connects the mine to the port of Takoradi, some 113 km to the southeast. Abosso Goldfields (a subsidiary of Gold Fields Limited) holds a mining lease in respect of the Damang mine that expires in 2025. The mine's current reserves are estimated to last until 2024.

Informal Economy

More than seven in every ten (71.3%) of the total employed persons in Ghana were employed informally and 28.7% were engaged in the formal sector. The likelihood of working in a formal job is greater among females (31.7%) than males (27.2%). In addition, urban dwellers (31.0%) were more likely than rural dwellers (22.9%) to be engaged in formal employment. In the Western Region, 9.7% of the employed population 15 years and older was engaged in the informal sector, with females (10.8%) slightly greater than the male percentage (9.2%) (Ghana Statistical Service, 2019).

The informal sector in Ghana consists of various small-scale businesses, for example, producers, wholesalers and retailers. Informal sector workers are largely self-employed persons such as farmers, traders, food processors, artisans and craft workers.

The rural informal economy centres on the following.

- Agricultural activities focused on family farming units or community-owned assets. Farming is generally on a low technology basis dependent on family labour.
- Artisanal fishing is predominantly undertaken by males (between 18 and 40 years old) along Ghana's coastline. Women generally undertake processing activities, including the smoking and marketing of fish, and this takes place in coastal villages.
- Rural agro-based processing activities of local crops. These include processing cassava, palm kernel, groundnut and copra oils, brewing distilling, and traditional soap making. These activities are generally undertaken by women (Osei-Boateng and Ampratwum, 2011).

The urban informal economy centres on the following.

- The services sector, for example, urban food traders, domestic workers and repairmen and women.
- The construction sector, for example, masons, carpenters, and small-scale plumbers (mainly men between 18 and 40).
- The manufacturing sector includes, food processing, textiles and garments, wood processing and metal works[1].

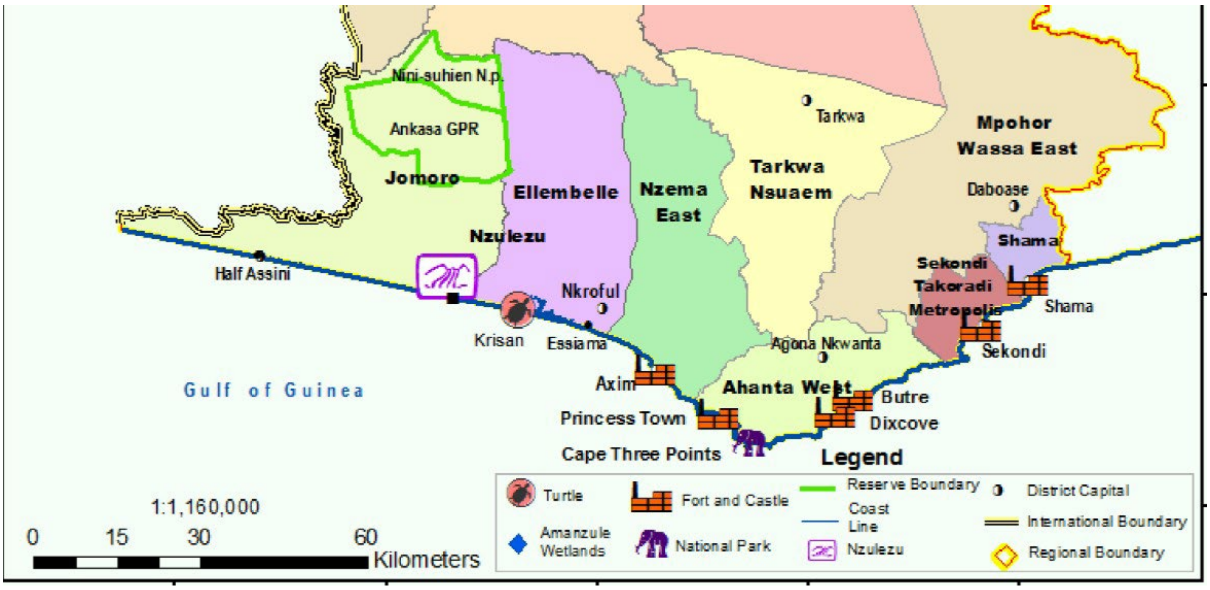
Tourism

Ghana has a wide range of natural, cultural and historical attractions, which provides the basis for a 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 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.

There is currently little development in terms of coastal tourist resorts (i.e. associated with marine-based recreational activities such as diving and deep-sea fishing).

The primary tourist sites in the Western Region pertain to national parks or reserves, forts and cultural heritage and beaches. These are considered sites that can attract tourists but would still need associated infrastructure developed to boost tourism in the region. **Error! Reference source not found.** shows key tourist sites in the coastal districts of the Western



Source: Ghana Statistical Service 2010

Region.

[1] Industry, according to International Standard Industrial Classification (ISIC), comprises value added in mining, manufacturing (reported as a separate subgroup), construction, electricity, water, and gas.

Figure 5.33 Tourist Sites in the Coastal Districts of the Western Region

An overview of tourism in the coastal districts in the AoI is provided below.

- Jomoro District. Places of attraction identified in the Jomoro Municipal Assembly Final Medium-Term Development Plan 2018-2021 include Fort Appoloniain Beyin, Miegyinla community, Nzulezo (the village on stilts), Captain William's Tomb in Half Assini (capital) and the mystery site in Kengen. With the exception of Fort Appolonia, the other historical sites have not been well developed to attract tourists. These potential sites, when developed, could diversify tourism activities in the Municipality. Some of the beaches of Jomoro have been developed to attract tourists, for example, investors are developing beaches at Beyin. There are also a few hotels and guesthouses in place.
- Ellembelle District. The district has a number of tourist attractions, which include the birthplace and initial tomb of the first President of the Republic of Ghana, Dr. Kwame Nkrumah at Nkroful, a 70 km stretch of sandy coastline that borders the district to the south, the navigable Ankobra River that links the northern and southern parts of the district, tracts of wetlands, crocodile pond at Baku. Popular hospitality facilities that exist include Maaha Beach Resort and Ankobra beach Resort. However, the tourism industry is not well developed in the district.
- Nzema East. The Municipality is rich in tourist attractions although most of these are still undeveloped. It is endowed with a huge potential for tourism development. Nzema East's capital Axim is the home of Sub-Saharan Africa's second oldest Fort. The Ahunyame mysterious rock formation is also an attraction for tourists. The district has sandy beaches, which provide conventional beach tourism. The navigable Ankobra River is another tourist attraction that provides tourists with the opportunity to enjoy riverboat trips. Hospitality facilities that exist to house visitors include the Axim Beach Resort (Fig. 4.19, Right), Lou Moon Beach Resort and Ankobra Beach Resort providing excellent comfort in varieties ranging from traditional to continental.
- Ahanta West. Out of the eight forts in the region, four are located in the district namely; Fort Dorothie, Fort Metal Cross, Fort Batenstein (Butre) and Fort Groot Fredriechsburg. In addition, Cape Three Point Forest reserve has been identified as potential for ecotourism development or used as a canopy walk as is the case at the Kakum National Park located in the Twifo-Hemang Lower Denkyira District in Central Region. Besides that, Recerca è Corperazione (RC) have developed West Coast Tourism in three communities (Butre, Busua and Dixcove) with the view of promoting water-based tourism. Another potential for ecotourism development is the planned plantation of GREL and Norpalm Ghana Limited. Other potential sites that could be developed are the monkey sanctuary and the crocodile pond at PrincessTown and Egyambra respectively. Furthermore, the district has nice sandy beaches located at Funkoe Beach, Adjua Beach Victoria Beach at New Amanful, Busua Beach, Miemia Beach, Princess Town Beach, Cape Three Point Beach, Asemkow Beach (Hideout and Fanta Folly) and the Green Turtle and Safari Beach at Akwidaa.
- Sekondi Takoradi Metropolis. Tourist attractions include the site of the 17th century Dutch Fort Orange, the English Fort Sekondi, the sandy Paradise Beach, Railway Museum, Sekondi Historic District and the Whin River and Lagoon. Due to the increase in the population size of the Metropolis, more pressure is placed on the social amenities available as well as the accommodation facilities such as motels and hotel services. Therefore, diversification and expansion of tourism are priority intervention areas defined in the 2018-2021 STAM Medium-Term Development Plan.
- Effia-Kwesimintsim. The Effia-Kwesimintsim Municipality is endowed with cultural and ecotourism assets that provide significant opportunities for tourism development and

quality job creation. Tourist attractions include the Kundum Festival, the Whin estuary as well as very good hotels within its catchment area.

- Shama. Tourism is not well developed but is represented by some hotels and recreation areas along the beach (La Bamba Beach Resort at Amenano and the Abuesi Beach Resort at Abuesi). There is a fort in the District, which could be developed into a tourist site. The estuary of the Pra River can also be developed to harness revenue for the District.

The annual ‘Kundum’ cultural festival takes place between August and October across the Ahanta and Nzema apeaking areas of the Western Region and attracts local people and tourists from elsewhere in Ghana and from abroad.

Overall, diversification and expansion of the tourism industry are considered key development opportunities to grow the economy of the coastal districts.


Figure 5.34 Typical Hotel in Anokyi (Left) and Axim (Right)

Gender-based livelihoods

Women continue to have lower status in society than men. In the past, women were considered more suited for childbearing and child upbringing while men were seen as more inclined towards the ‘public areas’ of work and finance. Though this trend is changing, women especially after the birth of the first child, continue to perform most of the household work and caregiving in their families despite working outside the home. As the society is moving predominantly toward a market economy, the number of mothers entering the labour force is increasing every year, also mothers with preschool children are increasingly attending the labour force. Since women are entering the labour market, gender roles have changed considerably. Women’s contribution to the family economy have made men somewhat alter their attitude and start helping with domestic chores. However, the invisible work of women remains largely unrecognised and undervalued[1].

According to the *WRCF Community Perceptions and Socio-Economic Survey (CPSES) Baseline Report (2016)*[2], both male and female heads of household in the six coastal districts are engaged in the fishing and farming sector (44% of men and 38% of women) with the women mainly engaged in fish processing (processing illustration in Figure 5.35).

[1] Ahanta West Municipal Assembly Medium-Term Development Plan 2018-2021

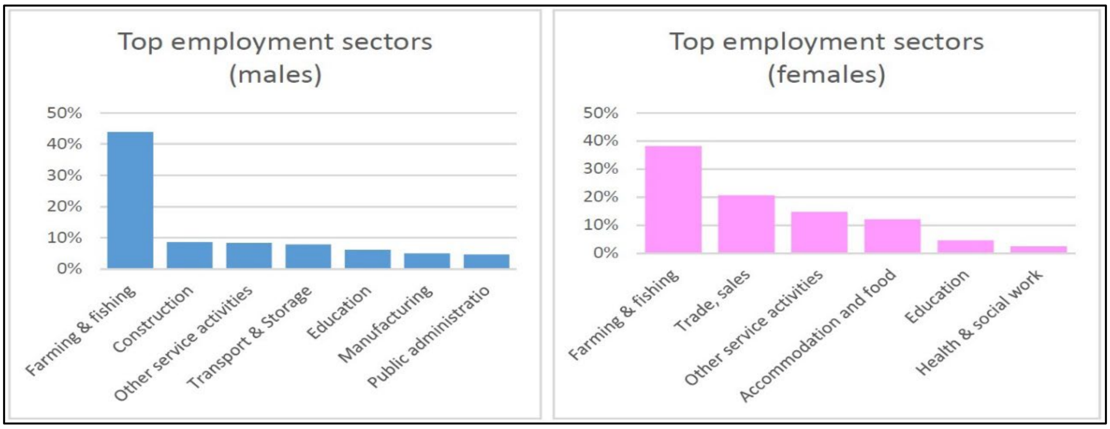
[2] Study published on the WRCF website, available at http://wrcfghana.org/wp-content/uploads/2016/11/CPSES-Baseline- Report.pdf and accessed in June 2022

Source: Subsidies in Ghana's Marine Artisanal Fisheries Sector, October 2016, University of Rhode Island[1].

Figure 5.35 Women Fish Processors

Female heads of household are much more likely to be engaged in trade and sales (21% for women vs. 4% for men) and accommodation and food services (12% for women vs. 2% for men). None of the female-headed households was engaged in the transportation and storage, construction, or public administration sectors, all of which employed substantial numbers of men.

The top employment sectors in the six coastal districts, by gender, according to a study conducted by the Western Region Coastal Foundation in 2016 are illustrated in Figure 5.36.



Source: WRCF Community Perceptions and Socio-Economic Survey (CPSES) Baseline Report (2016)

Figure 5.36 Top Employment Sectors in the Six Coastal Districts, by Gender of Head of Household

[1] https://www.crc.uri.edu/download/GH2014_POL059_CRC_-FIN508.pdf

An overview of women's roles in the coastal districts in the AoI is provided below.

- Jomoro. Most women in Jomoro Municipal are housewives and engage in petty trading. Women in the southern part of the Municipality (along the beaches) are involved in fishing activities while the others, away from the sea, assist their husbands in farming activities. Men are mostly dominant in leadership and other administrative functions. Women's representation in decision-making and formal employment is very limited[1].
- Ellembelle. Both women and men have equal opportunities to work in the formal and informal sectors. However, people acquire employment opportunities based on their expertise. Holistic approaches to community participation (old, young, male & female) are deployed as part of development processes. Traditionally, women play a significant role in the governance system with some communities having Queen mothers as part of their governance system[2].
- Nzema East. Women are engaged in raising pigs and are the predominant palm oil processors. They use traditional technologies that have a low oil recovery rate and imply a dependence on the traditional stoves, which poses significant health challenges.
- Ahanta West. Even among couples where wives earn more than their husbands, women still maintain most of the responsibilities for the household. Further, many women deliberately work to make it appear that their husbands are in control.
- Sekondi Takoradi Metropolis. Approximately 82% are engaged in the private informal sector compared to 56% of the men. This indicates that women should be the focal point when developing strategic policy for the private informal sector; e.g., revenue collection and construction of markets. On the other hand, there are more men in the private formal (23%) and public (government) 18.7% sectors than females 8%, respectively 9.7%[3].
- Shama. Women are also engaged in the manufacturing of craft products, extracting of oil palm and the processing of gari (cassava root, dried and ground into flour).

5.6.10 Education

Ghana's Education Act (2008) structures the education system on three levels: basic, second cycle and tertiary, making the nine years of education at the basic level free and compulsory and allocating responsibility to District Assemblies for the pre-tertiary education. Senior High School education became free following an education policy in 2017.

The education system consists of:

- basic education or first-cycle education, consisting of two years of kindergarten, six years of primary school, and three years of junior high school (JHS);
- second-cycle education, consisting of three years of senior high school (SHS), technical/vocational; business and agriculture education; or an apprenticeship training of not less than one year; and
- tertiary education, consisting of Colleges of Education (COEs), polytechnics, universities, and other degree- and diploma-awarding institutions accredited by the National Accreditation Board.

I.

[1] Jomoro Municipal *Medium-Term Development Plan* 2018-2021, page 78
[2] Ellembelle District *Medium-Term Development Plan* 2018-2021, page 93
[3] Sekondi Takoradi Metropolitan Assembly *Medium-Term Development Plan* 2018-2021, page 87

Table 5.15 Education levels (six years old and older) (PHC, 2021)

District	Total	Level of Education							
		Never Attended (%)	Pre-Primary (%)	Primary (%)	JSS/JHS (%)	SSS/SHS (%)	Voc. (%)	Post-Sec. (%)	Degree or higher (%)
Jomoro	107360	23.4	1.9	25.6	23.1	13.8	0.6	1.1	3.2
Ellembelle	102571	20.7	1.9	24.8	23.3	14.9	1.9	1.8	3.8
Nzema East	80117	25.6	2.5	26.4	24.0	12.3	0.7	0.8	2.6
Ahanta West	130920	17.3	2.6	25.7	26.0	13.8	1.4	1.2	4.4
STMA	215264	8.0	1.4	18.4	21.3	20.7	3.0	1.9	9.6
Shama	99730	17.5	2.2	24.3	26.1	14.0	1.7	1.2	3.0

Source: Ghana Statistical Service (2021) *Voc: Vocational School, *Post Sec: Post-secondary.

The percentage distribution of individuals aged six and older across different educational stages in each coastal district from the 2021 Population and Housing Census, as shown in Table 4.13 above, shows the education levels of the people in each of the six Western Regional Coastal Districts.

- In 2021, the percentage of people aged six years and older who never attended school was highest in the Nzema East district (25.5%), accounting for one-third of the population, and lowest in STMA (8.0%). This was closely followed by Jomoro (23.4%) and Ellembelle (20.7%).
- In terms of pre-primary education and primary education, Ahanta West (2.6%) had the highest percentage of people aged six years and older who completed pre-primary school, followed by Nzema East (2.5%) and Shama (2.2%). In contrast, Nzema East (26.4%) had the highest percentage of persons who completed primary education, accounting for one-third of the district's population, compared to Ahanta West (25.7%) and Jomoro (25.6%), both of which account for one-third of the district population.
- Shama had the highest percentage of people aged six years and older who completed JSS/JHS (26.1%). This was followed by Ahanta West (26.0%), Nzema East (24.0%), Ellembelle (23.3%), and Jomoro (23.1%). STMA, on the other hand, had the highest proportion of people who have completed SSS/SHS (20.7%), followed by Ellembelle (14.9%), Shama (14.0%), Jomoro (13.8%) and Ahanta West (13.8%). Similarly, STMA (3.0%) had the largest percentage of people who completed vocational school compared to other coastal districts such as Ellembelle (1.9%) and Shama (1.7%).
- Among the coastal districts, STMA had the highest percentage of post-secondary graduates (1.9%) and tertiary education graduates (9.6%). Elllembelle had the second highest percentage of post-secondary graduates (1.8%) while Ahanta West had the second highest percentage of tertiary education graduates (4.4%). Nzema East had the lowest number of post-secondary graduates (0.8%), as well as the lowest percentage of tertiary education graduates (2.6%).

Basic Education

Until 2015, primary education received the largest share of the Government of Ghana's education expenditures, to be then overtaken by JHS, SSH and tertiary as the number of teachers employed in the sector increased, according to the Ghanaian Ministry of

Education[1]. Public schools provision is complemented by a faster-growing private sector[2], which accounts for over 20% of the basic education and 6% of the SHS enrolment, albeit with substantial regional variations and a significantly lower percentage of trained teachers compared to public schools[3].

Gender parity in basic education was reached in 2011/12[4], and the aggregated data for each of the six districts would indicate the same conclusion (see Table 5.16 for enrolment data from 2016).

Table 5.16 Basic School Enrolment in Each District by Gender (2016)

District	Male	Female
Sekondi – Takoradi	54,495	55,455
Ahanta West	15,676	15,375
Ellembelle	18,042	17,294
Jomoro	20,940	20,430
Nzema East	12,909	12,412
Sharma	18,881	18,736

Source: Ghana Statistical Service - Education Statistics. Tracking progress in Ghana's basic level education across the districts 2010 – 2016, report dated June 2018

The provision of schools in the six districts within the AoI is presented in Table 5.17 The ratio of public versus private schools varies across the districts. For example, in Jomoro there are an equal number of public and private education institutions servicing the district's communities, whilst in Nzema East the majority of schools are public.

Table 5.17 The Number of Public and Private Schools in Each District

	Sekondi Takorad	Jomoro	Ellembelle	Ahanta West	Shama	Nzema East
Kindergarten*	217	130	114	113	99	80
Primary*	227	130	111	107	95	74
Junior High	197	100	53	103	64	46
Senior High	19	3	4	3	3	-
Tertiary**	7	-	2	-	-	-
Technical and	-	-	1	1	3	-

Sources:
* Ghana Statistical Service - Education Statistics. Tracking progress in Ghana's basic level education across the districts 2010 – 2016, report dated June 2018
** Medium Term Development Plans 2018 – 2021 of Sekondi-Takoradi, Jomoro, Ellembelle, Ahanta West and Shama

According to 2016 data provided by the Ghana Statistical Service, the ratio of students enrolled in basic education schools across the six districts is higher than 20%, reaching

[1] Ministry of Education - Education Strategic Plan 2018 - 2030
[2] According to the Education Sector Analysis (2018), private schools made up about half of JHS and SHS created between 2011 and 2017, nearly three-quarters of kindergartens, and close to 90% of primary and tertiary institutions.
[3] Ministry of Education – Education Sector Analysis 2018
[4] As above, page 34

approximately 40% in Sekondi Takoradi Metropolis (see Table 5.18 for a view of public and private enrolment split across the six districts.

Table 5.18 Enrolment in Public and Private Schools in the Six Districts

District	Public	Private
Sekondi – Takoradi	67,782	42,168
Ahanta West	31,051	13,561
Ellembelle	27,433	7,903
Jomoro	25,177	16,193
Nzema East	18,963	6,358
Sharma	24,553	11,944

Source: Ghana Statistical Service - Education Statistics. Tracking progress in Ghana's basic level education across the districts 2010 – 2016, report dated June 2018

Schools across the six districts face significant challenges in terms of access to electricity, access to sanitary facilities, adequate teaching resources and insufficiently trained teachers across all sectors, with corrective actions included in the Medium-Term Development Plan for 2018 – 2021 of each Assembly. Figure 5.37 shows a typical school in the Western Region.

Source: ESL, 2021

Figure 5.37 Typical School Facility in the Coastal Community in Western Region

Literacy Rates

According to UNESCO[1], in 2018 the literacy rate of Ghanaians 15 – 24 years was 92.49% with an insignificant gender gap. For the 15 – 64 age bracket it was 79.04% with an approximately 10% gender gap and for the people over 65 the rate was 50.93%, with an approximately 25% gender gap. The Ghana Statistical Services also reported 69.8% literacy among people 6 year and older in 2021[2].

Ghana Labour Survey (2015) states that aggregated literacy rates for both sexes 11 years and older is 63% (71.8% for males and 55.5% for females), with high urban-rural variations

[1] Ghana Country Profile on UNESCO website, accessed on 16.06.2022. http://uis.unesco.org/country/GH
[2] Ghana Statistical Services, 2021.

(74.5% in urban and 50.1% in rural areas). The same report provides Western Region data for urban areas which present very similar results as the national average for both men and women, but the data reported for rural literacy rates in Western Region is above the national values, with a 77.1% literacy rate for rural men and 57.6% literacy rate for rural women 11 years and older.

According to the Education Sector Analysis 2018 Report, only 54% of men and 43% of women who graduated basic education had acquired literacy skills that will persist through adulthood, thus only individuals who have completed Secondary High School education are considered by default to be fully literate.

Technical and Vocational Education

Although this sector has been developing steadily, there seems to be a mismatch between the skills supplied and the labour market demands, along with a lack of technical qualifications of the teaching staff, with poor learning outcomes, according to the Education Sector Analysis 2018 Report.

The Western Region Coastal Foundation (WRCF) and the Regional Maritime University signed a Memorandum of Understanding (MoU) on 1 March 2019 to work together to develop competent job-ready technical graduates for employment in the industry. The partnership aims to align the training programmes of technical institutions with the needs of the industry by providing support for developing

standards; accreditation for selected programmes and improved training facilities; developing a modern curriculum, and improved instructor training and industry experience.[1]

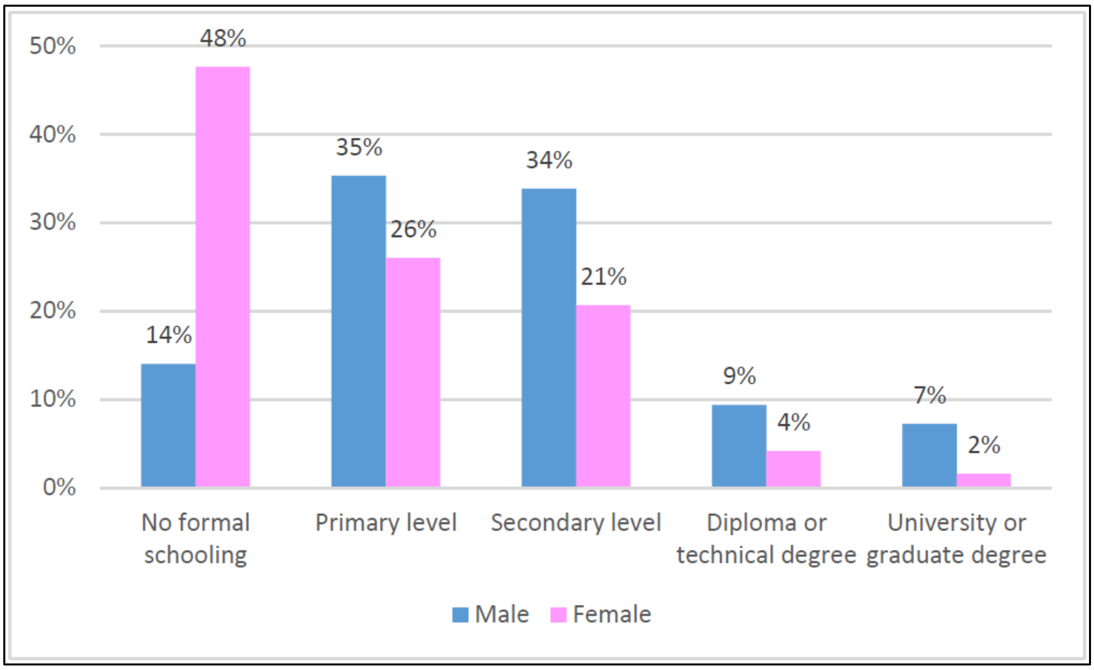
This joint initiative will support developing skills in the oil and gas sector, thus contributing to enhanced access to employment benefits associated with oil & gas development projects.

Gender-Based Educational Level

Confirming national-level figures, the field study undertaken by WRCF in 2016 indicated that female heads of household in the six coastal districts were significantly less educated or formally employed, particularly as salaried or seasonal workers. Nearly half (48%) of female heads of households had received no formal schooling, compared to 13% of male heads of households. In terms of employment type, females were 1.7 times more likely to be casual workers, without contracts or job security, and nearly 2 times as likely to be unpaid, as their male counterparts[2].

Figure 5.38 illustrates the highest level of education of the household head in the AoI, based on a field study conducted by the WRCF in 2016.

[1] Online article *WRCF signs MoU with RMU to improve skills to meet Industry needs - Western Region Coastal Foundation,* published on the WRCF website.
[2] Study published on the WRCF website, available at http://wrcfghana.org/wp-content/uploads/2016/11/CPSES-Baseline-Report.pdf and accessed in March 2020.



Source: WRCF Community Perceptions and Socio-Economic Survey (CPSES) Baseline Report (2016)

Figure 5.38 Highest Level of Education of Head of Household in the Six Coastal Districts, by Gender

5.6.11 Health Care

The Ghana Ministry of Health is responsible for the health system in Ghana and includes the Ghana Health Service (GHS) and five Teaching Hospitals (TH). The GHS is an autonomous Executive Agency under the control of the Ghana Minister for Health. It is responsible for the implementation of national policies and administration of the health services provided by the government. The mandate of the TH is set by Act 525 of the Ghana Health Service and Teaching Hospitals Act of 1996 which empower TH to function in the following three areas:

- the provision of advanced clinical health services;
- supporting the training of undergraduates and postgraduates in medical sciences;
- undertaking research into health issues for improving health care.

The National Health Insurance Scheme (NHIS) is a social intervention program introduced by the government to provide financial access to quality health care for residents in Ghana. The NHIS is managed by National Health Insurance Authority (NHIA)[1].

Funding of the scheme is through government allocation, a 2.5% levy on goods and services collected under the Value Added Tax (VAT), monthly contributions to the Social Security and National Insurance Trust return on investments by the National Health Insurance Fund and premium paid by informal sector subscribers. NHIS subscribers fall into two broad groups, the informal (who need to pay a premium that varies depending on the person's level of income) and the exempt groups, who do not pay the premium. The exempt group includes the following.

- Formal sector employees and the self-employed who contribute to the Social Security and National Insurance Trust (SSNIT contributors).
- Children (persons under 18 years of age).

[1] http://www.moh.gov.gh/national-health-insurance-authority/

- Persons in need of antenatal, delivery and post-natal health care services (pregnant women).
- Persons classified by the Minister for Social Welfare as indigents.
- Categories of differently-abled persons are determined by the Minister responsible for Social Welfare.
- Persons with mental disorder.
- Pensioners of the Social Security and National Insurance Trust (SSNIT pensioners).
- Persons above seventy years of age (the elderly).
- Other categories prescribed by the Minister.

In 2017, there were 10.5 million people, active members, within the NHIS, resulting in a coverage of approximately 35% of the population.

The National Health Insurance Authority (NHIA) is mandated by National Health Insurance Act, 2012 (Act 852) to regulate Private Health Insurance Schemes (PHIS) in Ghana. The law established two types of PHIS:

- Private Mutual Health Insurance Scheme (PMHIS);
- Private Commercial Health Insurance Scheme (PCHIS).

Community and sub-district levels provide primary care, with district and regional hospitals providing secondary health care as illustrated in Figure

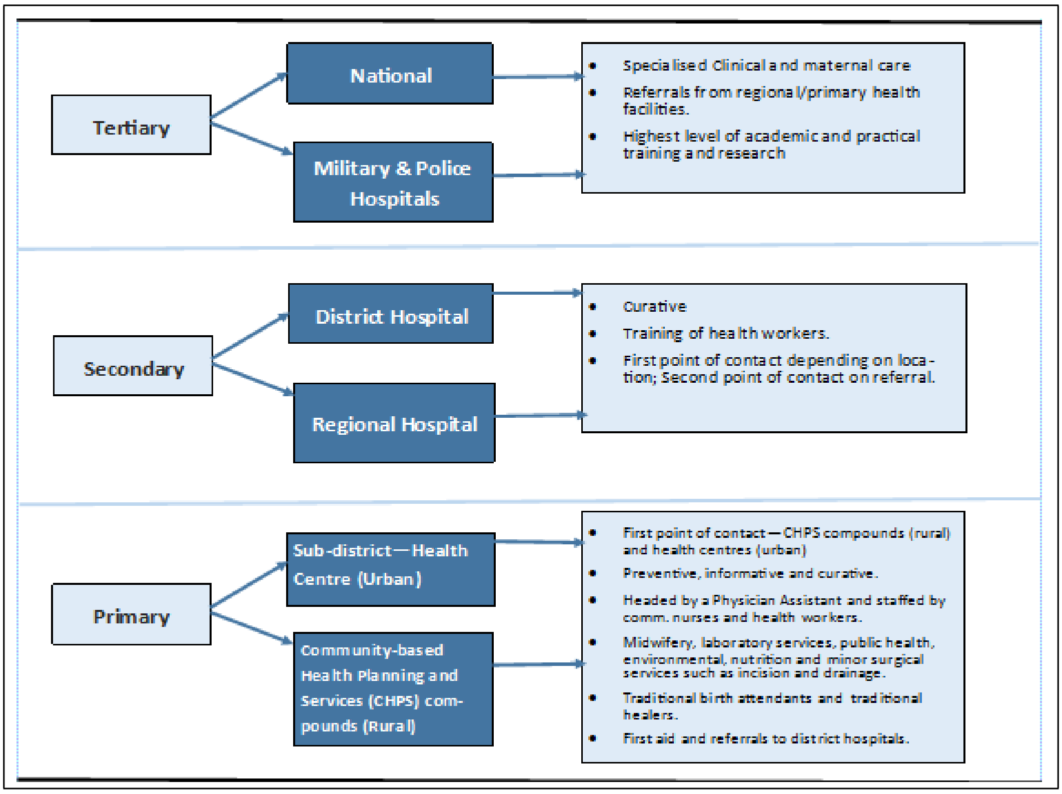


Figure 5.39 Health Care System in Ghana

Health Care Facilities

Several categories of health care facilities are accredited by the National Health Insurance Authority (NHIA) to provide services to subscribers and these include the following[1].

- Community-based Health Planning and Services (CHPS) – this programme was launched because a large proportion of Ghanaians lived over 8 km from the nearest health care provider compounded by inaccessible road and transport networks.
- Maternity homes.
- Health centres.
- Clinics.
- Polyclinics.
- Primary hospitals (district hospitals, primary hospitals of the Christian Health Association of Ghana, quasi- Government primary hospitals and private primary hospitals).
- Secondary hospitals.
- Tertiary hospitals.
- Pharmacies.
- Licensed chemical shops.
- Diagnostic centres.

There are 1,811 government-owned healthcare facilities and 1,356 private healthcare facilities[2]. In addition, the Christian Health Association of Ghana (CHAG) has a network of 302 health facilities and health training institutions owned by 25 different Christian Church Denominations. CHAG provides health care to vulnerable and underprivileged population groups, particularly in remote areas[3].

Approximately 90% of the population in the Region live within a 5 km radius of a medical facility, except for the Nzema East Municipal, where some people live approximately 31 km away from the nearest hospital (*e.g.* 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.

Out of the 133 ambulance stations across the country, only 45 (34%) were functional in 2017. Vehicle response time has been deteriorating since 2015, increasing from 17.4 minutes in 2015 to 30.44 minutes in 2017. A total of 9,180 cases were seen during the year, down by 53% from 14,085 cases in 2016. About 49% of the cases were medical, 28% were trauma and 19% were gynaecological cases[4].

In the 2017 annual health report, the 895 health facilities recorded in the Western Region were made up of 50 Hospitals, 80 Health Centres, 126 Clinics, 601 functional CHPS compounds and 38 Maternity Homes (Table 5.19).

[1] http://www.ghanahospitals.org/categories/ , accessed on 16 June 2022
[2] http://chag.org.gh/index.php/PublicDir/aboutus, accessed on 17 March 2020
[3] Holistic Assessment of 2017 Health Sector Programme of Work, July 2018, published by the Ministry of Health, available at http://www.moh.gov.gh/annual-reviews/ and accessed on 17 March 2020
[4] http://hefra.gov.gh/index.php/licensed-facilities/ - List of health facilities with valid licence, the list does not include pharmaceutical and government facilities), correlated with the facilities listed on http://www.ghanahospitals.org/regions/district_facilities.php?r=western&d=jomoro

Table 5.19 Health Facilities in the Western Region of Ghana

Category	Shama	STMA	Ahanta West	Nzema East	Ellembelle	Jomoro	Total
Clinics.	10	20	7	1	3	6	47
Hospital	4	4	1	1	1	1	12
CHPS	24	27	36	17	28	28	160
Health Centre	3	2	4	4	7	7	27
Total	41	53	48	23	39	42	246

Source: Regional Coordinating Council, Sekondi (2021)

Figure 5.40 L-R: CHPS Compound (Sanzule), Health Centre (Ekebaku), Regional Hospital (Takoradi)

Various illnesses are prevalent throughout the Western Region. In data recorded in hospitals in the region malaria, diarrhoeal diseases, and anaemia were the top three reasons for admission.

The average number of hospital admissions per 1,000 population in the Western Region in 2014 was 59.2, as compared to 55.6 at the national level. Malaria is by far the most prevalent accounting for 39.3 percent of admissions in 2013. Moreover, anaemia and malaria were the top two causes of hospital-recorded deaths, 8.21 and 7.7 percent respectively (Ghana Health Service, 2015).

The Ghanaian government is tackling malaria through the National Malaria Control Program, including a number of initiatives in the Western Region such as treated bed nets for vulnerable groups, intermittent preventive treatment (IPT) given to pregnant women, and pesticide spraying on households and community infrastructure. Malaria as a cause of hospital admissions in the Western Region dropped from 43.7 percent in 2012 to 39.30 percent in 2013 (Ghana Health Service, 2015). However, poor sanitation in the Western Region results in the high incidence of related infections including diarrhoea, typhoid, cholera, dysentery and gastritis.

Traditional Healers and Practitioners

The use of traditional healers is common in Ghana and is recognised by the Ghana Health Service (GHS) as part of the CHPS. 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 anemia, 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 (ERM, 2015).

Common Illnesses and Associated Issues

Error! Reference source not found. provides a comparative overview of Ghana's status against a number of indicators established under the Millennium Development Goals.

Table 5.20 Status of Performance against Millennium Development Goals (2017)

Indicator	Ghana
Under-five mortality rate (per 1000 live births)	49
Maternal mortality ratio (per 100 000 live births)	308
Deaths due to HIV/AIDS (per 100 000 population)	46
Deaths due to malaria (per 100 000 population) (malaria)	69
Deaths due to tuberculosis among HIV-negative people (per 100 000 population) - 2018	36

Source: WHO Global Health Observatory (GHO) data, https://www.who.int/data/gho/data/countries/country-details/GHO/ghana?countryProfileId=5dd8469d-7016-4b93-bf79-3978ef6e25ef ; Centre for Disease Control and Prevention, https://www.cdc.gov/globalhivtb/where-we-work/region/westafrica/ghana/ghana.html

According to the Ghana country profile overview[1]:

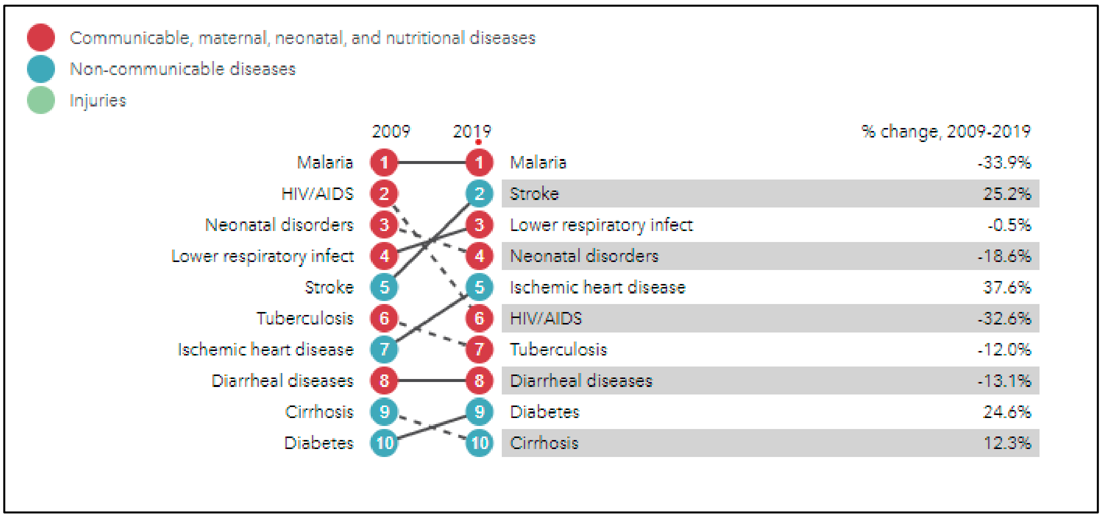
- in terms of the number of years of life lost (YLLs) due to premature death in Ghana, malaria, HIV/AIDS, and lower respiratory infections were the highest-ranking causes in 2010;
- of the 25 most important causes of burden, as measured by disability-adjusted life years (DALYs); diarrheal diseases showed the largest decrease, falling by 65% from 1990 to 2010.
- the leading risk factor in Ghana is household air pollution from solid fuels.

The top ten causes of death among children under five in 2016 were asphyxia (16.6% of morbidity), malaria (11.8%), pneumonia (7.4%), anaemia (4.9%), bronchopneumonia (3.1%), septicaemia (1.7%), gastroenteritis (1.5%), hypoglycaemia (1.3%), HIV/AIDS (0.9%) and enteritis (0.4%). Neonatal deaths accounted for 46% of under-five deaths in 2016. The top ten causes of death among people of all ages in 2016 included malaria (7.2% proportional morbidity rate), pneumonia (7% proportional morbidity rate), asphyxia (6.5% proportional morbidity rate), HIV/AIDS (6.4% proportional morbidity rate) and anemia (5.8% proportional morbidity rate), hypertension, cerebrovascular accidents, diabetes, septicemia and gastroenteritis[2].

The evolution of the top 10 causes of death among people of all ages is illustrated in Figure 5.41. According to IHME, the top six causes of most premature deaths among people of all ages have remained unchanged from 2007 to 2017. The figure also shows that ischemic heart diseases and road injuries have surged within this decade as compared to tuberculosis and meningitis for example who have shown a slight decline in the number of premature deaths.

[1] Ghana – Institute for Health Metrics and Evaluation, available at http://www.healthdata.org/sites/default/files/files/country_profiles/GBD/ihme_gbd_country_report_ghana.pdf and accessed in March 2017

[2] *The Health Sector in Ghana, Facts and Figures, 2017*, released by the Ghana Ministry of Health, available at http://www.ghanahealthservice.org/downloads/FACTS+FIGURES_2017.pdf referring to the results of the 2014 Ghana Demographic and Health Survey conducted within the former 10 regions.



Source: Institute for Health Metrics and Evaluation, http://www.healthdata.org/ghana

Figure 5.41 Top 10 Causes of Death in 2019 and % Change (2009-2019), All Age

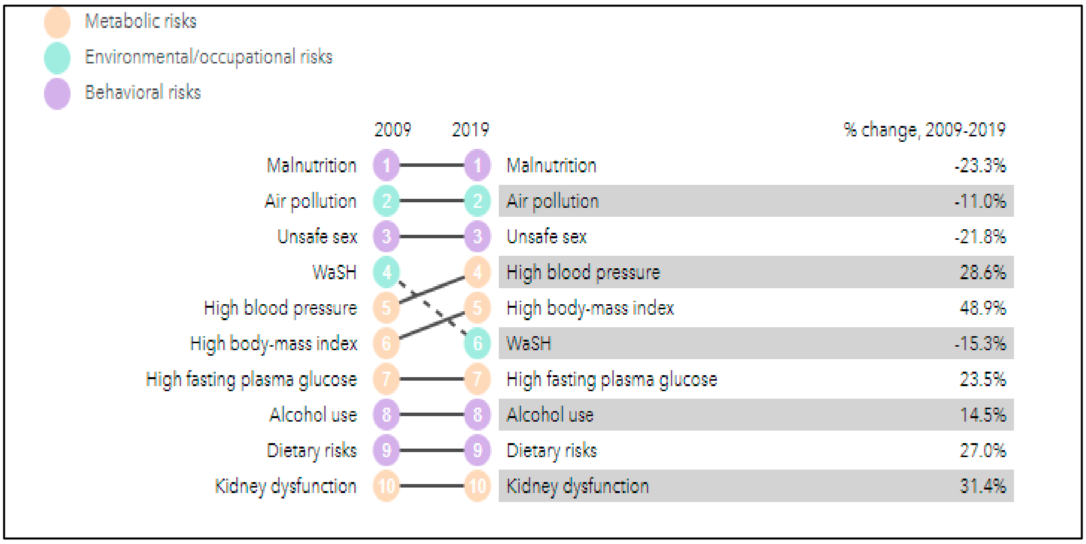
This shows that the most prevalent causes of death have not changed overall during the studied decade. The most notable change is the ranking of HIV/AIDS, which shows a reduction of almost -32.6% of cases in 2019 as compared to 2009.

Road accidents show an increasing trend, as has also been confirmed by the Medium-Term Municipal Development Plans of the coastal districts. Data compiled by the Motor Traffic and Transport Department (MTTD) of the Ghana Police Service has revealed that the total number of commuters killed in road traffic accidents in Ghana in 2018 recorded a 12.76% increase over the figure for 2017.

Non-Communicable Diseases

Non-communicable diseases (NCDs) include coronary heart diseases, diabetes, stroke, peripheral vascular disease, injuries, cancers, and Chronic Obstructive Pulmonary Disease. A number of risk factors related to these diseases can be reduced or eliminated such as tobacco use, alcohol consumption, elevated blood pressure, elevated lipid levels, overweight, low fruit/vegetable intake, physical inactivity, and elevated blood glucose. Clustering these risk factors significantly increases the risk of morbidity and mortality from cardiovascular diseases (Schuit et al, 2002).

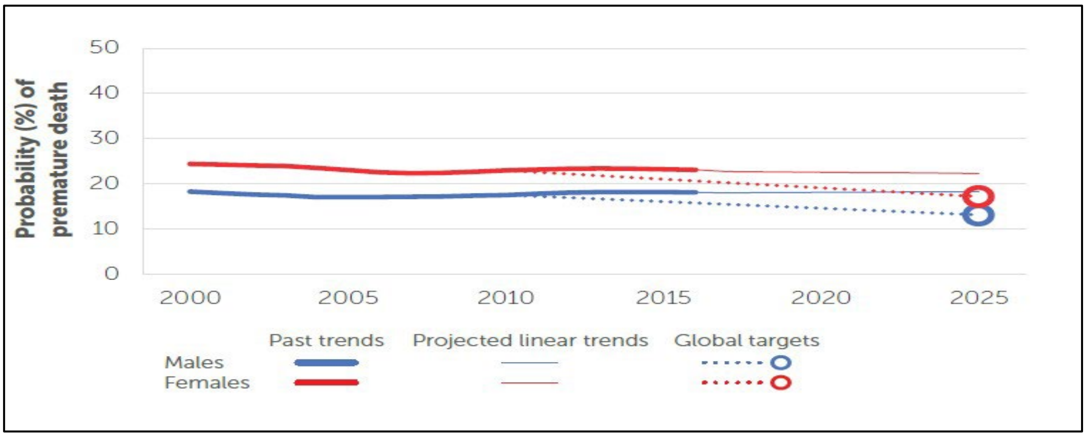
According to IHME, the top two risks that contribute to the disease burden are behavioural risks (malnutrition and unsafe sex) and have not changed from 2007-to 2017 as Figure illustrates. Tobacco uses continue to rank last throughout the decade as compared to alcohol use which shows a surge from seventh to the third-ranking risk factor.



Source: Institute for Health Metrics and Evaluation, http://www.healthdata.org/ghana

Figure 5.42 Risks Contributing to Disability-Adjusted Life Years in 2019 and % Change Since 2009

According to information published by the WHO[1], as of 2016, the probability of premature death due to non-communicable diseases (NCD) as well as projections by 2025 show that Ghana will be above projected global targets, as illustrated in Figure 5.43.



Source: WHO (2018)[2]

Figure 5.43 Risk of Premature Death Due to NCDs

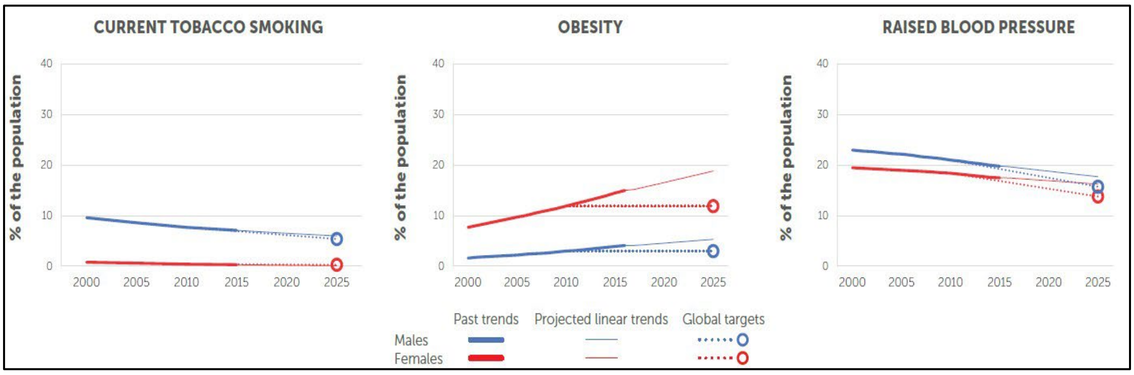
[1] World Health Organization - Noncommunicable Diseases (NCD) Country Profiles, 2018, available at https://www.who.int/nmh/countries/gha_en.pdf?ua=1. The mortality estimates for this country have a high degree of uncertainty because they are not based on any national NCD mortality data indicated by the WHO.
[2] As above

	NATIONAL TARGET SET		DATA YEAR	MALES	FEMALES	TOTAL
MORTALITY*						
Premature mortality from NCDs	X	Total NCD deaths	2016	41 300	53 100	94 400
		Risk of premature death between 30-70 years (%)	2016	18	23	21
Suicide mortality	-	Suicide mortality rate (per 100 000 population)	2016	-	-	5
RISK FACTORS						
Harmful use of alcohol	X	Total alcohol per capita consumption, adults aged 15+ (litres of pure alcohol)	2016	5	1	3
Physical inactivity	X	Physical inactivity, adults aged 18+ (%)	2016	17	23	20
Salt/Sodium intake	X	Mean population salt intake, adults aged 20+ (g/day)	2010	6	6	6
Tobacco use	X	Current tobacco smoking, adults aged 15+ (%)	2016	7	0	4
Raised blood pressure	X	Raised blood pressure, adults aged 18+ (%)	2015	20	18	19
Diabetes	X	Raised blood glucose, adults aged 18+ (%)	2014	5	5	5
Obesity	X	Obesity, adults aged 18+ (%)	2016	4	15	10
		Obesity, adolescents aged 10-19 (%)	2016	1	3	2
Ambient air pollution	-	Exceedance of WHO guidelines level for annual PM2.5 concentration (proportion)	2016	-	-	3
Household air pollution	-	Population with primary reliance on polluting fuels and technologies (%)	2016	-	-	78

Source: WHO (2018)[1]

Figure 5.44 Risk Factors Contributing to Mortality Due to NCDs in 2016

Risk factor trends by 2025 indicate that Ghana will follow global targets in terms of risk due to smoking; however, it will remain above global targets from the perspective of obesity and raised blood pressure. In terms of obesity, trends show that women are much more likely to be affected by this risk compared to men. This is illustrated in Figure 5.45.



Source: WHO (2018)[2]

Figure 5.45 Selected Adult Risk Factor Trends by 2025

HIV/AIDS

According to the National HIV & AIDS Strategic Plan 2016-2020, Ghana is classified as having a generalised HIV epidemic, with HIV prevalence, at the national level, of approximately 2% in adults 15-49 years according to the Ghana Demographic and Health

[1] World Health Organization - Noncommunicable Diseases (NCD) Country Profiles, 2018, available at https://www.who.int/nmh/countries/gha_en.pdf?ua=1. The mortality estimates for this country have a high degree of uncertainty because they are not based on any national NCD mortality data indicates the WHO.
[2] As above

Service (GDHS, 2014) and with significant variations across the country. HIV prevalence among pregnant women has been above 1% over the past seven years [1].

Ghana included the 'treat all' policy in its 2016–2020 National HIV/AIDS Strategic Plan. The adoption of 'treat all' requires strengthening the country's health systems to link and track HIV-positive clients so they can be immediately put on treatment. The current HIV strategy in the country aims at reducing new HIV infections in key populations and increasing retention in care and adherence to treatment.

In 2020 the number of persons living with HIV and AIDS was estimated at 346,120 indicating an increase of 10.7 percent from the 2010 estimated population of 308,992. The estimated number of Persons Living with HIV and AIDS in the Western Region is 25,620 which represents about 7.4 percent of the total national estimate. With regards to new infections, the estimated total new HIV infections for 2020 was approximately 18,928 with the Western Region recording 1,255 representing about 6.6 percent of the national estimate (Ghana AIDS Commission, 2021). HIV/AIDS cases and issues are poorly reported in general in Ghana, however, health professionals in the Western Region reported that HIV infection rates in women are higher than in men.

The causes of the recorded cases are generally attributed to people having multiple sexual partners and trading sex for livelihoods, as well as an influx of infected persons entering the Western Region to live and work, (Ghana AIDS Commission, 2021). The highest number of HIV/AIDS population and new infections in the Western Region is observed at the Sekondi-Takoradi Metropolis, accounting for 22.2 percent of new infections and 24.2 percent of persons living with HIV/AIDS. Nzema East records the lowest with 2.95 percent of new infections and 2.7 percent of persons living with HIV/AIDS. Table 5.21 presents the numbers and percentage of the Western Regional estimates of Persons Living with HIV/AIDS and new infections in the six coastal districts.

Table 5.21 Numbers of Persons Living with HIV/AIDS and New Infections in the Coastal Districts

	Persons Living with HIV/AIDS		**New Infections**	
District	**Total**	**% of WR**	**Total**	**% of WR**
Shama	874	3.41	47	3.75
STMA	6193	24.17	278	22.15
Ahanta West	1650	6.44	86	6.85
Nzema East	703	2.74	37	2.95
Ellembelle	1773	6.92	74	5.90
Jomoro	1944	7.59	101	8.05

Source: Ghana AIDS Commission, 2021

However, there are major gaps in both policy (lack of a structure to incorporate KP community workers into national programs) and programs for key populations (lack of systems to measure the quality and effectiveness of the available interventions, limited capacity and insufficient numbers of community organisations to provide quality prevention, and inadequate

[1] Sekondi Takoradi Metropolitan Assembly Draft Medium Term Development Plan 2018-2021

KP civil society organizational capacity to effectively advocate for changes to address service barriers) to meet these aims[1].

The predominant diseases in Ellembelle District include malaria, respiratory infections and diarrhoea. In Ahanta West, World Vision, an international NGO, is active in the district in the area of HIV/AIDS. This NGO started with small-scale care and support for three people who had been living with HIV/AIDS in the district in 2017. The support includes transportation from their respective communities to the health facilities to access health care. The Conservation Foundation also supports people with HIV/AIDS. The main purpose of the programme is to improve the quality of life of persons living with HIV/AIDS as well as affected individuals and families especially orphans and vulnerable children. Predominant diseases in Ahanta West Municipality include malaria, respiratory infections and diarrhoea. The Draft Medium Term Development Plan 2018-2021 for Sekondi-Takoradi, indicates that prostitution is increasing in the Metropolis. The District records the highest number of Persons Living with HIV/AIDS and highest number of new of infections.

In the Shama District, there is an Anti-Retroviral team in the district, which meets occasionally with the people living with HIV to discuss issues pertaining to HIV and provide support for the latter. This Team is made up of volunteers and is confronted with some challenges that impede their operation. These include inadequacy of funds for conducting regular meetings and a shortage of anti-retroviral drugs and other laboratory logistics for those living with HIV. The Municipal Health Directorate of Nzema East, provides the following HIV/AIDS services in the Axim Government Hospital:

- Prevention of Mother to Child Transmission;
- HIV Testing and Counselling;
- Anti-Retroviral Treatment;
- Opportunistic Infections;
- TB/HIV Blood Donor Screening;
- Free NHIS Registration and Renewal for People Living with HIV, with support from the National AIDS Commission.

Health needs identified in the coastal districts include improving the quality and access to health care delivery services. Among these, reduction of HIV/AIDS prevalence and support to people living with HIV are among the priority areas in the coastal districts.

Cholera

An alert posted on the website of the Ghana Health Service in May 2018 indicates that during the rainy season and due to other prevailing conditions in certain locations in the country, the risk for cholera outbreaks is very high. In 2014, 28,975 cholera cases were reported, out of which 243 people died within all 10 regions of Ghana. In 2015, 618 cases were recorded with five deaths. In 2016, more than 150 cholera cases were recorded in the Central Region with no known death recorded[2].

COVID – 19

Cumulatively, 163,332 COVID-19 cases have been recorded in Ghana since the virus hit the shores of the country in March 2020[3]. The region with the highest recorded cases is the

[1] Online Article Ghana's HIV epidemic and PEPFAR's contribution towards epidemic control, Ghana Medical Journal, March 2019, 53(1): 59–62, doi: 10.4314/gmj.v53i1.9 available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6527824/
[2] https://www.ghanahealthservice.org/ghs-item-details.php?scid=22&iid=140
[3] https://www.ghs.gov.gh/covid19/

Greater Accra Region (92,754) and Savannah Region recording the lowest (292). The Western Region has the third highest number of recorded cases (8,351) after Greater Accra and Ashanti Region.

There have been 160,823 recoveries since March 2020 with the Western Region seeing a recovery rate of 98.8 percent, a little above the national recovery rate of 98.5 percent.

On Covid vaccination, according to the Ghana Health Service, 16,396,820 doses have been administered. Persons fully vaccinated are 6,950,095, 30.4 percent of the targeted 22.9 million persons while those who have received one dose stand at 10,223,563, 44.7 percent of the targeted 22.9 million and 32.2 percent of the entire population of Ghana. In the Western Region, 26.9 percent of the population is fully vaccinated.

Table 5.22 below details COVID-19 cases recorded in the six coastal districts of the Western Region.

Table 5.22 COVID-19 Cases Recorded in the Western Region

District	Recorded Cases	Deaths recorded	Recoveries
Shama	336	1	335
STMA	2775	30	2745
Ahanta West	271	1	270
Nzema East	302	1	301
Ellembelle	211	4	207
Jomoro	109	1	108

Source: Western Regional Health Directorate, 2022

The incidence of Covid-19 cases closely follows the population density of the districts. The highest population density is in Sekondi-Takoradi Metropolis (1,847 people/km^2), which shows the metropolitan nature of this district. The following are Shama (379 people/km^2), Ahanta West (180 people/km^2), Jomoro (112 people/km^2), with Ellembelle (36 people/km^2) and Jomoro (26 people/km^2) at significantly lower densities.

5.6.12 Utilities, Infrastructure and Services

Water and Sanitation

Safe drinking water, sanitation and hygiene (WaSH) is widely recognised as a human right [1] that is vital for ensuring the health, welfare and productivity of an individual or community and fighting against transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid and polio.

Access to improved water sources, level of service and sustainability of the water supply systems represent dominant concerns in both rural and urban areas of Ghana, despite the fact that the proportion of the population without sustainable access to safe drinking water was halved between 1990 and 2015 [2]. Reasons include high capital costs and lack of a structured asset management system[3]. According to a study conducted in 2013, 33% of

[1] The UN General Assembly and Human Rights Council in 2010 and in 2015 explicitly define access to water and sanitation as a human right

[2] Delegation of German Industry and Commerce in Ghana, available at https://www.ghana.ahk.de/fileadmin/AHK_Ghana/Access_to_Clean_Drinking_Water_Sustainable_Water_Management_in_Gha na.pdf and accessed in March 2020.

[3] Kumasi, Tyhra Carolyn. (2018). Financing Sustainable Water Service Delivery of Small Town Water Systems in Ghana: The Gaps and Needs. 6. Page 427.

water points in Ghana were non-functional and a further 30-40% of the water points were delivering services below the basic acceptable levels.[1]

There are various organisations involved in the development and maintenance of the water infrastructure, which work in partnership with the District Assemblies. The Ghana Water Company Limited (GWCL) supplies potable water for domestic, industrial, institutional and commercial purposes within the region. Additionally, the Community Water and Sanitation Agency (CWSA) provides boreholes to communities with lower populations. Sustainable Rural Water and Sanitation Project (SRWSP), a World Bank project, supports the increase and improvement of access to water supply services through the construction and rehabilitation of on-site and piped water supply systems. Other actors include NGOs (e.g. Safe Water Ghana) or companies operating locally, via their community investment programs (e.g. Golden Star Resources (Wassa Mine)).

There are a series of major sources of drinking water: piped (inside the dwelling, outside the dwelling, tanker supply), well (covered, uncovered), borehole and natural (spring, river, stream, lakes and rainwater). Any of the following types of supply – piped water (into dwelling, compound, yard or plot, to a neighbour, public tap/standpipe), tube well/borehole, protected dug well, protected spring, rainwater collection, and packaged or delivered water are considered protected sources, whilst the rest present very high risk or may be contaminated with human or animal faeces containing pathogens, or with chemical and physical contaminants.

Jomoro District presents the lowest percentage of residents with access to safe water sources (54%), whilst Sekondi–Takoradi has the highest number of residents with access to pipe-borne inside dwellings (29%). Table 5.23 presents water coverage and sources.

[1] As above. Page 428

Table 5.23 Safe Water Coverage and Sources

District	Safe Water Coverage Estimation	Water Sources
Jomoro Municipal	54%	boreholes
		small town water system
Ellembelle District	90%	small town water system
		boreholes
Nzema East Municipal	70%	boreholes 30.1%
		protected wells 12.3 %
		pipe-borne outside dwelling 10.3%
		pipe-borne inside dwelling 6.8%
		public tap 4.4%
Ahanta West Municipal	90%	boreholes 37%
		small town water system 35%
		public tap 26%
		hand dug wells 0.01%
Sekondi Takoradi	80%	public tap 50%
		pipe-borne inside dwelling 29%
		pipe-borne outside dwelling 16%
		public well 2.5%
		in yard well 2.4 %
		boreholes 0.65 %
Sharma District	90%	public tap 43%
		pipe-borne outside dwelling 31%
		pipe-borne inside dwelling 10%
		protected wells 1.4 %

Notes:

1. Many of the boreholes or the wells are not functional and require rehabilitation, thus the above figures do not necessarily represent the actual coverage[1].
2. Service level is a major challenge across the six districts and nationally. The level of service prescribed by the Community Water and Sanitation Agency (CWSA) is 20 litres per capita per day, within 500 m, 95% functional in a year, 300 persons using a hand pump/spout and of good water quality.

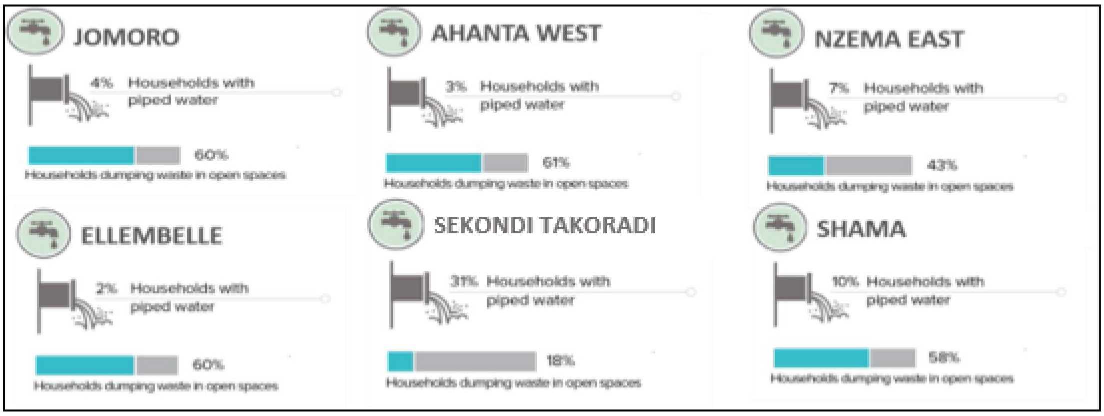
Sources:

- Medium Term Development Plans (2018 – 2021) for Jomoro, Sekondi-Takoradi, Ahanta, Ellembelle and Sharma Districts
- Nzema East Municipality – 2010 Population and Census – District Analytical Report

Lack of access to safe sources of water or the irregularity of the water supply significantly raises the risk of outbreaks of oral-faecal diseases (e.g., cholera and typhoid) or other water-related diseases caused by the rivers' pollution or salt-water intrusion.

Water security and sanitation is a focus area in all the District Medium-Term Development Plans (2018-2021) in the study area, to be improved via additional mechanised boreholes and small-town water systems, and building capacity for planning and maintenance of the existing facilities. The household water supply-demand increased in all study areas, and Sharma District was ranked by the local population as the priority for development.

Figure 5.46 shows the status of percentage of pipe-borne inside dwelling access across the six settlements, coupled with the waste disposal status.



Source: District Profiles (2017) published on the WRCF webpage, http://wrcfghana.org/publications.

Figure 5.46 Piped Water Supply and Waste Disposal in the Six Coastal Districts

Tightly linked to water access and water infrastructure, proper sanitation remains a critical issue in the country and the region, confronted with perennial outbreaks of cholera and other communicable "toilet" related illnesses. Ensuring access to basic sanitary services is also a key development priority for all the six districts under analysis.

According to Ghana Statistical Service 2017/2018, only 66.5% of the population in Western Region has access to improved sanitary facilities[1], very similar to the 65.2% national average. The percentage of open defecation, an issue that is on the agenda of all MTDPs 2018 – 2021 of the six districts, is however 15% in the Western Region compared to the 21% registered nationally.

Table 5.24 shows the distribution of household population according to type of sanitation facility at national level and in the Western Region.

Those using shared or public sanitation facilities, be they improved, are classed as having a 'limited' service; households using improved sanitation facilities that are not shared with other households meet the Sustainable Development Goal's criteria for a 'basic' sanitation service, and may be considered 'safely managed' depending on how excreta are managed. In the Western Region, only 21% of the population has access to basic sanitation services according to the UN's definition, whilst 44.5 % benefit from limited access – see Table 5.25 for more details.

[1] An improved sanitation facility is defined as one that hygienically separates human excreta from human contact.

Table 5.24 Distribution of Household Population by Type of Sanitation Facility (2017-2018)

	Type of sanitation facility used by household	National			Western Region %
		Urban %	Rural %	Total %	
IMPROVED SANITATION FACILITY	Flush piped sewer system	3.8	0.2	1.9	0.2
	Flush septic tank	28.9	3.6	15.3	14.5
	Flush pit latrine	4.0	1.0	2.4	2.8
	Ventilated improved pit latrine	27.9	17.6	22.3	14.8
	Pit latrine with slab	10.5	25.2	18.4	20.6
	Composting toilet	0.4	0.1	0.3	0.2
	Pit latrine with seat	4.2	4.0	4.1	12.9
	Percentage using improved	**80.7**	**52.0**	**65.2**	**66.3**
UNIMPROVED SANITATION FACILITY	Flush to open drain	0.2	0.0	0.1	0.0
	Pit latrine without slab/ open pit	6.4	16.9	12.1	17.8
	Hanging toilet/ latrine	0.4	0.0	0.2	0.0
	Open defecation[1]	11.4	30.6	21.7	15.5

Source: adapted from Ghana Statistical Service, 2018. Multiple Indicator Cluster Survey (MICS2017/18), Survey Findings Report. Accra, Ghana: GSS.

[1] A practice of disposing faeces in fields, forests, bushes, open water bodies of water, beaches or other open spaces, or with solid waste

Table 5.25 Distribution of Household Population by Use of Sanitation Facilities (2017-2018)

	Type of use	National			Western Region %
		Urban %	Rural %	Total %	
IMPROVED SANITATION FACILITY	Not shared[1]	24.6	17.3	20.7	21.3
	Shared by 5 households or less	12.9	14.3	13.6	18.2
	Shared by more than 5 households	8.6	3.5	5.9	7.7
	Public facility	34.5	16.4	24.8	18.6
UNIMPROVED SANITATION FACILITY	Not shared	1.4	4.8	3.2	1.7
	Shared by 5 households or less	0.9	3.1	2.1	3.4
	Shared by more than 5 households	1.0	1.0	1.0	1.6
	Public facility	4.5	8.4	6.6	11.5

Source: adapted from Ghana Statistical Service, 2018. Multiple Indicator Cluster Survey (MICS2017/18), Survey Findings Report. Accra, Ghana: GSS.

In Sekondi-Takoradi Metropolis, close to 70% of slum dwellers lack access to basic sanitary facilities. In addition, the non-existence of a strong platform for landlords and STMA to collaborate in the provision of these basic facilities further worsens the situation where open defecation persists[2]. The Metropolis Assembly Development Plan for 2018 – 2021 builds on the lessons learned from the attempt to assist 500 households with toilet facilities that resulted in only 23% of the target being achieved. The assembly intends to intensify the collaboration between the Global communities and City-Wide Slum Upgrading Fund to improve the overall public sanitary facilities in the Metropolis and especially in the inner cities, where most people in the communities have to queue daily for long hours early morning to access public or shared toilet facilities, wasting productive hours and ending up resorting to open defecation (Sekondi-Takoradi MTDP 2018 – 2021).

In Ahanta West, the Assembly estimates that 27.3% of the population has access to household toilet facilities. In the urban areas, 43% of the people use Ventilated Improved Pit (VIP) latrines, followed by 38.5% using flush toilet, whilst in the rural areas the main facilities used are the open and the KVIP[3] latrines. The Assembly is promoting and enforcing the construction of household toilet facilities by each household, especially in the newly built-up areas, in conformity with the national sanitation policy. In addition, the Assembly aims to

[1] According to the Multiple Indicator Cluster Survey (MICS 2017/18), those using shared or public improved sanitation facilities are classed as having a 'limited' service for SDG monitoring. Households using improved sanitation facilities that are not shared with other households meet the Sustainable Development Goal's criteria for a 'basic' sanitation service, and may be considered 'safely managed' depending on how excreta are managed.
[2] The Open Government Partnership Initiative, Subnational Action Plan for the Sekondi-Takoradi Metropolitan Assembly, 2017 available at http://www.stma.gov.gh/stma_metro/docs/827Sekondi-Takoradi%20Draft%20OGP%20Action%20Plan%202017.pdf and accessed in March 2020.
[3] KVIP stands for 'Kumasi Ventilated Improved Pit' and is a pit latrine commonly used in Ghana usually constructed with hand-washing stations.

raise the percentage of households with access to basic sanitation from 15% in 2017 to 40% in 2021, but also double the number of institutional latrines from 50 to 100 and build an additional 1,500 household latrines in the same plan period (Ahanta West Municipal MTDP 2018 – 2021).

Energy

The Power Distribution Services (PSD) is responsible for the distribution of power across southern regions of Ghana, including the Western Region. In the Western Region, electricity and kerosene lamps are used as the main sources of lighting with electricity dominating in urban areas and kerosene lamps in rural areas.

However, 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 (including urban dwellers), however liquid petroleum gas (LPG) and coconut husks are also used as a source of cooking fuel.

There have been frequent power shortages in Ghana in some previous year and this was linked to increased demand and limited power infrastructure. In some areas, residential customers experienced up to 24 hours of power outage for every 12 hours of power and thus are forced to use back-up power, kerosene lamps or forgo power. Ghana's businesses typically do rely on diesel generators that are easily purchased in country (Paradi-Guilford, 2015). Though the situation has seen significant improvement since 2017, there are still a few areas and occasions of power shortage in the country.

In Sekondi-Takoradi, only 60% of the rural areas have access to electricity, whilst in the urban areas 90% of the areas benefit from public lighting.

In Jomoro District, 87.1% of the households in urban areas and 61% of the households in rural areas are using electricity. Other sources include kerosene lamps (8.9% in urban and 22.6% in rural localities) and flashlight/ torch (1.4 % in urban and 22.6% in rural areas). 0.1% of the households in the district use gas lamp, solar energy, firewood, crop residue and other sources of light.

In terms of domestic use, firewood is the main sources of energy (36.1%), followed by kerosene (21.7%), charcoal (13.4 %) and liquefied petroleum gas (4%). The extensive use of firewood has led to a depletion of the forest fund.

In Ellembelle District, 70% of the entire district is connected to the grid, with the majority of the community from the northern part of the district yet to be connected. Lack of electricity in the Northern part of the district has led to the use of alternative energy solutions – e.g., solar panels, according to the Ellembelle District Assembly.

Waste Disposal

Typical liquid and solid waste management in Western Region does not meet basic sanitary requirements. Poor liquid waste [1] disposal causes the contamination of groundwater and produces serious health implications for both urban and rural communities in the six districts. For example, only 3.3% of the wastewater is disposed via the sewage system in the urban areas of Shama, whilst the rest is disposed directly in the environment (30.1%) or in the gutter (30%) [2]. In the peri-urban areas of Sekondi-Takoradi Metropolis, most wastewater is

[1] There are two liquid wastes; wastewater and fecal. The fecal are transported by cesspool emptier the appropriate treatment site at the landfill.
[2] Shama District Medium Term Development Plan 2018 – 2021

disposed of directly into the gutter (35%), followed by thrown into compound (30.5%) and thrown into streets (21.8%) [1].

The majority of landfills for solid waste are open, unlined, and largely unmanaged, giving rise to scavenging activities on the dumping sites and associated risks of disease, infection and personal injury (see Figure 5.47). In Ahanta West Municipal, Jomoro, Shama and Ellembelle Districts, 60% of the households are dumping waste in open spaces, whilst in Nzema East Municipal 43% use this method. Waste is burned at the site periodically to reduce waste levels.

Figure 5.47 Typical Open Waste Dump in the Western Region

An overview of the waste management context in the coastal districts (where information was available) is provided below.

- Ahanta West. Only four of the 123 communities benefit from skip containers, according the 2018– 2021 Medium Term Development Plan. The Plan notes that the waste management service is unsatisfactory even in these cases, due to inadequate skip containers, irregular haulage of containers by the Assembly and indiscriminate dumping practices. There are 250 dumpsites in the District; out them, only 14 are approved, whilst the rest of 231 are not managed properly. There is only one final disposal site for solid waste in the District Capital. Two small incinerators are in use at Princess Town and Princess-Aketakyi, with a new one being built in Agona Nkwanta at the time the MTDP was created.
- Sekondi Takoradi Metropolis. The Waste Management Department of the Metropolitan Assembly is responsible for waste management and, to a lesser extent, private companies that engage in waste collection as part of their social responsibility. The Metropolis benefits from one engineered landfill located at Sofokrom. According to the Metropolis Assembly's Middle Term Development Plan for 2018 – 2021, collection of

[1] Sekondi-Takoradi Medium Term Development Plan 2018 - 2021

solid waste is done in two ways in the Metropolis: 22.6%[1] door-to-door (service usually provided to middle class urban communities – e.g., Chapel Hill and Beach Road) and 47.1% by communal container system (provided to poorer class communities, like New Takoradi, Amanful, Kwesimintsim, Effiakuma and Kojokrom). Other forms of disposal include burning (19%, only in rural areas) and dumping in public open spaces (42.9% in rural areas and 17.4% in urban areas). The Assembly's goal for the 2018 – 2021 Plan period is to make the Metropolis the neatest city in the country. Some of the programmes outlined to achieve the set goal include household toilet facilities, recycling, a 'Waste to Energy' Project, safe management of human excreta and wastewater, education and behavioural change and law enforcement.

- Shama. Approximately 58% of the households are dumping waste in open spaces, with a higher percentage recorded in rural areas (68%) compared to urban areas (50.4%), according the Shama District Assembly's Medium Term Development Plan for 2018 – 2021. Other means of disposal include burning the waste (9.7% in rural and 5.9% in urban areas) and indiscriminate dumping (6.1% in rural and 1.9% in urban areas).

Similar information for Jomoro, Ellembelle and Nzema East districts was not available in the Medium- Term Development Plans prepared for these districts.

Roads

An overview of the road network and conditions in the coastal districts is provided below.

- JomoroThe road network of the Municipal Assembly consists of 40.5 km of highways and 471.2 km of feeder roads. The latter are in poor conditions and become impracticable during heavy downpour [(2)].
- Ellembelle. The road network of Ellembelle District Assembly benefits from 233 km of roads that link the District Capital to the sub districts, out of which only 61 km are tarred and the remaining 72% are gravelled or feeder roads. The untarred roads that link the food producing areas are mostly poorly maintained, lack bridges and culverts and tend to become almost inaccessible during rainy season. This raises significant development obstacles, considering that, with the exception of a few communities along the Ankobra River that can use boats, the main means of transportation in the district is by road. In particular, the Aiyinase North sub-district is inaccessible by car, moreover in the rainy season, causing trade with other districts to become impossible. The problem with the northern part of the district is more extensive, as the entire area suffers from lack of access to potable water as the drilling vehicles cannot access the area. To address this issue, the Assembly has built and access road linking the northern and southern parts of the district but require the Feeder Roads department to complete it [(3)].
- Nzema East. The Municipal trunk road network totals 120 km, of which only 30 km is tarred (part of the Trans-African Highway); this is being complemented by 200 km of feeder roads. From the entire network, only 100 km are accessible by car throughout the year. The road infrastructure is complemented by the use of fibreglass boats to transport goods on the Ankobra River. Most of the feeder roads are located in the southern part of the Municipality, where transportation between farms is done by foot, but lack of maintenance and the absence of bridges and culverts render some areas completely inaccessible during rainy season. Besides poor road quality, the density of the networks is an issue, with many of the farming communities not being linked by road at all. Some

[1] 23.2% of urban households have their solid waste collected, while in rural areas only 7.1% benefit from this service.
(2) Source: Jomoro Municipal Assembly Final Medium-Term Development Plan 2018-2021
(3) Source: Ellembelle District Assembly, Draft Medium-Term Development Plan 2018 – 2021, page 102

settlements can only be reached by access through another district (e.g. most parts of Kutukrom and Gwira areas) [(1)].

- Ahanta West. Out of the district's 200 km road network, 85% represents untarred roads, which during the heavy rainfall makes some of the settlements completely inaccessible, hindering access to basic services or trade. The only asphalt section is the Trans West African road that passes through the District Capital Agona Ahanta, along with a series of other paved roads linking the capital to Dixcove and Busua, Aboadi to Ayiem and Funkoe and New Amanful roads. Most of the main district facilities are situated in the main road corridor Takoradi - Apowa - Agona Ahanta– Abura – Ellubo, making access for the settlements located outside the main highway very difficult and expensive; access to hospital, health centres, weekly market, bank, etc. is described as poor [(2)]. If the standard time for accessing facilities like hospital and health centers is around 30 minutes in the more connected areas of Ahanta West Municipal district, people in Princess Town or Egyambra have to spend more than one hour to access facilities in the district capital. The Ahanta Medium-Term Development Plan 2018 – 2021 notes, however, that there has been considerable improvement in the road infrastructure that has reduced travel and waiting times. Public road transport services are provided by the Ghana Private Transport Union and other minor transportation groups of the Trades Union Congress with cargo trucks, mini-trucks, mini- buses and taxis.
- Sekondi Takoradi Metropolis. The urban roads network in the Sekondi Takoradi Metropolitan Assembly is 688.43 km. It consists of arterial, distributors/collectors and local roads of which 381.21 km are paved and 307.22 km unpaved. STMA's network consists of a hierarchy of arterials, which distribute traffic between Sekondi and the centre of Takoradi. A major missing link within the network is the Nkroful Junction-Kwesimintsim. In addition, a system of collectors and local roads complete the network within the Metropolis. In terms of the surface condition of the roads, it is estimated that 48.3%, 5.1% and 46.7% are good, fair and poor respectively [(3)].
- Effia Kwesimintsim. The Municipality has a road network of 346 km, with 17.05% being in 'Good' condition, 3.46% in 'Fair' condition and 79.49% in 'Poor' condition. A significant proportion of the total network is also unpaved. Most of the roads in the municipality are narrow by design (single lane) and are in bad condition. The Municipality is also crossed by the Takoradi-Axim Highway, the Takoradi-Accra Highway as well as the Kansawurodo-Apollo N1 Highway. These major roads make the municipality easily accessible from all parts of the country.
- Shama. The road transport network in Shama District has a total length of 91 km, out of which 20% are tarred; overall, roads are of poor quality. There is also a high incidence of road accidents determined by inadequate investment in road transport infrastructure and weak enforcement of road traffic regulations. Improvement of the transport infrastructure (road, railway and water) was identified as a development objective so that Shama District can reposition itself to harness development opportunities arising from the proximity to Sekondi-Takoradi Metropolis and attract investment in the forms of industries and residencies.

[(1)] Nzema East Municipal Assembly Composite Budget For the 2015 Fiscal Year, page 3
[(2)] Source: Ahanta West Municipal Assembly, Medium-Term Development Plan 2018-2021, page 84
[(3)] Sekondi-Takoradi Metropolitan Assembly, Final Draft Medium-Term Development Plan 2018-2021, page 83

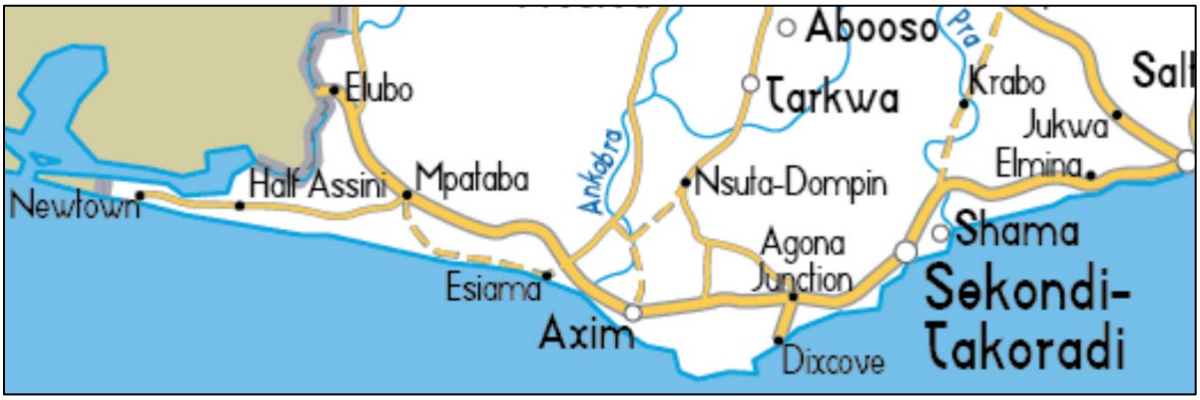


Figure 5.48 Main Coastal Road from Shama to Newtown

Ports and Harbours

The Ghana Ports and Harbours Authority (GPHA) manages all ports and harbours in Ghana and provides falities for bunkering, stevedoring and handling, electricity and water supplies. The main ports in Ghana are located at Tema in the east and in the twin towns of Takoradi and Sekondi in the west. Approximately 85% of Ghana's trade is done through these ports[1].

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 shows the locations of some major coastal fishing towns in Ghana and some images of the main ports.

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 a 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.

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, Elmina and Mumford. 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:

- the chief (omanhene) and lineage elders (mpanyinfo);
- the chief fisherman (apofohene) and the fisher woman or queen of the fish traders (konokohemaa); and
- fishing companies linked to old military (asafo) companies in the community (Marquette et al 2002).

[1] https://www.ghanaports.gov.gh/page/index/4/ZE4GGQFA/Welcome-to-Port-Of-Tema

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 capacity for boat building is low.

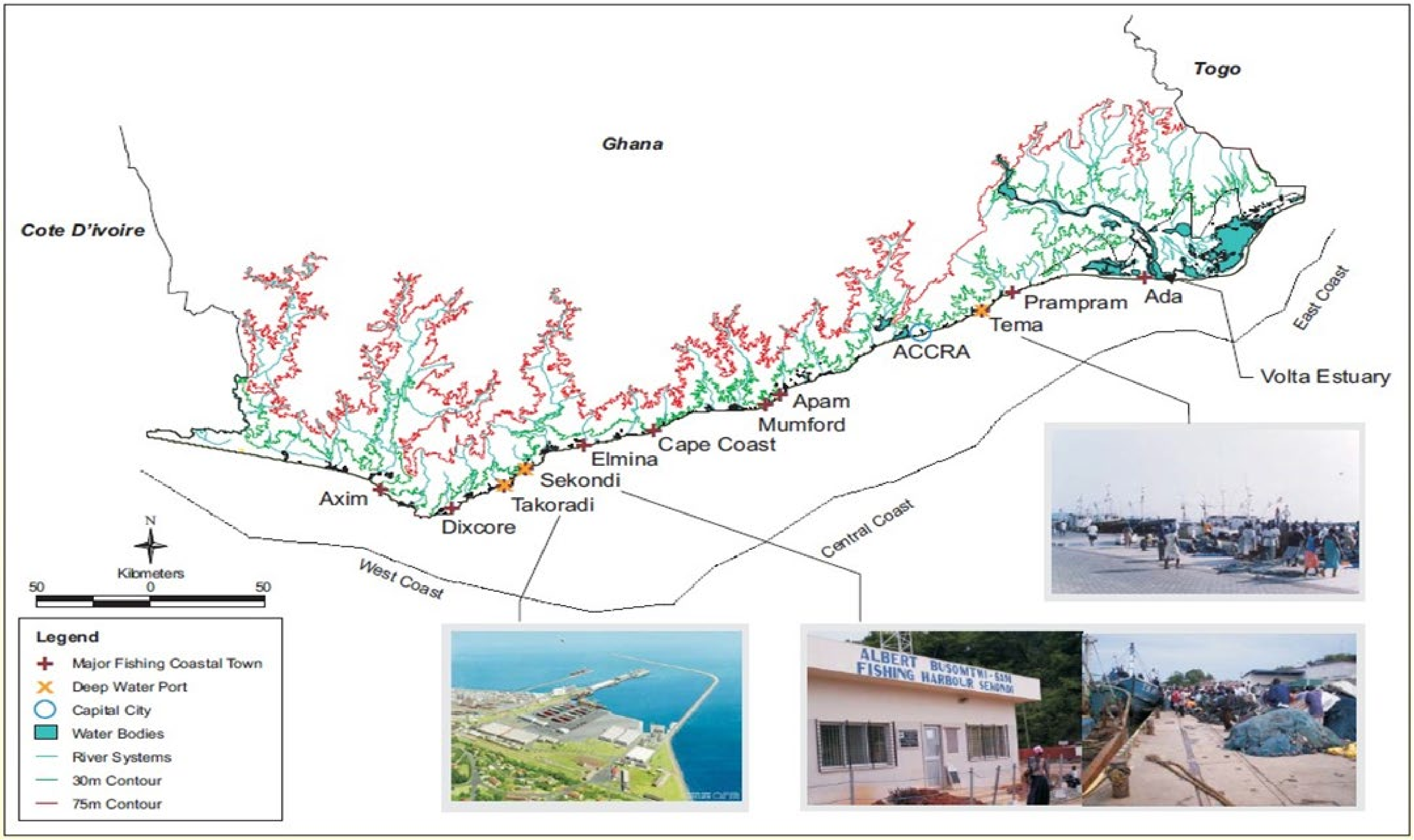
The Tema Boatyards and Drydock Corporation also provides dry-docking and repair facilities for all categories of fishing vessels and there are one other repair facilities at Tema. A number of private companies in Tema, Accra and Takoradi operate engineering workshops with foundries to undertake fishing vessel maintenance and repairs, although these facilities are in the need of investment to allow them to be fully operational.

The nearest operational commercial port to the Project Area is the Port of Takoradi. Sekondi-Takoradi possesses the majority of the basic infrastructure required to support the current offshore oil and gas industry.

Most oil and gas operational support bases are located in Sekondi-Takoradi, with administrative offices in Accra to deal with administrative and government relations. The Takoradi Airbase is used to run flights between offshore oil facilities in the region and Accra (Quayson 2012).

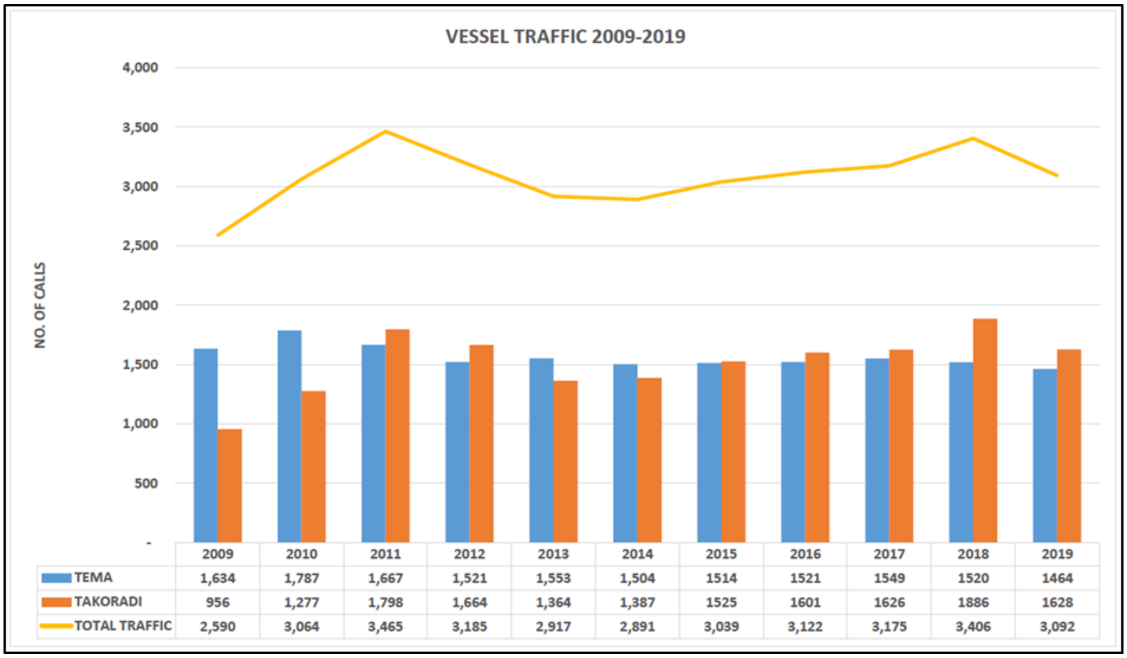
The Port of Takoradi was built as the first commercial port of Ghana in 1928 to handle imports and exports to and from the country respectively. The initial capacity of the port was 1 million tonnes of cargo.

With the first expansion in 1956, the port was able to handle 1,153 vessels carrying 2.3 million tonnes of cargo in 1964. The port in 2015 handled 27% of national seaborne traffic, 15% of national seaborne imports, 68% of national seaborne exports, 6% of National seaborne container traffic and 7% of transit traffic to the Sahelian countries of Burkina Faso, Niger and Mali. Over the years, vessel calls to the port have increased from 485 in 2003 to 1628 in 2019 (see Figure 5.50 presenting the performance of Tema and Takoradi Ports). The increase is attributed to the calls from Oil Supply vessels servicing the Jubilee Oil Fields at Cape Three Points.



Map Source: Coastal Zone Profile of Ghana (1998)

Figure 5.49 Location of Fishing Towns and Ports in Ghana



Source: GHPA, https://unity.ghanaports.org/publications/2ae93e7901d14c6c96b9725ac2719eb1.pdf

Figure 5.50 Tema and Takoradi Port Performance 2009-2019

Since the discovery of oil in 2007, supply vessel calls have increased from 11% to 52% in 2019 of total vessel calls (www.ghanaports.gov.gh). The Port of Takoradi is served by major shipping lines including Maersk, MSC, Delmas, Bolloré Group, CMA CGM, Hull Blyth, ISAG, Supermaritime, Macro Shipping, Conship, AMT, Comexas and SevenLog (Ghana Ports Handbook 2018-2019).

Given the presence of oil and gas operators in the region some of the dry docks at the port are being utilised as an assemblage and receiving point for industrial goods such as heavy materials and oil pipes that are then transported to offshore locations. The port was modernised in 1986 but the development of oil and gas in the region necessitated further expansion of the port. The Port of Takoradi has embarked on a major expansion and investment program to transform the port's capacity, facilities and operations. Phases I and II of the Project include the extension of the breakwater; provision of a bulk terminal/jetty to handle bulk commodities and dredging of the access channels and berths. The new bulk jetty will allow the port to handle larger vessels of between 200 and 250 metres LOA and 16.0 metres draught and 100,000 dwt capacity.

On completion, manganese, bauxite, clinker, limestone and other bulk cargo operations will be transferred to the new bulk jetty. There will also be a dedicated berth (oil and gas hub) with a depth of 10.0 metres to cater for supply activities related to the oil industry. The Project will involve reclaiming of the log pond area that will be used to build a 1 km quay with a depth alongside of 16 metres. Additional 770 metres of quay wall will be reclaimed from the existing berth 2 to 6 with 11-meter depth (GPHA 2019). The terminal is planned to be operational by the end of 2020[1]. Hence, the Port will continue to be the key logistics support base for the region's offshore industry by virtue of its proximity to the Tweneboa Enyenra Ntomme (TEN) and Jubilee fields, approximately 90 nautical miles from Takoradi as well as the Pecan field.

[1] Ghana Ports Handbook 2018-2019

Source: GPHA (Ghana Ports Handbook 2018-2019)

Figure 5.51 The upgraded Takoradi Port New Quay and Extended Breakwater

Various strategic measures have been introduced by the GHPA to support the oil and gas sector. These measures include the following.

- Tullow Oil Ghana Ltd has been leased a dedicated berthing space of 100 metres in length to support its operations.
- Land within the port has been leased to oil and gas support service providers in Ghana to enable them to serve the Jubilee and TEN oilfields.
- General Electric (GE), specialising in deepwater offshore services and supporting Eni operations, has secured a 10,000 square metre area in the port for the fast assembly and testing of subsea Christmas trees for the Offshore Cape Three Points (OCPT) integrated oil and gas project.
- Belmet 7 has secured space for its fabrication yard specialising in subsea and complex structures for Ghana and beyond. The fabrication yard has direct access to a 200 m long quay and is equipped with crawler cranes of 400 tonnes and 220 tonnes capacity for loading and offloading of large structures and transfer of items between ships and barges. The yard has a Davi MCB N-30 heavy plate-rolling machine with additional capability to fabricate piles of 24 m in height and 4 to 8 metres diameter.
- FMC Technologies has been operating from its service base in the port since 2008, supplying manifolds, riser bases, subsea controls, topside controls and most of the subsea trees for the Jubilee field.

The GHPA has partnered with Viking Offshore & Marine and Halliburton to construct a mud plant and install a desalination plant with an hourly capacity of 29 tonnes to supply water on a continuous basis to the oil and gas sector for drilling activities. In addition, GPHA has a partnership with Ghana Oil Company to construct a 13.5 million-litre capacity marine gas oil (MGO) tank farm to supply vessels calling at Takoradi. GHSA has partnered with Prime Meridian Docks Ghana Ltd to position a floating dry dock in the port for the use of vessels operating in the subregion, especially offshore supply vessels. A pier of 330 metres in length will be developed within the harbour basin to accommodate the floating dock.

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. 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.

The fishing harbour at Sekondi has been expanded with support from the Japanese International Cooperation Agency (JICA)[1]. The expansion involved:

- extension of breakwater by 188 metres;
- the new road has a total width of 9 metres with a walkway of 2 metres width on either side;
- installation of a new ice plant with a daily capacity of 15 tonnes (600 blocks of ice);
- a new one-storey administration block; and
- a new water tower with a capacity of 20 tonnes to improve sanitation at the harbour.

Shipping and Navigation

The Gulf of Guinea experiences high maritime traffic. Figure 5.52 provides a general illustration of shipping lanes across the Gulf of Guinea. The total number of different ships recorded during Oct 2012 to Mar 2013 was approximately 12,000, while the daily average number of ships was over 2,500.

For fishing ships, passenger ships, cargo ships and tankers, the daily average numbers were approximately 125, 190, 850 and 505 respectively. The activities of passenger ships, cargo ships and tankers were relatively constant over the period, whereas the activity of fishing ships and yachts changed from month to month (Greidanus et al 2013).

Maritime piracy in West Africa is increasing and the seas around West Africa remain the world’s most dangerous for piracy (ICC 2019[2]). Of the 75 seafarers taken hostage onboard or kidnapped for ransom worldwide in the first half 2019, 62 were captured in the Gulf of Guinea – off the coasts of Nigeria, Guinea, Togo, Benin and Cameroon. Three incidents of piracy occurred in Ghana in February to March 2019 related to anchorages off Takoradi.

[1] Ghana Ports Handbook 2018-2019
[2] https://icc-ccs.org/

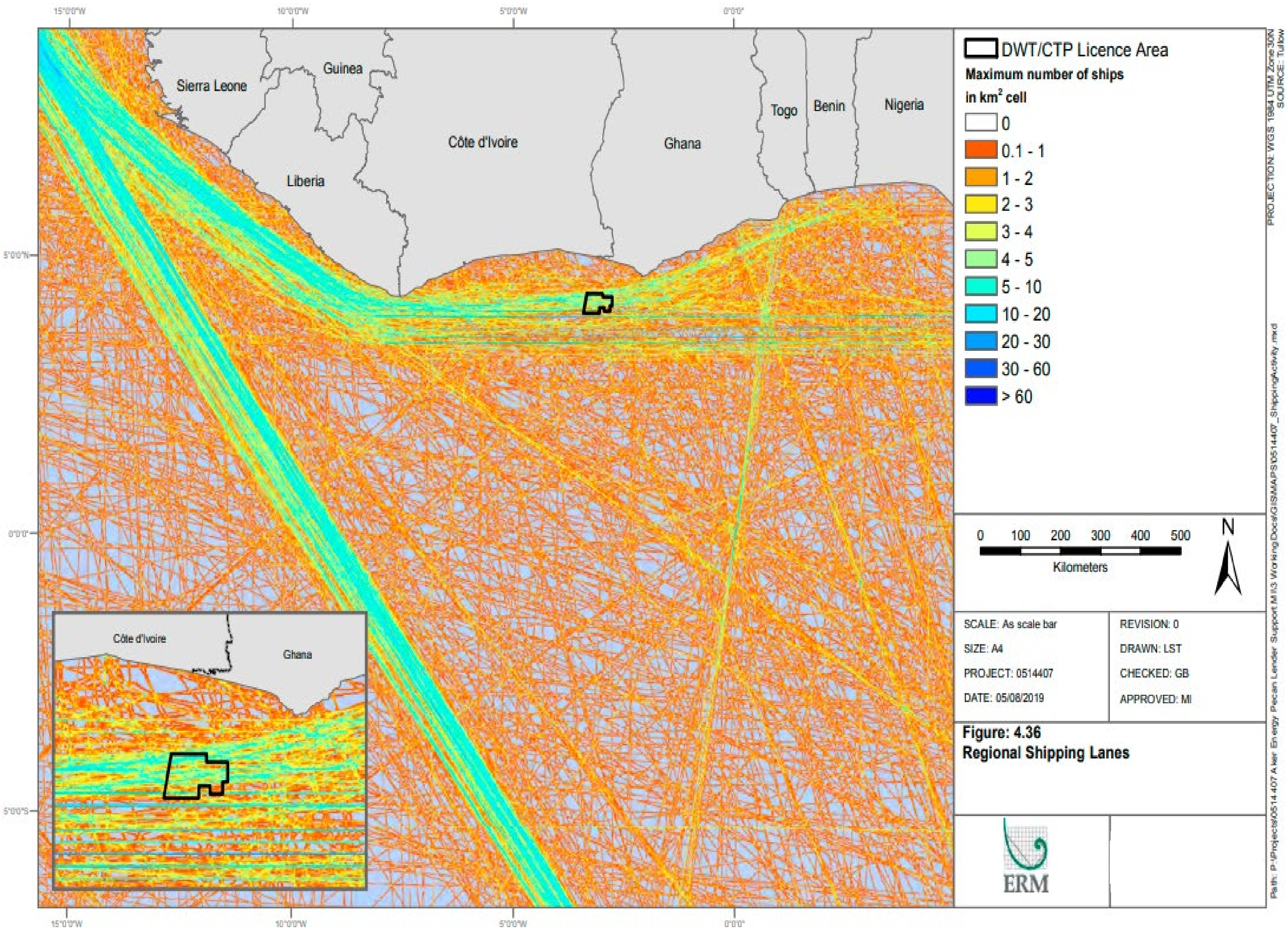


Figure 5.52 Regional Shipping Lanes and Vessel Density

Oil and Gas Downstream

Ghana has one oil refinery, the Tema Oil Refinery (TOR), with a design capacity of 45,000 bbl/d (TOR, 2019[1]. Tema predominantly processes crude oil and the refinery's installed capacity includes a Crude Distillation Unit (CDU), a Residue Fluid Catalytic Cracker (RFCC) and a Premium Reforming Unit (PRF). Refined products include (TOR, 2019) the following:

- Liquefied Petroleum Gas (LPG).
- Gasoline (Petrol).
- Kerosene.
- Aviation Turbine Kerosene (Jet A1).
- Gas Oil (Diesel).
- Premix.
- Naphtha.
- Fuel Oil.
- Cracked Fuels.

Over the years, the refinery's capacity to produce and store LPG has improved from 7,560 to 10,560 tonnes, whilst the total storage of the refinery for both crude oil and finished petroleum products has increased from 340,000 to more than 1,000,000 tonnes. This expansion has allowed TOR to maintain its market stature and help facilitate economic growth (TOR, 2019).

Power generation is the main consumer of gas in Ghana and power demand is expected to grow at an annual rate of 7.5 percent for the period 2012-2021 and 6.3 percent from 2022 onwards2. Gas demand for power generation is expected to start at 150 mmscfd in 2013 and grow to reach about 300 mmscfd in 2020 and about 600 mmscfd in 2030.

Ghana's oil production in 2017 was about 58.6 million barrels coming from the three main commercial fields, Jubilee (55.8%), TEN (34.9%) and Sankofa-Gye Nyame (9.3%) compared to about 32.3 million barrels in 2016, representing an increase of about 81% over the previous year. Average daily production for the year was about 175,000 barrels against the targeted production of about 250,000 barrels.

The Energy Commission predicted the total gas required for power generation would be approximately 67 million mmBTU for 2018, largely sourced from the local fields. They also predicted the average West African Gas Pipeline (WAGP) gas flow would be 60 mmscfd throughout the year with the possibility of increase to 200-300 mmscfd (Energy Commission, 2018).

Current known existing and potential gas supplies include the following:

- Imported gas from Nigeria via the West Africa Gas Pipeline (WAGP);
- Associated gas from the Jubilee Field;
- Associated and non-associated gas production from TEN and Mahogany East, Teak and Akasa (META) discoveries and other offshore fields; and
- Non-associated gas from the ENI Sankofa gas fields.

[1]http://www.tor.com.gh/about-tor/company-profile/
[2]http://africaoilgasreport.com/wp-content/uploads/2015/07/Natural-Gas-Pricing-Policy-for-Ghana.pdf

There are proposals for LNG import projects to supply gas on a temporary basis for power plants. These projects are in early stages of development (Energy Commission, 2018).

Pipelines and Cables

Ghana is experiencing a significant amount of offshore oil and gas development, and as a result there is subsea infrastructure currently in place and planned for the future. This includes submarine cables and pipelines such as the existing subsea pipeline from the Jubilee Field to the Ghana Gas Plant at Atuabo. There is also an onshore national gas supply pipeline from the central gas processing facility in Atuabo to Aboadze, just north of Takoradi.

Information and Communication Technology

Ghana's ICT sector continues to play a key role in Ghana's broader economic growth, contributing more than 40% to the overall GDP growth rate in the first quarter of 2020, for example. Industry experts estimate that the ICT sector in Ghana currently is valued at about $1 billion and may reach $5 billion by 2030. The sector includes telecommunication service providers, internet service providers, software OEMs, and training institutions[1]. The percentage of the population using the internet increased from 53% in 2019 to 58% in 2020(see Table 5.26). Hence, there were 16.99 million internet users in Ghana in January 2022[2]. According to the report, Ghana's internet penetration rate stood at 53.0 % of the total population at the start of 2022. Kepios analysis[3] indicates that internet users in Ghana increased by 350 thousand (+2.1 %) between 2021 and 2022. These user figures revealed that 15.07 million people in Ghana did not use the internet at the start of 2022. Apparently, it presupposes approximately 47.0 % of the population remained offline at the beginning of the year. However, issues pertaining to COVID-19 continued to impact research into internet adoption, hence actual internet user figures may be higher than these numbers suggest. Despite these challenges, ICT has become a new driver of growth in Ghana, offering unprecedented opportunities for investment and job creation.

Table 5.26 Ghana ICT Sector Growth

Country Profile – Ghana							
	2014	2015	2016	2017	2018	2019	2020
Mobile cellular subscriptions (per 100 people)	112	126	134	126	138	134	130
Individuals using the internet (% of population)	19	23	28	38	43	53	58
High-technology exports (% of manufactured exports)	7	8	2	4	8	1	-
Secure internet servers	148	200	2761	2744	649	1369	1846
Fixed broadband subscription (per 100 people)	0.26	0.26	0.3	0.2	0.21	0.19	0.25

Source: Word Bank, World Development Indicators, last updated 27 February 2022

Ghana currently has four registered mobile operators: MTN, Vodafone, Glo Ghana, and Airtel Tigo. South Africa-based MTN Ghana remains the market leader with more than 17

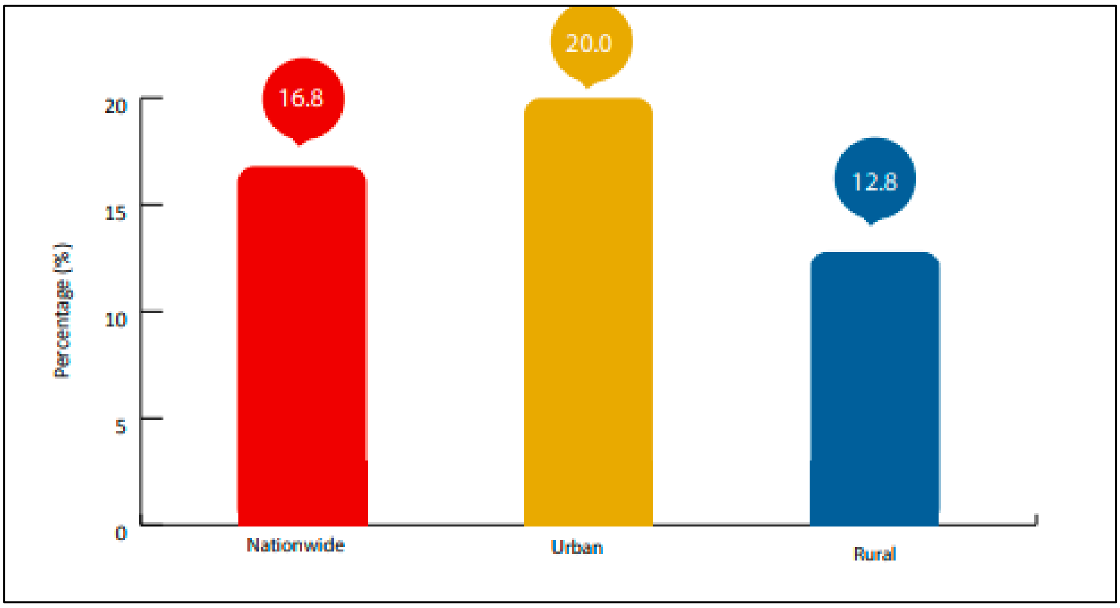
[1] Ghana – Country Commercial Guide. Ghana - Information and Communications Technology (ICT), 2022. Available online at , last accessed in June 2022.

[2] Digital 2022: Ghana – DataReportal - Global Digital Insights. Available online at https://datareportal.com/reports/digital-2022-ghana. Last accessed June 2022.

[3] Same as above

million subscribers, accounting for 57% of market share; Vodafone has 23% of market share[1]. The National Communications Authority estimates that, as of August 2021, mobile voice subscriptions reached 41.4 million, a 132% penetration rate. Additionally, data from GSMA Intelligence[2] shows that there were 44.90 million cellular mobile connections in Ghana at the start of 2022. However, it is noted that many people around the world use multiple mobile connections – for instance, they might have one connection for personal use, and another one for work – so it is not unusual for mobile connection figures to significantly exceed figures for total population. The GSMA Intelligence numbers indicated that mobile connections in Ghana were equivalent to 140.0 % of the total population in January 2022. The number of mobile connections in Ghana increased by 2.6 million (+6.2 %) between 2021 and 2022.

A household survey on ICT in Ghana[3] conducted by the National Communications Authority and the Ghana Statistical Service in 2019 (Figure 5.53) indicated that households in Ghana who had access to internet services was 16.8 %. However, access to internet is relatively higher in urban areas (20.0 %) as compared to rural localities (12.8 %).



Source: National Communications Authority and Ghana Statistical Service - Abridged Report, 2020

Figure 5.53 Household Access to Internet

In 2018, the findings of a survey conducted by the Ghana Statistical Service (Multiple Indicator Cluster Survey -MICS2017/18)[4] indicated that in the Western Region, internet use was 2% above the national average, even though the percentage of households having a computer was 2% lower than nationally. The percentage of households having a mobile (92.3 %) were very similar to the national average of 92.5%. In the case of radio or mobile phones, the

[1] As above

[2] Digital 2022: Global Overview Report; GSMA Intelligence. Available online at https://data.gsmaintelligence.com/research. Last accessed in June 2022.

[3] Household survey on ICT in Ghana. GSS ICT Survey 2019 – Ghana Statistical Service. Available on https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/Household%20Survey%20on%20ICT%20in%20Ghana%20%28Abridged%29%20new%20%281%29.pdf. Last accessed June 2022.

[4] Ghana Statistical Service, 2018. Multiple Indicator Cluster Survey (MICS2017/18), Survey Findings Report. Accra, Ghana: GSS.

differences between urban and rural penetrations were less than 5% at national level, but in the case of computer presence in households and internet access, the urban-rural gap was 7% and 10%, respectively. Considering lack of access to electricity in some rural areas in the six districts, it was reasonable to assume such gaps were reflected in the AoI also. With the current national internet penetration rate of 53.0 %, the 2022 may have seen an increase in internet use in the Western Region, however, the differences between urban and rural penetrations or gap may not see significant change given that only a few rural areas have been provided access to electricity over the past three years.

In Ellembelle District, Esiama and Aiynasi[1] are two larger communities that benefit from a government commercial ICT Centre, along with Nkroful, Eikwe and Ngalekyi where ICT projects have also been implemented, according to the Medium-Term Development Plan for 2018 – 2021. However, the plan notes that about 70% of the total district population does not have access to a computer, largely due to lack of electricity supply in rural areas. Another Community Information Centre has been established in Agona Ahanta by the Ministry of Communication (MoC) in collaboration with Ghana Investment for Electronic Communications (GIFEC), the United Nations Development Programme (UNDP) and the Ahanta West Municipal Assembly; the centre is a key resource for the basic schools in the district that are otherwise deprived of access to computers (and electricity)[2].

In Shama District, mobile telephony is widely used, as noted in the 2018 – 2021 Development Plan, reflecting regional and national statistics. Local radio and television benefit from good reception locally and are widely popular. Additionally, satellite dishes are also used by some households. The local radio station is used by many local people and by the Assembly to disseminate information in the community; other local FM stations from Takoradi and Cape Coast have extended their transmissions to Shama. This is a good illustration of the available data about mass media use at national and regional level placing television as number one mass media utilised by both men and women, followed by radio, in both rural and urban environments.

5.6.13 Community Cohesion and Conflict

Social Cohesion

According to the Ghana Statistical Service (2019), communities reported to have often experienced force or violence from other groups of people or one group against the other in the past 3 years preceding the Ghana Livings Standards Survey. About 6 out of 10 communities (61.2%) of Ghanaians indicated that their communities had never experienced any force or violence by other groups of people or one group against the other, while 18.7% indicated that their communities have occasionally experienced force or violence (Ghana Statistical Service 2019). Most urban dwellers (62.2%) indicated that they never experienced any force or violence in their communities from other group of people or one group against the other, while 20.7% indicated that their communities occasionally experienced this. Similarly, about six out of every ten (59.7%) rural dwellers indicated that they never experienced any force or violence in their communities. However, 17.1% have experienced some force or violence in their communities once while 15.7 percent have occasionally experienced it. Nevertheless, 7.5% have frequently experienced the use of force and violence in their communities or neighbourhood in the past three years preceding the survey.

[1] The Aiyinasi Community Information Centre (CIC) is a UNDP Funded facility that students in the District benefits from.
2 Ahanta West Municipal Assembly – Medium Term Development Plan 2018 – 2021, page 122
4.Source: adapted from Ghana Statistical Service, 2018. Multiple Indicator Cluster Survey (MICS2017/18), Survey Findings Report. Accra, Ghana: GSS

The Greater Accra (89.8%), followed by the Upper West Region (82.7%) indicated they never experienced any force or violence in their communities with the Ashanti region having the lowest proportion of 37.3 percent. In the Western Region, 64.3% of the people indicated they had never experienced the use of force or violence in communities or neighbourhood in the past three years.

At regional level, the Western Region (46.2%) ranks third out of the ten regions with the highest percentage of people indicating they feel very safe, after Upper East (54.1%) and Brong Ahafo (46.9%) Regions. Only 0.5% of the people in the Western Region indicated to be feeling very unsafe, as compared to 1.9% in Eastern Region (highest percentage) and 0% (lowest percentage) in Ashanti Region (Ghana Statistical Service 2019).

Most urban dwellers in the Western Region indicated to feel safe (45.5%) and very safe (47.7%) similarly to those in rural areas where 44.9% feel very safe and 49.8% feel safe. The share of people feeling very unsafe is similar between urban (0.6%) and rural (0.5%) dwellers.

No breakdown of the safety level from crime and violence at home was available from the six coastal districts in the Project AoI.

Conflict in the Community

Conflict in communities may occur because of many factors. Indebtedness, ethnic/ tribal conflict, political differences, land disputes, chieftaincy, and religion, among others, are mostly the cause of conflict in communities. According to the Ghana Statistical Service (2019), in most cases of conflict, Ghanaians have identified chieftaincy disputes (45.2%) as the most common cause of conflict in communities. This is followed by land disputes (19.8%) and conflict due to political differences (11.7%). Issues related to marriage are not so prominent (2.9%), but are higher compared to causes of conflict related to religion (0.3%).

This is also observed in the Western Region, where chieftaincy is the major cause of conflict in communities (76.7%). This is followed by land disputes (9%) and conflict due to ethnic/tribal differences (8.2%). Chieftaincy disputes are significantly more prevalent in the rural (88.2%) than in the urban areas (31.8%).

The criminal offences committed in the Jomoro district range from offensive conduct, assault, threatening, stealing, fraud, murder, to, more recently, robbery. Prevalent among these are stealing of dried coconuts and assault.

5.7 Heritage Context

5.7.1 Introduction

This section provides a brief overview of the heritage context within the AoI. There is generally very little information on offshore marine heritage sites in Ghana, with the main sources being the site surveys undertaken by oil and gas operators. Marine surveys undertaken on behalf of Pecan Energies for geophysical and geotechnical purposes in December 2021 and June 2021 respectively (Fugro 2021 and Fugro 2022) and the EBS (Gardline 2014) did not identify any seabed wreckage or other sites of potential heritage value. During any future site surveys prior to drilling and laying anchors, additional information on any potential wreck sites will be identified, as these are areas to be avoided for drilling and field development purposes.

For the onshore areas, the Project will use facilities at Takoradi Harbour. The approved development of Takoradi Harbour has been subject to its own EIA process (SAL 2015). The issue of cultural heritage was scoped out of that EIA as the development was at an existing port. The Project will use contractors with existing shore bases in Takoradi and no new sites to be developed within Takoradi are planned. Therefore, potential impacts on onshore cultural heritage have been scoped out of the EIA.

This section provides an overview of the historical context of Takoradi and the surrounding area to provide background information in the event that any extensions to Contractors' existing shore bases are planned.

5.7.2 European Colonialisation and the Slave Trade

The first European contact with Ghana was probably made by Portuguese navigators seeking gold, ivory and spices in the first half of the 15th century. Gold was obtained in the districts between the Ankobra and Volta Rivers, resulting in the Portuguese building Elmina Castle as a permanent trading post in 1482.

The trade in gold and slaves was so profitable that increasingly other European traders became interested - the Dutch, followed by the British, French, Danes, Swedes and Germans. Traders arranged treaties with coastal African leaders, who allowed the Europeans to establish small, well-defended centres of trade in strategic locations. These European beachheads greatly affected the settlement patterns, demographics, and trade routes associated with African coastal towns.

In the Gold Coast (the section of the coast of the Gulf of Guinea from Axim in the west to the Volta River in the east), many forts and other substantial structures such as castles were built. From positions high above the shoreline, cannons were faced toward the sea, to ward off ships from rival European powers.

Europeans negotiated with local chiefs to construct so-called 'factories', or trading houses, in which factors, or employees of European trading firms, managed the purchase of captives from middlemen who linked coastal traders to vast slaving frontiers in the interior. From these coastal forts, castles, and factories, captives were loaded by small vessels onto slave ships anchored offshore. In some cases, European traders sailed from factory to factory, acquiring small numbers of slaves at each stop until their vessels were full. In other cases, European traders filled their ships by negotiating a single purchase of hundreds of captives from one location.

By the middle of the 18th century, there was competition in the slave trade all along the coast of West Africa, with many forts and castles built by competing powers. Abolition of the slave trade saw a noticeable increase in missionary activities and by the middle of the 19th century, missionaries had moved inland and built schools and colleges. In 1872, the Danish and Dutch governments withdrew entirely from Ghana. At that stage, Britain converted the areas it controlled in the south of the country into a British Crown Colony. From this base in the south, the British became involved in a series of wars resulting in the final defeat and annexation of the Ashanti Empire in northern Ghana, in 1901.

5.7.3 UNESCO World Heritage Site

The remains of fortified gold and slave trading forts and trading posts, erected between 1482 and 1786, exist along 500 km of the coast of Ghana between Keta and Beyin. In 1979, these sites were inscribed on the list of UNESCO World Heritage Sites.

The UNESCO site consists of:

- three Castles (Cape Coast, St. George's d'Elmina and Christiansborg at Osu, Accra),
- 15 Forts (Good Hope at Senya Beraku; Patience at Apam; Amsterdam at Abandzi; St. Jago at Elmina; San Sebastian at Shama; Metal Cross at Dixcove; St. Anthony at Axim; Orange at Sekondi; Groot Fredericksborg at Princesstown; William (Lighthouse) at Cape

Coast; William at Anomabu; Victoria at Cape Coast; Ussher at Usshertown, Accra; James at Jamestown, Accra and Apollonia at Beyin),

- four forts partially in ruins (Amsterdam at Abandzi; English Fort at British Komenda; Batenstein at Butre; Prinzensten at Keta),
- four ruins with visible structures (Nassau at Mouri; Fredensborg at Old Ningo; Vredenburg at Dutch Komenda; Vernon at Prampram and Dorothea at Akwida) and
- two sites with traces of former fortifications (Frederiksborg at Amanful, Cape Coast and Augustaborg at Teshie, Accra).

The basic architectural design of the Forts was in the form of a large square or rectangle. The outer components consisted of four bastions/batteries or towers located at the corners, while the inner components consisted of buildings of two or three storeys with or without towers, in addition to an enclosure, courtyard or a spur. Many have been altered, during their use by successive European powers, and some survive only as ruins.

The closest fort to the onshore sites for the Pecan Project is Fort Orange, which was built as a trading post on the Dutch Gold Coast in 1642, near Sekondi (Figure 5.54). When the Dutch stronghold on the coast was weakened in the 1670s, the English built a succession of forts and lodges within gunning range of Dutch fortresses (an English Fort was built at Sekondi in 1682). Following a number of attacks, for example by the Ahantas in September 1694, it was reconstructed as a more fortified fort by 1704. In 1872, the fort was sold with the rest of the Dutch Gold Coast to the United Kingdom in 1872. Fort Orange now serves as a lighthouse under the control of the Ghana Ports and Harbours Authority. Table 5.27 presents historical monuments situated along the coast of the Western Region of Ghana and indicates when they were built.

Table 5.27 Historical Monuments situated in the Western Region of Ghana

Town/Location	Monuments
Beyin	Fort Appolonia built in 1770 by Britain
Axim	Fort Antonio built in 1515 by the Portuguese
Princess Town	Fort Gross Fredericksburg built in 1683 by Brandenburg-Prussians
Akoda	Ruins of 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

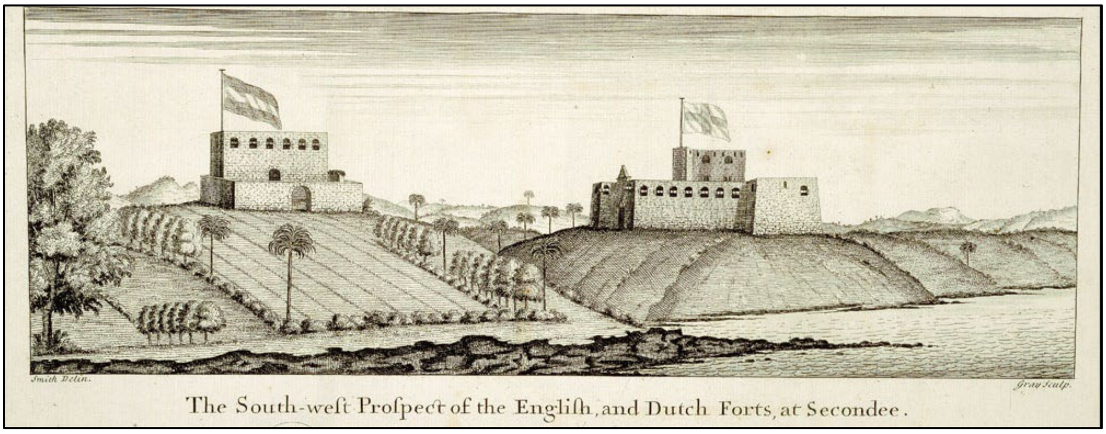


Figure 5.54 Fort Orange, Sekondi

Fort Witsen, Takoradi

Fort Witsen, also known as Fort Tacaray, is thought to have been founded by the Swedish in 1653 but was taken over by the Dutch in 1658 (shown in Figure 5.55). This fort was destroyed after a few years, and in 1684, the site was abandoned. A map from 1791 indicates that the Dutch had renewed their presence in the fort again. A number of historic and modern maps indicate a Dutch Fort (in ruins) in Takoradi (see Figure 5.56). It appears to have been a trading post 'abandoned by the Dutch'. If these ruins can be identified, and if they survived, they may well be considered for inclusion as part of the UNESCO World Heritage Site.

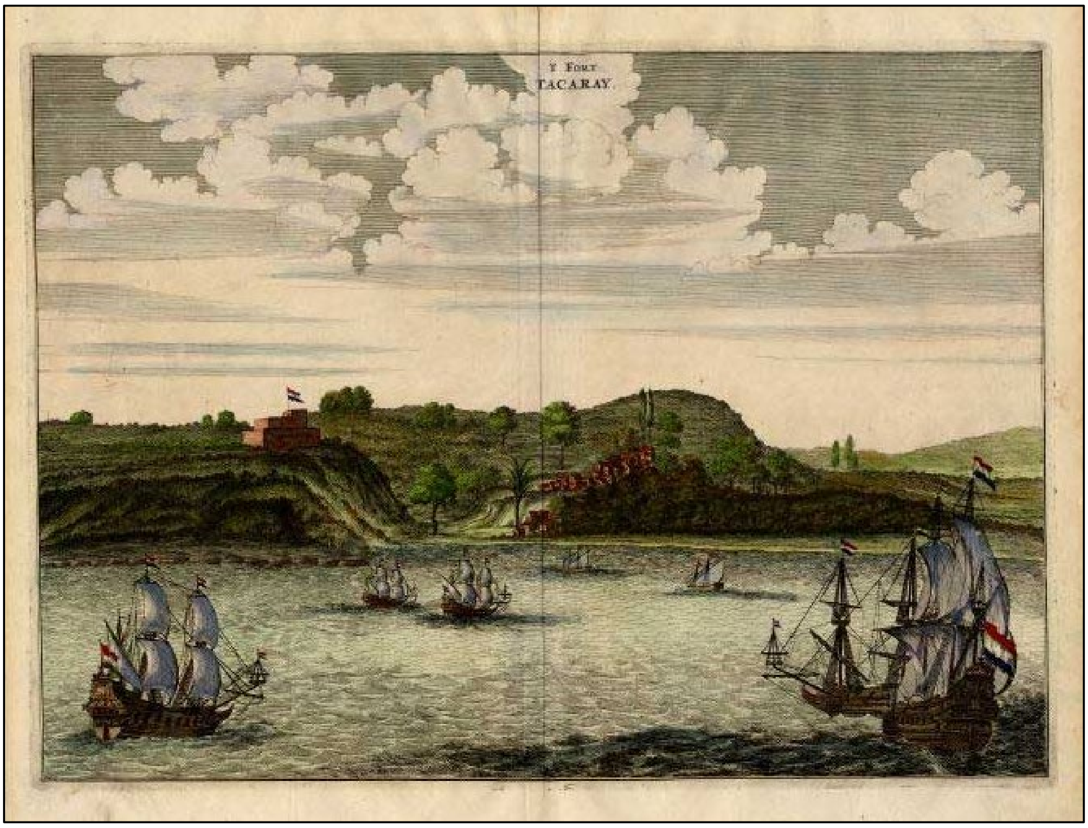


Figure 5.55 Fort Witsen Takoradi

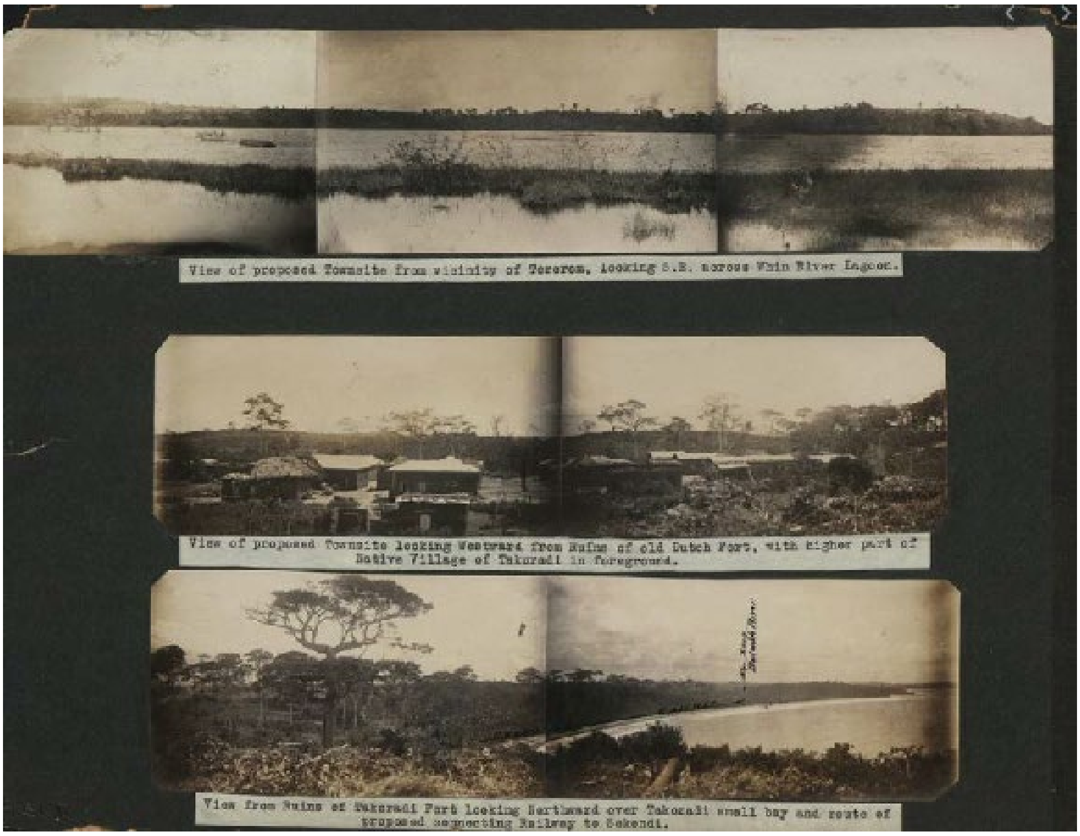


Figure 5.56 References to Ruined Dutch Fort in Takoradi

Heritage of Takoradi Harbour

Takoradi Harbour is a significant heritage site in Ghana. Geographically, it has always been seen as of strategic value along the Gold Coast from the 15th Century onwards. The idea for the construction of the port at Takoradi was first advocated in 1895 by the British. The engineers proposed that the harbour when constructed could serve as both a terminal port for the Tarkwa railway project (built in 1903 to hinterland mineral and timber resources) and a naval port to serve the British Empire regionally. The site for the harbour was proposed at the Amanful village that sat in the bay of the harbour today. The construction of the port begun in 1921 and was completed in 1928 (see Figure 5.57). Historical maps suggest that there was some settlement that may have contained a fort or 'factory' at Augube (at Takoradi point) (see Figure 5.58). The site of this may be within the developed or planned for development harbour site.

Figure 5.57 Construction of Takoradi harbour During 1920s

Figure 5.58 1670 map of West Africa by English Cartographer John Ogilby

During World War II, RAF Takoradi was an important staging point for British aircrafts destined for Egypt. Spitfire fighter planes were shipped in crates from England to Takoradi where they were assembled and then flown via Nigeria and Sudan to the war in Libya. The 26 Squadron SAAF was also based in Takoradi during World War II flying anti-submarine and convoy protection patrols over the Atlantic.

As the starting point of the Allied trans-African supply line to Egypt that became known as the West African Reinforcement Route (WARR), Takoradi became one of the most important bases for the RAF. On September 5, 1940, the first shipment of a dozen Hurricane and Blenheim aircraft fighters in large wooden crates arrived at Takoradi by boat from the United Kingdom for assembly locally to be made airworthy for the flight to Cairo. The first delivery flight to Cairo left Takoradi on September 20, 1940. Between August 1940 and June 1943, over 4,500 British Blenheims, Hurricanes, and Spitfires were assembled at Takoradi and ferried to the Middle East. Between January 1942 and the end of the operation in October 1944, 2,200 Baltimores, Dakotas, and Hudsons arrived from the United States. Figure 5.59 illustrates some other activities at Takoradi during WWII.

Figure 5.59 Takoradi Harbour During WWII

6. Impact Assessment

6.1 Introduction

This chapter provides an assessment of the environmental and social impacts that may result from the Project, together with details of the mitigation measures and management actions that will be implemented to avoid, minimise, reduce, remedy or compensate for significant adverse impacts and, where practicable, to enhance potential positive benefits and opportunities from the Project.

The assessment covers impacts over the Project's lifecycle, including well drilling and completions, installation and commissioning of subsea infrastructure and the FPSO, and the operational phase. A detailed impact assessment for the decommissioning phase will be conducted in due time prior to the decommissioning and will be part of the decommissioning permit application. An outline Decommissioning and Abandonment Plan is presented in Chapter 8.

The significance of the impacts that remain following application of the mitigation measures, also referred to as residual impacts, is assessed and reported in this chapter. The assessment methodology is described in Section 5.2.

The impacts are assessed under the following headings:

- Project footprint;
- Underwater sound;
- Impacts from lighting and flaring;
- Marine animal collision risk;
- Aerial noise;
- Drill cuttings and fluid disposal;
- Well completion and operational discharges;
- Emissions to atmosphere;
- Greenhouse gas emissions;
- Waste management;
- Potential impacts on critical, natural and modified habitat;
- Socio-economic and community health impacts;
- Ecosystem services;
- Cumulative impacts;
- Unplanned events: navigation risk;
- Unplanned events: oil spill risk.

The EIA adopted a standard approach of identifying the impacts that are likely to be significant, with those impacts that are not likely to be significant scoped out from the assessment. This process of scoping potential impact in or out of the assessment does not take into account the application of mitigation measures, other than those that are built into the design of the Project. The EIA scoping process identified key issues for assessment in the EIA based on industry knowledge of sources of potential impact associated with offshore oil and gas development and production and the issues raised during the scoping consultation process. The outcomes of the scoping process were presented in the Scoping report (submitted in February 2019 and updated in November 2021 after further field optimisation studies). Additional issues were identified through the EIA community consultations that were held from October 2021 until May 2022. A register of the issues that were raised during both the Scoping and EIA consultations is included in Annex A.

Where there is any uncertainty in the scoping process a precautionary approach was applied such that potential impacts are included in the assessment, although subsequently following assessment they may ultimately be judged to be Not Significant.

Worker occupational health and safety topics are not addressed within the EIA process as these issues will be addressed through a wide set of occupational health and safety assessments as the Project Safety Case and managed through the health and safety management systems of the operator and main contractors, as well as through plans and working procedures relevant to the phase of the Project (drilling, operations, etc.).

6.2 EIA Assessment Methodology

The purpose of an environmental and social impact assessment is to identify and evaluate the significance of potential impacts on identified physical, biological and social receptors and resources; to develop and describe mitigation measures that will be implemented to minimise potential adverse effects and enhance potential benefits; and to report the significance of the residual impacts that remain following mitigation.

The methodology adopted for the Pecan Development Project EIA is consistent with the methodology used in the environmental and social assessment of potential effects of offshore activities in other areas around the world and in previous activities performed in Ghana (i.e. the Tullow Jubilee and TEN and Eni OCTP EIAs).

The impact assessment is undertaken in the following key stages.

- Identification of potential environmental and social receptors.
- Identification of the activities of the proposed drilling, installation, commissioning, production and decommissioning activities with the potential to contribute to or cause impacts to bio-physical and social resources and receptors.
- Assessment of the likely magnitude of the impact (depending on its intensity, its duration, its scale, etc.), and the sensitivity of the resource and receptors affected to determine its significance.
- Impact significances are assessed for the Project including the embedded controls (i.e., those that have been incorporated into the Project design), and residual impact significances are assessed based on a consideration of the embedded controls and additional mitigation and management measures that have been defined during the IA process.

A summary of the EIA process is presented in Figure 6.1.

In addition to predicted impacts from planned activities, those impacts that could result from an accident or unplanned event within the project (*e.g.* 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, i.e. taking into account both the consequence of the event and the probability of occurrence.

Overview

The purpose of the impact assessment process is to identify any likely significant effects on receptors/resources as a result of impacts from a Project and develop appropriate mitigation measures to effectively manage these environmental and social effects. The process is iterative and can be summarised by the figure to the right.

The detailed impact assessment methodology used is in accordance with widely accepted international practice for impact assessment. The overarching principles of this methodology are illustrated here, but note that each topic area will have specific criteria for defining receptor sensitivity/vulnerability and impact magnitude.

Evaluation of Significance

The significance of the potential effect on receptors/resources is determined through the combined consideration of:

- **the importance of the affected environment and its sensitivity/vulnerability to the particular impact being assessed, and**
- **the magnitude of the potential impact.**

Note that the term **'magnitude'** is used as shorthand to encompass various possible dimensions of the predicted impact, such as:

- the nature of the change (what is affected and how);
- its size, scale or intensity;
- its geographical extent and distribution;
- its duration and frequency; -and
- where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

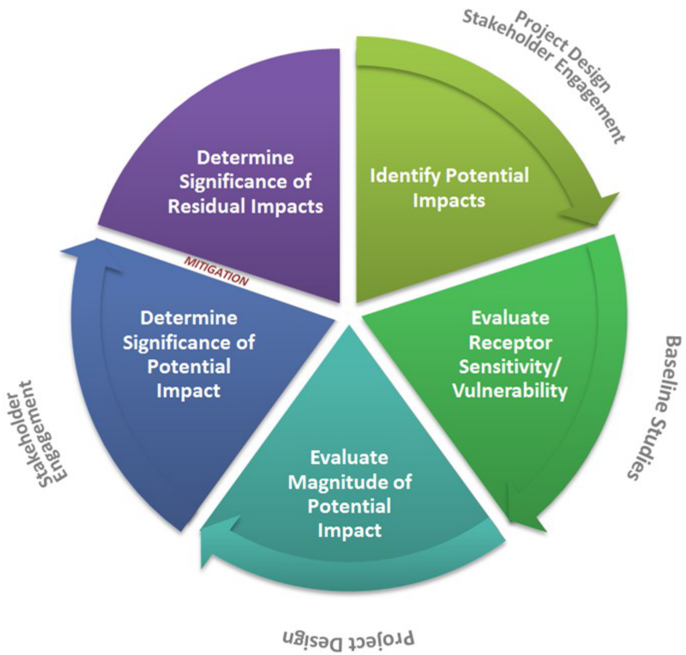
		Sensitivity of Resources/Vulnerability of Receptors		
		Low	Medium	High
Magnitude of Impact	Negligible	Not Significant	Not Significant	Not Significant
	Small	Not Significant	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

There is no statutory definition of significance however, for the purposes of this assessment, the following practical definition is proposed:

An impact will be judged to be significant if, in isolation or in combination with other impacts, the effects will be a notable change from baseline conditions and may require mitigation to management environmental/social effects and risks.

Magnitude and vulnerability/sensitivity will be looked at in combination to evaluate whether an impact is significant and if so its degree of significance. The principle is illustrated here.

The impact assessment process evaluates both beneficial and adverse impacts, however the magnitude rating is only assigned for adverse impacts.



Residual Impacts/Effects

Is it still significant?

Once mitigation has been identified, a re-assessment of impacts to determine the magnitude and significance of any residual effects (after mitigation) will be undertaken.

The results are represented in the EIA Report, with an explanation of how the impacts have been reduced to as low as reasonably practicable (ALARP) levels.

ERM
Environmental Resources Management Ltd
2nd Floor, Exchequer Court
33 St Mary Axe
London, EC3A 8AA

Figure 6.1 Environmental Impact Assessment Method

6.3 Project Footprint

6.3.1 Description of Potential Impacts

The 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 on seabed habitats, component species and demersal fish that rely on these habitats.

The main impacts are expected to arise from the following sources.

- Short-term disturbance directly to the seabed (e.g. from sediment suspension disturbed by placement of seabed infrastructure), with secondary impacts on the benthic and demersal community (e.g. smothering) as disturbed sediment redeposits away from the area of direct disturbance.
- Permanent habitat and associated species loss or damage from coverage of areas of seabed by moorings, well manifolds, well heads, riser bases, flowlines and umbilicals.
- Permanent loss and/or alteration of seabed habitat arising from the physical presence of subsea production infrastructure (e.g. sediment disturbance and reef effects from marine organisms growing on subsea infrastructure).

The impacts of drill cuttings are assessed in Section 5.8.

6.3.2 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.

- Seabed geophysical survey data will be used to design the layout of the subsea infrastructure to avoid any geo-hazards and to identify any sensitive seabed features such as hard ground that would potentially have more diverse habitats and species.
- The in-field subsea flowlines will be laid directly on the seabed. Flowline burial using methods such as dredging and jetting which creates sediment plumes will be avoided.

6.3.3 Impact Assessment

Impacts from Suspended Sediment

Quantities of sediment will become disturbed and suspended in the water column by activities on or near the seabed such as installation of flowlines, well conductors, moorings, manifolds, riser bases and flowlines. For example, seabed disturbance of the sediments and benthic fauna will occur along the routes of the flowlines; however, impacts will be limited as burial (e.g. by trenching or jetting) is not proposed. Suspended solids concentrations will be temporarily increased in the bottom waters around the works.

Suspended sediment could have two main types of impact: the smothering of sessile species; and possible secondary effects such as impacts on the respiration of benthic organisms and demersal fish.

Bottom current data shows currents speeds circa 0.15 ms^{-1} at the seabed which is indicative of a good dispersive capacity for the fine and medium silt sediments (see Chapter 4: Section 4.2.2) in the Project area. Therefore, suspended sediments in the water column will likely be dispersed relatively quickly. The duration of installation activity is relatively short-term and localised. Demersal fish will tend to avoid areas of elevated suspended sediment concentrations, thus limiting the duration and extent of exposure to impacts on respiratory processes. The overall magnitude of the impact is considered to be small.

Installation of Infrastructure

The installation and long-term presence of sub-sea infrastructure, especially the flowlines, will result in the direct loss of existing benthic habitat and associated communities and replacement with new hard substrate materials. The new hard substrate is likely to be colonised over time by epifauna of different species to those in the fine and medium silt habitat (see below).

Mortality is likely to occur for most individuals immediately beneath the installed infrastructure, especially for sessile species and some burrowing species (which are typical to benthic communities) where avoidance or vertical migration is not possible.

The area of the Project encompassing all the wells, seabed infrastructure, including the four FPSO anchor lines, is approximately 50.25 km^2. The total area of seabed that will be directly affected by the physical presence of subsea infrastructure is relatively small at approximately 0.36 km^2, representing approximately 0.7% of the total area.

The impact on seabed habitats and species, and prey items for predators will be localised; although long-term, the loss of areas of fine sediment habitat is considered to be of small magnitude.

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, deep-water location and consequently the loss of areas of muddy/silty habitat is considered to be of small magnitude.

Changes to Sediment Structure and Composition

Changes to sediments may occur from a variety of processes, e.g. from compaction or changes to water current flow caused by the presence of the infrastructure leading to sediment scour or accretion. Any changes to seabed habitat conditions are expected to be very localised and small-scale (i.e. limited to the immediate footprint of subsea infrastructure).

Secondary Impacts on Demersal Fauna

The loss of or damage to seabed habitats and associated communities will reduce prey availability to demersal deep water fish species in the area. However, as assessed above, the impacts on benthic organisms are considered to be localised and the total loss will represent a very small portion of the available prey to deep-water fish predators. In addition, the area affected will be very small in the context of the range over which deep-water predatory species forage and the similar habitats available in this offshore, deep-water location. The impact is therefore considered to be of small magnitude.

Physical Barrier Impacts

Flowlines of significant linear length and diameter have the potential to create a physical barrier to mobile benthic organisms, such as crustaceans. However, the height of the flowlines (17 to 32 cm in diameter) is not expected to create a significant barrier, especially as the flowlines are likely to settle into the soft sediments by up to 50% of their diameter. The impact is therefore considered to be of small magnitude.

Creation of New Hard Substrate

The placement of seabed equipment, in an otherwise uniform and relatively featureless habitat, often provides some positive benefits in terms of increasing the diversity of organisms present. This is through providing hard substrate features on the seabed, which in turn offer a protective and stable substrate which fauna can colonise over time. The features also provide a ‘shelter’ effect (e.g. for smaller demersal fish) in an otherwise featureless seabed environment. This ‘reef effect’ will be at a small scale and localised but nevertheless would add to local biodiversity.

Overall Physical Footprint Impact

The offshore habitat has been assessed as low conservation value/sensitivity given the generally featureless benthic habitat (Fugro 2022) and relatively homogeneous benthic fauna across the survey area (Gardline 2014).

The installation and presence of structures on the seabed constitutes small magnitude impacts on 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 Project area. The positive impacts from the small-scale introduction of new substrates for colonisation by benthic organisms and providing shelter to other organisms are assessed as being Not Significant

6.4 Underwater Sound

6.4.1 Description of Potential Impacts

Sources of Underwater Sound

Sounds in the marine environment can be naturally occurring and anthropogenic (human produced) in origin. Natural sounds include from physical sources (wind, rain and breaking waves) and biological sources (marine mammal vocalisations, sounds from other marine life). Anthropogenic sounds come from shipping, fishing, dredging, oil and gas exploration and production activity, sonar (navigation, fishing and defence), seismic survey sources and construction (e.g. pipe jetting and trenching, percussive piling). In any one area, most sound sources are intermittent, although in busy shipping lanes sound can be near continuous.

The main sources of underwater sound associated with the Project are as follows.

- Drilling: most of the sound produced by drilling activities at the seabed is continuous and of low frequency.
- Use of propeller and thrusters (on the MODU and construction and support vessels): noise from propellers and thrusters is predominantly from cavitation around the blades while the vessel is moving at speed or is operating thrusters under load to maintain its position. Typically, the noise from these sources is broadband, with some low tonal peaks.
- Vessel machinery noise: machinery sound is often of low frequency, usually becoming more apparent when vessels are stationary or moving at low speeds. The main sources for this type of sound are larger items of machinery, such as power generation units, compressors and fluid pumps. Sound can be transmitted via different paths: structural (i.e. machine to hull to water); airborne (i.e. machine to air to hull to water); or a combination of both. The nature of sound from machinery sources depends on variables that include: number and sizes of machinery operating; mode of coupling between machinery and deck; and position within the vessel. 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 greater for sub-sea valves.
- During operations, the FPSO will produce continuous or near continuous sound. There will be intermittent sound from visiting vessel movements during the construction and operations phases.

Sound levels and frequencies for a range of offshore operations have been reported by Richardson et al (1995) (Table 6.1).

Table 6.1 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
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 lower in sound level.

Sound Propagation

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, seabed characteristics, temperature and pressure (McCauley et al 2000). The potential for sound produced by the Project to affect marine animals will therefore be mainly influenced by the distance between sound source and receptor, and the sensitivity of the affected species to sound of different frequencies.

Sound Pressure Level (SPL), which measures the sound energy, is the metric that has most often been measured or estimated during marine animal disturbance studies. However, it is recognised that the Sound Exposure Level (SEL), which takes into account the duration of exposure, also influences animal behavioural changes.

Sound frequency is the property of sound that most determines pitch and is measured in Hertz (Hz).

Receptor Sensitivity

Marine fauna, especially mammals but also species of fish, use sound for various purposes including navigation, communication and the detection of prey (Southall et al, 2019; Richardson et al, 1995). As a result, underwater sound arising from the various Project activities has the potential to affect marine fauna. At very high levels, underwater sound has the potential to cause auditory or other physical damage and in extreme cases mortality.

Different species have different thresholds at which physical harm and behavioural changes may occur and respond to sound in different ways. The effect of sound on any particular species depends on several factors including:

- the level and characteristics of the sound (e.g. frequency, pulsed versus continuous);
- the hearing sensitivity of the species; and
- the behaviour of the species at the time of exposure (e.g. feeding, breeding, with young).

Consequences for marine mammals can vary from temporary avoidance or changes in diving behaviour through to material behavioural changes and physical harm. Physical harm can include temporary or permanent reduction in hearing sensitivity. The types of impacts of underwater sound on some species of marine mammals, due to their known reliance on sound for activities such as communication and navigation, has been reported by Richardson et al (1995).

Turtles are less reliant on sound and are considered less sensitive to sound from marine activities and are unlikely to be affected by sound levels expected from the Project (Weir 2007).

Physical damage to fish is possible at high noise levels in the range 180 to 220 dB (Evan and Nice 1996), for example from seismic airgun sources, which would only exist very close (a few metres) to the source and these areas are likely to be avoided by fish. Non-auditory effects in some species of fish can include damage to body tissues, especially air-filled cavities including the swim bladder and muscle tissues.

Available information on birds indicate that they are not particularly sensitive to underwater sound.

Overall, it is therefore important to note that although some activities are short-term (or temporary), hearing damage, for example, to a marine mammal could be a permanent effect. Southall et al (2019) defines broad groups of marine mammals that are expected to have similar sensitivity to noise. The categories for those likely to be present in Ghanaian offshore waters (see Chapter 4: Section 4.3.2) are listed in Table 6.2.

Table 6.2 Marine Mammals in Ghanian Waters and their Hearing Category

Species	Hearing category
Common bottlenose dolphin (*Tursiops truncatus*)	High frequency
Clymene dolphin (*Stenella clymene)*	High frequency
Spinner dolphin *(Stenella longirostris*)	High frequency
Pantropical spotted dolphin (*Stenella attenuate)*	High frequency
Atlantic spotted dolphin (*Stenella frontalis*) (G. Cuvier, 1829)	High frequency
Long-beaked common dolphin (*Delphinus capensis*)	High frequency
Fraser's dolphin *(Lagenodelphis hosei*)	High frequency
Rough-toothed dolphin (*Steno bredanensis*)	High frequency
Risso's dolphin (*Grampus griseus*)	High frequency
Melon-headed whale (*Peponocephala electra*)	High frequency
Pygmy killer whale (*Feresa attenuata*)	High frequency
Short-finned pilot whale (*Globicephala macrorhynchus*)	High frequency
Killer whale (*Orcinus orca*)	High frequency
False killer whale (*Pseudorca crassidens*)	High frequency
Cuvier's beaked whale (*Ziphius cavirostris*)	High frequency
Dwarf sperm whale (*Kogia sima*)	Very high frequency
Sperm whale (*Physeter macrocephalus* or *Physeter catodon*)	High frequency
Humpback whale (*Megaptera novaeangliae)*	Low frequency
Sei whale *(Balaenoptera borealis)*	Low frequency
Bryde’s Whale (*Balaenoptera edeni*)	Low frequency

After Southall et al (2019)

Potential effects on marine mammals are considered in the context of effect threshold values for temporary threshold shift (TTS) and permanent threshold shift (PTS) as reported in Southall et al (2019) and summarised in Table 6.3 When the hearing threshold returns to its pre-exposure levels this is termed a temporary threshold shift (TTS); when it does not this is termed a permanent threshold shift (PTS) and implies irreversible damage to an animal's hearing. The TTS and PTS values are for non-impulsive noise sources as the Project will not involve impulsive sources (such as seismic, or percussive piling). Exposure to intense sound may induce an elevated hearing threshold (or threshold shift).

Table 6.3 TTS and PTS Onset Sound Exposure Level (SEL)

Marine mammal hearing group	TTS onset: SEL (weighted)	PTS onset: SEL (weighted)
Low frequency	179	199
High frequency	178	198
Very high frequency	153	173

From Southall et al (2019). Thresholds for Non-impulsive Noise in dB re 1 µPa. TTS: Temporary threshold shift. SEL Sound Energy Level.

As noted above, in addition to the effects of high noise levels on hearing, 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.

6.4.2 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.

- 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.
- Marine mammal observation and monitoring programme will be implemented while vessels are in transit.
- Adoption of suction piling (versus percussive piling) and laying flowlines onto the seabed (as opposed to trenching or jetting) will both avoid noise impacts.

6.4.3 Impact Assessment

Noise modelling undertaken by Gardline (2011) in the Jubilee Field (reported in ERM et al 2014) assessed sound levels and propagation over distance using measured sound data. The results showed that during normal operations the FPSO produced noise levels of 160 dB which would attenuate to approximately 120 dB at a range of less than 500 m. During tanker loading operations noise levels near the surface were approximately 120 dB at less than 1 km. The study concluded that in the offshore area disturbance effects on marine mammal behaviour could occur within 5 to 6 km of the FPSO. These findings support similar work by Richardson et al (1995) (see Table 6.1 above).

None of the noise sources from the Project are capable of causing instantaneous injury for low and high frequency category cetaceans because the source levels are not high enough, even at very short ranges. For very high frequency cetaceans (in this area the only such species would be the dwarf sperm whale) for harm to occur they would need to be very close to a noise source that suddenly commenced operating at full power and then remain in the same location. Marine mammals display avoidance behaviour when exposed to high noise level therefor significant exposure to sustained high levels of noise for ant dwarf sperm whales in the area is considered unlikely in this open water location.

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. The loudest noises are likely to be generated during oil offloading (due to propeller cavitation).

Based on the Gardline (2011) 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 up to 6 km radius for diving species such as sperm whale (recognising that more than one vessel may be operating in the same area). The supply or support vessels may have a greater potential to temporarily disturb marine mammals over a wider area in relation to their sound level, since they will regularly move between Takoradi port and the Project area. However, it should be noted that as the Project vessels near the coast and Takoradi port they would become part of general maritime traffic. Similarly, the Project area is close to a major West African shipping route (see Chapter 4: Figure 5.52)

In the context of the size of the areas over which marine mammals range the magnitude of the impact is small and the impact on behavioural response of these species is assessed to be of Minor significance.

6.5 Aerial Noise

6.5.1 Description of Potential Impacts

The drilling and installation activities and the operating FPSO will all constitute sources of aerial noise but will be too distant from any sensitive receptors to have any impacts.

Closer to sensitive receptors the main potential impacts will be from:

- general port activities involving Project vessels; and
- helicopter flights to and from the offshore Project area.

6.5.2 Mitigation Measures

Helicopter flight planning will make provisions to avoid sensitive areas of population and nature conservation. Pecan Energies will assure that the helicopter operator follows national and local regulations and restriction regarding flight routes.

6.5.3 Assessment of Impacts

Onshore noise at the port in Takoradi from the Project is assessed as Not Significant as the activities will take place within an existing operating port.

Noise from helicopter flights between the Air Force base at Takoradi and the Project area have the potential to cause disturbance. Flight planning to avoid sensitive areas and adopting minimum flight heights will avoid significant impacts.

6.6 Impacts from Lighting and Flaring

6.6.1 Description of Potential Impacts

Lights (and flares where used) on the MODU, FPSO and support vessels could potentially attract, disturb and disorientate seabirds and turtles feeding or passing through the area. Attraction or disorientation could increase the risk (albeit low) of collisions with the MODU, FPSO and other vessels.

6.6.2 Mitigation Measures

The need for pilot flame flaring has been designed out of the Project by the FPSO having a closed flare system. The only flaring will be in emergencies, during gas injection downtime and at the production commissioning phase until stable production and gas injection has been achieved. The need for lighting will be dictated by operational safety requirements. No specific mitigations measures for lighting are proposed.

6.6.3 Assessment of Impacts

Some species of birds, especially migrating land birds, may be attracted to lights on the MODU and the FPSO as these vessels will be in one location for some periods of time. Birds attracted/disorientated could risk collision and be diverted from their intended flight route. Given the distance from shore of circa 113 km for the nearest well site and 98 km for the FPSO location, the number of birds involved is likely to be very small and the impacts will be Not Significant.

Other species of birds using the area will be seabirds involved in foraging and other activities. The MODU and FPSO may constitute a source of disturbance for some species of seabirds while others may be attracted; however, any zone of disturbance will be a negligible proportion of the wider areas that seabirds forage over. Attraction to artificial lights is usually more of a concern for seabirds nearer to shore and in coastal locations, especially near to breeding colonies, than in the open ocean. As noted in Chapter 4: Section 4.3.4, there is an absence of suitable breeding sites (e.g. remote islands and rocky cliffs) off the Ghana coast, indicating the Project area is not likely to be important for foraging seabirds during the breeding season. Seabirds are not vulnerable to attraction to vessel lights in the way that migrating land birds are and therefore impacts on seabirds will be Not Significant.

For turtles, the main concern is on disorientation of nesting females and to hatchlings. There is the potential that turtles will be attracted to the FPSO (and the MODU while present) at night where hatchlings could be subject to increased predation by birds and fish that are also attracted to the vessels. However, the Project area is circa 90 to 103 km offshore (from the well sites nearest and farthest from the shore with the FPSO located circa 98 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 light disturbance/attraction is considered to be Not Significant.

6.7 Marine Animal Collision Risk

6.7.1 Description of Potential Impacts

Large fauna swimming at or near the sea surface are most likely to be at risk from collision with the Project vessels. Turtles and species of larger, slow-moving whales are usually considered to be most at risk from vessel collision (Crum et al, 2019; Hazel et al, 2007; Gende et al, 2019).

6.7.2 Mitigation Measures

There are options for reducing vessel-whale collision risk for example through direct observation, communication and navigational responses, particularly speed restrictions (Gende et al 2019). Conn and Silber (2013) modelled mortality when the vessel speed restrictions were and were not in effect and estimated that vessel speed restrictions to 10 knots maximum reduced ship strike mortality risk levels by 80–90%. Support and supply vessels and tankers will consider to adopt observation, communication and navigational responses, to reduce collision risks with marine mammals.

6.7.3 Assessment of Impacts

Turtles

Hazel et al (2007) has studied vessel collision risk for green turtle (*Chelonia mydas*). Turtle behaviour in response to an approaching vessel was observed over a number of encounters and key findings included the following.

- The proportion of turtles that moved to avoid the vessel noticeably decreased in proportion to the speed of the approaching vessel.
- Turtles moving from moderate (5.9 knots) and fast (10.3 knots) approaches began moving from the vessel at much shorter distances than turtles that moved from slow approaches (2.2 knots).

Overall, the results implied that a vessel operator could not rely on turtles actively avoiding a collision at speeds of much greater than 2.2 knots. The consequences of a collision increase with vessel speed and reduces with the ability to avoid collisions. There will be no collision risk to turtles from the presence of the MODU and FPSO therefore risks will be limited to possible collisions from the movement of shuttle tankers, support and supply vessels. As noted in Section 4.2.5 turtles can be expected to be encountered in the waters of the Project area and are also likely to be present between there and the coast. Collisions and physical harm are a possibility; however, in the context of the main threats to turtle populations of loss of nesting habitat, hunting, bycatch in fisheries and the risks from existing shipping traffic, any Project-related collision impacts would not be significant.

Whales

Collisions between vessels and whales have been known to occur worldwide and also in West Africa (Félix and Van Waerebeek 2005; Van Waerebeek et al 2007). Laist et al (2001) cited collisions with ships as a recognised source of whale mortality in a review of historical records for evidence of vessel strikes involving baleen whales and the sperm whale. Of the 11 species recorded as being struck by vessels, fin whales were the most frequent victims; right whales, humpback whales, sperm whales, and grey whales were also commonly struck. Of these species, sperm whale has been observed in the Project area.

Increased marine vessel traffic from the Project's support and supply vessels between the Project area 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 the vessels move at (typically less than 12 knots). No collisions between vessels and marine mammals have been reported from the Jubilee and TEN fields. Large slow-moving whales are at most risk in areas with fast moving vessels which frequently change direction. They will be more able to avoid the large, relatively slow-moving Project support vessels on fixed courses. The risks to marine mammals from vessels collisions associated with the Project are considered to be low and are assessed as Not Significant.

6.8 Drill Cuttings and Fluid Disposal

6.8.1 Description of Potential Impacts

As described in Chapter 3: Section 3.1, the development involves drilling a total of 14 wells (seven producers and seven water alternating gas injectors) over two phases. Discharges of drill cuttings to the environment have the potential to affect the water column and seabed.

To varying degrees, the extent of the impacts on water quality and sediments will be dependent on the following factors:

- the point of discharge, e.g. 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 (e.g. water-based or oil-based fluids), which may include particle size distribution and particle cohesion, and their chemical characteristics; and
- the extent of mixing and dispersion, which can be influenced by the currents present and the water depth into which the cuttings are released; and the presence and sensitivity of pelagic, demersal and benthic communities.

The impacts on marine biota will arise from the following two types of cuttings and mode of discharge.

- Cuttings generated from the top sections drilled with WBM will be released at the seabed from the well.
- Cuttings generated from the lower well sections will be drilled with NADF, which will be treated to reduce (to limits permitted by the local regulation) the retention of oil on cuttings and discharged at approximately 15 m below the sea surface from the MODU.

6.8.2 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 shakers and dryers, to reduce oil on cuttings when drilling with NADF to a target of an average 2-5% oil on cuttings overall for the sections drilled with NADF.
- 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 in the barite used in the drilling fluids.

6.8.3 Assessment of Impacts

Assessment Approach

The assessment of impacts of drill cuttings discharges is based on modelling undertaken by DNV GL (see Annex J). The modelling examined sedimentation at the seabed and concentrations in the water column from the discharge of treated cuttings, and the associated potential for toxic effects on marine biota. The Dose-Related Risk and Effects Assessment Model (DREAM) model was used which examined the following:

- discharges of drill cuttings, NADF and water-based mud (WBM) from production and injection wells in terms of seabed deposition in millimetres (mm); and
- dispersion modelling and calculation of Environmental Impact Factors (EIF) based on concentrations of oil on cuttings (OOC) in the water column

The modelling examined two concentrations of OOC: 1% and 4%. The modelling work was undertaken based on an earlier development concept with total of 26 wells being drilled from four drill centres, which is almost twice the numberplanned for Pecan Phase 1. The modelled wells were also longer than the planned wells for Pecan Phase 1 as the 14 wells will have individually distributed drilling and the 26 modelled wells were drilled from 4 drill centres. Thus, the modelled discharge volumes were significantly higher than the planned discharge volumes. The DREAM modelling result for the 26 wells was chosen to be used as basis for discussing impact from the currently planned 14 wells as the impact from the 14 wells will be lower than for the 26 modelled wells. Thus, the results are valid as a conservative approach for impact assessment.

Brief Description of DREAM

DREAM has been developed over many years by Sintef in cooperation with the oil and gas industry. The model is a three-dimensional Lagrangian particle model and is able to accommodate up to 200 chemical components and assess their fate in the marine environment. For each chemical component the model considers its physical, chemical and toxicological properties. The EIF approach provides a quantitative measure of the potential environmental risks involved from discharges to the sea, in turn providing a basis for examining how to reduce impacts in a systematic and quantitative manner. The EIF approach is based on Predicted Environmental Concentration (PEC) and Predicted No Effect Concentration (PNEC) for pollutant components of discharges, where the PEC/PNEC ratio is used as an indicator of potential risk (or Hazard Quotient).

PNEC values are derived from laboratory experiments that typically result in values for LC50 (Lethal Concentration that kills 50% of the individual test species) and NOEC (No Observed Effect Concentration). PNEC values are selected for the most sensitive species. Common practice is to consider water concentrations of potentially toxic compounds corresponding to a PEC:PNEC ratio < 1 as environmentally safe (Karman et al, 1996).

The calculation of the EIF looks at discharge behaviour through applying:

- a generalised transport equation, accounting for advection and turbulent diffusion in the water column; and
- several transformative processes that occur post discharge such as sinking, dissolution, sedimentation and biodegradation.

The DREAM model defines a 5% risk as equating to a PEC/PNEC ≥1 in 100,000 m^3 of water or 10,000 m^2 of seabed.

Modelling Results: Water Column Concentrations

The modelling predicted no clear difference between the risk /effect of discharges of 1 % OOC and 4 % OOC in the water column. The main difference between the two alternatives are the discharges using a thermomechanical cuttings cleaner (TCC powder) compared to using sieves and driers.

A PNEC for TCC powder is not available, therefore for the purposes of modelling a PNEC of 10 mg/l based on a literature study of the effects of particles in general was used. For cuttings a PNEC of 100 mg/l is used which is standard for EIF calculations. Concentrations of 10 mg/l and 100 mg/l are predicted only in the vicinity of the discharge points, at some distance these discharges are quickly diluted with ambient sea water through advective, turbulent and other physical processes.

Following initial dilution, the oil on discharges with cuttings or TCC powder is not especially toxic in the sense it has a high PNEC and is degraded relatively quickly in the environment. The data provided suggest a PNEC of >2,700 mgl^{-1} (see Annex H) and full biodegradation within 28 days.

Modelling Results: Sediment Deposition

A threshold level (PNEC) for sediment burial of benthic fauna used in the risk assessment of drilling discharges is based on 6.3 mm which the burial level adopted in the Norwegian North Sea that reflects a hazardous level for 5 % based on benthic species sensitivity distribution (Smit et al, 2008).

The area of accumulated sediment thickness above 6.3 mm predicted by the modelling gave a total influence area exceeding the PNEC of approximately 0.25 km^2 for all the wells for the whole drilling campaign (noting that almost double the number of wells was assessed in the modelling report).

The modelling showed that there is no overall differences between the 1% and 4 % OOC discharges. Where the PNEC is 6.3 mm and greater the contribution to these areas is considered as most likely arising from the top-hole cuttings discharged at the sea floor. The other discharges as slurries at approximately 2,400 m above the seabed are predicted to disperse over a much larger area and made very little contribution in the areas exceeding the 6.3 mm threshold.

When comparing the area for accumulated sediment thickness greater than the PNEC level for the different discharge locations (i.e. the manifold tie-ins), the largest influenced areas were predicted to be at Drilling Centre P1 and Drilling Centre P2, i.e. the locations with highest numbers of wells (see Figure 6.3 and Figure 6.4 in Annex H). The planned well layout is without drill centres therefore the volume of drill cuttings discharged at individual well sites will be less than the volume that would be discharged if using four drill centres assumed for modelling purposes, i.e. the drill cuttings will be spread more thinly across a wider area (14 wells sites rather than 4 drill centres) therefore having a lesser impact on the seabed sediments as thinner areas of deposition cause less smothering of benthos and biodegrades more quickly

Assessment Conclusions

Discharges from drilling will result in temporary and localised degradation of water quality in the close vicinity of the MODU. The treated discharges will be of relatively low toxicity to marine biota, will physically disperse within small distances from the MODU and their oil components will biochemically degrade over time. Effects on marine biota will be localised, temporary and of small magnitude; over the larger area and in the long term there will be no significant effects.

There will be smothering effects on benthic organisms in the immediate vicinities of the well heads. The majority of the effect will be from the top-hole cuttings comprising natural mineral material. The area of seabed and benthic habitat affected will be small (circa 0.25 km^2 based on almost twice as many well as planned) compared with the wider area of seabed habitat available within the Project area. The loss and disturbance of habitat effects will largely coincide with the effects of installation and long-term presence of seabed infrastructure; however, in terms of impact, the magnitude will still be small and the effects of the loss of areas of muddy/silty habitat on benthic fauna will be Not Significant.

6.9 Well Completion and Operational Discharges

6.9.1 Description of Potential Impacts

During well completion and operation there will be several different discharges to sea with the potential to have impacts on water quality and effects on marine biota. The Project is too distant from shore to have any impacts on coastal water quality.

Some key operational discharges have been modelled (see Annex H). The purpose of the modelling study was to determine the size and configuration of the thermal plumes as well as the dilution of a number of chemical constituents resulting from long-term operational discharges from the FPSO. The three discharges analysed in the study were as follows: Cooling Water (CW) discharge, Wastewater (WW) discharge and Produced Water (PW) discharge.

The United States Environmental Protection Agency (USEPA)-approved near-field model, CORMIX (Version 12.0) was used which has been applied to many similar cases (http://www.cormix.info) and is recognised by the USEPA as an appropriate model for computing trajectories, dilution rates, and mixing zone dimensions.

The following physical and chemical water quality constituents were selected for modelling:

- Temperature
- Free Chlorine
- Corrosion Inhibitor
- Scale Inhibitor
- H2S Scavenger
- Water Clarifier
- Oil in Produced Water

Since the behaviour of a discharged effluent is influenced by ambient conditions (e.g. current, water temperature) the modelling study looked at a range of scenarios, including worst cases. As well as predicting the physical behaviour and dispersion and dilution of the discharge plumes, the modelling study also assessed chemical water quality impacts and potential hazards to marine biota.

The resulting diluted concentrations in the various discharges were compared to the derived thresholds to compute a hazard quotient (HQ) (see literature references in Annex H) as follows.

- A HQ for a chemical is computed by dividing the probable (i.e. predicted) chemical concentration by the chemical threshold.
- At a HQ value of 1.0, the probable concentration of the chemical is equal to concentration of the chemical that resulted in a hazard.
- A HQ value of greater than or equal to 1.0 indicates a potential hazard.

For all cases, excess temperatures +/- 3 °C are met within a distance (length) of 7.31 m from the discharge outlet in the lateral direction; excess temperatures below 3 C are met within 7.53 m of the discharge outlet in the vertical direction.

Within 500 m for all of the extreme conditions modelled, the initial effluent concentrations are diluted at least by a factor of 98.6. The modelling study concluded that in comparison to threshold concentrations, there are no potential hazards to the aquatic community from exposure to produced water or wastewater.

6.9.2 Mitigation Measures and Assessment of Impacts

The various discharge sources are described in Table 6.4 together with the mitigation measures that will be applied and an assessment of the residual environmental effects.

Table 6.4 Well Completion and Operational Discharges: Mitigation Measures and Assessment of Impacts

Discharge Source	Mitigation Measures	Residual Impacts
Well completions and workovers. Completion fluids will typically include weighted brines, acids, methanol and glycols and other chemical, and seawater used as a displacement and circulation fluid. Well workovers result in similar discharges to well completions. Potential effects on water quality and marine biota.	Chemical selection and use will be advised by '*Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2011)*'. • Completion fluids will be tested for total oil and grease content to ensure that it is below the specification for discharge to sea (i.e. Oil in water not to exceed 40 ppm daily maximum and 29 ppm monthly average, in accordance with EPA guidelines and Pecan Energies project standards). If the fluids exceed the specification, they will be retained on the vessel and shipped for onshore disposal. • If acid is used during well completions or workovers, the spent acid will either be injected into the rock formation or neutralised prior to discharge to sea.	The impacts on water quality from well completion and workover discharges will be occasional, localised and temporary. There will be no significant effects on marine biota.
Black and Grey Water and Food Wastes: there will be FPSO, MODU and vessel discharges of black water (from toilets) and grey water (from washing, laundering, bathing and showering) and macerated food waste. The volumes involved are estimated in Chapter 3: Table 4.12, based on monitoring data for similar FPSO facilities with a similar number of persons on board (PoB). Discharges will be via holding tank storage and from single point sources at the sea surface. Potential effects on water quality and marine biota.	• Black water will be treated using a marine sanitation device that treats the waste and produces an effluent with a maximum residual chlorine concentration of 0.5 mg l^{-1} and no visible floating solids or oil and grease. • Under MARPOL grey water does not require treatment before discharge. • Food wastes will be macerated to acceptable levels such that they will pass through a 25 mm mesh.	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 and these will comply with Annex IV of MARPOL in regard to discharges. 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

Discharge Source	Mitigation Measures	Residual Impacts
		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 be Not 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.
Deck Drainage – Hazardous Drains: areas which may be contaminated with hydrocarbons on the FPSO and MODU will drain to the hazardous drain system. This also includes areas of potential hydrocarbon leakage (e.g. pumps, exchangers, filters). Potential effects on water quality and marine biota.	• Hydrocarbon contaminated fluids will be routed to a hazardous drain tank with oil/water separation. The hazardous drain tank will be heated, as necessary, to aid oil / water separation and there will be provision for biocide treatment. Process fluids sent to the hazardous drain tank will not be recycled into the process unless approved. To manage the volume of fluids in the system, the main deck scuppers (holes to allow drainage) will have plugs that are typically opened manually during heavy rains to allow excess water to be discharged to sea. • Drains will be provided with removable covers to prevent debris from entering the system.	The total volumes of drainage water produced by the FPSO, MODU and support vessels as part of the Project will, to a degree, be dependent upon weather conditions (i.e. 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 an FPSO can be in the order of 100 m^3 per day. Bilge water volumes will be smaller and more intermittent. The volumes to be discharged constitute relatively small-scale inputs into deep-water offshore with good capacity for dilution and dispersion. 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 on board the vessels, the residual impacts on water quality and marine organisms associated with discharge of drainage and bilge water will be Not Significant.
Deck Drainage – Non-Hazardous Drains: the non-hazardous drainage systems on the FPSO, MODU and vessels will take run-off from areas unlikely to be contaminated by hydrocarbons and drain to a non-hazardous drain tank and thence to a single discharge point to the sea surface. Potential effects on water quality and marine biota.	Non-hazardous drains will be provided with removable covers to prevent debris from entering the drains systems. The system will have provision for biocide treatment.	
Bilge Water: discharged in various volumes from single points at the sea surface from support vessels, MODU and FPSO.	Treatment in the bilge water separator to achieve no free oil and maximum 15 mgl^{-1} instantaneous reading oil water threshold.	

Discharge Source	Mitigation Measures	Residual Impacts
Potential effects on water quality and marine biota.	If onboard treatment to the required standard is not possible the effluent will be retained onboard until it could be discharged to an approved reception facility.	
Ballast Water: from vessels with volumes and frequencies dependent on vessel trim requirements. Potential effects on water quality and marine biota (through changes in water quality and introduction of pathogens and alien invasive species).	• Project vessels will be designed with separate ballast tanks, according to class notation and MARPOL. Discharges will meet standards of no free oil and maximum 15 ppm instantaneous reading oil water threshold. • Discharges will meet the requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments. Project vessels will have onboard and implement a Ballast Water Management Plan. All ships using ballast water exchange will do so at least 200 nm from nearest land in water at least 200 m deep. • The FPSO, MODU, supply and support vessels, installation vessels and incoming export tankers 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 discharge of invasive foreign marine species into deep water at the location of the Project (1,600 to 2,700 m depth) and circa 90-103 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. 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 Project area, potential impacts are assessed as Not Significant given the distance from shore and water depths involved.
Pre-commissioning - treated seawater from flooding, cleaning and gauging flowlines, hydrotest and leak tests: fluids will be discharged subsea at the pig launcher/receiver. The seawater will typically contain corrosion inhibitor, biocide, oxygen scavenger and tracer dye. Potential effects on water quality and marine biota.	Chemicals will be chosen to minimise impacts on the aquatic environment in accordance with the Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2011).	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
Pre-commissioning - gas system dewatering fluids: fluids will be discharged subsea at the pig		

Discharge Source	Mitigation Measures	Residual Impacts
launcher/receiver. The seawater will typically contain corrosion inhibitor, biocide, oxygen scavenger and tracer dye. Methanol or Monoethyleneglycol, dosed with tracer dye, will also be used in dewatering fluids. Potential effects on water quality and marine biota.		consumed/degrade in the flowlines depending on how long it resides there. MEG and methanol are rated as Category Green (– OSPAR PLONOR chemical, Poses Little or No Risk) according to the Ghanaian chemical categorization scheme (Offshore Oil and Gas Development in Ghana, Guidelines for Environmental Assessment and Management 2011) (i.e. least potential for adverse environmental effects). 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 discharge (at the pre-commissioning of Phase 1a and 1b), impacts will be short-lived, and regeneration will be rapid. Any secondary impacts higher in the food chain will be Not Significant.
Production system commissioning fluids from FPSO: these fluids will include treated seawater, diesel or crude. Treated water will be discharged from the FPSO at the sea surface. Potential effects on water quality and marine biota.	Treated water will be processed on the FPSO via the oil in water (OIW) treatment system. Diesel / crude will be routed to the crude oil stock tanks.	Discharge of treated seawater with a maximum oil content of 40 mgl^{-1} daily and 29 mgl^{-1} monthly average, undertaken at the commissioning of Phase 1a and 1b will disperse rapidly in the open ocean conditions. The impact on local water quality and marine biota will be localised, temporary and Not Significant.
Hydraulic fluid: small volumes of hydraulic fluid will be vented from the control system equipment such as subsea valves. Valves on the production manifolds and trees are required to be tested by actuating them at least once every 3 to 6 months.	The subsea control system will use as ecological friendly hydraulic fluid as possible, the actual fluid has not been decided yet, but the relevant candidates are ranked as Yellow according to the Ghanaian chemical categorization scheme (Offshore Oil and	The small volume and intermittent discharges of fluid from the system will be rapidly diluted and dispersed in the receiving water column. The residual impact of the discharge of hydraulic fluids is assessed as Not Significant given the small scale, localised and intermittent nature of

Discharge Source	Mitigation Measures	Residual Impacts
Testing or operation of the subsea blowout preventer would also result in small releases. Over the course of a year less than 1 m^3 of fluid might be released. 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. Potential effects on water quality and marine biota.	Gas Development in Ghana, Guidelines for Environmental Assessment and Management 2011) . (i.e. biodegradable and non-bioaccumulative).	the impact and the low toxicity and rapidly biodegradable fluid used.
Cooling Water Effluent. Cooling water will be discharged at a rate of 3,500 m^3 hr^{-1}. The dispersion of the cooling water effluent has been modelled and the methodology and results are presented in Annex H. Passage through the cooling system was assumed to increase the intake water by 5 °C. Applied to the range of water temperatures withdrawn at the 100 m depth, the effluent temperatures ranged from 19.8 °C for the 95%-probability and 22.8 °C for the 5%-probability. At the surface discharge, the difference between the effluent temperature and the ambient temperature ranged between 4.4 °C cooler in the 95%-probability case, and 7.1°C cooler in the 5%-probability. The cooling water is assumed to contain up to 2 ppm free chlorine.	• A maximum chlorine content of 2 ppm will be used for dosing the cooling water system. • Biological fouling of the cooling water system will be monitored to establish times of year and ambient conditions under which the dosing can be reduced.	Good industry practice (IFC 2007) for thermal discharges indicates that there should be no more than a 3˚C increase within 100 m of the discharge. Since the cooling water is drawn from depth it will be several degrees cooler than ambient surface water and even with a 5˚C increase in temperature as it passes through the cooling system it will still be cooler than ambient when discharged. The dispersion modelling has shown that that the +/- 3 °C temperature requirement is reached within less than 10 m of the discharge (7.31 m in the lateral direction and 7.53 m in the vertical direction). Therefore, impacts are assessed as Not Significant. Comparison with chlorine threshold concentrations indicate that there is no potential hazard to the aquatic community at 500 m from the discharge location (HQ<1). Impacts are assessed as being of Minor significance.
Produced water effluent: produced water will be discharged at a rate of 497.9 m^3 hr^{-1} during operation and will contain the following main constituents: oil at up to 29 ppm monthly average; scale inhibitor at up to 50 ppm and corrosion inhibitor at up to 50 ppm, H2S scavenger up to 8 ppm and water clarifier up to 100 ppm. The discharge temperature of the produced water was assumed to be 96 °C. The dispersion of the produced water effluent has been modelled and the methodology and results are presented in Annex H.	Produced water will be continually monitored and if oil in water (hydrocarbons) exceeds the daily limit of 40 mgl^{-1} or the 30 day average of 29 mgl^{-1} as per EPA (2011), the water will be routed to the off-specification tank for further treatment prior to any discharge.	Produced water discharges have the potential for impacts on water quality and possible secondary effects on marine organisms (e.g. plankton, larger invertebrates and fish) in the vicinity of the discharge. 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 temperature and 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.

Discharge Source	Mitigation Measures	Residual Impacts
		The dispersion modelling show that the +/- 3 °C temperature requirement is reached within less than 10 m of the discharge (7.31 m in the lateral direction and 7.53 m in the vertical direction). In the worst-case scenario the chemical constituents of the effluent are predicted to be diluted by 77.5 times at 100 m and 98.6 at 500 m from the discharge, with HQ all less than 1 within 500 m from the discharge location. The impacts on water quality are therefore predicted to be highly localised. The waters in the Project area are considered to be of medium sensitivity. Marine organisms such as plankton within the mixing zone will be affected, 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.

6.10 Emissions to Atmosphere

6.10.1 Description of Potential Impacts

The Project will emit various pollutants to atmosphere as a result of combustion products (e.g. from power generation, vessels' engines) and from processes on board the FPSO. There is also the potential for fugitive emissions (e.g. volatile organic compounds during loading of oil to the shuttle tankers). A calculation of emissions to air from the Project in tonnes per annum is provided in Annex I.

During commissioning and operations, 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. Emissions from vessels will be greatest during the drilling and subsea infrastructure installation phases.

Emissions from vehicle and helicopter operations at the onshore bases at Takoradi Port and the Air Force base are considered to be small in scale and Not Significant given the limited number of movements and the absence of large combustion sources. Emissions from activities at the port and from vessels transiting to and from Takoradi are also not considered to be significant based on Local Air Quality Management (LAQM) Technical Guidance from the UK (DEFRA 2009). This guidance advises that when there are less than 5,000 additional 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 the contribution of such vessel numbers exceeding air quality standards will be negligible. The number of vessel movements during the drilling, installation and operational phases for the Project are expected to be well below this level of activity.

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 of potential concern:

- oxides of nitrogen (NO_X), including nitrogen dioxide (NO_2); and
- sulphur dioxide (SO_2).

NOx and SO_2 emissions from the main sources, during drilling, installation and operations are presented in Chapter 3: Section 3.10.1.

Greenhouse gas emissions are addressed in Section 5.11.

6.10.2 Mitigation Measures

The following specific mitigation measures will be implemented which will reduce the impact of the Project on air quality.

The FPSO will be equipped with new low NOx gas turbines for energy generation and will run on associated gas most of the time, which minimise the SOx emissions. The gas turbines selected will meet the 2007 WBG EHS Guidelines for NOx emissions from natural gas (at less than 25 ppm for turbines of 15 MWth to less than 50 MWth). The MODU, construction/installation and support/supply vessels will comply with MARPOL 73/78 Annex VI standards with regards to emissions to air (see Chapter 2 Table 3.5). Annex VI sets limits on oxides of sulphur and nitrogen emissions from ship exhausts and diesel engines and prohibits deliberate emissions of ozone-depleting substances, including halons and chlorofluorocarbons.

The Project will use low-sulphur diesel fuel.

Methods for controlling and reducing leaks and fugitive emissions, such as the use of fuel gas (i.e. 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 FPSO.

Routine flaring will be avoided and non-routine flaring will be kept to a minimum to maintain safe conditions or during short-duration activities such as commissioning, start-up, re-start and maintenance activities. The flare design will be closed flare that eliminates the need for a pilot flame and thus reduces the emission further.

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

6.10.3 Assessment of Impacts

Atmospheric dispersion modelling using the United States Environmental Protection Agency's AERMOD dispersion model was undertaken for the TEN FPSO project (ERM et al 2014) to predict concentrations of pollutants at sensitive receptors from emissions during drilling, completions, commissioning and operations, as well as the cumulative impacts with the Jubilee FPSO. The air quality impact assessment was carried out with reference, where appropriate, to Ghanaian national air quality standards and World Health Organization (WHO) air quality guidelines in accordance with IFC (2019). In addition, impacts at sensitive ecological receptors due to emissions of NO_X and SO_2 were assessed.

The results of the abovementioned 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 and cumulatively with the Jubilee FPSO. The greatest impacts were predicted to 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.

The TEN Project location was in the order of 40 to 60 km away from sensitive coastal receptors. At 90 to 103 km distance from the coast, the Project will have substantially less impact on air quality than the TEN Project; therefore, the Project's impacts on air quality at sensitive receptors will be negligible and Not Significant.

On the basis of the above considerations, defining the exclusion zone to 500 m is a reasonable precaution to ensure that transient receptors, such as fishing vessels, are not exposed to unacceptable air pollution.

6.11 Greenhouse Gas Emissions

6.11.1 Potential Impacts

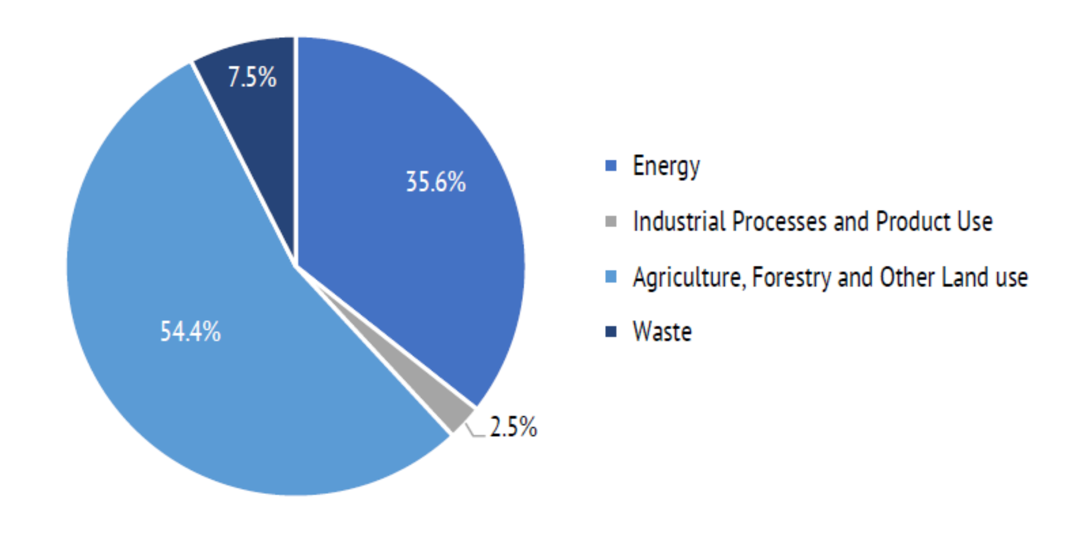
Project activities will emit varying amounts of Greenhouse Gases (GHGs) (e.g. carbon dioxide (CO_2) and methane (CH_4)), which contribute to global climate change. This section aims to quantify and assess the significance of GHG emissions expected to be generated by Project activities. GHG estimations include well drilling and completions, subsea and FPSO installations, commissioning and production operations activities. Emission calculations are provided in Annex I.

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_2e (carbon dioxide equivalents). Emissions of GHGs are given by using the GWP as weighting factors for the emissions of CO_2 (with a weighting factor of 1) and CH_4 (with a weighting factor of 23).

The standards for reporting GHG emissions and country targets are managed by the United Nations Framework Convention on Climate Change (UNFCCC) that was ratified by Ghana in 1995. According to Ghana's Fourth National Greenhouse Gas Inventory Report - National Greenhouse Gas Inventory to the United Nations Framework Convention on Climate Change (EPA, 2019), the GHG emissions for Ghana in 2016 (the most recent year available) were 42.2 million tonnes CO_2e per year. The approximate distribution of GHG emissions by sector is provided in Figure 6.2.

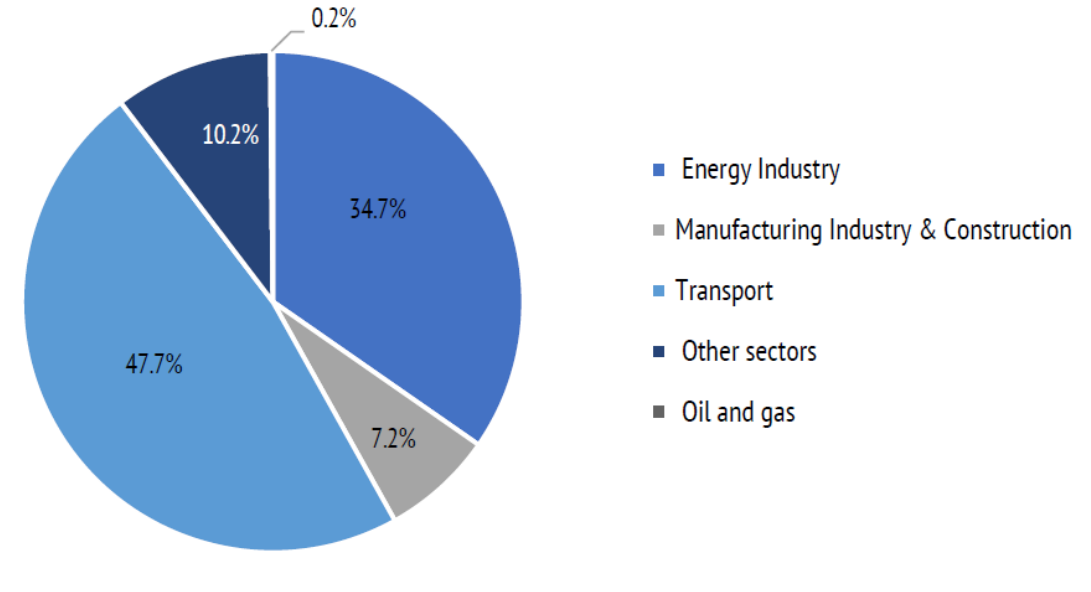
The overall energy sector emissions aggregated to 15.02 million tonnes CO_2e in 2016 making the energy sector the second largest source of GHG emissions in the country

(Figure). It should be noted that the emissions from the Project will be represented in more than the 'oil and gas' category as emissions from the burning of fuel (diesel or gas) for production and transport will be included within the energy industry and transportation industry categories.



Source: EPA 2019.

Figure 6.2 Breakdown of Ghana's GHG Emissions by Sector



Source: EPA 2019.

Figure 6.3 Breakdown of Ghana's Energy Sector GHG Emissions

6.11.2 Mitigation Measures

The mitigation measures aimed at reducing GHG emissions to as low as reasonably practicable are generally built into the design of the FPSO and focus predominantly on:

- efficiency of power generation;
- optimisation of overall energy efficiency;

- reduction in flaring; and
- reduction in venting.

To inform the detailed design of the Project so that energy efficiency and emissions reduction from combustion (i.e. fuel use and flaring) can be built into the Project, a Best Available technology (BAT) assessment (see Annex B) and an Energy Efficiency of Design study (see Annex C) were undertaken. The results of these studies optimised the design of the FPSO facilities to reduce GHG emissions in the following ways.

- FPSO design with electrical power generation provided by high efficiency low NOx gas turbines, sized and configured to life-of-field power demand.
- FPSO design to minimise process electricity demand through optimal sizing, configuration and selection of energy efficient equipment, in particular, compressors and pumps.
- Hydrocarbon blanket gas in the oil storage tanks will be recovered in a VOC recovery unit. The recovered VOC will be introduced into the gas handling system for mixing with produced gas.
- A closed flare system with a flare gas recovery unit.

In addition, the pre-commissioning testing of the FPSO gas compression systems and process systems in the construction and supply bases prior to shipping equipment to Ghana will reduce the requirement to flare gas during the commissioning phase. The driver for the duration of flaring during commissioning will be the mitigation of risk for asphaltene in the first injection well.

To mitigate flaring of well fluid during well clean-up all producing wells will be cleaned-up to the FPSO across Phase 1a & 1b and all injectors suspended ready for direct injection service. This revised well clean-up strategy significantly reduces the anticipated carbon footprint at the Drilling Unit during well construction phase.

In compliance with IFC (2015) EHS guidance and to monitor the effectiveness of measures to reduce the levels of emissions, Pecan Energies will quantify total GHG emission from production and flaring activities as an aggregate on an annual basis in accordance with internationally recognised methodologies and reporting procedures (WRI 2006). An Energy Management System will also be developed with the aim to minimise GHG emissions.

6.11.3 Impact Assessment

Annual greenhouse gas (GHG) emissions for each year of the Project have been calculated and are presented in Annex I. The calculations were based on the methodology and emissions factors from the API Compendium (2021).

The sources considered included the following:

- FPSO - fuel use;
- FPSO – flaring;
- drilling rig – flaring;
- drilling rig - fuel use;
- helicopter transport;
- marine operations (drilling phase);
- marine operations (construction phase);
- marine operations (production phase); and
- diesel use for FPSO generators and pumps during commissioning and routine testing of emergency generators and pumps.

The principal sources of GHGs from the project will include the following.

- Combustion emissions from main power generation systems on the FPSO that are used to generate power for gas compression, water injection, process equipment and pumps.
- There will be no operational flaring and no pilot flare as the flare system is closed. The only flaring will be short term flaring of gas and oil during well clean-up before production starts, short term flaring of gas during start-up of the first injection well, and non-routine flaring of gas due to upset, maintenance and emergency conditions
- Lesser sources such as back-up generators; MODU power generation during drilling and well completions; installation/construction vessels; and supply/support vessels.
- Personnel transportation with helicopter.

The total energy use for the Project by the main contribution sources are shown in Chapter 3: Figure 4.17. The calculated CO_{2e} values for 15 years of production are shown in Figure 6.4. The GHG emissions data has been assessed in relation to the planned oil production profile to obtain a Carbon Intensity Profile (i.e. the GHG emissions on kgs per barrel of oil equivalent (boe) produced for the FPSO operations) over the Petroleum Agreement lifetime (Figure 6.5).

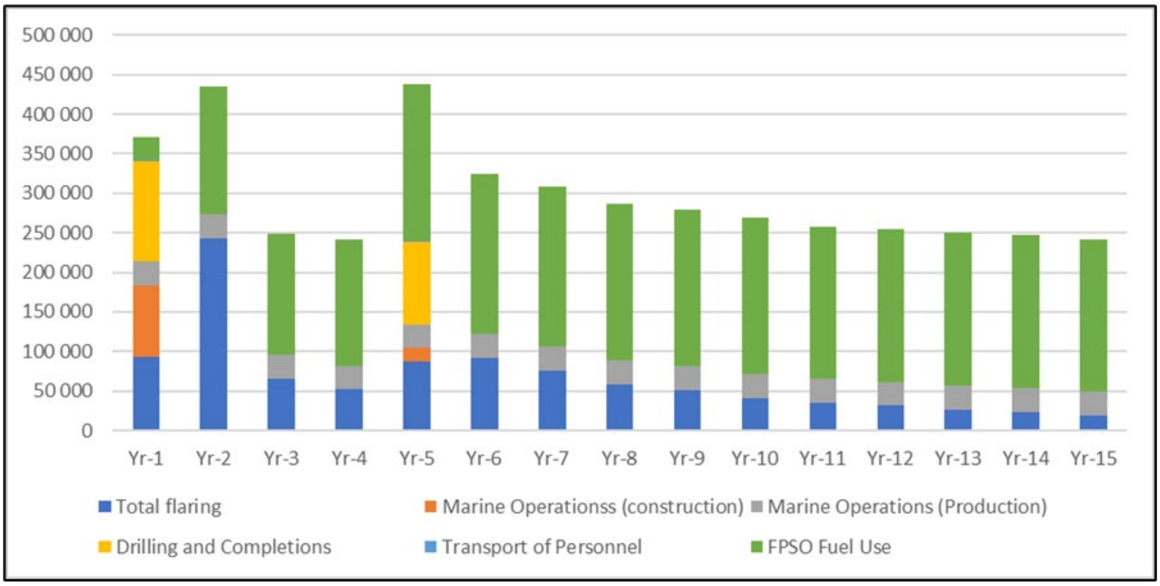


Figure 6.4 Calculated CO2e Emissions From the Main Project Sources for 15 Years of Production

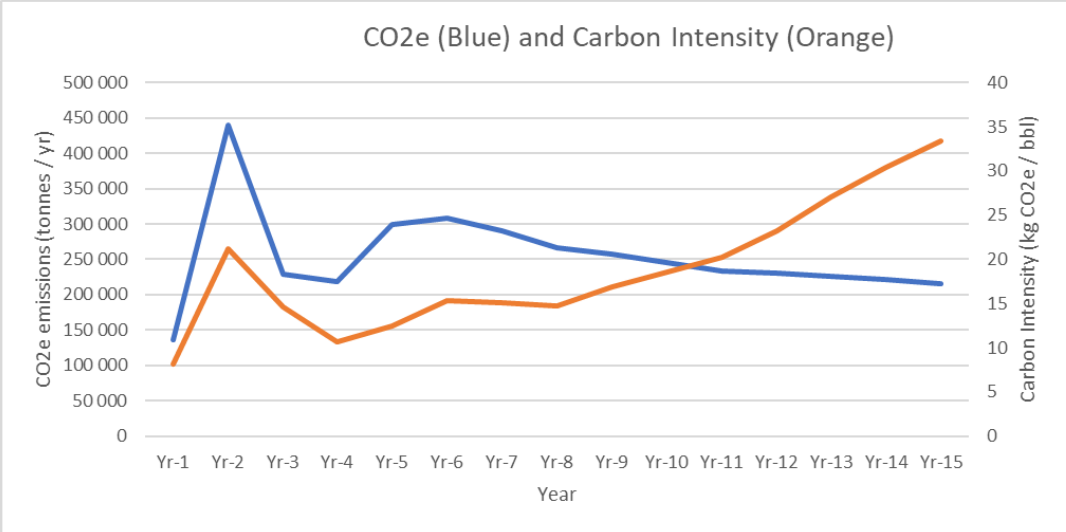


Figure 6.5 Calculated CO2e Emissions and Carbon Intensity for FPSO Operations for 15 years of Production

GHG emissions were predicted to be highest during the first few years during the main well drilling and completion phase as well as the installation and commissioning phase when there will be MODU and construction related vessels operating. During commissioning, there will be flaring activity for about three months when the FPSO produces first oil and as the plant and process stabilises. Thereafter flaring will be intermittent, for example, occurring when the FPSO compression system is unavailable or during start-ups and operational upsets.

Releases of GHG to atmosphere once operational will predominantly constitute emissions from the FPSO (power generation and non-routine flaring). Routine emissions from support vessel engines will continue as well as occasional emissions during well interventions and workover operations from MODUs.

Estimated annual average GHG emissions throughout the Petroleum Agreement lifetime are 254,600 tonnes CO_2e. 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 2007). Under PS 3, the GHG reporting threshold for a single project is 25,000 tonnes CO_2e per annum.

The Project will result in an average 0.8% increase in CO_2 emissions based on the estimated annual average national emissions. The magnitude of impact is therefore small but the sensitivity is high (contribution to climate change) giving an overall Moderate significance of impact.

The impact can be provided with more context by considering 'carbon intensity', which relates the amount of greenhouse gasses generated to unit volumes of hydrocarbon produced. The carbon Intensity in terms of emissions of CO_2e per barrel of oil produced averages 15 kg CO_2 / boe, which is within the 10 to 40 CO_2e / boe range that most operators achieve (Rystad, 2021), and also is significantly better than regional data which shows offshore developments in the region at around 30 kg CO_2e / boe (S&P Global Commodity Insights 2022).

6.12 Waste Management

6.12.1 Overall Considerations for Waste Management

The Project will generate both hazardous and non-hazardous solid and liquid wastes during the well drilling and completions, subsea installation, commissioning, operational and decommissioning phases. The main waste types expected to be produced by the Project are outlined in Chapter 3: Section 3.13.

Wastes will be actively managed, with the process of waste management involving several stages, each with potential risks of impacts on people and the environment. The main stages are as follows:

- waste segregation and storage at both offshore and onshore locations.
- transportation of waste from the point of generation (mainly offshore) to onshore waste handling locations.
- impacts associated with management practices of specific waste treatment and disposal sites.

For each of the above stages, the potential impacts, mitigation measures and residual impacts are discussed in the following subsections. Effluent discharges as well as drilling waste (drill cuttings and fluid) are discussed in Sections 5.8 and 5.9.

6.12.2 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.

Offshore
The inappropriate or inadequate storage of wastes on the MODU, FPSO or supply vessels could result in accidental release of wastes to the marine environment, in turn leading to an adverse impact on marine water quality, locally, and/or a hazard to marine life. This could include the spillage and discharge of liquid hazardous wastes (e.g. used oil and chemicals) and impacts on marine fauna; for example, the overboard release of solid wastes, such as plastics, can be ingested by seabirds, turtles or other marine species, or eventually wash up on beaches as litter.

Onshore
The inappropriate or inadequate storage and containment of wastes at the port or the waste disposal site, and supply base could result in accidental release of liquid wastes to soils and water resources. This could result in direct exposure to staff, contamination of soils used by local communities for agricultural purposes, or surface waters, groundwaters, or coastal waters used by local communities for drinking, washing, or fishing.

Large quantities of certain wastes stored in inappropriate or inadequate ways could constitute a fire risk.

The proper segregation of waste streams will facilitate recycling and reuse allowing for value recovery from the waste stream, leading to positive impacts.

Mitigation Measures

There will be designated areas for the temporary storage and segregation of waste 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 will be through operational controls. The key procedures for controlling wastes from offshore and onshore will be set out in the Project Waste Management Plan (WMP) which will be developed based on the specific requirements of the Project.

The WMP will require all facilities that are operated or controlled by the Project (including contractors based within the Project's onshore base facilities) to adopt specific procedures for the management of wastes, including the segregation of recyclable, non-hazardous and hazardous wastes at source and appropriate containment measures for specific waste types.

The WMP will cover both offshore (the FPSO, supply vessels, installation vessels and the MODU during well drilling and completions) and onshore (support base at Takoradi Port and supply base) Project facilities.

Assessment of Impacts

On the basis that the mitigation measures are implemented as defined in the WMP, the risk of significant accidental releases of wastes to the receiving environment will be minimised through good waste management practices including safe and secure segregation, storage and containment as well as planned audits to waste management contractors' facilities to guarantee a duty of care. 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 Not Significant.

6.12.3 Transport of Waste

Description of Potential Impacts

Wastes from the Project will need to be transported for waste treatment and disposal. Potential impacts could occur during transport from offshore to onshore facilities and then from the onshore facilities to the eventual disposal locations. The main sources of potential environmental impact during the transport of wastes include the following:

inappropriate handling and containment of wastes during transport on supply vessels (i.e. taking waste from the FPSO to onshore facilities) could result in accidental releases of wastes to the marine environment (including near to the coast).

inappropriate management and control of vehicles transporting wastes from Takoradi port facilities up to and including the approved disposal site could result in potential impacts on both the environment (e.g. soils and groundwater) and local communities, for example due to littering, release of potentially hazardous wastes during transport, and poor security of waste.

Mitigation Measures

Mitigation of potential impacts during waste transport will be by the way of operational controls. These will be documented in the WMP.

Operational controls will include the following.

- Waste will be transported in a safe manner, in accordance with the associated Safety Data Sheets (SDS) 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 vessels and vehicles that are crewed/driven by appropriately trained and licensed operators.
- Vehicles will be equipped with the appropriate emergency response system to deal with emergencies such as spills.
- Vessels and vehicles to be used for transporting wastes will be assessed and approved to meet minimum standards and Project vehicle policy.
- Waste will only be transported by Project and EPA approved waste contractors.

Impact Assessment

The risks of any significant accidental releases of wastes to the receiving environment will be minimised through good waste transport practices and use of approved waste transporting contractors. The residual impacts are assessed as Not Significant.

6.12.4 Waste Treatment and Disposal

Description of Potential Impacts

The main sources of potential environmental impact that could result from the treatment and disposal of wastes from Project operations include the following.

Inappropriate disposal of wastes, e.g. 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 noxious vapours to the atmosphere. 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 affect 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) could contaminate soils, and surface or groundwater, potentially adversely affecting human health and/or ecosystems.

Waste facilities or sites with inadequate security could potentially affect local communities due to littering and health and safety risks associated with uncontrolled public access to areas containing wastes.

Mitigation Measures

Mitigation measures for potential impacts associated with waste treatment and disposal will be documented in the WMP and include the following.

- Only EPA approved contractors providing waste treatment and disposal services will be selected.
- Pre- Audits, ensuring compliance prior to contract award.
- 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 Project 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 Project WMP. Proposed waste management options that have been identified for the main waste types are outlined below and summarised in Chapter 3: Table 4.15.
- Non-hazardous waste will be segregated and recycled where possible. Pecan Energies 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 for recycling/treatment where possible. Unused chemicals will be returned to suppliers.

The Project will store small quantities of hazardous waste types, for which 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.

Assessment of Impacts

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 the Project's waste contractors in line with international good practice. The Project 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.

There may be small quantities of hazardous waste that currently cannot be treated in-country. These will be stored in a secure holding area for future processing or export. The Project 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. The Project will continue to work with waste contractors to facilitate the continuous improvement and upgrading of facilities.

6.13 Potential Impacts on Critical, Natural and Modified Habitat

6.13.1 Introduction

This section sets out an assessment of the impacts of the Project on critical, natural and modified habitats, as defined in IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. The assessment comprises:

- a determination of the presence of natural, modified and critical habitats and summary of impacts on these features;
- mapping of nationally protected and internationally recognised areas and summary of impacts on these features;
- an assessment of the potential effects of invasive species.

6.13.2 Overview of Approach to Defining Critical, Natural and Modified Habitat

The general approach taken to defining critical, natural and modified habitats comprised the following steps.

- The Project site was defined (onshore and offshore) and Area of Influence (AoI) of the Project were identified.
- Areas of Assessment (AoA) were identified based on landscape / seascape features. The AoA included the AoI, but also extended beyond it. The boundaries of the AoA followed logical boundaries (e.g. coastlines, extent of natural or modified habitat). Habitat was not considered further if it was within the AoA, but beyond the AoI and there was no pathway of effect between it and the Project activities.
- Candidate biodiversity features within the AoA that could trigger critical habitat were identified, along with the habitat types supporting them that occurred in the AoI and where that habitat extended beyond it. The numbers of species / proportions of populations in those habitats were then estimated (based on percentage of total species range, baseline survey results and expert judgement), to confirm if critical habitat was triggered under IFC PS6 Criteria 1-3. Ecosystems, areas and underlying ecological processes that met IFC Criteria 4-5 within the AoA were also identified.

- In the case of wide-ranging species (e.g. marine mammals, migratory fish species), likely to spend a significant part of their lifecycle outside of the AoA, the potential for the Project to affect the survivability of the species or population was assessed.
- Information on biodiversity features from the findings of desk studies and baseline surveys were used to identify areas of natural and modified habitat in the AoI.
- An assessment was made of the potential impacts from the Project from the introduction of invasive species and how this will be managed.

6.13.3 Definitions and Criteria

Area of Influence (AoI) / Area of Assessment (AoA)

An AoI is the area within which Project effects on biodiversity may occur. AoIs were based on how far effects from the Project were considered to extend. They took account of the activities of the Project, their locations and the specific biodiversity features affected.

An AoA is the area considered for the identification of critical habitat. AoAs were based on ecologically appropriate landscape (onshore) and seascape (offshore) scale units. The identification of AoAs were informed by the ecologically definable boundaries.

Natural Habitat

Natural habitat is a term used by IFC PS6 that defines natural habitats as "…areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition".

Critical Habitat

IFC PS6 defines critical habitats as "...areas with high biodiversity value, including:

- habitat of significant importance to Critically Endangered and/or Endangered species;
- habitat of significant importance to endemic and/or restricted-range species;
- (habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- highly threatened and/or unique ecosystems; and/or
- areas associated with key evolutionary processes".

Modified Habitat

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. They may include areas managed for agriculture, forest plantations, reclaimed coastal zones / wetlands and urban areas.

6.13.4 Basis of Assessment and Data Used

To inform the assessment of impacts on biodiversity receptors, a desk-based review of available information on biodiversity receptors within the project AoI was undertaken. These sources included:

- Integrated Biodiversity Assessment Tool (IBAT) data for the offshore and onshore Project areas;
- Offshore Ghana EIA Reports and other public domain data sources; and

- Gardline Deep Water Tano / Cape Three Points Environmental Baseline Survey (2014).

The desk-based assessment also included a review of published information from international data sources.

6.13.5 The Project Area of Influence

In determining the AoI, it has been acknowledged that direct impacts will occur within the Project footprint. However, indirect impacts will extend beyond this, due to air quality, light, noise and vibration.

Onshore

In the onshore environment, the farthest extent over which an impact is likely to occur is heavily influenced by the fact that Takoradi port is an existing operational port set in an extensive urban area. There will be no new construction of buildings or roads. Taking into account the highly developed nature of the receiving environment a worst case AoI of 200 m was selected for potential air quality and noise/disturbance impacts on biodiversity receptors.

Offshore

In the offshore environment, the furthest extent over which an impact is likely to occur relates to underwater noise and in particular its impact on marine reptiles, marine mammals and fish. Noise modelling conducted for a similar project in this region (Gardline 2011, reported in ERM et al 2014) used noise levels of 120 dB as a level above which a behavioural response might be elicited in sensitive species[(1)]. Modelling of a similar FPSO vessel determined that for deep water (>1,000 m) noise attenuation would be such that a level of 120 dB would be reached c. 5 to 6 km from the point of origin. At shallower depths (< 500 m) noise attenuation is such that a level of 120 dB would likely be achieved at around 3 km from the point of origin. For other vessels, such as support vessels, noise attenuation to 120 dB is anticipated to occur at a distance of approximately 1 km. As such the maximum AoI on biodiversity receptors for the FPSO (in the context of sensitive species) is considered to be 6 km with the route of vessels commuting to and from the port being 1 km. As the potential impact footprint from elevated noise levels was the largest of any potential impact, these AoIs were taken as worst case AoI for all biodiversity receptors.

6.13.6 Area of Assessment

The scale at which a critical habitat determination takes place depends on underlying ecological processes for the habitat in question and is not limited to the footprint of the Project.

The AoA for the onshore aspect of the Project is deemed to be limited to the urban expanse around Takoradi, as all shipping traffic will be received into the existing harbour where the Project facilities will be located. Fixed wing flights and helicopters will operate out of the Airforce base within the city of Takoradi.

The main offshore operations of the Project will be located on the continental slope approximately 90 to 103 km offshore, south of the Ghana / Cote d'Ivoire border. The water depth within this area ranges from 1,600 m to 2,700 m. The area falls within an area of relatively high shipping traffic nearer to shore, with lesser levels at and around the FPSO location. The main offshore AoA has been defined as the extent of the continental slope from the drop off from the continental shelf at approximately 200 m water depth down to approximately 2,700 m depth offshore, stretching from offshore of Cape Coast in

(1) 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).

the east to the border with Cote d'Ivoire in the west. This large AoA encompasses habitats in similar water depths across the continental slope to those found in the Project Area. Baseline surveys for the Project (Gardline 2014 and Fugro 2021) and for the TEN and Jubilee Projects to the north of the Pecan field reported that habitats in this area comprised sands and muds with low abundance of benthic fauna.

Vessel movements between the FPSO and Takoradi port will be required as part of the Project but will be restricted to set shipping routes, and a relatively restricted AoA has been defined for these vessel movements, matching the vessel transit routes. Given the limited Project activities in the nearshore area, defining a larger nearshore AoA was not considered to be appropriate. The Project AoA is shown in Figure 6.6.

6.13.7 Determination of Onshore AoA Natural and Critical Habitats

Natural and Modified Habitat

Based on a review of the satellite imagery available for Takoradi, the distribution of natural and modified habitat has been determined for the onshore AoA. All of the onshore elements of the project lie within modified habitat composed of built urban environment (predominantly associated with the harbour).

Critical Habitat

A landscape level approach has been used to undertake an initial assessment of the protected and recognised areas, habitats and species that occur in the AoA and may meet the criteria for critical habitat (Table 6.5).

This assessment has then been based on the results of IBAT data and baseline surveys which have been undertaken for the Project to identify those species which occur within the Project AoI. Species not taken forward for assessment did not meet the criteria for critical habitat (e.g. a nationally Endangered species that the AoA is not considered to support a significant population of). Given the relatively small and urbanised area of the AoA, IUCN Vulnerable species have not been assessed as it is considered unlikely that any IUCN Vulnerable species occur in the AoA in sufficient numbers that, if lost, could affect the conservation status of the species.

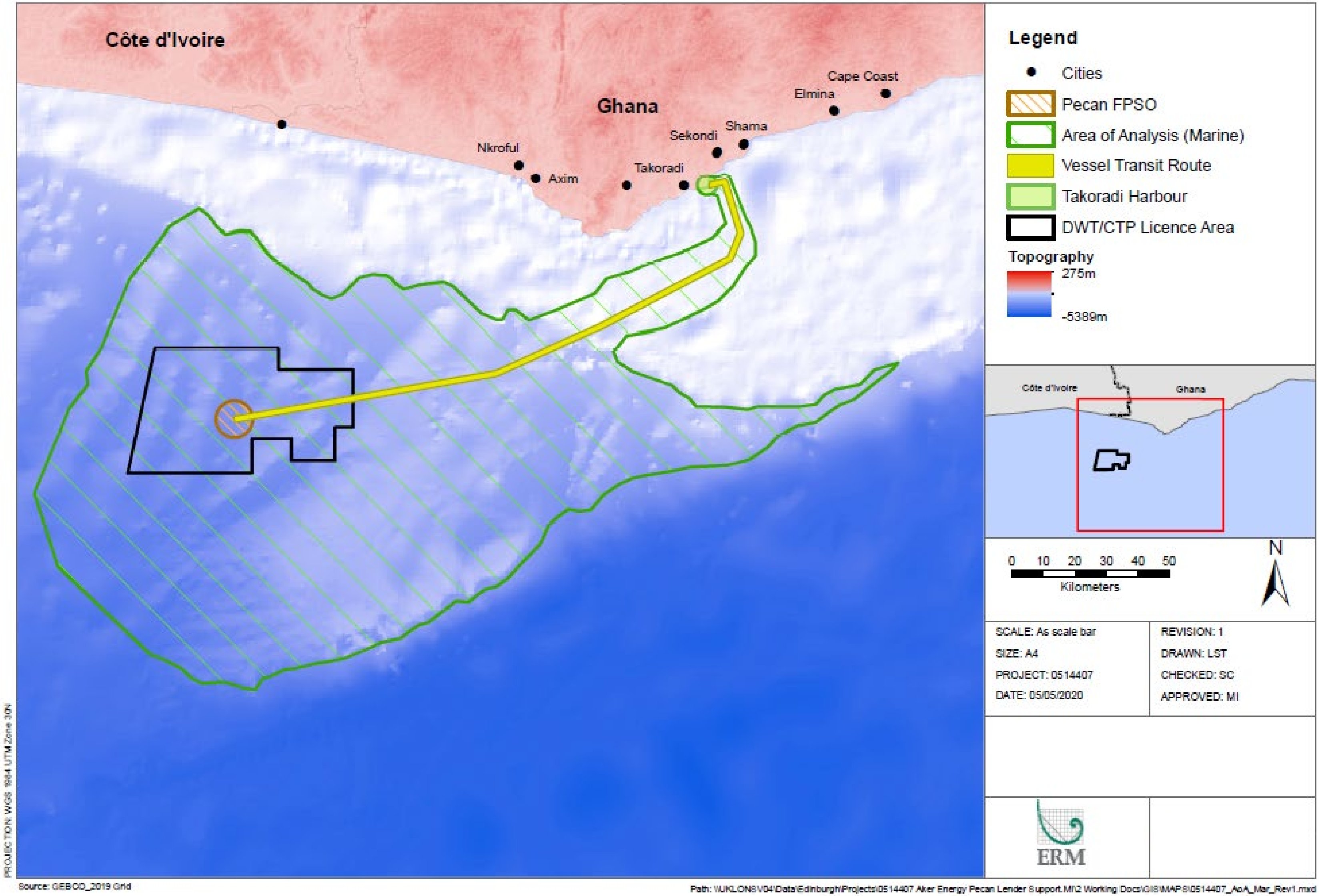


Figure 6.6 Area of Analysis (AoA) Marine Western Coast, Ghana

Table 6.5 Onshore Critical Habitat Features

Species/Feature	Description/Distribution	Critical Habitat
Criterion 1 – Critically Endangered and Endangered Species		
Necrosyrtes monachus (Hooded Vulture) IUCN: CR	This species is distributed throughout central Africa albeit with a contracting range and decreasing population trend. The species is found in forest, artificial/terrestrial, savanna, shrubland, grassland, and desert. The historical range included all of Ghana however it is considered to be extinct along much of the coastline of Ghana, including the full extent of the terrestrial AoA(1).	N
Lagarosiphon hydrilloides (plant) IUCN: EN	This species is found throughout most of Ghana and is thought to be the only population in West Africa, the only other population known being found across Uganda, Kenya and Tanzania (East Africa). The population trend of this species is unknown, but its distribution does coincide with this projects AoA, however, the plant is only found in inland wetlands (freshwater) therefore is unlikely to be present in the urban areas of Takoradi in sufficient numbers to meet the thresholds for critical habitat(2).	N
Psittacus erithacus (Grey Parrot) IUCN: EN	This species is found in Central Africa from the DR Congo to its Western extent in the east of Cote D'Ivoire and its population trend is decreasing. The population in Ghana and Cote D'Ivoire is likely isolated from the rest of the range due to its extinction from the east of Ghana (through Togo and Benin) to the west of Nigeria. Whilst this species will inhabit artificial/ habitats (plantations, rural gardens and urban areas) these are not considered to be of major importance to the species, and the population in Takoradi is unlikely to meet the thresholds for critical habitat(3).	N
Criterion 2 – Endemic/Restricted Range Species		
Limbochromis robertsi (endemic Cichlid fish species) IUCN: EN	This species is endemic to Ghana and is suffering a decreasing population trend. The species is restricted to inland wetlands of the upper tributaries of the Pra basin, the southernmost extent of its distribution being located approximately 4 km north-east of the terrestrial AoA of this project(4).	N
Chrysichthys walkeri (endemic fish) IUCN: EN	As *Limbochromis robertsi*(5).	N
Criterion 3 - Migratory /Congregatory Species		
None	Some species of migratory birds occur in the project AoA, however, there is no overlap with any internationally recognised sites or areas that support internationally important concentrations of migratory or congregatory species (e. g. Important Bird and Biodiversity Areas or Ramsar Sites) and no other species are considered likely to meet the thresholds for critical habitat under Criterion 3 in the urban Takoradi area.	N

[1] IUCN Red List (global). Hooded Vulture *Necrosyrtes monachus*. https://www. iucnredlist.org/species/22695185/118599398 [accessed 16.03.2020].
[2] IUCN Red List (global). *Lagarosiphon hydrilloides*. https://www. iucnredlist.org/species/185508/84270516 [accessed 16.03.2020].
[3] IUCN Red List (global). Grey Parrot *Psittacus erithacus*. https://www. iucnredlist.org/species/22724813/129879439 [accessed 16.03.2020].
[4] IUCN Red List (global). *Limbochromis robertsi*. https://www. iucnredlist.org/species/182617/7927544 [accessed 16.03.2020].
[5] IUCN Red List (global). *Chrysichthys walker*. https://www. iucnredlist.org/species/182617/7927544 [accessed 16.03.2020].

Species/Feature	Description/Distribution	Critical Habitat
Criterion 4 – Highly Threatened or Unique Ecosystems		
None	The area of analysis does not overlap with any threatened ecosystem according to IUCN Red List of Ecosystems, or any designated/protected habitats identified by biodiversity stakeholders.	N
Criterion 5 – Key Evolutionary Processes		
None	The terrestrial habitats within the project area of analysis do not contain structural attributes that can significantly influence evolutionary processes.	N

6.13.8 Determination of Offshore AoI Natural and Critical Habitats

Natural and Modified Habitat

The determination of natural and modified habitat for the offshore AoA, has been based on the benthic baseline biodiversity surveys undertaken in 2014. The marine habitats are considered to support viable assemblages of native habitats and species. No significant man-made structures, or modified habitats, have been identified in the offshore AoA. As a result, the majority of the marine AoA is considered to comprise natural habitat with the exception of the harbour area.

Critical Habitat

A seascape level approach has been used to undertake an initial assessment of the protected and recognised areas, habitats and species that occur in the offshore AoA and may meet the criteria for critical habitat. This assessment has then been refined based on the results of the baseline surveys which have been undertaken for the Project to identify those species which occur within the Project AoI. For mobile fauna only those that have been recorded within the AoA, or based on their known distribution and population are expected to occur within the AoA, have been presented in the assessment tables.

Critical habitat features identified within the AoA are presented in Table 6.5. The table also identifies those features which, based on the results of desk-based assessment and survey work undertaken to date have been taken forward for assessment.

Table 6.6 Offshore Critical Habitat Features

Species/Feature	Description/Distribution	Critical Habitat
Criterion 1 – Critically Endangered and Endangered Species		
Eretmochelys imbricate (Hawksbill Turtle) IUCN: CR	This species has a broad equatorial distribution around the globe occupying the marine intertidal, marine neritic, marine oceanic habitat types. Their distribution extends as far north as the southern coast of the UK and as far south as the southern tip of New Zealand but with a decreasing population trend. Whilst this species may use the marine AoA of this project it has not been confirmed nesting in Ghana in that time. Primary threats to this species are destruction of nests and bycatch through fishing (Agyekumhene and Kouerey Oliwina, 2018).	N
Pristis pectinate (Smalltooth Sawfish) IUCN: CR	The distribution of this species is unclear however, its habitat is the marine intertidal and its lower depth limit is 88 m placing it out with the main marine AoA. With a decreasing population trend, threats to this species include commercial and residential development and fishing (Carlson and Smith 2013).	N

Species/Feature	Description/Distribution	Critical Habitat
	Based on the distribution and habitat requirements of this species, the marine AoA is not considered to support a population that meets the threshold for critical habitat.	
Carcharhinus longimanus Oceanic (Whitetip Shark) IUCN: CR	This species has a broad equatorial distribution around the globe occupying the marine neritic oceanic habitats. The population trend within its range is decreasing with fishing the primary threat. Given this species is one of the most widespread sharks ranging across entire oceans, and the lack of particular habitat features within the project AoA (e.g. upwellings), the population within the AoA is not considered likely to meet the thresholds for critical habitat (Rigby et al 2019a).	N
Sphyrna lewini (Scalloped Hammerhead) IUCN: CR	This species has a circumglobal distribution in coastal warm-temperate and tropical seas (Ebert et al 2013). Occupying marine oceanic and marine neritic habitats down to 1043 m, the population trend is decreasing. Adults spend most of their time in midwaters with females migrating to coastal areas to give birth. Whilst this species is likely present within the AoA it is considered unlikely that the population meets the thresholds for critical habitat (Rigby et al 2019b).	N
Sphyrna mokarran (Great Hammerhead) IUCN: CR	This species has a similar distribution to *S. lewini* but with a lower depth limit of 300 m. Found both close inshore and well offshore this species is likely present within the AoA. Given the large distribution of this species and the expanse of similar habitat relative to the area affected by the project, the AoA is considered unlikely to support a population that meets the threshold for critical habitat (Rigby et al 2019c).	N
Rhynchobatus luebberti (African Wedgefish) IUCN: CR	This species occurs from close inshore to depths of 35 m on the continental shelf, in the eastern Atlantic from Mauritania to the Democratic Republic of the Congo and Angola. Given its limited coastal distribution throughout Western Africa and habitat requirements, the marine AoA is not considered to support a population that meets the threshold for critical habitat (Kyne and Jabado 2019a).	N
Squatina oculata (Smoothback Angelshark) IUCN: CR	This species occupies the marine deep benthic and marine neritic habitats around the coasts of north and west Africa. A warm-temperate and tropical demersal species it inhabits sandy-muddy habitat on continental shelves and upper slopes from 10 to 500 m. Given its limited coastal distribution throughout north and west Africa, and the water depth throughout the majority of the marine AoA, it is considered unlikely that the AoA supports a population that meets the threshold for critical habitat (Morey et al 2019).	N
Pristis (Largetooth Sawfish) IUCN: CR	This species occurs in wetlands (inland), marine neritic and marine intertidal habitats, generally restricted to shallow waters (<10-26 m), although its distribution is unclear. The species is listed as possibly extinct in Ghana. Given its limited coastal distribution and the known status of the population in Ghana the marine AoA is not considered to support a population that meets the threshold for critical habitat (Carlson and Smith 2013).	N
Glaucostegus cemiculus	This species occurs from close inshore to depths of 80 m on the continental shelf. It occurs on sandy and muddy substrates. Distributed in coastal habitats between Spain and Angola this species primary threat is fishing. Given its limited	N

Species/Feature	Description/Distribution	Critical Habitat
(Blackchin Guitarfish) IUCN: CR	coastal distribution and the water depth throughout the majority of the marine AoA, it is considered unlikely that the AoA supports a population that meets the threshold for critical habitat (Kyne and Jabado 2019b).	
Sousa teuszii Atlantic (Humpback Dolphin) IUCN: CR	This species is found exclusively in waters less than 30 m deep, often found close to shore and venturing up rivers (Collins et al 2017). Given its limited coastal distribution throughout Western Africa and predominantly coastal distribution, the marine AoA is not considered likely to support a population that meets the threshold for critical habitat.	N
Chelonia mydas (Green Turtle) IUCN: EN	Despite uncertainty over their distribution, this species has nine confirmed nesting sites along Ghana's coastline and they are often encountered in Ghanaian waters. Primary threats include nest destruction and fishing (Agyekumhene and Kouerey Oliwina, 2018). Whilst this species may use the marine AoA of this project it is unlikely to support a population that meets the threshold for critical habitat.	N
Cetorhinus maximus (Basking Shark) IUCN: EN	This species is distributed throughout the Atlantic Ocean including the entire coastline of west Africa. Its habitat includes marine oceanic and neritic, down to 1264 m. The current population trend is decreasing and threats include shipping lanes and fishing. On account of its migratory behaviour and wide range the AoA is unlikely to support a population that meets the threshold for critical habitat (Rigby et al 2019d).	N
Rhincodon typus (Whale Shark) IUCN: EN	This species broad equatorial distribution occupying marine neritic and oceanic habitats down to 1928 m. The current population trend is decreasing and threats include oil and gas drilling, shipping lanes, fishing and recreational activities (Pierce and Norman 2016). Given the extent of their distribution and migratory nature it is unlikely that the AoA of this project meets the threshold for critical habitat.	N
Isurus oxyrinchus (Shortfin Mako) IUCN: EN	This species is widespread in temperate and tropical waters of all oceans occupying the marine oceanic habitat its lower depth limit is 888 m. The species population trend is decreasing and its primary threat is considered to be fishing (Rigby et al 2019e). Given the extent of their distribution it is unlikely that the AoA of this project meets the threshold for critical habitat for this species.	N
Mobula tarapacana (Sicklefin Devilray) IUCN: EN	This species has a patchy circumglobal distribution and is found in tropical, subtropical, and temperate waters of the Pacific, Atlantic, and Indian Oceans. One recorded population occurs off the coast of Liberia, Cote D'Ivoire and Ghana, occupying marine neritic and oceanic habitats, down to 1896 m. The population trend is decreasing and threats are attributed to fishing. Given the species migratory nature it is unlikely the AoA of this project meets the threshold for critical habitat for this species.	N
Mobula thurstoni (Bentfin Devilray) IUCN: EN	This species has a patchy circumglobal distribution and is found in tropical, subtropical, and temperate waters of the Pacific, Atlantic, and Indian Oceans. One recorded population occurs off the coast of Liberia, Cote D'Ivoire and Ghana, occupying marine neritic and oceanic habitats, down to 100 m. Given the species transient nature it is unlikely the AoA of this	N

Species/Feature	Description/Distribution	Critical Habitat
	project meets the threshold for critical habitat for this species (Marshall et al 2019).	
Isurus paucus (Longfin Mako) IUCN: EN	This species is a poorly-known epi-, meso- and bathypelagic species found in tropical and warm-temperate seas. It usually occurs to depths of 760 m, but has been reported to 1,752 m. With a decreasing population trend the primary threat for this species is fishing. Given the extent of their distribution within the Atlantic it is unlikely that the AoA of this project meets the threshold for critical habitat for this species (Rigby et al 2019f).	N
Rostroraja alba (White Skate) IUCN: EN	This is a benthic species of sandy and detrital bottoms from coastal waters to the upper slope region between about 40 to 400 m and exceptionally down to 500 m. This species is distributed from the southern tip of S. Africa to the south coast of Ireland. The population trend for this species is decreasing with fishing being the primary threat. Given its distribution and behaviour it is unlikely that the AoA of this project meets the threshold for critical habitat for this species (Dulvy et al 2006).	N
Rhinobatos rhinobatos (Common Guitarfish) IUCN: EN	This species is a bottom dwelling species inhabiting shallow waters in the intertidal zone to waters of up to 180 m in depth. Distributed between Spain and Angola the population trend of this species is decreasing with fishing cited as the primary threat. Given its distribution and behaviour it is unlikely that the AoA of this project meets the threshold for critical habitat for this species.	N
Fontitrygon margarita (Daisy Stingray) IUCN: EN	This species occupies the marine neritic zone and is distributed from Senegal to Congo. The population trend is decreasing and the primary threat is fishing. Given its distribution and behaviour it is unlikely that the project AoA meets the threshold for critical habitat for this species (Compagno and Marshall 2016).	N
Pterodroma madeira (Zino's Petrel) IUCN: EN	This species breeds on two Portuguese islands, during the non-breeding season it ranges as far north as the UK and as far south as southern Africa (Birdlife International 2018). Given its distribution and behaviour the AoA of this project will not meet the threshold for critical habitat for this species.	N
Balaenoptera borealis (Sei Whale) IUCN: EN	This species is distributed throughout most oceans, with the exception of polar regions, occupying marine oceanic and neritic habitats. Although the current population is increasing, primary threats include shipping lanes and fishing. Given its global distribution and the lack of specific habitat features within the AoA e.g. upwellings or other known feeding grounds)) it is considered unlikely that the AoA supports a population that meets the threshold for critical habitat. Existing vessel traffic in this species potential habitat (within the AoA) yield any likely affects negligible (Cooke 2018).	N
Carcharhinus obscurus (Blue Whale) IUCN: EN	This species is distributed throughout most oceans, with the exception of parts of the northern polar region, occupying marine oceanic and neritic habitats. Although the current population is increasing, primary threats include climate change and fishing. Blue Whales feed almost exclusively on euphausiids (krill) (Gill 2002). On account of its migratory behaviour and wide range the AoA is unlikely to support a population that meets the threshold for critical habitat (Cooke 2018).	N

Species/Feature	Description/Distribution	Critical Habitat
Mobula mobular (Giant Devilray) IUCN: EN	This species is a pelagic species that resides in coastal and continental shelf waters. It spends the majority of its time in less than 50 m of water but occasionally dives to depths of 1,112 m. It occupies marine oceanic and neritic habitats and undertakes large scale movements of up to 63 km per day. Its population trend is decreasing and its primary threat is identified as fishing (Marshall et al 2019a). Given the species distribution and transient nature it is unlikely the AoA of this project meets the threshold for critical habitat for this species.	N
Mobula hypostoma (Atlantic Devilray) IUCN: EN	This species is a schooling pelagic species of coastal and oceanic waters from the surface down to depths of 100 m. IUCN lists this species as possibly extant off the coast of Ghana, however, the nearest known population is north west coast of Liberia (Marshall et al 2019b). Given the species distribution and nature it is unlikely the AoA of this project meets the threshold for critical habitat for this species.	N
Criterion 2 – Endemic/Restricted Range Species		
None	No endemic species (other than where stated under Criterion 1 where a species is also listed as Endangered or Critically Endangered) occur in the project area of analysis.	N
Criteria 3 - Migratory /Congregatory Species		
None	Some migratory species occur in the project area of analysis. However, the AoA does not overlap with any sites or areas that support internationally important concentrations of migratory or congregatory species. No further migratory / congregatory species (other than stated under Criterion 1 where a species is also listed as Endangered or Critically Endangered) occur in the project area of influence.	N
Criteria 4 – Highly Threatened or Unique Ecosystems		
None	The area of analysis does not overlap with any threatened ecosystem according to IUCN Red List of Ecosystems.	N
Criteria 5 – Key Evolutionary Processes		
None	The marine habitats within the project area of analysis do not contain structural attributes that can significantly influence evolutionary processes.	N

6.13.9 Assessment of Effects on Natural and Critical Habitat

Summary of Effects on Offshore Critical Habitat

No species or areas in the offshore AoA have been identified that meet the thresholds for critical habitat. A number of IUCN Critically Endangered or Endangered species are likely to occur or pass through the AoA in small numbers, however based on known distributions, ecology and available habitat in the AoA are not considered to occur in sufficient numbers to meet the thresholds for critical habitat. Mitigation measures identified in various sections of this report are relevant to avoiding or reducing potential impacts on sensitive species groups.

Summary of Effects on Offshore Natural Habitat

There will be a permanent loss of approximately 0.36 km^2 of offshore natural habitat under the footprint of the Pecan FPSO from subsea in field infrastructure. In addition, drill cuttings modelling indicted there will be a loss of up to 0.25 km^2 of seabed from the deposition of drill cuttings as a result of the Project (however, this was based on almost double the number of wells being assessed and some of these losses will coincide with the loss of seabed from the physical infrastructure discussed above). Based on the 2021 seabed mapping, the 2014 baseline benthic survey and other deep-water offshore surveys (i.e. the adjacent TEN project area), the benthic habitat lost is likely to comprise sandy-muddy sediments. The Project will introduce hard substrate (in the form of the subsea infrastructure) which will be colonised by marine species throughout the lifetime of the Project.

Given the relatively small area of offshore natural habitat affected (circa 1% of the overall Project area), and the extensive areas of similar natural habitats on the Continental Slope off Ghana, the Project is not predicted to significantly convert or degrade offshore natural habitats.

Summary of Assessment of Invasive Species

Potential impacts on marine biodiversity have been identified from the spread of invasive species through vessel movements associated with the Project. One potential marine invasive species was identified in the zooplankton community during baseline survey (Gardline 2014), however its spread is thought to be linked to climate change.

Measures to control the spread of marine invasive species as a result of the Project have been identified (see Section 5.9.2) and include Ballast Water Management Plans, approved by the Administration (under Regulation B-1). The plans will be specific to each vessel and include a detailed description of the actions to be taken to implement the Ballast Water Management requirements and supplemental Ballast Water Management practices.

Project onshore operations will be limited in extent and will occur in the urban areas of Takoradi. Activities will not involve any new construction activities. Given the urban environment and limited nature of activities, no specific measures to control onshore invasive species have been identified.

No significant residual effects are therefore predicted with the mitigation set out.

6.13.10 Protected and Internationally Recognised Areas of Biodiversity Value

There are no nationally protected or internationally recognised sites within 50 km of the proposed FSPO location and no nationally protected or internationally recognised sites within 10 km of the proposed onshore facilities (see Figure 6.7).

6.13.11 Summary

The assessment has considered Project impacts on Critical and Natural habitat, as well as impacts from the introduction and spread of invasive alien species. Loss of natural habitat has been identified for the offshore aspect of the project and will be limited to the infrastructure installed on the seabed and areas affected by drill cuttings discharges. No loss of Critical habitat has been identified.

No significant residual impacts from invasive alien species have been identified.

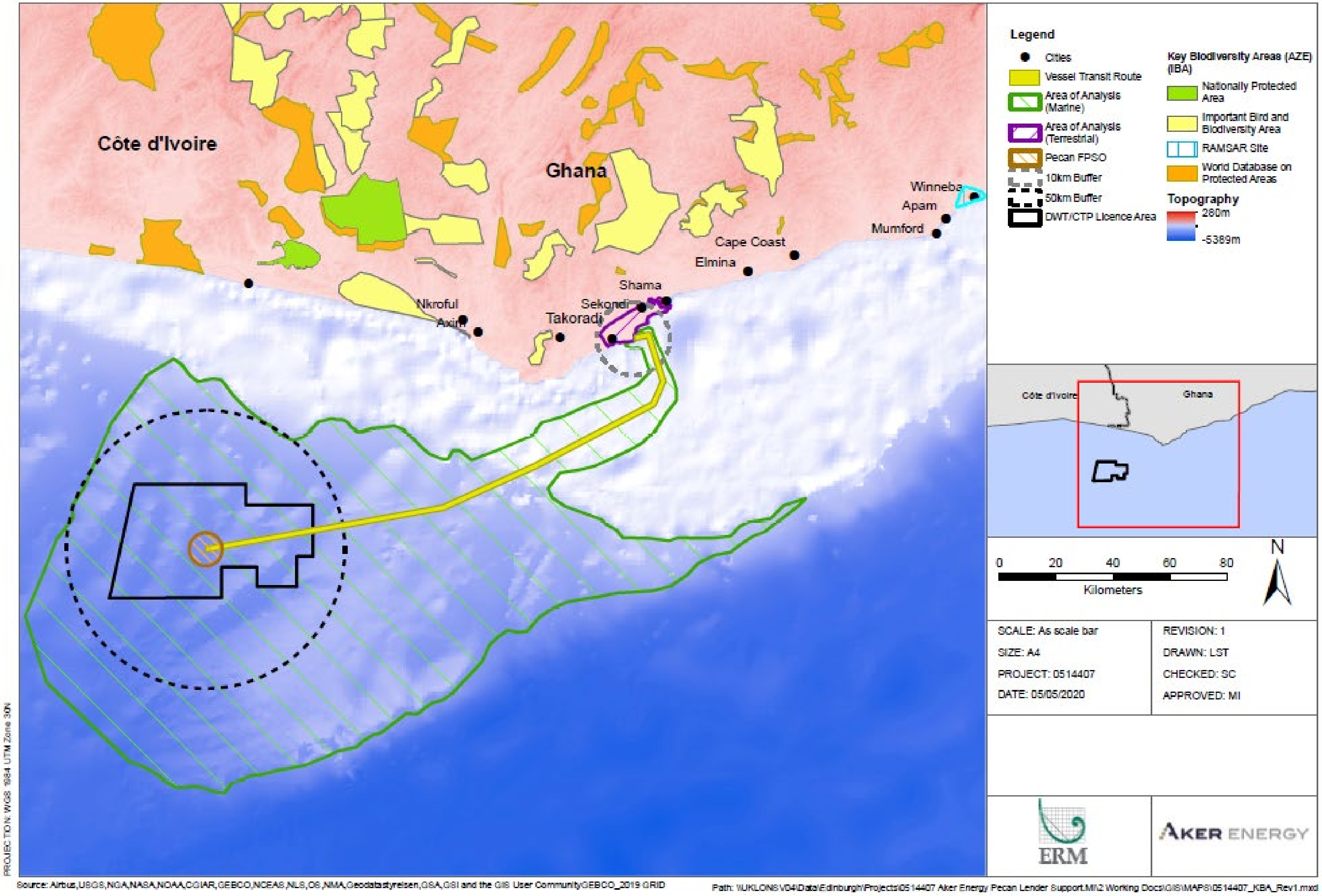


Figure 6.7 Nationally Protected and Internationally Recognised Areas, Western Coastline, Ghana

6.14 Socio-economic and Community Health Impacts

6.14.1 Scope of Assessment

This section identifies and assesses potential impacts and risks on socio-economic aspects and community health of the Project, including details of proposed mitigation measures. The impacts identified refer to those that can reasonably be expected to affect Ghana both nationally, regionally (i.e. in the Western Region) and locally (i.e. coastal communities).

The Project Description and the Baseline information about the social, economic and health conditions have been used to assess the possible socioeconomic and health impacts.

The main potential sources of impacts identified are the following.

- Fish and Fisheries
- Increased government revenue.
- Employment and skills development.
- Procurement of goods and services.
- Worker management and rights
- Commercial shipping.
- Community health, safety and security
- Influx of job seekers
- Heightened and unmet public expectations.
- Shore based activities
- Marine cultural heritage

6.14.2 Impacts on Fish and Fisheries

Description of Potential Impacts

Pelagic fish species and deep-water fish species will be present in the Project area. As the Project area is in a deep-water offshore area in a water depth that precludes trawling or other bottom fishing activities, pelagic fishing methods are used in these areas, mainly targeting large oceanic species, using passive gear (longlines) and active gear (pole and line, purse seines).

Pelagic species living in the surface layers of the water column are likely to be affected by the presence of the FPSO, MODU while on station and support vessels (to a much lesser extent) as many pelagic fish species are known to readily associate with floating objects (known as Fish Aggregating Devices (FAD)) (Røstad et al 2006). Some species may be attracted by the shelter provided and slight local nutrient enrichment from discharges; others may be attracted in search of prey.

Fish may also be attracted to the artificial lights on the FPSO, MODU and support vessels and lights in the event of abnormal flaring at the FPSO.

The deep-water fish communities are likely to be affected by the installation and presence of subsea infrastructure.

The main target pelagic 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 FPSO, MODU etc. These offshore fisheries are mainly prosecuted by larger ocean-going vessels from foreign or foreign-owned fleets. Although it is known that since the Jubilee, TEN and OCTP fields were developed, fishermen operating from canoes have travelled to the FPSOs and MODUs to target the fish that have been attracted to these structures. The Project area is a substantially greater distance from shore (circa 100 km) and likely to be beyond the range of very small-boat fisheries, although some may venture out to the Project area.

Potential impacts on fisheries can arise from several sources:

- loss of access to the area of the FPSO and MODU during drilling, 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; and
- disturbance to fishing activities and damage to fishing gear from Project support vessels and supply vessels transiting to and from Takoradi.

Mitigation Measures

Measures described elsewhere in regard to various discharges, including produced water and drill cuttings (see Sections 6.8 and 6.9) will be applied to avoid and minimise impacts on water quality and sediments that could have effects (e.g. due to toxicity and smothering) on marine biota and up the food chain. The following mitigation measures will be implemented as precautionary measures to minimise any potential impact on the fishing industry.

- Community Liaison Officers (CLOs) will be employed to liaise between fishermen and the Project and to provide information to fishing communities regarding Project activities and notify them of the requirements to keeping away from the operations for safety reasons. The CLOs will also deal with any complaints through Pecan Energies grievance mechanism.
- Pecan Energies and its contractors will notify mariners and fishers of the presence of the MODU, FPSO and other marine operations within the Project area though consultations and Notice to Mariners and the safety and advisory areas will be marked on nautical charts as cautionary advice to all sea-users.
- Fisheries Liaison Officers, recruited from the fishing communities, will be placed onboard the guard vessels to liaise with any fishermen operating close to the 500 m safety zones to warn them of the dangers of operating in these areas.
- The safety zones will be monitored and enforced, by the Project with the assistance of the agencies of the Government of Ghana. Pecan Energies will develop a code of practice based on the UN Voluntary Principles of Security and Human Rights and give training for those responsible for maintaining the safety zones.
- Vessel transit routes will be agreed with the GMA and communicated to fishermen and other marine users.
- Pecan Energies will liaise with the Fisheries Commission, Marine Police and related agencies 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.
- Fishery Liaison Officers (FLO) will be placed on the guard vessels to ease communication with potential intruders of the safety zone in the local language
- Pecan Energies is a member of the Ghana Upstream petroleum Chamber which has as one of its goals to engage stakeholders in the fishing industry to ensure a peaceful

collaboration and safe coexistence. It does this mainly through the Ghana Oil and Gas Cumulative Impacts Co-Management Platform.

Impact Assessment

The main pelagic species found in offshore deep-water locations in the Gulf of Guinea that are targeted by fishermen are highly migratory and will not be permanent residents in one area. Those that may be attracted to the FPSO (and other infrastructure) are not likely to spend significant periods of time under or close to 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 the size of such objects (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 any 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 the vessels. 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 deep-water species range. Negative impacts due to disturbance during installation may occur, e.g. 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.

Although there will be various discharges to sea during drilling and normal operation of the Project the impacts on water quality will be localised and discharges will be to a highly dispersive water environment. Fish will tend to avoid the small areas of poor water quality. There will be no significant impacts on fish as a result of changes in water quality (see Section 5.8.3 on the results of the discharge modelling).

The possible impacts on fish in the event of an oil spill are addressed in Section 5.18.

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 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, however due to the risk of fishing vessels such as canoes drifting towards operational area fishermen will be advised to keep well outside the 500 m safety zone.

Fishing activities take place throughout the Ghanaian EEZ. The areas that fishermen will be excluded from is less than 1.57 km^2 (exclusion zones of 0.785 km^2 around the FPSO and the MODU) 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 0.0007% of the Ghanaian EEZ (225,000 km^2). 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 are likely to range through the Project 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 fisherfolk during the periods they are within the safety zones. 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 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 negligible as only a very small proportion of the potential fishing grounds will be temporarily affected at any one time by the Project. Impacts from the Project on the availability of fish to the offshore fishing industry are assessed as Not Significant.

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 metres below the surface and left for many hours. Therefore, there is the potential for this gear, which is left floating in the open ocean, to enter the safety zone and become entangled in the subsea infrastructure, risers 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 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 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 and in extreme cases, fishing crew. Vessel transit routes 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 the installation phase, 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.

6.14.3 Increased Government Revenue

Description of Potential Impact

The primary economic impact of the operational phase of the Project will be the payment of taxes and royalties related to the income production by the Project. 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. This revenue is likely to be received starting from the initial phases of drilling, installation and commissioning.

The payment of royalties and taxes and other incomes will be undertaken in accordance with the Petroleum Agreement (March 2006) and the Amendment to the PA dated 16. December 2019. The allocation of increased government revenue cannot be accurately quantified at this stage. The government will be solely responsible for the allocation of revenue based on internal government policies and the country's development needs.

Mitigation Measures

Good governance and fiscal management are the key measures for Ghana's benefit from the economic gains by the royalties and taxes paid by the Project. The absolute value of oil will also be a key factor and it will depend directly on market prices. Pecan Energies 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.

Impact Assessment

The impact of the increased government revenue is expected to occur during the lifetime of the Project. During this period, the Project will contribute a positive impact on the national economy and to a lesser extent, at the regional level through Pecan Energies Community Development and Corporate Social Responsibility (CSR) Strategy and associated programmes. In its CSR projects, Pecan Energies will seek to actively engage affected stakeholders and local communities throughout the project cycle, from project identification through to project design, implementation and monitoring. This will ensure Pecan Energies CSR projects are well-aligned with communities' self-identified needs and will increase local ownership of projects, which increases the chances of projects becoming sustainable beyond the first project cycle.

Ghanaians will in turn experience government spending as an indirect positive impact. The Project will also induce associated growth and development. 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.

6.14.4 Employment and Skills Development

Description of Potential Impacts

The Project is expected to contribute to the creation of direct and indirect employment opportunities in the Western Region. Given the nature of the Project's activities, the majority of the jobs will need to be filled with qualified and experienced personnel.

Direct employment with Pecan Energies will vary from 70 to 120 people through the execution and operation phase. The manning of the drilling and well contractors during the two drilling phases will be approximately 150 people. While the FPSO Operation and Maintenance contractor estimates a total manning of 150 people during operation. With the aim of 50-60% local content for management and technical staff after 5 years operation and 70-80% after 10 years operation, and more than 80% for all other staff from start of the operation.

The work composition in the coastal districts is mostly informal and subsistence-based. Agriculture is the main activity practiced across the coastal district. An average of 40% of the population is engaged in agriculture and agro-processing activities across the municipal and district assemblies. According to the Education Sector Analysis in 2018 while there is public investment in primary and tertiary education, there appears to be a gap between the skills supplied in the vocational training centres in Ghana and the labour market demands, along with a lack of technical qualifications of the teaching staff and poor learning outcomes. This results in a shortage, at a local level and in the Western Region, of technically qualified workers of the types required for the construction and operation of the Project.

Job opportunities during the drilling, installation, commissioning and decommissioning phases will be temporary, while job opportunities during the operational phase will mostly be permanent. Temporary employment includes people directly employed by the primary contractor as well as jobs supplying the goods and services needed to support the drilling, installation and commissioning phases (food and transport services and support staff).

Mitigation Measures

The potential benefits from direct and indirect employment will require enhancement of relevant skills in the local workforce through the development of a Manpower Project Plan as part of the Local Content Plan. The plan will contain the following measures.

- Pecan Energies will develop guidelines on recruiting and employment practices, training and succession practices, and reporting of training and employment activities, to ensure compliance with applicable requirements and to achieve Pecan Energies strategic employment and training local content objectives.
- Pecan Energies will include the plan for recruitment, employment and training of local personnel in Ghana as a requirement to engage with contractors and subcontractors.
- Where qualified Ghanaian personnel are available for employment to support operations, whether staffed directly or via third party, Pecan Energies will develop procedures to provide opportunities for employment/services as far as reasonably possible. Where possible, priority will be given to vulnerable groups such as women and youth.
- The Project'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 via national or local media at an early stage to manage job-seekers expectations.
- Relevant job opportunities will be specifically communicated via district and municipal authorities to communities in the coastal districts of the Western Region by the CLOs.

The Local Content Plan aims at developing initiatives to train and build local capacity through the development of the Project as follows:

- Educational Sponsorship;
- National Service Placement;
- Secondment Agreement with GNPC;
- Recruitment of Ghanaians;
- Pecan Energies Ghana Internship Programme; and
- Support to Accelerated Oil and Gas Capacity.

Pecan Energies will support the Ghanaian government's Accelerated Oil and Gas Capacity Programme. The support consists of four main areas:

- training individuals in various technical and vocational areas;

- building the capacity of educational institutions to be able to train students and provide internationally recognised training certificates;
- providing business and management training for small and medium enterprises (SMEs).

Impact Assessment

The embedded and additional mitigation measures considered above could pave the way to direct and indirect employment opportunities. As the Project moves into the operational phase, there will be opportunities progressively for more Ghanaians employed through further skills development and creation of jobs that can be satisfied by the skill base available nationally. Direct employment by the Project and indirect employment through contractors and suppliers, albeit limited, will have a positive impact on those people employed, their families and their local communities from wages and other benefits.

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 marketplace, facilitating increased opportunities and skills transfer.

Direct and indirect employment opportunities offered by the Project will have a positive impact on the households' earnings of those employed as well as local businesses as more families will be spending and consuming. However, the magnitude of the impact will be small as few additional employment and training opportunities will be created. Due to the high-level expectations of the population at a regional level, the sensitivity of receptors is deemed to be medium. This results in an impact of Minor significance.

6.14.5 Procurement of Goods and Services

Description of Potential Impacts

During the lifetime of the Project there will be procurement of goods and equipment (e.g. food, fuel, chemicals and other consumables), and services (e.g. onshore administrative support, accommodation staff, security, catering, cleaning staff) from national and, where possible, local businesses.

Pecan Energies has determined the following strategic local content objectives as part of the Local Content Plan in relation to sourcing of goods and services through the supply chain.

- To give preference to locally produced goods and services where they meet the standards generally acceptable in the international petroleum industry and can be supplied at commercial terms equivalent or more favourable than those outside Ghana.
- To progressively increase sourcing of locally procured goods and services over the Project's lifetime.
- To facilitate participation of Ghanaian companies in the supply chain, either in direct relation with the contractor, or through international subcontractors, by using procurement and contracting strategies that implies work scope and services suited for participation and development of local companies.
- To require subcontractors to commit to the Pecan Local Content Plan and local content reporting template in compliance with regulations applicable for subcontractors.
- To promote the establishment and development of Joint Ventures, strategic alliances, and channel partnerships between international companies engaged in the Project and indigenous Ghanaian companies.
- Require contractors to comply with the DWT/CTP Procurement Procedure and for subcontractors to have a right to follow the same process securing transparency and information to the Petroleum Commission.

- Right of Contractor and subcontractors to use a split-contract model.

Actions required for implementation of the plan have been identified and outlined for Pecan Energies and subcontractors respectively to fulfil the intentions and requirements of the local content regulations.

A Country Office, facilities at an existing onshore supply base, related facilities, buildings and other physical structures in Ghana, referred to as Local Infrastructure, will be established and administered by Pecan Energies and subcontractors with the aim to manage, support and supervise the local activities of the Project. Pecan Energies is committed to ensure that establishment and continued operation of Contractor's and subcontractors' Local Infrastructure adheres to the local content guidelines set forth in the Local Content Plan and to applicable regulations.

With respect to local content in contracting and procurement activities, Pecan Energies will comply with the applicable requirements and commitments to achieve the purpose of the local content regulations while adhering to the obligations and rights under the Petroleum Agreement and the Project's frame conditions for safe, predictable and timely project execution.

Pecan Energies will use a stepwise procurement and contracting methodology to maximise local supplier participation while incorporating required input, reviews and permits by the Petroleum Commission prior to bidding and award of contracts / agreements including the following:

- mapping and segmentation of local industry;
- establishment of a list of potential local suppliers;
- scope definition for local content;
- pre-qualification and supplier engagement;
- invitation to tender, evaluation, negotiation and award of contract; and
- supplier development and performance management.

In addition, all subcontractors will be required to outline their proposed Local Content Plan in their bid documents with the expectation that, if selected, their plan will be incorporated in the corresponding Contract. International (non-Ghanaian) subcontractors will, consistent with the applicable requirements of local content regulations in Ghana, incorporate a Joint Venture with a Ghanaian contractor, and afford that Ghanaian contractor an equity stake of at least 10%. Subcontractor's Local Content Plan and will be required to be consistent with Pecan Energies Local Content Plan.

Based on the above methodology for procurement and contracting, Pecan Energies will define packages for in-country scope for Facilities (FPSO, SPS, and SURF), Operations & Maintenance and Drilling & Wells. These packages, which are outlined in the Local Content Plan, will facilitate local suppliers to participate in the delivery of the Project and enable expansion of the local petroleum industry.

Mitigation Measures

Additional measures to be included into the Local Content Plan to enhance procurement of goods and services from companies in Ghana include the following.

- Pecan Energies has developed plans and procedures to support the corporate Local Content Policy and Pecan Local Content Strategy. Contractors will also be required to support and implement the national content strategy and plans and procedures that support it.
- Pecan Energies has developed 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.

- Pecan Energies 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, e.g. through pre-tender workshops and training.
- Pecan Energies will audit local content through site visits and interviews to monitor and track the effects of the contractors' strategy to maximise local content over the life of the Project.
- Pecan Energies will ensure that the grievance mechanism in place will be accessible to all suppliers.

Impact Assessment

Impacts from procurement of goods and services are likely to be positive through stimulating SME 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.

For those companies that meet eligibility criteria, become approved suppliers and enter the supply chain, there will be long-term benefits to the businesses and their employees through increased experience, capacity and training. This will come particularly from requirements to meet stringent international standards.

However, there will be a relatively low level of supply of goods and services (fuel, food, water, repair and maintenance services). The sensitivity of the receptor is likely to be medium, as per the risk of having unmet expectations for local employment and procurement of goods and services. The overall significance of the positive impact will be of Minor significance.

6.14.6 Workers Management and Rights

Description of Potential Impacts

Workers' rights, including occupational health and safety, will be addressed to avoid accidents and injuries, loss of man-hours, labour abuses and to ensure fair treatment, remuneration and working or living conditions. These issues will be considered not only for those who are directly employed by Pecan Energies but also its contractors (including sub-contractors) and within the supply chain.

Pecan Energies supports the fundamental principles of human and labour rights as defined in the Universal Declaration of Human Rights. As part of Pecan Energies management procedures, measures have been introduced to prevent human rights abuses throughout development and supply chains. In this regard, the Pecan Energies Code of Conduct specifies that all operations are reviewed in detail to avoid conflict with fundamental human rights. This includes that all Pecan Energies employed suppliers have to sign a Supplier Declaration which specifies that the Supplier as well as any Sub-Suppliers are expected to respect internationally recognised human rights as well as to comply with all applicable laws and regulations.

Pecan Energies has developed a Health, Safety, Security and Environmental (HSSE) management approach outlining its commitment to ensuring the health and safety of its workers. This management approach is in line with Petroleum (Exploration and Production) (Health, Safety and Environment) Regulation (L.I. 2258), the applicable requirements in the

Labour Act 651 (2003) Part 15 and the relevant flag state requirements, as well as international worker health and safety standards, namely IFC Performance Standards.

- To promote the fair treatment, non-discrimination, and equal opportunity of workers.
- To establish, maintain, and improve the worker-management relationship.
- To promote compliance with national employment and labour laws.
- To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain.
- To promote safe and healthy working conditions, and the health of workers.
- To avoid the use of forced labour.

Shore based Pecan Energies staff will be accommodated in Accra and Takoradi. Pecan Energies is committed to providing for responsible housing and accommodation arrangements for its own and subcontractors' workforce in line with local legislation and tariff agreements where the situation indicates such matters are required to be arranged by the employer. The type of accommodation will vary depending on the income and the type of worker involved. Economic expenditures are foreseen in the existing formal and informal businesses in the service sector (local shops, bars, cafes and restaurants), not only by the workers themselves but also by their families.

Mitigation Measures

Pecan Energies will develop a People Policy and Management plan that includes the following measures.

- Contracts will the right for the Project monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching the required standards, Pecan Energies policies or clauses in the contract.
- Pecan Energies, contractors and subcontractors will put in place hiring mechanisms to ensure that no employee or job applicant is discriminated against on the basis of his or her gender, marital status, nationality, age, religion or sexual orientation.
- Pecan Energies will provide training on workers' rights as part of their induction. Pecan Energies will also require contractors and subcontractors to provide training on workers' rights to its employees.
- Pecan Energies, contractors and subcontractors will ensure that all their employees have contracts that clearly state the terms and conditions of their employment and their legal rights.
- Pecan Energies, contractors and subcontractors will verbally explain contracts to all their workers where this is necessary.
- Pecan Energies will undertake robust compliance monitoring of all contractors and sub-contractors.
- Pecan Energies will review and monitor the outcomes of community engagement, media coverage and its workforce and community grievance mechanism regarding labour welfare issues.
- Pecan Energies will update the Health, Safety, Security and Environment System including the following measures.
- Pecan Energies will not accept forced labour, child labour or any form of human trafficking including purchase of sexual services.
- Surveillance programs for workers health status will be established and implemented.

- Occupational health and safety training to all workers, including contractors and subcontractors will be provided.
- In all contractor contracts, the Project will make explicit reference to the need to abide by national law, international standards and Pecan Energies policies in relation to health and safety, labour and welfare standards.
- Contractor contracts will specify monitoring to be undertaken by the contractor, establish the right for the Project monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching national legal requirements, international standards, policies or clauses in the contract. Contractor contracts will specify that the same standards will be met by their sub-contractors and suppliers.

Impact Assessment

As a result of the policies and procedures that Pecan Energies has to protect workers' rights, including health and safety, workers should be adequately protected. However, issues with implementation and capacity may result in some breaches of workers' rights. If issues arise there is the opportunity for these to be identified and addressed through the worker grievance mechanism. Therefore, the residual impact is of Minor significance.

6.14.7 Commercial Shipping

Description of Potential Impacts

Additional vessel movements associated with the Project could arise as a potential source of impact on existing navigation and shipping traffic in the area. During the installation of the Project offshore there will be a larger number of vessels will be involved and impacts could be largest during this phase.

Mitigation Measures

The Project will develop a Marine Traffic Management Plan to ensure appropriate protocols are followed during offshore vessel movements. This plan will also consider vessel movements associated with other Projects in the area as well as fishing and other commercial shipping traffic. The plan will aim at reducing risk of vessel collision and minimising inconvenience to other sea users by establishing the following.

- Project vessels will use established shipping routes, particularly in approaches to harbours and heavily trafficked coastal waters.
- Project vessels will have standard vessel navigation and communication equipment (radar, ship to ship radio).
- Standby vessels and offloading tugs will be present at the FPSO location.
- A Simultaneous Operations (SIMOPS) review and plan will be developed.
- 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).
- Marine contractors will be required to submit and have available suitable HSE plans including a security management plan and marine safety risk assessment, together with qualifications of marine vessel captains and crew, training conducted, and compliance auditing provisions.

- Project vessels will adopt the GMA VTMIS (Vessel Traffic Management Information System) for access to real-time data on the presence of vessels in the vicinity of the exclusion zones.

Impact Assessment

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 of Minor significance.

6.14.8 Community Health, Safety and Security

Description of Potential Impacts

Onshore activities associated with the Project could affect the health, safety and security of the communities around the shore base facilities. Any community concerns or perceptions with regard to reduced health and physical safety by the community need to be addressed.

The potential sources of impacts on the health and safety of local communities include the following:

- worker-community interactions resulting in increased communicable diseases, including sexually transmitted infections (STIs);
- road traffic movements resulting in the potential for accidents and injury; and
- possible drawdown and increased pressure on health care resources.

Mitigation Measures

Pecan Energies has developed a HSSE management approach outlining its responsibility for its personnel by means of systems and procedures to:

- perform Industrial Hygiene sampling;
- conduct medical surveillance;
- exercise drug and alcohol control at the heliport;
- assist in rehabilitation of personnel; and
- record and monitor health certificates.

The Pecan Energies HSSE management system is aligned with the objectives of IFC Performance Standard 4.

- To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances.
- To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimises risks to the Affected Communities.

The application of the Pecan Energies HSE policy will significantly reduce the potential for impacts affecting health and safety by following the approach of reducing risks as much as reasonably practicable.

The following additional mitigation measures will be implemented as part of the Pecan Energies to manage potential impacts on community health.

- Pecan Energies will ensure the implementation of its Code of Conduct not only to Pecan Energies direct staff but also contractors' and subcontractors' staff. According to the Code of Conduct, Project sub-contractors are required to have their own HSE management systems in place, which, at a minimum, meet the Project's standards.

- Workforce (including subcontractors) will be provided with health awareness training, including a significant briefing of hygiene practices (such as hand washing), implementation of educational outreach to increase awareness of major communicable disease and how to protect against infection and about transmission routes and the symptoms of the communicable diseases of concerns (including STIs).
- 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 Covid-19) and vector borne diseases, notably malaria, as part of induction. Other diseases will be covered as appropriate.

Regarding measures to minimise the risks to community safety from Project traffic, Pecan Energies will implement the following.

- A specific Traffic Management Plan will be established for driving management planning for the onshore activities.
- Drivers' codes of conduct will be enhanced through a driver safety awareness training programme.

To manage the risk if increased pressure on health care resources, in addition to measures around worker-community interaction, Pecan Energies will:

- develop an Emergency Response Plan (ERP) for the Project taking into account access to health care, major incidents, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident; and
- continue to implement a programme of stakeholder engagement, including a grievance mechanism.

Impact Assessment

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, staff associated with onshore operations will be mainly local residents. The majority of personnel working offshore will be passing through Takoradi but will not be accommodated there.

Considering the adoption of the embedded controls inherent in the Project design and management procedures and the proposed mitigation measures to minimise direct impacts, any residual impacts will be of Minor significance.

Transport of goods and personnel to the port at 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. 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.

Project-related traffic will represent a small increase in the overall traffic volume and will utilise existing routes through areas where people have become accustomed 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 roads. However, considering the management procedures and the proposed mitigation measures to minimise direct impacts, the residual impacts will be of Minor significance.

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.

Considering the implementation of the mitigation measures referred to above, the impact of increased pressure on health care resources is considered to be of Minor significance.

6.14.9 Influx of Job-Seekers

Description of Potential Impacts

The expansion in communication, energy, transportation, water and sanitation, the social interactions of people and the development of the oil and gas industry over the past years, mainly based in Takoradi, function as a pull factor to attract migrants into the city from different parts of the country. As the development of the oil and gas sector off the coast continues, additional influx of employment seekers can be expected into the Takoradi-Secondi municipality. While urban migration may not be a problem in itself, issues may arise if individuals do not have the sufficient skills or funds to seek alternative livelihoods.

The influx can result in an increase in cost of living (e.g. property rents) and could cause adverse effects such as prostitution influx and an increase in drug consumption, as well as road traffic pressures.

Mitigation Measures

Facilitated by its Stakeholder Engagement Plan, Pecan Energies will seek to develop strong partnerships with government agencies, traditional authorities, district assemblies, youth groups, non-governmental organisations (NGO), community-based organisations (CBO), civil society, fishing communities and other relevant stakeholders. Pecan Energies will adopt a proactive approach to sharing information with stakeholders and gathering feedback on potential issues arising. In all relevant CSR projects, Pecan Energies will seek to actively engage affected stakeholders and local communities throughout the project cycle. Additional measures that will be considered by Pecan Energies (if necessary) for the management of influx include the following.

If it is determined through feedback from stakeholder engagement / grievances that there is need for implementing measures to manage Project induced migration influx, appropriate measures shall be considered in consultation with the key stakeholders especially, the Regional Security Coordinating Council to minimize the negative impacts of rapid in-migration. This plan would consider the immediate measures to manage the negative impact and medium-long term approach to avoid recurrence of such impact.

Impact Assessment

Although the mitigation measures described above are expected to provide some amelioration for the issue, it is likely that the levels of in-migration of jobseekers 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 jobseekers attracted by the development of the area, not necessarily to those specifically attracted by the Project.

The impacts related to further influx of jobseekers into the area as a direct result of the oil and gas developments will have a negative effect; 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.

6.14.10 Heightened and Unmet Expectations

Description of Potential Impacts

People in the Western Region are anticipating that oil and gas developments in the region will provide employment opportunities. More specifically, the communities are expecting that jobs will be made available for the youth who are unemployed or who are employed but seeking alternate employments.

The population in the Western Region consists predominantly of people of Akan descent (the largest ethnic group in Ghana) and is dominated by two ethnolinguistic groups: the Nzema primarily occupy the western coastline whilst the Ahantas occupy the eastern coastline of the region. In addition, the area hosts people of other ethnolinguistic groups who have moved to the area in more recent times. These groups are fully integrated members of the communities. Thus, no rivalry between ethnic groups is expected. However, the influx of newcomers to Takoradi and the surrounding areas could constitute a potential source of conflict and a sense that residents are less likely to benefit from the Project.

Infrastructure development and general improvements to living conditions could also be expected from the oil and gas industry.

Mitigation Measures

Implementation of the Stakeholder Engagement Plan (SEP) will be the key mitigation measure to redress the incorrect public perceptions about potential Project benefits and for addressing public expectations related to development opportunities and investments.

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. Pecan Energies will address unmet expectations of communities through on-going communication in accordance with the SEP. These above-mentioned measures may not eliminate these issues but will serve to improve relations between Pecan Energies and stakeholders (including coastal communities) through pro-active management of issues and concerns. Considering this, the impact is regarded as of Minor significance.

Stakeholders' exceptions and perceptions can change, and Pecan Energies will engage with the stakeholders to remain aware of these perceptions and expectations so that they can respond to issues as they arise.

6.14.11 Shore Based Activities

Description of Potential Impacts

In addition to the existing offices in Accra, the Project will establish a base within Takoradi port, comprising the use of a supply vessel berth, offices and material storage and laydown areas. These will all be within the existing established complex. In addition, accommodation in Takoradi for Pecan Energies staff will be required. The use of these locations will be required for all phases of the Project, with activity levels higher during drilling and installation activities. Contractors providing services such as rental of drilling equipment and provision of drilling fluids will operate out of their own shore bases.

The quayside facilities will have sufficient frontage and depth to accommodate daily berthing construction support vessels during drilling and installation phases and berthing of the field support vessels during operations. Logistics services will mainly be carried out by contractors and include the following.

- Shore base services.
- Warehousing.
- Helicopter.
- Supply vessel.
- Emergency vessel.
- Warehousing and a storage yard are intended to be provided from existing port facilities.

Since Pecan Energies will not be constructing and operating its own dedicated shore base, there will be no 'Associated Facilities' as defined by IFC PS1[(1)]. There will be potential impacts not directly under the control of Pecan Energies through its supply chain. Where Pecan Energies can reasonably exercise control, the risks and impacts identification process will also consider those associated with primary supply chain facilities (e.g. suction anchor fabrication yard). The approach to managing these issues, primarily focussed on health and safety and labour conditions, will be documented within the ESMP[(2)].

Activities in Takoradi have the potential for both positive and negative impacts on surrounding communities regarding traffic and noise related impacts and infrastructure implications. 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.

The main potential sources of impacts identified are the following.

- Traffic. The road network in the Region is limited and the conditions of the roads can be very poor, particularly in the rainy season. Disruption to road users, temporary road closures, damage to roads or traffic congestions are can potentially occur due to onshore logistics and the activities of Pecan Energies contractors.
- Noise disturbance to communities. Existing noise in the harbour area could be increased additional activities at the port of Takoradi and from the increased level of traffic movements. There might also be increased traffic at night causing increased noise. Traffic volume, vehicle types, operating speeds as well as proximity to receptors are key determinants of these impacts.
- 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, including the Takoradi Port. This could lead to potential competition over water resources with local communities.

There will be no requirement for land acquisition and involuntary resettlement as part of this Project, therefore no physical or economic displacement will occur.

Mitigation Measures

The means to manage the potential impacts from use of the facilities in Takoradi port will be focused on the implementation of engagement activities as defined in the SEP and the

[1] International Finance Corporation, 2012. Performance Standard 1 - Assessment and Management of Environmental and Social Risks and Impacts.
[2] With specific reference to paras 27 and 29 of PS 2 and para 30 of PS6 covering use of child and forced labour and purchasing primary production from areas where threats to natural / critical habitat are known.

grievance mechanism. Pecan Energies CLOs will disseminate information about the Project to the community and process any suggestions, complaints or grievances received.

Pecan Energies will undertake periodic audits and reviews of its shore-based operations to review site HSE performance and take corrective actions as required. Periodic audits of third-party operations and facilities will also be carried out. This will involve routine management meetings with the main operators of these facilities and the agreement of common environmental and social management measures.

A Traffic Management Plan will be developed including the following.

- Engagement with local authorities to acknowledge the traffic patterns in the road network, optimise traffic routes, minimise traffic queuing to the extent practicable.
- Some abnormal loads will need to be delivered from time to time. These will be scheduled wherever possible during off-peak periods.
- Precautions will be taken by the Contractor to avoid damage to the roads. Any road damage will be repaired to an equal or better standard in a timely manner.
- Traffic flows will be timed, wherever practicable, to avoid periods of heavy traffic flow along main roads.
- Measures to avoid damaging local infrastructure, control all vehicle movements and implement maintenance procedures.
- Measures to define behaviours for safe driving as well as driver training and driver competence requirements.
- The Project will establish a grievance mechanism to follow-up and close out any traffic related issues reported by stakeholders.
- Regular road safety awareness campaigns in surrounding schools, markets etc. to sensitise other road users.

Impact Assessment

Project activities will incrementally increase overall fresh-water demand from facilities at the port of Takoradi. However, assuming the water sources will be treated piped water, no apparent competition over water resources is expected with local communities. 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.

6.14.12 Marine Cultural Heritage

Potential Impacts

Both the onshore and offshore activities have the potential to affect tangible and intangible heritage through the damage or loss of wrecks and structures and interference with cultural activities.

Offshore, there are no historical records of wrecks sites in the Project area or evidence of wreckage from the site surveys undertaken. The location of shore-based offices will be within existing facilities at Takoradi port therefore there is minimal potential for impacts, therefore no mitigation is required.

Assessment of Impacts

Marine heritage along the Gold Coast is linked in many ways to the colonial history between the 15^{th} to 20th centuries. Recent shipwreck discoveries near Elimina of two Dutch colonial ships highlight the potential of the waters to contain wrecks from this era. Coastal marine heritage (such as historic jetties and local fishing structures) is likely to have been subsumed by the reclamation works and railway construction of the 20th century. Recent modern developments, including extensive dredging programmes in and around Takoradi port are likely to have severely impacted or removed any heritage wrecks from the Project development area.

The proposed area for the production wells, FPSO etc is 113 km offshore and is confined to a relatively small area with a small seafloor impact area. The seabed mapping during the geophysical survey by Fugro in 2021 showed no evidence of any wrecks within the Pecan field. With a chance find procedure (i.e. a procedure to outline the actions to be taken in the event that future survey work discovers wrecks or other items of cultural heritage significance) in place for offshore operations potential impacts on marine heritage are considered to be Not Significant.

For onshore areas, impacts on heritage at existing infrastructure at Takoradi port is also considered to be Not Significant.

6.15 Ecosystem Services

6.15.1 Overview

Ecosystem services are resources or processes in natural ecosystems that benefit humans. This includes many resources that underpin basic human health and survival needs, support economic activities and provide cultural fulfilment.

The ecosystem services approach aims to consider resources in an integrated assessment, so that the realisation of one benefit is not achieved at cost to other services and their beneficiaries.

The Millennium Ecosystem Assessment[1] classified them into four main categories to provide a clear and consistent classification scheme.

- Provisioning services are the goods or products obtained from ecosystems, such as food, timber, medicines, fibres, fuelwood, and freshwater.
- Regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate regulation, disease control, pollination, erosion prevention, water flow regulation, water purification and protection from natural hazards.
- Cultural services are the nonmaterial benefits obtained from ecosystems, such as recreation, sacred sites and aesthetic enjoyment.
- Supporting services are the services necessary for the production of all other ecosystem services. This refers to natural processes, such as soil formation, nutrient cycling and primary production, which maintain the other services.

The screening of the Ecosystem Services for the Project serves to identify crosscutting issues and whether any services that are often overlooked, such as regulating or cultural services, should be considered in the analysis of impacts.

6.15.2 Ecosystem Services Screening

The aim of the Ecosystem Services Screening is to provide a comprehensive list regarding the ecosystem services that are present in the area of Influence (AoI). The screening process uses a master list (presented in) published by the World Resources Institute (WRI 2011) and based on the 2005 Millennium Ecosystem Assessment Reports[2].

Each of the services in the table was then checked to consider the likelihood that it is present in the Project AoI. For a service to be considered present, it must meet the following two criteria.

[1] Ecosystem and Their Services (2000). Millennium Assessment Ecosystem Services Report. Available at: https://www.millenniumassessment.org/documents/document.300.aspx.pdf

[2] Millennium Ecosystem Assessment. 2005. Accessed at: https://www.millenniumassessment.org/en/index.html

- The habitats present in the study area are known to provide this service or are similar to habitats elsewhere that provide this service.
- People are believed to benefit from the service, either at the local, national or global level and /or the Project is expected to benefit from this service.

6.15.3 Ecosystem Services Assessment

Table 6.7 lists those services that could be affected by the Project. The potential impacts on Ecosystem Services are addressed in the various impact assessment sections in this chapter and the conclusions are summarised in Table 6.8.

Although several cultural services are present in the AoI (traditional practices; recreation and tourism; and non-use value of biodiversity), the Project's interaction with them is anticipated to be minimal and indistinguishable from other on-going human and economic development activities and therefore these are not assessed further.

Table 6.7 Ecosystem Services Screening

Ecosystem Service	Description	Present in the Study Area
Provisioning Services: The goods or products obtained from ecosystems		
Food: wild-caught fish and shellfish & aquaculture	Fish caught for subsistence or commercial sale; Fish, shellfish, and/or plants that are bred and reared in ponds, enclosures, and other forms of fresh- or salt-water confinement for harvesting	**Yes**
Food: wild foods	Edible plant and animal species gathered or captured in the wild	
Food: crops	Annual and permanent crops grown for subsistence use and commercial sale	
Livestock farming	Sedentary and nomadic livestock farming	
Biological raw materials: timber and wood products	Wood collected for local use or for sale as timber, wood pulp, paper	
Biological raw materials: non-wood fibres and resins	For example, cane, palm, straw, cotton, hemp, twine and rope, natural rubber	
Biological raw materials: ornamental resources	For example, pelts, carved or decorative animal products, live animal trade	
Freshwater (potable)	Freshwater for drinking	**Yes**
Freshwater (non-potable)	Freshwater for irrigation, laundry, household and industrial use	
Biochemicals, natural medicines, pharmaceuticals	Natural medicines, biocides, food additives, pharmaceuticals and other biological material for commercial or domestic use.	
Biomass fuel	Wood, dung and plant matter collected for charcoal, fuel	
Genetic resources	Genes and genetic information used for animal breeding, plant improvement, and biotechnology	
Regulating Services: The benefits obtained from an ecosystem's control of natural resources		
Regulation of air quality	The influence ecosystems have on air quality by extracting chemicals from the atmosphere (i.e., serving as a sink) or emitting chemicals to the atmosphere (i.e., serving as a source)	**Yes**
Climate regulation: global	Carbon sequestration (impacts on global climate change)	
Climate regulation: local	Regulation of temperature, shade air quality by vegetated areas	
Regulation of water timing and flows	Influence ecosystems have on the timing and magnitude of water runoff, flooding, and aquifer recharge	
Water purification and waste treatment	Role played by vegetation and bacteria in the filtration and decomposition of organic wastes and pollutants and the assimilation and detoxification of compounds.	
Shoreline protection	Role of natural habitats (e.g. wetlands, beaches, reefs) in protecting crops, buildings, recreation areas from waves, wind and flooding from coastal storms.	

Ecosystem Service	Description	Present in the Study Area
Fire regulation	Regulation of fire frequency and intensity (e.g. dense forest can provide firebreaks)	
Pest regulation	Predators from forests, grassland areas, etc. may control pests attacking crops or livestock	
Disease regulation	Influence ecosystems have on the incidence and abundance of human pathogens	
Erosion regulation	Role of vegetation in regulating erosion on slopes and riparian areas	
Pollination	Birds, insects and some small mammals pollinate certain flora species, including some agricultural crops	
Cultural Services:		
Spiritual, religious or cultural value	Natural spaces or species with spiritual, cultural or religious importance	
Traditional practices	Cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources.	**Yes**
Recreation and tourism	Use of natural spaces and resources for tourism and recreation (e.g. swimming, boating, hunting, birdwatching, fishing)	**Yes**
Aesthetic value	Cultural value placed on the aesthetic value provided by landscapes, natural landmarks	
Educational and inspirational values	Information derived from ecosystems used for intellectual development, culture, art, design, and innovation.	
Non-use value of biodiversity (e.g. existence, bequest value)	Species and areas valued globally as of high conservation value	**Yes**
Supporting Services		
Primary production	Formation of biological material by plants through photosynthesis and nutrient assimilation.	**Yes**
Nutrient cycling	Flow of nutrients (e.g., nitrogen, sulphur, phosphorus, carbon) through ecosystems.	**Yes**
Water cycling	Flow of water through ecosystems in its solid, liquid, or gaseous forms.	
Soil formation	Natural soil-forming processes throughout vegetated areas.	
Habitat provision	Natural spaces that maintain species populations and protect the capacity of ecological communities to recover from disturbances.	**Yes**

Table 6.8 Ecosystem Services Assessment

Ecosystem service	Justification for Inclusion in the Assessment	Impact Assessment and Mitigation
Food: wild caught fish and shellfish	Wild fish are a provisioning ecosystem service for the Project	The Project impacts on fish populations will all be localised (mainly to the MODU and FPSO) to the installation and operational activities and/or temporary and there will be no significant adverse impacts and no significant effects on the ecosystem services provided by wild fish and shellfish. No specific mitigation measures are required beyond those already committed to for example to minimise impacts on water quality.
Freshwater (potable)	The operation of the onshore facilities at Takoradi port may temporarily increase demand on utility supply, including water supply.	Use of existing shore base facilities will lead to an incremental increase in demand on existing supplies of potable water. This is anticipated to be within existing supply capacities and therefore will not have any significant impacts on the ecosystem services provided locally by freshwater.
Regulation of air quality	Industrial emissions are a source of impact on air quality. The Project will cause localised increases in air pollutants.	The Project will result in incremental increases in road traffic around the port of Takoradi but probably at a level that is indistinguishable from existing sources. The Project will implement road traffic and other controls on its haulage contractors, such as vehicle maintenance and other good practice requirements. Emissions from offshore activities will dissipate within short distances from the sources and will not affect any receptors. There will be no significant impacts on air quality.
Primary production	Supporting services provide intermediate ecological outcomes that are captured elsewhere in the provisioning and regulating services that they support	The Project impacts on water quality will be of Minor significance at most and localised mainly to the MODU and FPSO. There will be no significant impacts on the provisioning and regulating services provided by primary production.
Nutrient cycling	Supporting services provide intermediate ecological outcomes that are captured elsewhere in the provisioning and regulating services that they support.	The Project impacts on water quality in terms of input of nutrient material will be of minimal and localised mainly to the MODU and FPSO. There will be no significant impacts on the provisioning and regulating services provided by nutrient cycling.
Habitat provision	Habitat provision is a supporting service that can also be assessed directly.	The Project will affect a small area of seabed which has no important ecosystem functions and is well represented across the much larger area offshore.

6.16 Cumulative Impacts

6.16.1 General Considerations

An assessment of cumulative impacts requires the consideration of other plans or projects that may impact on the same receptors and resources as the Project, leading to greater environmental and social impacts than might arise from the Project alone. Consideration of other plans or projects in a cumulative impact assessment is usually restricted to those plans or projects occurring at the same time but not already acting in the baseline, those that have been consented but not yet completed, or those that are under consideration by the determining authority and have a strong likelihood of proceeding.

The resources and receptors that may be subject to cumulative impacts include those that have been identified as potentially affected by the Project at the offshore Project location, onshore port location and the transit routes between these. Coastal areas that could potentially be affected in the event of a large oil spill are excluded from the cumulative impact assessment on the basis that such an event is unplanned and has a very low likelihood of occurring concurrently with a similar large-scale incident from another project to affecting the same resources and receptors.

6.16.2 Other Plans and Projects

There are several other current operations or regularly performed activities in the general Project area that have the potential to cause environmental and social impacts. These are summarised in Table .

Table 6.9 Other Activities within the Project Area

Activity	Description	Location	Comment
Oil and Gas Production Activities	Existing FPSO based production operations. Potential future expansions/development of these fields.	Tullow Ghana's TEN and Jubilee fields north of Pecan, Eni Ghana's OCTP field	Potential for contributing to cumulative impacts with the Project
Oil and Gas Exploration Activities	Future seismic survey and exploratory drilling activities	There are licence blocks across the shallow and deep-water areas	Potential for contributing to cumulative impacts with the Project
Onshore Gas Processing and Power Generation	Operation of gas processing and power plants	Takoradi power plant Atuabo Gas Plant Eni Ghana's Onshore Receiving Facility (ORF) at Sanzule	Potential for contributing to cumulative impacts with the Project
Oil Services Terminal	Proposed Oil Services Terminal providing support services to oil and gas operations offshore Ghana. The proposed development has EIA approval from the Government of Ghana and is currently pending finance approval	Adjacent to Atuabo, in the Western Region	Low potential for contributing to cumulative impacts with the Project

Activity	Description	Location	Comment
Shipping	Commercial ship traffic	In the Gulf of Guinea and near main ports	Baseline activity – low potential for contributing to cumulative impacts with the Project
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	Baseline activity – low potential for exposure to cumulative impacts with the Project
Commercial Fishing	Fishing by commercial vessels using trawling and line methods	In deeper water areas using main ports (including Takoradi) for berthing	Baseline activity – low potential for contributing to cumulative impacts with the Project
Dredging	Maintenance dredging of Takoradi port area	Within and near Takoradi port	Baseline activity – minimal or no potential for contributing to cumulative impacts with the Project
Transport Infrastructure	Construction and maintenance of roadways such as road asphalt widening and new bridge construction	In Takoradi near the port and airport	Baseline activity – minimal or no potential for contributing to cumulative impacts with the Project
Agriculture	Plantations and agricultural activities	Along coastline	Baseline activity – minimal or no potential for contributing to cumulative impacts with the Project
Tourism, and Recreation	Tourism, swimming, fishing and boating	In the nearshore areas and along beaches	Baseline activity – minimal or no potential for cumulative impacts with the Project
Real Estate Development	Business and housing construction projects	In Takoradi and along coastline	Baseline activity – minimal or no potential for contributing to cumulative impacts with the Project
Environmental Restoration	Shoreline stabilisation work or hydrologic restoration	Along the coastline near land developments	Baseline activity – minimal or no potential for contributing to cumulative impacts with the Project

Of the other activities listed in Table 6.9, many have little or no potential to have impacts on the same resources and receptors as the Project and therefore little or no potential to lead to cumulative impacts with the Project. For those activities which do have some potential to have cumulative impacts with the Project further consideration is given below.

6.16.3 Resources and Receptors that could be affected by Cumulative Impacts

The Project's operations will be concentrated at the Pecan field, with the wells and FPSO located between 90 and 103 km from shore. Therefore, the ecological resources and receptors that could be affected by cumulative impacts are limited to marine fauna (especially fish, mammals and turtles) that may be encountered in the area, together with commercial fisheries targeting certain species of fish.

Vessel movements will also take place between the Pecan field and shore and therefore coastal resources and receptors could be potentially exposed to cumulative impacts from increased volumes of shipping from the Project with similar increases from other future plans and projects. The main receptors that could be most affected by such cumulative impacts are other shipping and coastal fisheries, especially artisanal fisheries.

6.16.4 Management of Cumulative Impacts

Pecan Energies can mitigate potential impacts associated with the Project but 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 in general and other sectors operating in the area now and 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. In the meantime, Pecan Energies will manage the contribution of the Project to cumulative impacts by minimising the impacts from operations under its own control.

6.16.5 Assessment of Cumulative Impacts

The offshore impacts from the Project are generally localised to the Pecan field area, and specifically at the FPSO and subsea infrastructure locations. The Pecan field is some distance from other offshore oil and gas activity and the potential for impacts on the same receptors is limited. Cumulative impacts from other current and planned projects are assessed as being Not Significant.

Closer to shore the support and supply vessels for the Project will add to the general maritime traffic moving between oil and gas fields and shore bases and cumulative impacts on other sea users (including fisheries) are assessed to be of Minor significance at most.

Emissions of GHG from the Project will act cumulatively with existing and potential future offshore oil and gas developments as well as onshore sources to increase national emissions given the relatively low level of current national emissions.

Onshore, the potential exists for both positive and negative impacts, particularly if Takoradi continues to develop as a base to serve a growing offshore oil and gas industry. On the basis that the necessary infrastructure, such as waste management facilities, grow at the same pace, cumulative impact should be manageable and of Minor significance at most.

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.

6.17 Unplanned Events: Navigation Risk

6.17.1 Description of Potential Impacts

The MODU, during the drilling phase and the FPSO, during operation, will effectively be stationary and present a theoretical hazard to passing third party shipping (as well as to supply, support and standby Project vessels and the visiting offloading tankers).

Collision between vessels of sufficient energy could lead to injuries, fatalities, loss of assets and release of harmful materials (especially fuel oil or crude product oil) to sea.

6.17.2 Mitigation Measures

Pecan Energies has undertaken safety studies to assess the likelihood of collisions between Project vessels and the FPSO, the energy involved in possible collisions and how the FPSO structure might respond to such collisions (see Annex K and Annex L). On review of the results of these studies Pecan Energies has decided to modify the FPSO hull with sandwich plate system compact double hull (SPS-CDH) with double sides at the starboard side (noting the FPSO already has a double-bottom hull).

The Project vessels will adhere to standard navigational procedures while on station, together with Project-specific operational procedures in accordance with the International Guidelines for Offshore Marine Operations (G-OMO) guidelines (the standard global approach for good practice and safe vessel operations in the offshore oil and gas industry). The guideline covers all relevant aspects from vessel procurement, voyage planning, mobilisation, loading, outward voyage, approach to location, working at location, departure from location and inward voyage, with specific guidelines related to collision risk management.

The ‘Field operations Manual’ for Pecan will be updated for Pecan to reflect the G-OMO guidelines as well as the local metocean conditions.

In terms of collision risk management at the field the following measures will also be implemented during drilling and production.

- The ship traffic around the locations will be monitored by a dedicated stand-by vessel onsite equipped with Automatic Identification System (AIS) and Automatic Radar Plotting Aids (ARPA)(or similar).
- A 500 m safety zone around the MODU and FPSO will be established.
- The team directing operations on the supply vessel bridge will have the necessary experience for the planned operations.
- Visiting vessels will be required not to use the FPSO as a final waypoint in their sailing plan and should set a course which is off set from the FPSO and at a tangent to the safety zone
- Entry to the 500 m safety zone thereafter to the set-up position will be taken at a speed of 3 knots or less.
- Prior to entering the safety zone of the MODU or FPSO, the pre-entry check list for the vessel will be completed.
- Specific measures for the offloading tanker approach and offloading minimum set-off distance.
- A riser exclusion zone prohibiting vessel movement close to risers will be established.
- An operational limit will be established limiting visiting vessel operations to within the one-year weather state limit.

Regarding passing third-party vessels, details of the planned drilling programme and production operations will be notified to other sea users through the ‘Notice to Mariners’ system, as well as through NAVTEX (automated Navigation Telex).

6.17.3 Assessment of Impacts

Pecan Energies commissioned a Ship Collision Risk Assessment Report which is provided in Annex K. The collision risk assessment considered one year of AIS-data for a 10 nm radius search area around the proposed FPSO location. This exercise was performed to identify the passing vessel traffic pattern at the Project location. 2019 data were used as being most recent representative traffic volume due to COVID-19 likely skewing 2020 data.

A total of 2,276 vessels per annum were identified as passing vessels, corresponding to an average of approximately 44 vessels per week and 6 vessels a day. The majority of the traffic sailed in the east to west or west to east directions, and 519 vessels (22.8%) passed the location within 3 nm. Overall, the Pecan Field FPSO location can be described as having a low traffic density.

The passing vessel collision frequency was calculated using the AIS vessel traffic data as input to the COLLIDE 3.0 model (see Annex K for a description of the model and the results of the modelling). Collisions risks were predicted in terms of annual frequency of collision for passing vessels per collision type, collision point and total collision energy, and taking into account the effect of risk reducing measures. Collision damage to the risers was also considered.

The modelling showed that the total collision risk for the FPSO (and by extrapolation, the MODU) is considered low. The frequency of high energy collisions from passing vessels is very low, considering that sufficient vessel traffic monitoring is performed by the standby vessel. On the basis that the FPSO can sustain vessel impacts from supply vessels up to a certain energy level and G-OMO guidelines are adhered to, the risk of supply vessel collision is considered low. The risk for collision related to offloading (offtake tanker, line handler and tugs) is also considered low.

Based on the collision risk modelling and the extent of mitigation that will be applied, collision with passing third-party vessels is very unlikely to occur in the first place and if a collision does occur it is unlikely to have sufficient energy to lead to significant effects on people and the environment.

6.18 Unplanned Events: Oil Spill Risk

6.18.1 Potential Impacts from Oil Spillage

The risk of an oil spill into the marine environment is inherent in all offshore oil developments. The likelihood (probability) of significant oil spills, i.e. those that can reach the shoreline or other sensitive areas from the 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 whilst 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 Pecan Energies overall Emergency Preparedness and Response Plan for the project.

6.18.2 Spill Scenarios: Sources and Likelihood of Occurrence

Spill Scenarios

Based on the nature of the Project, two project-specific studies (see the Pecan Ship Collision Risk Assessment Report in Annex K and Collision Analysis Report in Annex L) and historical spill incidents in the industry (SINTEF Offshore Blowout Database and Chen et al 2011), four oil spill scenarios were identified to represent a range of spill sizes (Tiers) and release rates, as shown in Table 6.10. The scenarios represent a variety of spill rates and duration combinations ranging from large unlikely spills to small possible spills as follows. The rates in scenario 3 and 4 have been modelled by Add Well Flow using the OLGA well flow and kill modelling tool.

- Scenario 1: 10 m^3/d for 1 day, represents a low-rate spill that lasts for up to one day before it is located and stopped (e.g. a slick joint leak or similar).
- Scenario 2: 2,000 m^3/d for 0.5 days, represents a large-rate spill that has a short duration before it is localised and controlled (e.g. an export hose rupture).
- Scenario 3: 9,210 m^3/d for 1 day discharged at the sea surface, represents a worst-case blowout rate through an open hole (i.e. without drill string in the well). The duration for this scenario is limited as the riser may collapse and the blowout occur subsurface (represented by scenario 4).

- Scenario 4: 2,160 m^3/d discharged subsea at the well head, modelled for release durations of 1, 15 and 50 days (with a probability distribution of 41 %, 42 % and 17 % respectively) to represent the probability of a blowout lasting for these periods. This scenario represents a worst case open hole subsea blowout. The blowout duration and probability distribution is based on Lloyd's, 2019: Blowout and well release frequencies which is based on SINTEF offshore blowout database 2018. Report no: 19101001-8/2019/R3. Rev: Final. Date 08 April 2019.

Table 6.10 Oil Release Scenarios

Scenario	Tier	Oil release rate	Duration and percentage probability distribution of release used for modelling			
		(Sm^3/d)	0.5 days	1 day	15 days	50 days
Sc1 - Slick joint leak	1	10		100%		
Sc2 - Export hose rupture	2	2,000	100%			
Sc3 - Open hole to surface	3	9,210		100%		
Sc4 - Open hole to seabed	3	2,160		41%	42%	17%

Slick Joint Type Leak (Scenario 1)

This type of leak, e.g. from a slick joint part of the production riser system would typically be very small and of short duration. The Quantitative Risk Assessment (QRA) prepared for the Project does not specifically examine this type of leak as the focus of study was on incidents that could expose personnel to danger. However, it does look at accidental release of oil from the riser system in general and suggests a likely frequency of occurrence of circa 1.0 x 10^{-1} (less than once per 10 years) per year of operations.

Large Scale Short Duration Leak (Scenario 2)

This type of leak, e.g. from a large rupture (as opposed to a leak) of the offloading hose would typically be relatively high rate but of short duration. The QRA study suggested a likely frequency of occurrence of such an event is circa 1.0 x 10^{-3} to 1.0 x 10^{-2} (once in 100 to once in 1,000 years) per year of operation.

Blowout and Well Releases (Scenarios 3 and 4)

The potentially most severe oil spill event would be the result of a loss of well control and containment (known as a blowout). Primary well control is the process that maintains a hydrostatic pressure in the wellbore greater than the pressure of the hydrocarbons in the formation being drilled via a drilling fluid / mud. If the formation pressure is greater than the hydrostatic pressure of the drilling fluid in the wellbore the hydrocarbons will enter the wellbore. If the primary well control fails, this flow may be stopped by closing the Blow-Out Preventer (BOP), which is the initial stage of secondary well control. The is followed by pumping a high density drilling fluid into the wellbore to 'kill the well'.

A blowout is defined as an uncontrolled flow of formation hydrocarbons from the reservoir to the surface that occurs as a result of loss of primary (hydrostatic pressure) and secondary (BOP) well control and may lead to the potential for release of hydrocarbons to the environment.

6.18.3 Behaviour of Hydrocarbons at Sea

The potential environmental impact of an accidental hydrocarbon release depends on a wide range of factors, which include:

- release volume;
- type of hydrocarbon released;
- direction of travel of release;
- weathering properties of the hydrocarbon;
- any environmental sensitivities in the path of the release (these may change with time); and
- sensitivity of the impacted locations.

The physical and chemical changes that spilled oil undergoes in the environment is collectively known as 'weathering' (Figure 6.8). 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 Table 6.11.

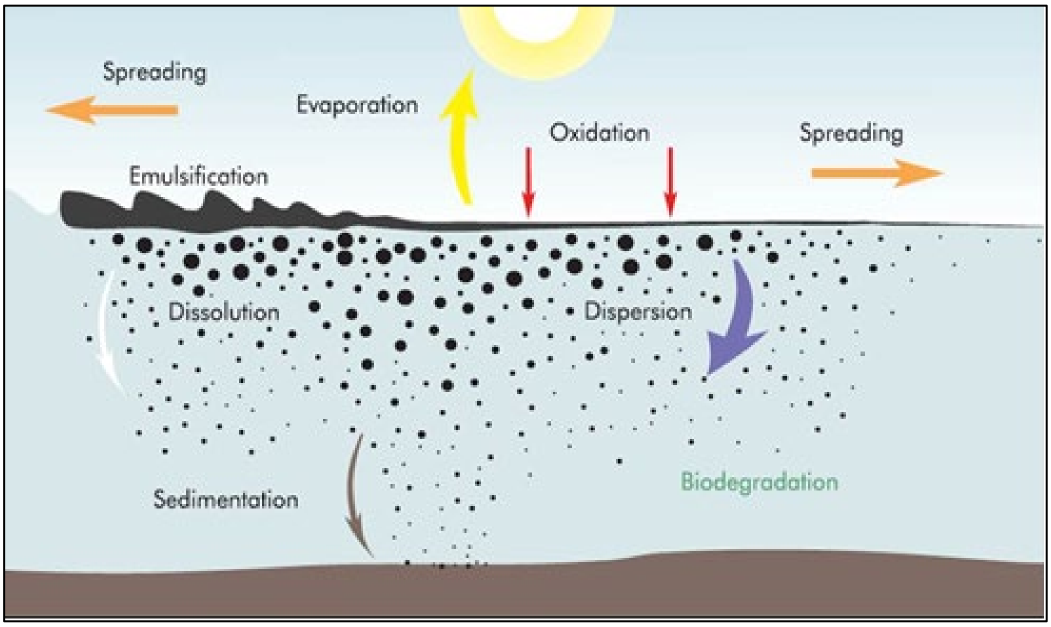


Figure 6.8 Weathering Processes for Oil at Sea

Table 6.11 Oil Weathering Process

Term	Definition
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	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.

6.18.4 Oil Spill Modelling

General Approach

To inform the assessment of oil spill risk, oil spill drift modelling was undertaken by DNV-GL (2020b). The oil drift modelling included the worst-case scenario of a blowout with the drill string pulled out of the well (which would allow unimpeded reservoir fluid flow through an unrestricted, or open hole, giving the highest flow rates). A copy of the modelling report is included in Annex M and a summary of the outputs is provided here.

Oil spill drift predictions for each of the four scenarios from the Pecan field were modelled using the SINTEF oil spill model OSCAR V10.0.1 (2018). The model is a three-dimensional model calculating and recording the distribution, as mass and concentrations, of hydrocarbons on the water surface, in coastal habitats, in the water column and in sediments.

Wind data for the modelling study were obtained from the U.S. National Center for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR) model. Currents for the Ghanaian waters were acquired from the U.S. Navy Global HYCOM (Hybrid Coordinate Ocean Model) circulation model. All data were acquired and used for the period between January 2006 and December 2012.

For subsurface releases (e.g. blowouts from seabed as per scenario 4), the near field part of the simulation was conducted with a multi-component integral plume model that is embedded in the OSCAR model, named PLUME3D. The near field model accounts for buoyancy effects of oil and gas, as well as effects of ambient stratification and cross flow on the dilution and rise time of the plume.

The OSCAR model computes surface spreading, slick transport, entrainment into the water column, evaporation, emulsification and coastal habitat interactions to determine oil drift and fate at the surface. In the water column, horizontal and vertical transport by currents, dissolution, adsorption, settling and degradation are simulated. Oil weathering was based on parameters from a crude oil that best matches the oil from Pecan, in this case Balder Blend.

The model is capable of undertaking both stochastic and deterministic modelling as described below.

- The stochastic mode is used to estimate the likelihood of particular trajectories occurring, based on historical wind speed and direction data. Stochastic models, often called probability models, show the probability of where an oil spill may spread to from the spill source under different environmental conditions. The model computes a series of trajectories under various wind current conditions from the historic wind records and current records. These results are combined in a probability density map of the spatial likelihood of occurrence.
- The deterministic mode is used to predict the route of a hydrocarbon slick over time, and to estimate the oil weathering profile, under specific meteorological conditions. Modelling outputs include the trajectory of the slick and mass balance estimates over time (i.e. the slick volume and how much oil is estimated to have dispersed, emulsified or evaporated). The deterministic modelling investigates whether or not, and how quickly, oil might reach the coast under a constant (typical worst-case) wind speed and direction.

The model was run in these two modes for each spill scenario. In stochastic mode, the probability (greater than 1%) of an area of the sea being impacted by oil (more than 1 tonne) in the event of a spill was determined, based on a series of 10 by 10 km cells. In deterministic mode, the amount of oil predicted to land on the coast and the time that would take, was calculated, based on the worst cases for each scenario.

For each scenario the model was run in stochastic (annual probabilities) and deterministic mode (trajectory) (for largest volume of oil emulsion to reach the coast). The probability of oil entering each grid cells (10 by 10 km for open sea grid cells or coastal grid cells), is defined as the relative number of simulations in which a particle, representing surface oil, has entered the grid cell. The influence area is defined as the area with a probability of oiling >10% for >1 tonne of oil (equals 0.01 tonne per km^2). The results are presented as annual data (i.e. under all seasonal conditions). It is noted that in Scenario 1, the oil does not reach the coast therefore trajectory modelling results are not presented for this scenario.

Scenario 1 Results

Scenario 1 is a topside oil spill release with limited amount of oil, 10 m^3/d, and relatively short release duration, 1 day. The influence area, based on the modelling inputs, is expected to be restricted, see Figure 6.9. The influence area is limited to offshore waters close to the release site.

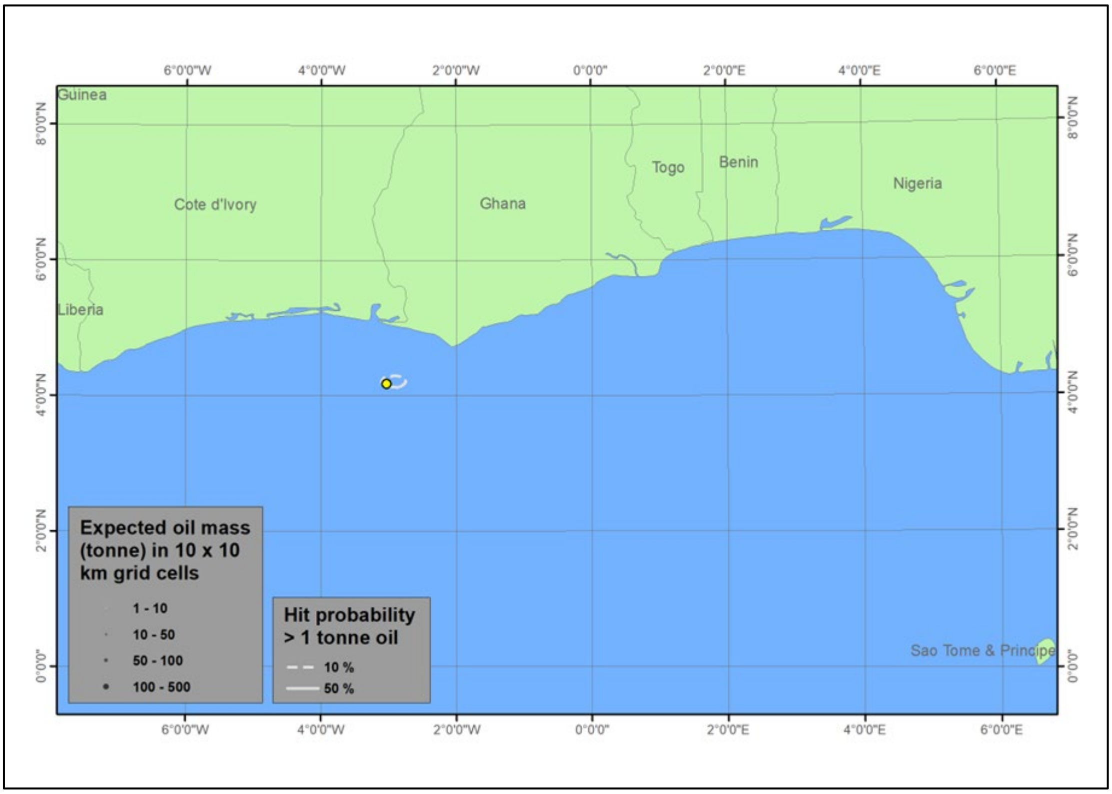


Figure 6.9 Annual Surface Oiling Probabilities for Scenario 1

Scenario 2 Results

Scenario 2 is a topside oil spill release with a medium amount of oil (2,000 m^3/d and a short release duration of 0.5 day). The influence area is expected to be quite small due to the short duration (see Figure 6.10). The probability of oil entering shoreline grid cells in the western part of the Ghanaian shore was predicted to be 10% with an expected oil mass in the category 1-10 tonnes, which equates to 0.01-0.1 tonnes per km^2.

The model outputs show the probability distribution of arrival time to the shore and oil mass on shore (see Annex M: Figure 3.4). The results show that the shortest arrival time to shore from the start of the release is predicted to be 3 days and the expected (50 %) arrival time is 8.5 days. The maximum oil stranded on the entire coastline is predicted to be 449 tonnes and the expected oil mass to shore is 157 tonnes. Nearly 87% of the 72 simulations performed by the model were predicted to reach the coastline.

Trajectory modelling based on 95-percentile single simulation (from the total 72 simulations) with the largest oil volume to the shore is presented in Figure 6.11.

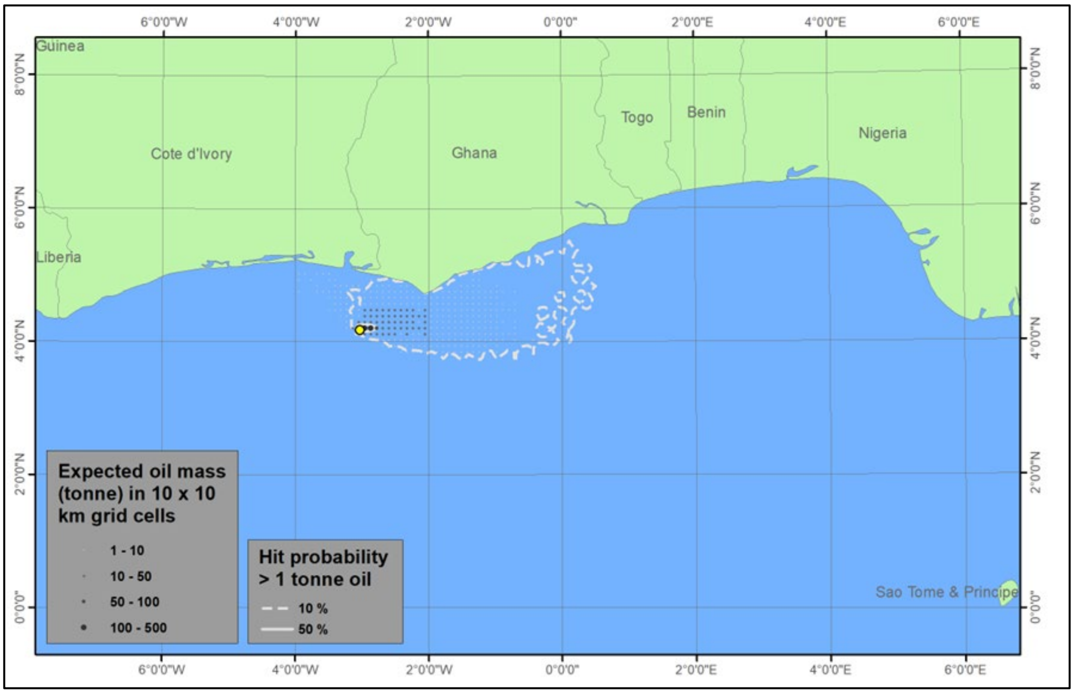


Figure 6.10 Annual Surface Oiling Probabilities for Scenario 2

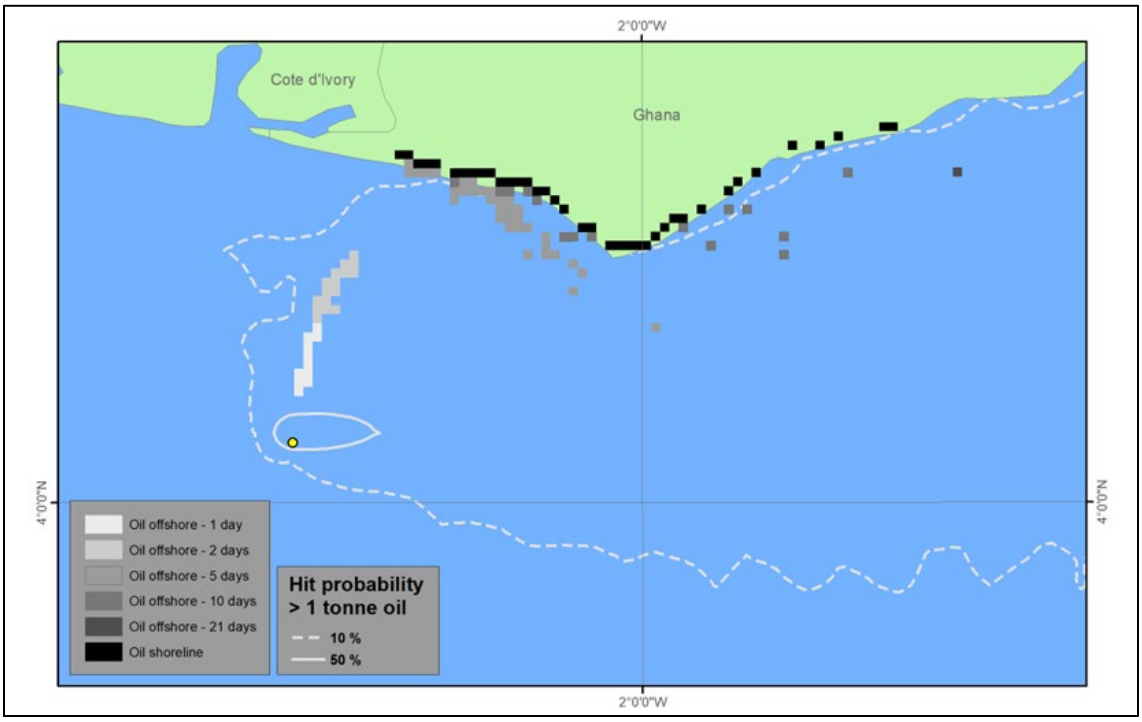


Figure 6.11 Trajectory of Oil Spill Over Time for Simulation with Largest Mass of Oil Reaching the Coast for Scenario 2

Scenario 3 Results

Scenario 3 is a topside oil spill release with a relatively high release rate of oil (9,210 m^3/d and release duration 1 day). The influence area is expected to be larger than scenario 2 (see Figure 6.12). The oil was predicted to hit coast cells mostly at the coast of Ghana with 10-50% probability and with expected oil mass in the category 10-50 tonnes in the western part and 1-10 tonnes in the eastern part. The eastern part of the shoreline of Ivory Coast was also predicted be hit in the probability category 10-50%.

The model outputs show the probability distribution of arrival time to the shore and oil mass on shore (see Annex M: Figure 3.7). The results show that the shortest arrival time to shore from the start of the release is predicted to be 2.9 days and the expected (50%) arrival time is 7.4 days. The maximum oil stranded on the entire coastline is predicted to be 3,527 tonnes and expected oil mass on shore is 1,918 tonnes. 92% of the simulations were predicted to reach the coastal area.

Trajectory modelling based on the 95-percentile single simulation (from the total 72 simulations) with the largest oil volume to the Ghanaian shore is presented in Figure .

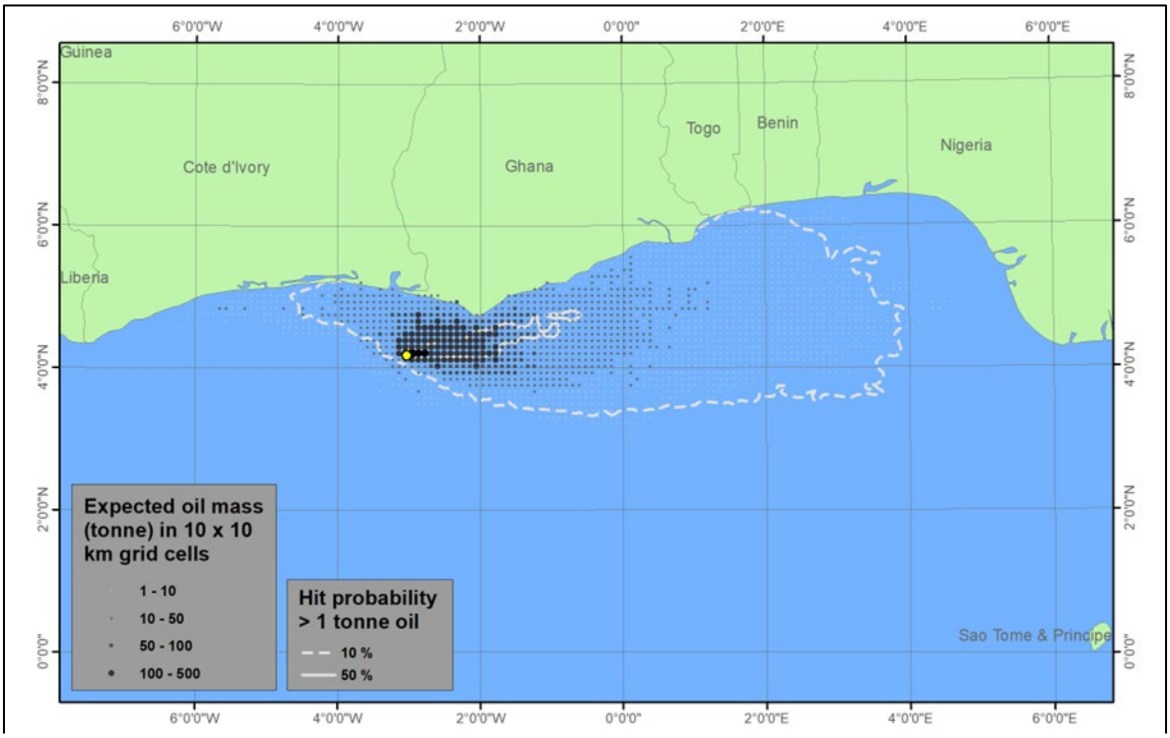


Figure 6.12 Annual Surface Oiling Probabilities for Scenario 3

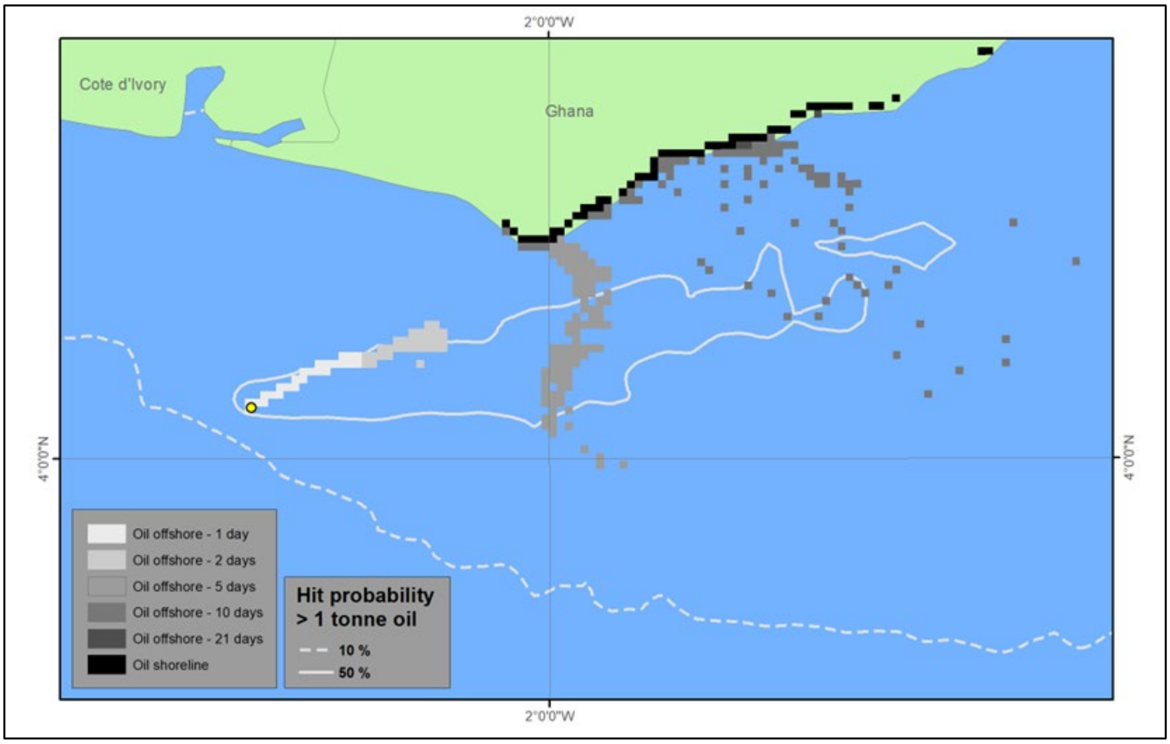


Figure 6.13 Trajectory of Oil Spill Over Time for Simulation with Largest Mass of Oil Reaching the Coast for Scenario 3

Scenario 4 Results

Scenario 4 is a seabed oil spill release with a medium release rate of oil 2,160 m^3/d and a release duration matrix of 1, 15 and 50 days with a probability distribution of 41 %, 42 % and 17 % respectively (Lloyds 2019). The stochastic results for each of the combination of rate and duration was given an individual probability and a weighted picture is then presented. The influence area is expected to be much larger than for scenario 3, see Figure . The oil is predicted to extend to almost the entire Ghanaian shoreline with 10-50 % probability in the expected oil mass category 10-50 tonnes. The eastern part of the Ivory Coast shoreline is predicted to have a 10-50 % probability of oil reaching the shore, with a maximum expected oil mass in the category 10-50 tonnes. For the other neighbouring countries, Togo, Benin and Nigeria, expected oil mass is in the category 1-10 tonnes.

To encompass variations in weather conditions scenario 4 has been set-up with a total of 144 simulations; 72, 48 and 24 for the durations 1, 15 and 50 days, respectively.

The model outputs show the probability distribution of arrival time to the shore and oil mass on shore (see Annex M, Figure 3.10). The results show that the shortest arrival time to shore from start of the release is predicted to be 3.5 days and the expected arrival time (50 %) is 8.8 days. The maximum oil stranded on the entire coastline is predicted to be 22,104 tonnes and expected oil mass on shore is 1,071 tonnes. Nearly 92 % of the simulations were predicted to reach the coastal area.

Figure 6.15 shows trajectory modelling based on the 95-percentile single simulation (from the total 144 simulations) with the largest volume of oil to the Ghanaian shore.

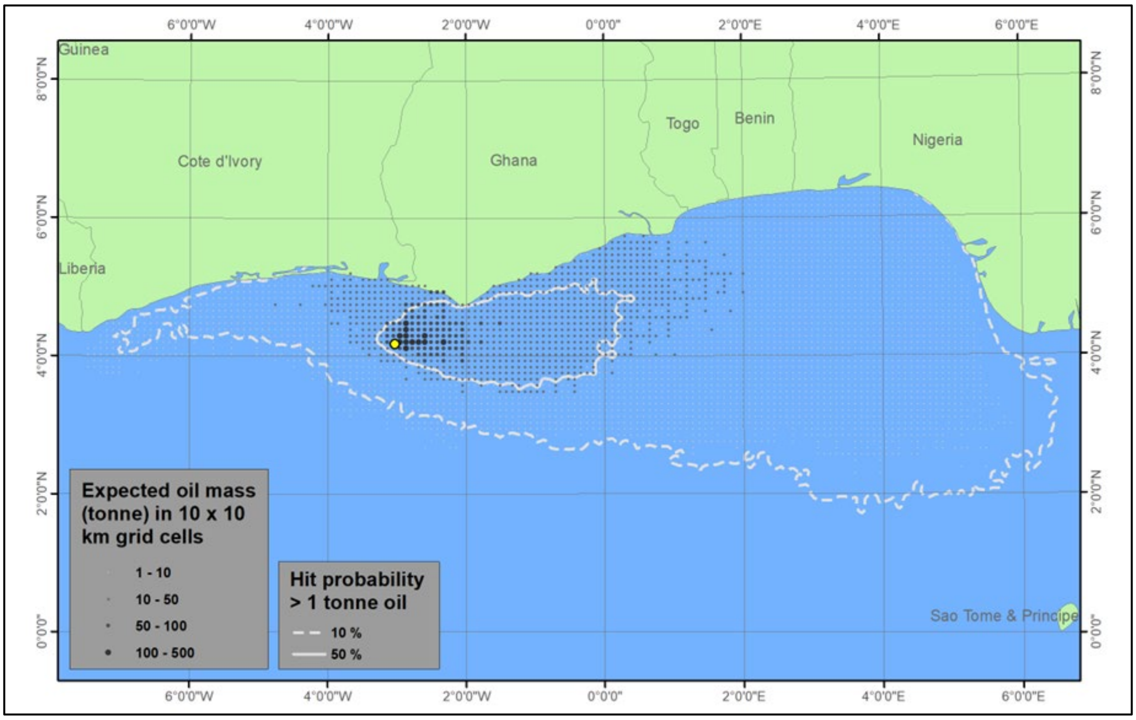


Figure 6.14 Annual Surface Oiling Probabilities for Scenario 4

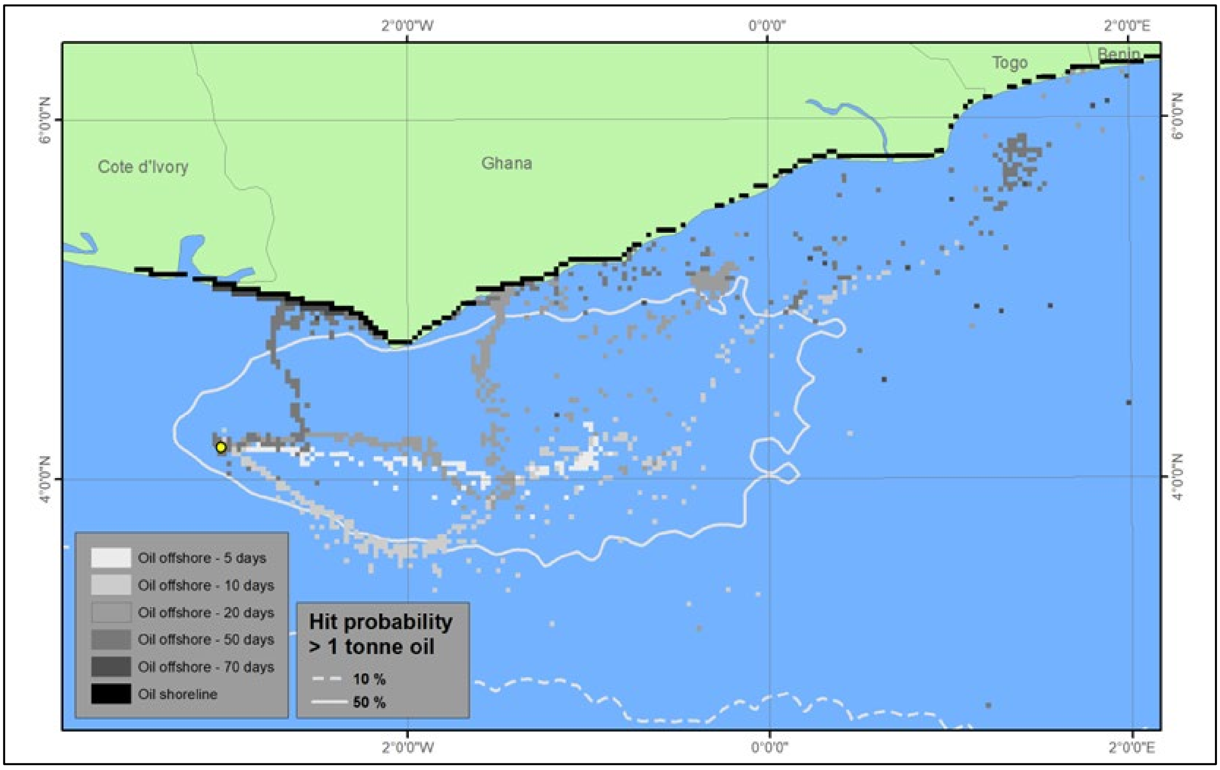


Figure 6.15 Trajectory of Oil Spill Over Time for Simulation with Largest Mass of Oil Reaching the Coast for Scenario 4.

6.18.5 Mitigation Measures

Introduction

Mitigation of oil spill incidents for the 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 occurring in the first place. Avoidance of oil spill incidents is highly dependent on design and planning (including training and emergency response exercises). Pecan Energies will be responsible for ensuring that oil spill risks have been fully considered and addressed to the extent that residual risks have been reduced to as low as reasonably practicable (ALARP). A diagram illustrating the risk of, and key barriers to prevent, oil spills is provided in Figure 6.16.

Oil Spill Prevention

Pecan Energies 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 installed on the subsea wells during drilling and well completions, and double mechanical barrier systems will be used during production and injection operations using the subsea 'vertical X-mas 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.

The offloading hose, associated pumps and valves will be fitted with safeguards, including non-return valves in the hose and automatic pressure shut off valves on the pumps.

Pecan Energies will have chemical permit in place for its dispersant inventory which pre-approve their use (although Pecan Energies would be required to notify the EPA in the event it intends to use dispersants). In the event of a spill, dispersants would not be used where there could be a detrimental impact on areas designated by the EPA as environmentally sensitive (i.e. in shallow water areas).

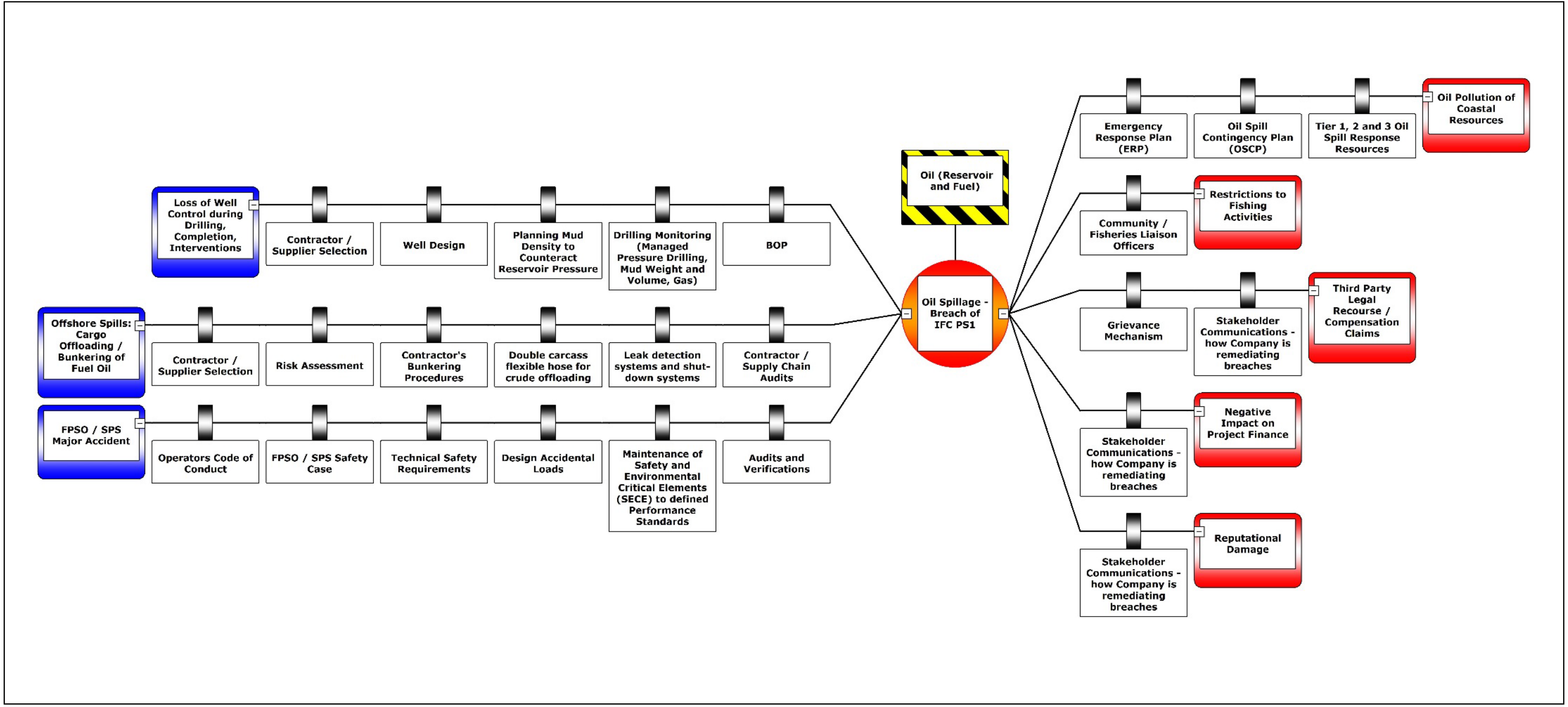


Figure 6.16 Bowtie Figure Illustrating High Level Overview of Barriers to Prevent and Mitigate Oil Spill

Spill Preparedness and Response

Despite the prevention measures and management procedures built into the design of the project, if there was a spill then the response requirements will be detailed in the Project Oil Spill Contingency Plan (OSCP) which will set out the strategy and procedures that will be taken in the event of an oil spill. In addition to the OSCP, Pecan Energies will have a plan for blowout and well control, including deployment of a capping stack and drilling of a relief well, if needed.

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 for each tier. This approach is aligned with Ghana National Oil Spill Contingency Plan and the International Petroleum Industry Environmental Conservation Association (IPIECA) guidance that 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 level of response required. Table 6.12 provides indicative conditions for the establishment of different tiers of response. The definition of oil spills is based on operational factors (e.g. probability and frequency of a spill event, oil volume and type), setting factors (e.g. proximity to operations, sensitive resources) and response capability factors (e.g. adequate resources/capacity to respond).

Table 6.12 Conditions for the Establishment of a Tiered Response

CHARACTERISTICS OF A TIER 1 OIL SPILL
The spill is less than 10 tonnes* 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 10 and 1000 tonnes* • 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 1000 tonnes* • 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**

*Ghana National Oil Spill Contingency Plan Version 6 (December 2020)
**ITOPF (2012)

Pecan Energies 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.

Pecan Energies will develop an OSCP that covers all onshore and offshore aspects of the Pecan field, and will define the following:

- key personnel, roles and responsibilities;
- internal and external notification procedures;
- response strategies and control procedures; and
- internal and external resources.

The OSCP will comprise a number of sub-plans including action plans for offshore, onshore and harbour spills, a Waste Management Plan, response resources, and a risk review. The OSCP will be complemented by Site Specific Mobilisation Plans that provide guidance for the deployment of shore protection resources,if there is a probability of shoreline impacts.

Training and Exercises

Pecan Energies will establish a programme to train relevant personnel in oil spill response. The programme will include training on oil spill preparedness and response and periodic oil spill preparedness exercises.

The oil spill preparedness and response training will include:

- 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.

Pecan Energies 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.** Pecan Energies will have in place a range of spill response equipment to respond to oil spill incidents. Offshore resources will be located mainly on the support vessels and include oil containment and recovery equipment as well as dispersant spraying systems. The FPSO will have oil spill containment and absorption equipment onboard. Onshore resources will include containment and recovery equipment, ground clearing equipment and additional stock of dispersant.
- **Tier 2 Resources.** Pecan Energies will have access to resources within Ghana that can respond to a Tier 2 spill. Oil Spill Response Limited's (OSRL), in partnership with Action Air Environmental (AAE), has a regional aerial surveillance service.
-
- **Tier 3 Resources.** Pecan Energies 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 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 would provide technical advice to Pecan Energies on the most appropriate spill response equipment for a specific incident. The necessary equipment would be transported by cargo aircraft to Ghana and then to the site. To support response and clean-up of wildlife, Pecan Energies would mobilise the oiled wildlife response group (Sea Alarm) through its membership with OSRL. Ghana has a national oil spill preparedness plan that will be in force during a Tier 2 and Tier 3 spill.

Tier 2 and Tier 3 oil spills will be managed from Operator's Incident Management Team in Accra in collaboration with governmental agencies such as the National Oil Spill Contingency Plan Steering Committee, Environmental Protection Agency, Petroleum Commission, the Ghana Navy, the Ghana Air Force, the Ghana Maritime Authority and Ghana Port and Harbour Authority as well as other expertise and resources. Impact Assessment

In the event of an oil spill, the offshore marine environment and coastline Ghana would be impacted. In the event of a very large 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 and 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 Ghana Coastal Sensitivity Atlas (Armah *et al* 2004; EPA 2020) identifies the presence of bird areas (including shore birds, gulls and terns, waders and waterfowl, designated Important Bird Areas), estuaries, fish nursery areas, lagoons, river mouths, and turtle and crocodile areas in the Western Region of Ghana. Additionally, the following sensitive human use features are shown on the maps: aquaculture sites, beach seine net fishing sites, historical monuments, landing sites and public/bathing beaches.

The probability for pollution of more than 100 tonne oil in a 10 by10 km (100 km^2) open sea or shoreline area obtained from the oil spill model outputs, have been overlaid on the coastal sensitivity maps to show oil spill probability contours in relation to sensitive ecological and human use coastal features along a wider stretch of coastline at different levels of probability down to less than 5%. These maps are presented in Figure 6.17 to Figure 6.22. A 100 tonne oil distributed over a 100 km^2 area represents the oil thickness that is the lower limit of potential impact.

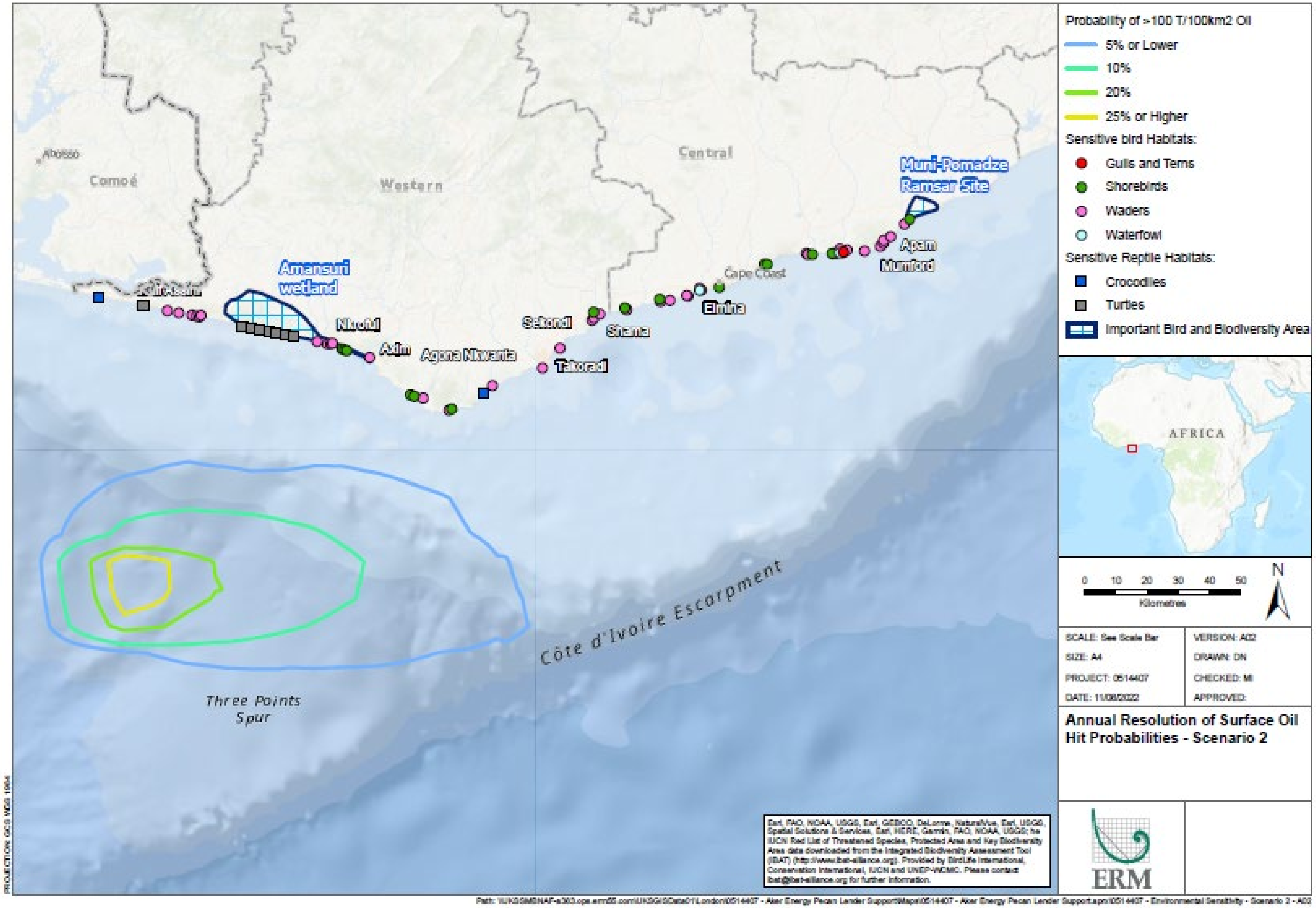


Figure 6.17 Environmental Sensitivity – Scenario 2

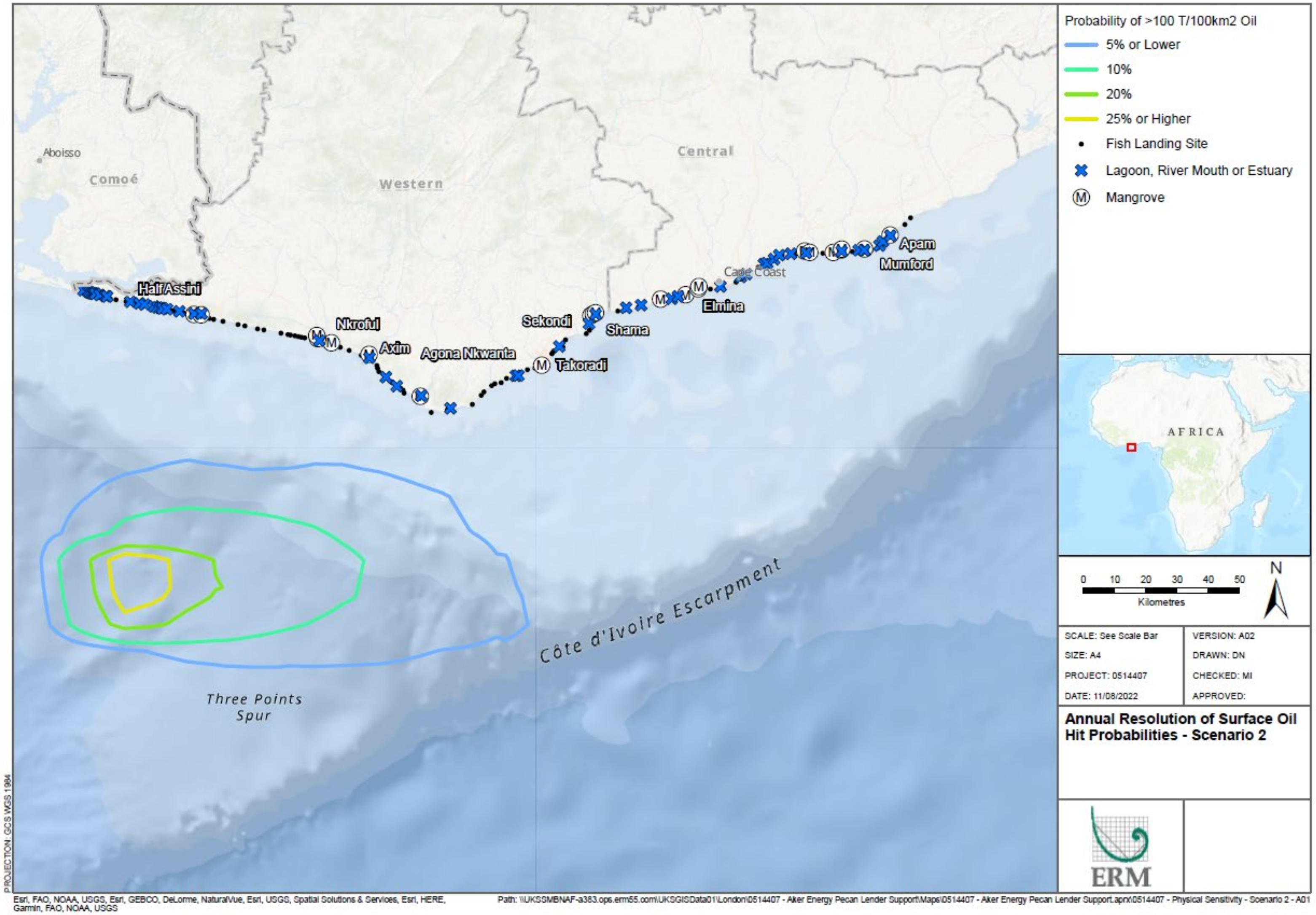


Figure 6.18 Physical Sensitivity – Scenario 2

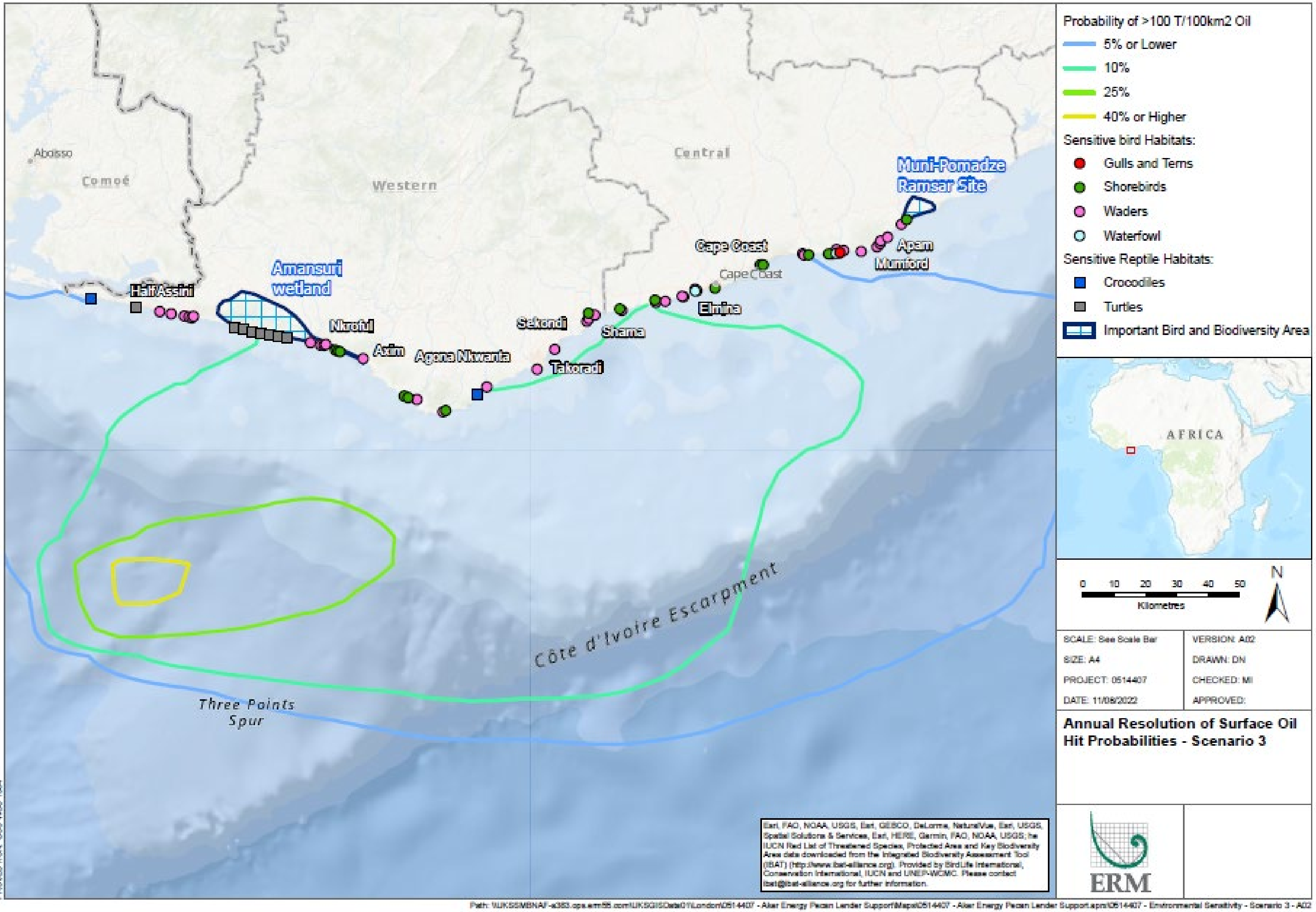


Figure 6.19 Environmental Sensitivity – Scenario 3

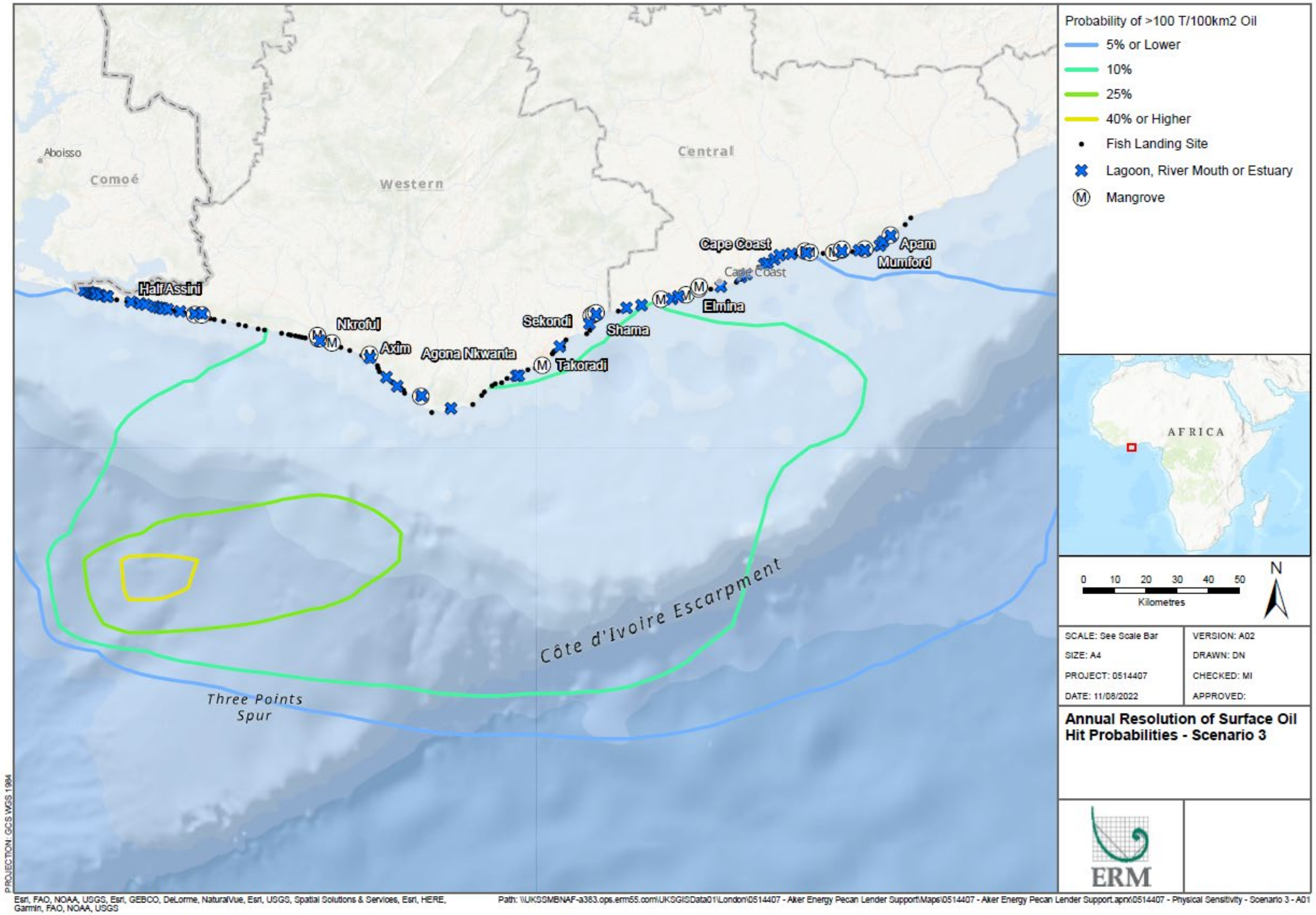


Figure 6.20 Physical Sensitivity – Scenario 3

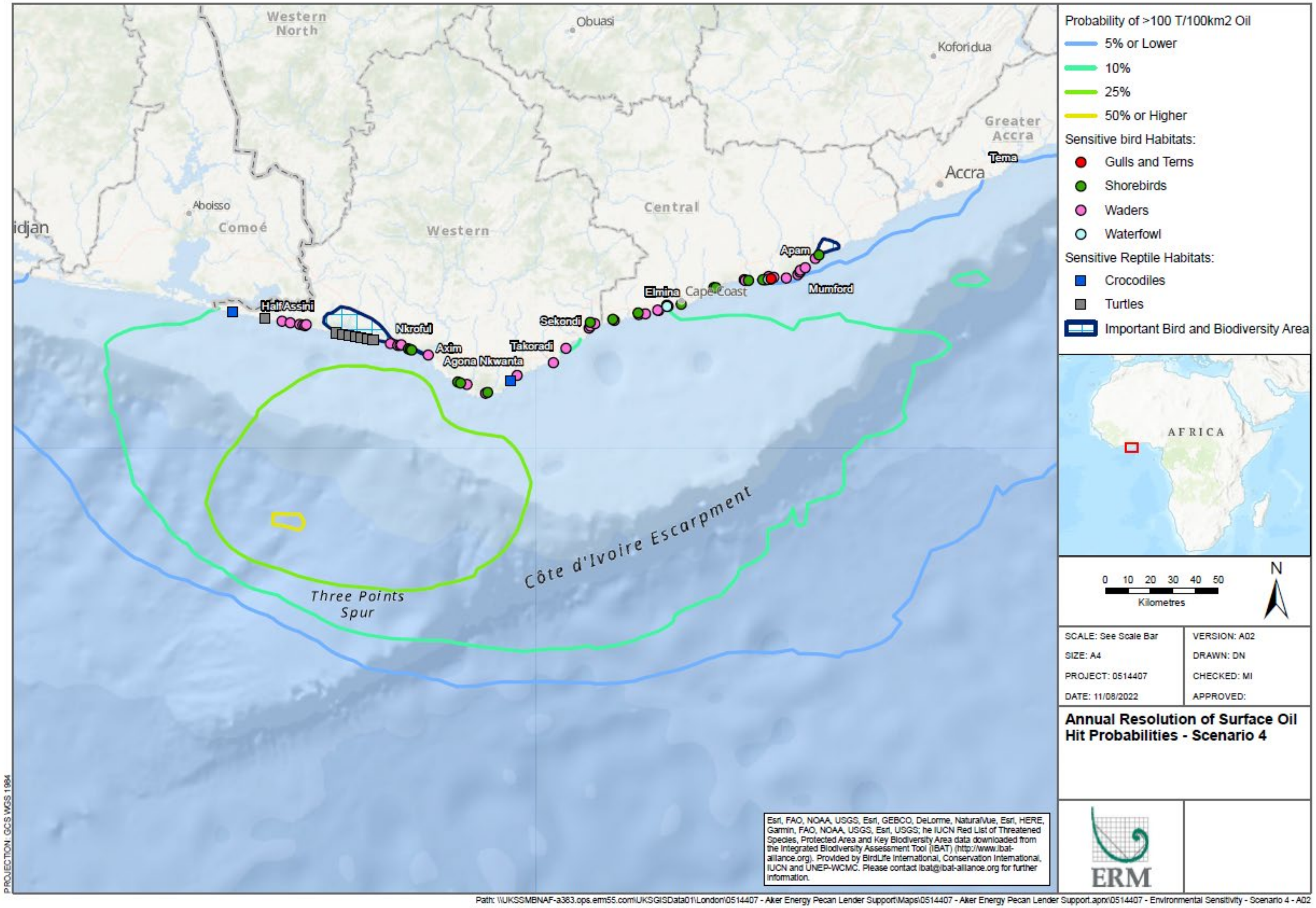


Figure 6.21 Environmental Sensitivity – Scenario 4

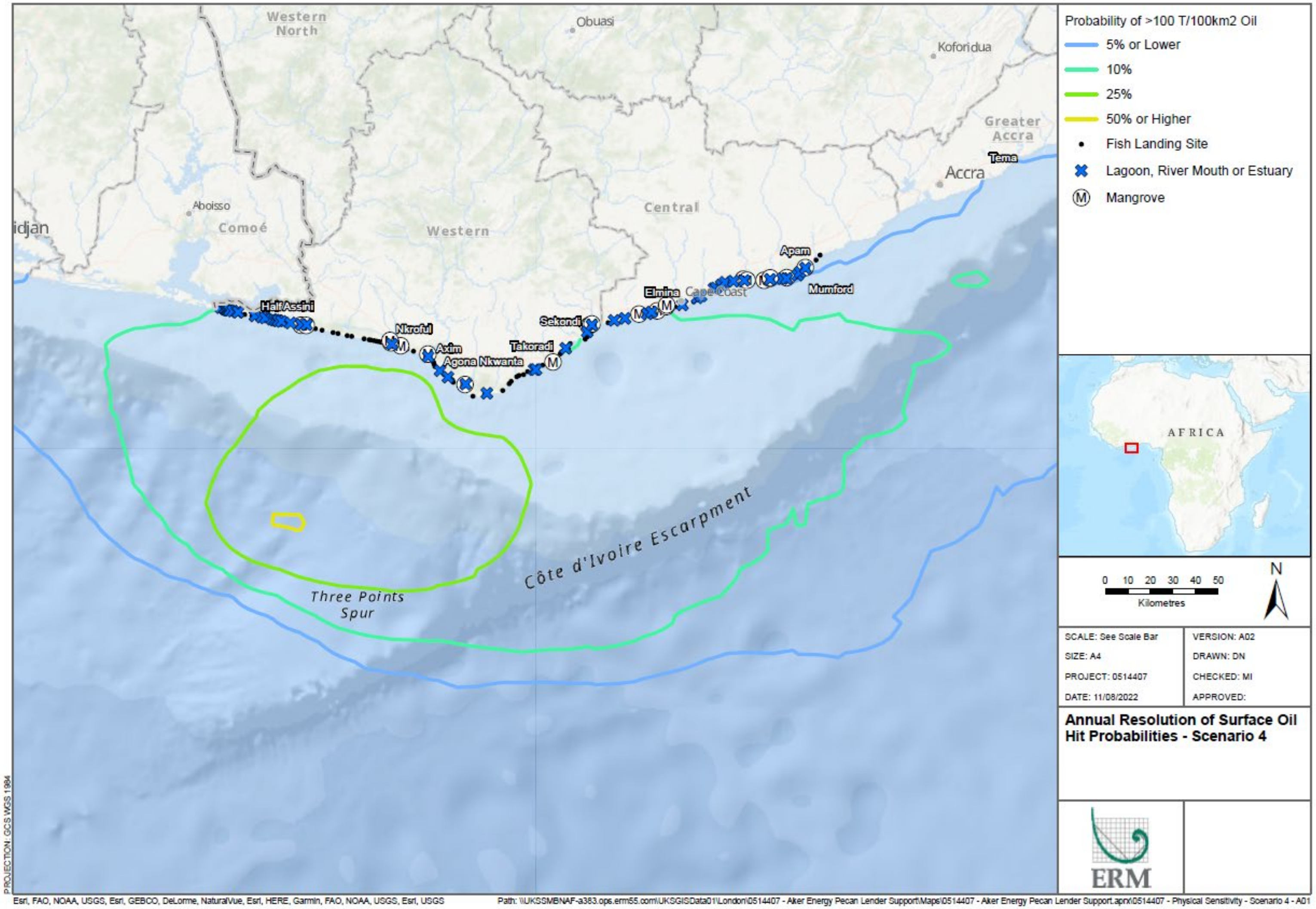


Figure 6.22 Physical Sensitivity – Scenario 4

Coastal Habitats

While it is unlikely that under any scenario oil would beach along the entire stretch of coastline, it is not possible to determine with any accuracy the particular coastal areas that would likely be affected by a large 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). 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 an open lagoon or wetland, natural removal rates would be 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 be deposited on the aerial roots and sediment surface as the tide recedes. The oil would clog the pores in the aerial roots and if many roots were oiled, the respiratory system would fail and the tree would die.

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.

There are several other lagoons and wetlands including Domini Lagoon, Amansuri Lagoon, Ankobra (Ankwao) Estuary and the Ehnuli Lagoon that 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 on 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 would be feeding intensively and often dive through the surface oil to feed on fish. Birds are affected by oil pollution in the following three ways.

Stains of oil on the plumage may destroy the insulating and water repelling properties that 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 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 sei and sperm whale. While the seasonal distribution of these species is not well understood it is likely that several species of whale and dolphin will occupy the Project 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 Cape Three 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.

Although 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.

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 effects on 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 (e.g. 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 (e.g. because sex determination in turtles is temperature dependent, shifts in sand temperature caused by oiling could potentially change hatchlings sex ratios).

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 are able 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 would likely be short lived due to the death of affected individuals and the persistence of healthy individuals unaffected by contamination. Non-lethal negative effects would be more likely, and fish could be affected in the long term in some circumstances, especially if spilled oil spill reached shallow or confined waters. Fish exposed to elevated concentrations of hydrocarbons could absorb contaminants though their gills, accumulating it within their internal organs potentially leading to long-term, sub-lethal effects. In addition, spilled oil in confined and shallow waters, such as lagoons, would pose a threat to fish eggs and larvae that are unable to actively avoid oil. Fish eggs and larvae are mostly present in the upper planktonic layers, and hence would be most affected and heavy mortalities could result. Lethal effects on the population as a whole would be unlikely but long-term, sub-lethal effects would be possible, particularly if a major spawning area was affected.

In terms of the vulnerability of impacts on 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 (e.g. 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 would usually be suspended by the regulatory authorities to avoid contamination of fish being lifted through the oil slick on the surface waters and to prevent gear contamination. Fishing would therefore be difficult or impossible in areas directly affected by an oil spill. Vessels and gear would be smeared in oil and the catch would likely be spoiled. The fishermen might for a period be forced to stop or temporarily move to other nearby fishing grounds free of oil slicks. These fisheries closures would 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 would impact fisheries affected by oil spills. Tainting of fish would reduce the quality of the fish landed and sold to traders. As a result, 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, Ellembelle 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 regarding 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 would 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 for future years. 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

Oil spill events can be categorised by their magnitude (i.e. size of spill). Small spills are more likely to occur than large spills. Given the proposed controls, it is considered unlikely that a large oil spill incident may occur from the loss of well control during drilling, completions and well intervention.

Industry data reports (IAOGP 2010) the likelihood of a blowout occurring during drilling of a 'normal' (i.e. not high-temperature, high pressure) development oil well, following a North Sea Standard (NSS) operation (i.e. drilling carried out with a BOP installed including shear ram and two barrier principle followed) is 4.8×10^{-4} (circa 5 per 10,0000 years) per well drilled. The likelihood of a blowout during well completion activities is reported as 5.4×10^{-5} (circa 5 per 100,000 years) per operation. In an unlikely event of a blowout, the duration and rate will vary based on where the loss of well control occurs.

In the event of an oil spill there will be localised impacts on 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 a large spill 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 possible 'significance' of oil spill impacts can be considered through a combination of the likelihood of a spill occurring and the potential severity of the environmental and socioeconomic impacts if a spoil did occur. Table 6.13 sets out a range of likelihoods in terms of frequency per year of operation and applies the ratings assessment of the scenarios examined for the Project.

Table provides impact/damage severity descriptions and also relates these to the Project spill scenarios. Table 6.15 combines likelihood with severity to provide the significance (or overall risk) of oil spill impacts.

Evaluated based on the Project Risk Tolerance Criteria (PECAN1-AKE-S-FD-0001) Scenario 1-3 examined are rated as Level Risk 4, Tolerable.

Scenario 4 (worst case scenario) is rated as Level Risk 3: 'Tolerable, if as low as reasonably practicable (ALARP-2)'.

Table 6.13 Oil Spill Frequency Risk Ratings

Rating	Likelihood	Frequency per year of operation	Assessment of the Project frequency
1	Extremely rare	$< 10^{-4}$	Scenario 3, Scenario 4
2	Rare	10^{-4} - 10^{-3}	
3	Very Unlikely	10^{-3} - 10^{-2}	Scenario 2
4	Unlikely	10^{-2} - 10^{-1}	Scenario 1
5	Possible	10^{-1} – 0.5	
6	Likely	>0.5	

Table 6.14 Oil Spill Scenario Damage Assessment

Damage Category	Damage description	Assessment of the Project damage
A Catastrophic/ Major	Oil spill reaching >1000km coastline affecting sensitive coastal fauna and flora ecosystem. Permanent damage to ecosystem.	
B Severe	Oil spill reaching 500-1000km coastline affecting sensitive coastal fauna and flora ecosystem. Qualitative estimation of ecosystem restitution within 20-30 years.	Scenario 4
C Serious	Oil spill reaching 250-500km coastline affecting sensitive coastal fauna and flora ecosystem. Qualitative estimation of ecosystem restitution within 10-20 years.	Scenario 3
D Moderate	Oil spill reaching 50-250km coastline affecting sensitive coastal fauna and flora ecosystem. Qualitative estimation of ecosystem restitution within 5-10 years.	
E Minor	Oil spill reaching 1-50 km coastline affecting sensitive coastal fauna and flora ecosystem. Qualitative estimation of ecosystem restitution within 1-5 years.	Scenario 2

Damage Category	Damage description	Assessment of the Project damage
F Insignificant/ undetectable	Oil spill reaching <1 km coastline affecting sensitive coastal fauna and flora ecosystem. Qualitative estimation of ecosystem restitution within less than 1 year.	Scenario 1

Table 6.15 Oil Spill Risk Matrix with Assessment of Project Scenarios

	Frequency					
Damage	**<10^{-4}**	**$10^{-4} – 10^{-3}$**	**$10^{-3} – 10^{-2}$**	**$10^{-2} – 10^{-1}$**	**10^{-1} – 0.5**	**>0.5**
A Catastrophic/Major						
B Severe	**Scenario 4**					
C Serious	**Scenario 3**					
D Moderate						
E Minor			**Scenario 2**			
F Insignificant				**Scenario 1**		

Key:

Level 1 Risk (Not Acceptable)	
Level 2 Risk (First Priority - Tolerable if As Low As Reasonably Practicable (ALARP-1))	
Level 3 Risk (Second Priority -Tolerable if As Low As Reasonably Practicable (ALARP-2))	
Level 4 Risk (Broadly Tolerable)	

7. Mitigation Measures

7.1 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 potential negative impacts and to create or enhance potential positive impacts such as environmental and social benefits. For the purposes of this EIS the term mitigation measures have been used to include aspects of the design, engineering controls and procedures, and operational plans and procedures.

The objectives of mitigation have been established through legal requirements and industry good practice standards (as described in Chapter 2). The focus of mitigation is to avoid or reduce negative impacts through the Project design. Where that is not practicable then operational and management measures are taken to reduce the magnitude of potential impacts. The final approach in the mitigation hierarchy is to respond to significant impacts that may occur such as through Emergency Response Plans or repair or remedy actions. This can include compensation for loss or damage.

7.2 Summary of Mitigation and Management Measures

Table 7.1 provides a summary of environmental and social mitigation measures that have been identified in the description of the project design (Chapter 3) and through the impact assessment process (Chapter 5). During the concept and design phase Best Available Technique (BAT) assessments for the field design were conducted which informed the mitigating measure identification. Monitoring requirements associated with the mitigation measures are provided in the provisional Monitoring Plan (see Chapter 7). Operational mitigation measures will be implemented through Pecan Energies HSSEQ Management System and related detailed management plans (see Chapter 9).

Table 7.1 Summary of Mitigation Measures

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
	Project Footprint and Presence			
Section 6.3.2	Seabed impacts on the benthic environment	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. In-field subsea flowlines will be laid directly on the seabed and flowline burial using methods such as dredging and jetting which creates sediment plumes will be avoided.	Design/Planning Installation	
Section 6.4.2	Underwater sound impacts mainly on marine mammals	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. 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 using vessels transiting in the field. Although not directly aimed at mitigating noise impacts on marine fauna, adoption of suction piling (versus percussive piling) and laying flowlines onto the seabed (as opposed to trenching or jetting) will both avoid noise impacts.	Drilling Installation Operation Decommissioning	Marine Traffic Management Plan
Section 6.6.2	Lighting and flaring impacts mainly on birds, but also fish and turtles	The requirements for lighting and use of flaring will be dictated by operational safety. As part of the lighting planning, the following principles will be taken into consideration to reduce the effects of light pollution: • Avoid unnecessary light use • Closed flare with no pilot flame • Avoid operational flaring except for: ○ during project start-up; ○ during well clean-up to drilling vessel; ○ during planned maintenance shutdown (on average 10 days annually); ○ when required for safety of persons engaged in petroleum operations in accordance with international petroleum industry practice; ○ during unplanned gas injection downtime.	Drilling Commissioning Operation	GHG and Energy Management Plan
Section 6.7.2	Risk of collision with marine mammals and turtles	Measures for reducing vessel-animal collision risk will include direct observation, communication and navigational responses, particularly speed restrictions when the risks of collision are expected to be high. Support and supply vessels will adopt observation as part of regular navigation, communication and navigational responses, to reduce collision risks with marine mammals and turtles.	Drilling Installation Operation	Marine Traffic Management Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
Section 6.5.2	Aerial noise impacts on natural populations	Helicopter flight planning will make provisions to avoid sensitive areas of population and nature conservation. Pecan Energies will assure that the helicopter operator follows national and local regulations and restriction regarding flight routes.	Drilling Installation Operation	Helicopter Operations Plan
	Drilling Discharges and Releases			
Section 6.8.2	Impacts on sediment and water quality and associated benthic and water column fauna	Solid control systems will be used, including shakers and dryers, to reduce oil on cuttings when drilling with NADF to a target of an average 2-5% oil on cuttings for the sections drilled with NADF. Low toxicity (Group III) NADF will be used with limits on mercury and cadmium concentrations. Low toxicity water-based fluid (WBF) will be used in the upper sections of the wells. Both NADF and WBF • Hg – 1 mg/kg dry weight, Cd - 3 mg/kg dry weight in stock barite • Maximum chloride concentration must be less than four time's ambient concentration of fresh or brackish receiving water	Drilling	Chemical Management Plan
	Well Completion and Operational Discharges and Releases			
Section 6.9.2, **Table** 6.4	Well completion and workover discharge impacts on water quality and marine biota	Chemical selection and use will be advised by 'Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2011)'. Completion fluids will be tested for total oil and grease content to ensure that it is below the specification for discharge to sea (i.e. daily limit of 40 mgl^{-1} or 30 day average of 29 mgl^{-1} as per EPA (2011). If the fluids exceed the specification they will be retained on the vessel and shipped for onshore disposal. If acid is used during well completions or workovers, the spent acid will either be injected into the rock formation or neutralised prior to discharge to sea.	Completions Operation	Waste Management Plan
Section 6.9.2, **Table** 6.4	Black and grey water discharge impacts on water quality and marine biota	Black water will be treated using a marine sanitation device that treats the waste and produces an effluent with a maximum residual chlorine concentration of 0.5 mg l^{-1} and no visible floating solids or oil and grease. Under MARPOL grey water does not require treatment before discharge. Food wastes will be macerated to acceptable levels such that they will pass through a 25 mm mesh.	Drilling Operation	

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
Section 6.9.2, **Table** 6.4	Hazardous deck drainage discharge (from MODU and FPSO mainly) impacts on water quality and marine biota	Hydrocarbon contaminated fluids will be routed to a hazardous drain tank with oil/water separation. The hazardous drain tank will be heated, as necessary, to aid oil / water separation and there will be provision for biocide treatment. Process fluids sent to the hazardous drain tank will not be recycled into the process unless approved. To manage the volume of fluids in the system, the main deck scuppers (holes to allow drainage) will have plugs that are typically opened manually during heavy rains to allow excess water to be discharged to sea. Drains will be provided with removable covers to prevent debris from entering the system.	Drilling Operation	
Section 6.9.2, **Table** 6.4	Non-hazardous deck drainage discharge impacts on water quality and marine biota	Non-hazardous drains will be provided with removable covers to prevent debris from entering the drains systems. The system will have provision for biocide treatment.	Drilling Installation Operation	
Section 6.9.2, **Table** 6.4	Bilge water discharge impacts on water quality and marine biota	Treatment in the bilge water separator to achieve no free oil and maximum 15 ppm instantaneous reading oil water threshold. If onboard treatment to the required standard is not possible the effluent will be retained onboard until it could be discharged to an approved reception facility.	Drilling Installation Operation	
Section 6.9.2, **Table** 6.4	Ballast water discharge impacts on water quality and marine biota	Project vessels will be designed with separate ballast tanks, according to class notation and MARPOL. Discharges will meet standards of no free oil and maximum 15 ppm instantaneous reading oil water threshold. Discharges will meet the requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments. Project vessels will have onboard and implement a Ballast Water Management Plan. All ships using ballast water exchange will do so at least 200 nm from nearest land in water at least 200 m deep. The FPSO, MODU, supply and support vessels, installation vessels and incoming export tankers 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.	Drilling Installation Operation Drilling Installation Operation	Ballast Water Management Plan
Section 6.9.2, **Table** 6.4	Discharges of pre-commissioning treated seawater from flooding, cleaning and gauging flowlines, hydrotest and leak tests and pre-commissioning gas system dewatering	Chemicals will be chosen to be minimise impacts on the aquatic environment in accordance with the Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2011).	Commissioning	

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
	fluids, impacts on water quality and marine biota.			
Section 6.9.2, **Table** 6.4	Discharges of production system commissioning fluids from FPSO, impacts on water quality and marine biota.	Treated water will be processed on the FPSO via the oil in water (OIW) treatment system. Diesel / crude will be routed to the crude oil stock tanks.	Commissioning	
Section 6.9.2, **Table** 6.4	Releases of hydraulic fluid impacts on water quality and marine biota.	The subsea control system will use a water-based hydraulic fluid that is biodegradable with low toxicity and minimal impact to the marine ecosystem rated yellow according to the Ghana Guideline on Environmental Assessment and Management (EPA 2011).	Operation	
Section 6.9.2, **Table** 6.4	Discharge of cooling water from FPSO, impacts on water quality and marine biota.	Max chlorine content 2 mgl^{-1}	Operation	
Section 6.9.2, **Table** 6.4	Discharge of produced water from FPSO, impacts on water quality and marine biota.	Produced water will be continually monitored and if oil in water (hydrocarbons) exceeds the daily limit of 40 mgl^{-1} or the 30 day average of 29 mgl^{-1} as per EPA (2011), the water will be routed to the off-specification tank for further treatment prior to any discharge.	Operation	
Section 6.10.2	Emissions from vessels, impacts 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 emissions to air (see Chapter 2 (Table 3.5). Annex VI sets limits on oxides of sulphur and nitrogen 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. The Project will use low NOx GTGs and use marine diesel fuel. Methods for controlling and reducing leaks and fugitive emissions, such as the use of hydrocarbon gas for crude oil storage tank blanketing together with a vapour recovery unit, will be implemented in the design, operation and maintenance of the FPSO. Routine flaring will be avoided and non-routine flaring will be kept to a minimum to maintain safe conditions or during short-duration activities such as commissioning, start-up, re-start and planned maintenance activities.	Drilling Installation Operation	

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		Routine inspection and maintenance of engines, generators, and other equipment will be carried out to maximise equipment fuel efficiency and minimise excess pollutant emissions.		
Section 6.11.2	Emissions of greenhouse gases from vessels and installations, impact on global warming.	The mitigation measures aimed at reducing GHG emissions to as low as reasonably practicable are generally built into the design of the FPSO and focus predominantly on: • efficiency of power generation; • optimisation of overall energy efficiency; • reduction in flaring; and • reduction in venting. To inform the detailed design of the Project so that energy efficiency and emissions reduction from combustion (i.e. fuel use and flaring) can be built into the Project, a Best Available technology (BAT) assessment (see Annex B) and an Energy Efficiency of Design study (see Annex C) were undertaken. The results of these studies optimised the design of the FPSO facilities to reduce GHG emissions in the following ways. • FPSO design with electrical power generation provided by high efficiency low NOx gas turbines, sized and configured to life-of-field power demand. • FPSO design to minimise process electricity demand through optimal sizing, configuration and selection of energy efficient equipment, in particular, compressors and pumps. • Hydrocarbon blanket gas in the oil storage tanks will be recovered in a VOC recovery unit. The recovered VOC will be introduced into the gas handling system for mixing with produced gas. • A closed flare system with a flare gas recovery unit. In addition, the pre-commissioning testing of the FPSO gas compression systems and process systems in the construction and supply bases prior to shipping equipment to Ghana will reduce the requirement to flare gas during the commissioning phase. The driver for the duration of flaring during commissioning will be the mitigation of risk for asphaltene in the first injection well. To mitigate flaring of well fluid during well clean-up all producing wells will be cleaned-up to the FPSO across Phase 1a & 1b and all injectors suspended ready for direct injection service. This revised well clean-up strategy significantly reduces the anticipated carbon footprint at the Drilling Unit during well construction phase. An Energy Management System will also be developed with the aim to minimise GHG emissions.	Drilling Installation Operation	Energy Management

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
	Waste Management			
Section 6.12.2	Potential impacts on the marine and onshore environment from waste segregation and storage	There will be designated areas for the temporary segregation and storage of waste on the FPSO, MODU and supply vessels. The onshore bases at Takoradi Port and the Sekondi Naval Base will also have designated secure waste reception and temporary storage facilities. Mitigation of potential impacts related to storage and segregation of waste will be through operational controls. The key procedures for controlling wastes from offshore and onshore will be set out in the Project Waste Management Plan (WMP) which will be developed based on the specific requirements of the Project. The WMP will require all facilities that are operated or controlled by the Project (including contractors based within the Project's onshore base facilities) to adopt specific procedures for the management of wastes, including the segregation of recyclable, non-hazardous and hazardous wastes at source and appropriate containment measures for specific waste types. The WMP will cover both offshore (the FPSO, supply vessels, installation vessels and the MODU during well drilling and completions) and onshore (support base at Takoradi Port and supply base) Project facilities.	Drilling Installation Commissioning Operation Decommissioning	Waste Management Plan
Section 6.12.3	Potential impacts on the marine and onshore environment from transport of waste	Mitigation of potential impacts during waste transport will be by the way of operational controls. These will be documented in the WMP. Operational controls will include the following. • Waste will be transported in a safe manner, in accordance with the associated Safety Data Sheets (SDS) 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 vessels and vehicles that are crewed/driven by appropriately trained and licensed operators. • Vessels and vehicles to be used for transporting wastes will be assessed and approved to meet minimum standards and Project vehicle policy. • Waste will only be transported by Project and EPA approved waste contractors.	Drilling Installation Commissioning Operation Decommissioning	Waste Management Plan
Section 6.12.4	Potential impacts on the environment (onshore)	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 Project waste contracts.	Drilling Installation	Waste Management Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
	from the treatment and disposal of waste.	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 Project WMP. Proposed waste management options that have been identified for the main waste types are outlined below and summarised in Chapter 3: Table 4.15 • Non-hazardous waste will be segregated and recycled where possible. Pecan Energies 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 Sekondi-Takoradi Municipality for recycling/treatment where possible. Unused chemicals will be returned to suppliers. The Project will store small quantities of hazardous waste types, for which 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.	Commissioning Operation Decommissioning	
	Accidents and Unplanned Events			
Section 6.17.2	Risk of vessel collisions	The FPSO hull will be modified with double side on the side where vessels are approaching. Large parts of the opposite side will be covered by riser installations. The FPSO already has a double-bottom hull. The Project vessels will adhere to standard navigational procedures while on station, together with Project-specific operational procedures in accordance with the International Guidelines for Offshore Marine Operations (G-OMO) guidelines. G-OMO is a standard global approach to encourage good practice and safe vessel operations in the offshore oil and gas industry. The guideline covers all relevant aspects from vessel procurement, voyage planning, mobilisation, loading, outward voyage, approach to location, working at location, departure from location and inward voyage. A specific guide is prepared related to collision risk management within GOMO. The "Field operations Manual" for Pecan will be updated for Pecan to reflect the G-OMO guidelines as well as the local Metocean conditions.	Drilling Completions Design/Planning Installation Commissioning Operation Decommissioning	Marine Traffic Management Plan FPSO Security Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		In terms of collision risk management at the field the following measures will also be implemented during drilling and production. • The ship traffic around the locations will be monitored by a dedicated stand-by vessel onsite equipped with AIS and ARPA radar (or similar). • A 500 m safety zone around the MODU and FPSO will be established. • The team directing operations on the (supply vessel) bridge will have the necessary experience for the planned operations. • Visiting vessels will be required not to use the FPSO as a final waypoint in their sailing plan and should set a course which is off set from the FPSO and at a tangent to the safety zone • Entry to the 500m safety zone thereafter to the set-up position will be taken at a speed of 3 knots or less. • Prior to entering the safety zone of the MODU or FPSO, the pre-entry check list for the vessel will be completed. • Specific measures for the offloading tanker approach and offloading minimum set-off distance. • A riser exclusion zone prohibiting vessel movement close to risers will be established. • An operational limit will be established limiting visiting vessel operations to within the one-year weather state limit. Regarding passing third-party vessels, details of the planned drilling programme and production operations will be notified to other sea users through the “Notice to Mariners” system, as well as through NAVTEX and NAVAREA.		
Section 6.18.5	Oil spill and potential consequences to the marine and coastal environments (natural populations and humans uses).	Mitigation of oil spill incidents 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 occurring in the first place. Avoidance of oil spill incidents is highly dependent on design and planning (including training and emergency response exercises). Pecan Energies will be responsible for ensuring that oil spill risks have been fully considered and addressed to the extent that residual risks have been reduced to as low as reasonably practicable (ALARP). Pecan Energies will have 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 will be based on the standard 3-tiered response approach.	Drilling Completions Design/Planning Installation Commissioning Operation	Oil Spill Contingency Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		Section 6.18.5 provides more detail on avoidance, preparedness and response measures.		
	Socio-economic and Community Health Impacts			
Section 6.14.3	Benefits to Ghana nationally from increased Government revenue.	Good governance and fiscal management are the key measures for Ghana's benefit from the economic gains by the royalties and taxes paid by the Project. The absolute value of oil will also be a key factor and it will depend directly on market prices. Pecan Energies 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.	Operation	
Section 6.14.4	Potential benefits from employment and skills development	Pecan Energies will seek to enhance local employment and skills development from direct and indirect employment through the development of an Employment and Training Plan as part of the Local Content Plan (LCP). The plan will contain the following measures. • Pecan Energies will develop guidelines on recruiting and employment practices, training and succession practices, and reporting of training and employment activities, to ensure compliance with applicable requirements and to achieve Pecan Energies strategic employment and training local content objectives. • Pecan Energies will include the plan for recruitment, employment and training of local personnel in Ghana as a requirement to engage with Contractors and Subcontractors. • Where qualified Ghanaian personnel are available for employment to support operations, whether staffed directly or via third party, Pecan Energies will develop procedures to provide opportunities for employment/services as far as reasonably possible. Where possible, priority will be given to vulnerable groups such as women and youth. • The Project'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 via national or local media at an early stage to manage job-seekers expectations. • Relevant job opportunities will be specifically communicated via district and municipal authorities to communities in the coastal districts of the Western Region by the CLOs. CLOs will also provide information on job application procedures. The LCP aims at developing initiatives to train and build local capacity through the development of the Pecan Project as follows: • Educational Sponsorship; • National Service Placement;	Drilling Design/Planning Installation Operation	Employment and Training Plan Local Content Plan Community Development and CSR programme

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		• Secondment Agreement with GNPC; • Recruitment of Ghanaians; • Pecan Energies Ghana Internship Programme; and • Support to Accelerated Oil and Gas Capacity. The support to Ghanaian government's Accelerated Oil and Gas Capacity Programme will be done through Pecan Energies Community Development and CSR programme. The support consists of four main areas: • training individuals in various technical and vocational areas; • building the capacity of educational institutions to be able to train students and provide internationally recognised training certificates; • providing business and management training for small and medium enterprises (SMEs).		
Section 6.14.5	Opportunities to provide benefits through the procurement of goods and services.	Additional measures to be included into the LCP to enhance procurement of goods and services from companies in Ghana include the following. • Pecan Energies has policies and procedures to support the strategy. Contractors will also be required to support and implement the national content strategy and policies/ procedures that support it. • Pecan Energies has contract conditions that ensures 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. • Pecan Energies 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, e.g. through pre-tender workshops and training. • Pecan Energies will audit local content through site visits and interviews to monitor and track the effects of the contractors' strategy to maximise local content over the life of the Project. • Pecan Energies will ensure that the Grievance procedure in place will be accessible to all suppliers.	Drilling Design/Planning Installation Operation	Local Content Plan
Section 6.14.6	Protection of workers' rights	Pecan Energies will develop a People Policy that includes the following measures. • Contracts will the right for the Project monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching the required standards, Pecan Energies policies or clauses in the contract.	Drilling Design/Planning Installation Operation	People Policy Code of Conduct Terms and conditions in contractor and

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		• Pecan Energies, contractors and subcontractors will put in place hiring mechanisms to ensure that no employee or job applicant is discriminated against on the basis of his or her gender, marital status, nationality, age, religion or sexual orientation. • Pecan Energies will provide training on workers' rights as part of their induction. Pecan Energies will also require contractors and subcontractors to provide training on workers' rights to its employees. • Pecan Energies, contractors and subcontractors will ensure that all their employees have contracts that clearly state the terms and conditions of their employment and their legal rights. • Pecan Energies, contractors and subcontractors will verbally explain contracts to all their workers where this is necessary. • Pecan Energies will undertake robust compliance monitoring of all contractors and sub-contractors. • Pecan Energies will review and monitor the outcomes of community engagement, media coverage and its workforce and community grievance mechanism regarding labour welfare issues. • Pecan Energies will update the Health, Safety, Security and Environment System including the following measures. • Pecan Energies will not accept forced labour, child labour or any form of human trafficking including purchase of sexual services. • Surveillance programs for workers health status will be established and implemented. • Occupational health and safety training to all workers, including contractors and subcontractors will be provided. • In all contractor contracts, the Project will make explicit reference to the need to abide by national law, international standards and Pecan Energies policies in relation to health and safety, labour and welfare standards. • Contractor contracts will specify monitoring to be undertaken by the contractor, establish the right for the Project monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching national legal requirements, international standards, policies or clauses in the contract. Contractor contracts will specify that the same standards will be met by their sub-contractors and suppliers.		supplier agreements Employment and Training Plan HSSE Management Plan
Section 6.14.2	Impacts on fishing activity	CLO's will cover the coastal districts to liaise between fishermen and the Project and to provide information to fishing communities regarding Project activities and notifying them of the requirements to keep away from the operations for safety reasons. The CLOs will also deal with any complaints through Pecan Energies grievance mechanism.	Drilling Installation Operation	Stakeholder Engagement Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		Pecan Energies and its contractors will notify mariners and fishers of the presence of the MODU, FPSO and other marine operations within the 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 and enforced by Pecan Energies with the assistance of the agencies of the Government of Ghana.. Pecan Energies will develop a code of practice based on the UN Voluntary Principles of Security and Human Rights, and give training for those responsible for maintaining the safety zones. Fishery Liaison Officers (FLO) will be placed on the guard vessels to ease communication with potential intruders of the safety zone in the local language. A vessel transit route will be agreed with the GMA and communicated to fishermen and other marine users. Pecan Energies will 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.		
Section 6.14.7	Impacts on commercial shipping	Pecan Energies will develop a Marine Traffic Management Plan to ensure appropriate protocols are followed during offshore vessel movements. This plan will also consider vessel movements associated with other Projects in the area as well as fishing and other commercial shipping traffic. The plan will aim at reducing risk (see also Section 7.10 for more operation-specific measures) of vessel collision and minimising inconvenience to other sea users by establishing the following. • Project vessels will use established shipping lanes, particularly in approaches to harbours and heavily trafficked coastal waters. • Project vessels will have standard vessel navigation and communication equipment (radar, AIS, ship to ship radio). • Standby vessels and offloading tugs will be present at the FPSO location. • 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). • Marine contractors will be required to have available suitable HSE plans including a security management plan and marine safety risk assessment, together with qualifications of marine vessel captains and crew, training conducted, and compliance auditing provisions.	Drilling Installation Operation	Marine Traffic Management Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		• Project vessels connect with the GMA VTMIS (Vessel Traffic Management Information System) for access to real-time data on the presence of vessels in the vicinity of the exclusion zones.		
Section 6.14.8	Potential impacts on community health, safety and security	Pecan Energies has developed a HSSE management approach outlining its responsibility for its personnel by means of systems and procedures to: • perform Industrial Hygiene sampling; • conduct medical surveillance; • exercise drug and alcohol control at the heliport; • assist in rehabilitation of personnel; and • record and monitor health certificates. The Pecan Energies HSSE management system is aligned with the objectives of IFC Performance Standard 4. The following additional mitigation measures will be implemented as part of the Pecan Energies to manage potential impacts on community health. • Pecan Energies will ensure the implementation of its Code of Conduct not only to Pecan Energies direct staff but also contractors' and subcontractors' staff through the FPSO sub-contractors Management System. According to the Code of Conduct, Project sub-contractors are required to have their own HSE management systems in place, which, at a minimum, meet the Applicable Standards. • The Contractor will regularly monitor interactions between the community and workers both in public spaces in the communities and in private spaces, where vulnerable people have the greatest potential for abuse, especially children and young women. • Workforce (including subcontractors) will be provided with health awareness training, including a significant briefing of hygiene practices (such as hand washing), implementation of educational outreach to increase awareness of major communicable disease and how to protect against infection and about transmission routes and the symptoms of the communicable diseases of concerns (including STIs). • 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.	Drilling Design/Planning Installation Operation	Stakeholder Engagement Plan Traffic Management Plan Emergency Response Plan Project Security Plan HSSE Management Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
		Regarding measures to minimise the risks to community safety from Project traffic, Pecan Energies will implement the following. • A specific Traffic Management Plan will be established for driving management planning for the shore base operation. • Drivers' codes of conduct will be enhanced through a driver safety awareness training programme. • To manage the risk if increased pressure on health care resources, in addition to measures around worker-community interaction, Pecan Energies will: • develop an Emergency Response Plan (ERP) for the Project taking into account access to health care, major incidents, multiple casualty events and pandemics to avoid draw-down of community health resources in the event of an incident; and • continue to implement a programme of stakeholder engagement including a grievance mechanism. CLOs/Fishery Liaison Officers will inform local fishermen from the coastal communities of the offshore activities, locations, vessel movements, routes and timing, as well as the safety reasons for keeping away from operational areas.		
Section 6.14.9	Potential impacts from an influx of job seekers	Facilitated by its Stakeholder Engagement Plan, Pecan Energies will seek to develop strong partnerships with government agencies, traditional authorities, district assemblies, youth groups, non-governmental organisations (NGO), community-based organisations (CBO), civil society, fishing communities and other relevant stakeholders. Pecan Energies will adopt a proactive approach to sharing information with stakeholders and gathering feedback on potential issues arising. In all relevant CSR projects, Pecan Energies will seek to actively engage affected stakeholders and local communities throughout the project cycle. If it is determined through feedback from stakeholder engagement / grievances that there is need for implementing measures to manage Project induced migration influx, appropriate measures shall be considered in consultation with the key stakeholders especially, the Regional Security Coordinating Council to minimize the negative impacts of rapid in-migration. This plan would consider the immediate measures to manage the negative impact and medium-long term approach to avoid recurrence of such impact.	Drilling Design/Planning Installation Operation	Stakeholder Engagement Plan
Section 6.14.10	Risk of heightened and unmet expectations regarding potential benefits	Implementation of the Stakeholder Engagement Plan (SEP) will be the key mitigation measure to redress the incorrect public perceptions about potential Project benefits and for addressing public expectations related to development opportunities and investments.		Stakeholder Engagement Plan

EIS Reference	Nature of Impact	Mitigation Measures	Project Stage	Relevant Project Plan/Procedure
Section 6.14.11	Impacts on local communities from shore based activities	The means to manage the potential impacts from use of the facilities in Takoradi port will be focused on the implementation of engagement activities as defined in the SEP and the grievance mechanism. Pecan Energies CLOs will disseminate information about the Project to the community and process any suggestions, complaints or grievances received. Pecan Energies will undertake periodic audits and reviews of its shore-based operations to review site HSE performance and take corrective actions as required. Periodic audits of third-party operations and facilities will also be carried out. This will involve routine management meetings with the main operators of these facilities and the agreement of common environmental and social management measures. A Traffic Management Plan will be developed including the following. • Engagement with local authorities to acknowledge the traffic patterns in the road network, optimise traffic routes, minimise traffic queuing to the extent practicable. • Some abnormal loads will need to be delivered from time to time. These will be scheduled wherever possible during off-peak periods. • Precautions will be taken by the Contractor to avoid damage to the roads. Any road damage will be repaired to an equal or better standard in a timely manner. • Traffic flows will be timed, wherever practicable, to avoid periods of heavy traffic flow along main roads. • Measures to avoid damaging local infrastructure, control all vehicle movements and implement maintenance procedures. • Measures to define behaviours for safe driving as well as driver training and driver competence requirements. • The Project will establish a Grievance Mechanism to follow-up and close out any traffic related issues reported by stakeholders. • Regular road safety awareness campaigns in surrounding schools, markets etc. to sensitise other road users	Drilling Installation Operation	Traffic Management Plan Stakeholder Management Plan

8. Provisional Monitoring Plan

8.1 Introduction

This Provisional Monitoring Plan outlines the key monitoring requirements identified through the EIA process that will be taken forward and developed into a detailed Pecan Phase 1 Project Monitoring Plan prior to commencement of Project activities.

The overall objectives of the Monitoring Plan will be to:

- verify predictions made in the EIA;
- verify that mitigation measures are effective and implemented in the manner described in Chapter 6; and
- inform future operations and contribute to continuous improvement in the management of environmental and social issues related to the Project.

Through the process of inspection, monitoring and auditing, Pecan Energies will seek to ensure that the requirements of the ESMP and its applicable standards, procedures and guidelines are complied with.

Specific monitoring requirements will apply to the various Project phases such as drilling, installation, commissioning, operations, and decommissioning.

8.2 Monitoring Approach

Monitoring will be overseen by the Pecan Energies HSSEQ and Corporate Social Responsibility (CSR) departments and most monitoring activities will be undertaken by the drilling and FPSO contractors as defined in their contractual obligations to undertake inspections, monitoring, and reporting.

The following five types of inspections and monitoring will be employed.

- Planned Inspections will be planned and conducted on a regular basis to ensure that mitigation measures and commitments, and permit requirements are properly maintained and implemented, and that specific management procedures are being followed (e.g. practices on waste storage and disposal).
- Receptor monitoring will be 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 (e.g. monitoring disturbance of affected communities 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 and Project Environmental Permits (e.g. 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.
- Review of social performance to assess the effectiveness of stakeholder engagement strategies and impacts of social investment programs.

The Project will establish a schedule for HSSEQ audits / inspections of the principal contractors and primary supply chain facilities. The principal contractors will be required to establish a similar schedule for their activities and those of any subcontractors and suppliers. Audits and verification of subcontractors and suppliers will, wherever possible, be performed as a joint effort with the principal contractors.

Inspections, monitoring and audits will be documented and any corrective actions will be assigned to owners along with timescales for implementation. An action-tracking database will be used to coordinate the close out of corrective actions in a timely manner. The frequencies of inspection, monitoring, audits and reporting are based on Project risk management requirements and standard industry practices. The responsibilities for reviewing monitoring reports and progress with corrective actions are outlined in the provisional ESMP (see Chapter 8).

In addition to routine reporting monitoring reports, aggregating the data produced by the other reporting processes, will be submitted to the Ghana Government (PC and EPA), Project Partners and lenders as per reporting frequency requirements.

The Pecan Phase 1 Monitoring Plan will be implemented at the start of the Phase 1 and be reviewed and updated in accordance with the Project ESMP review schedule and if significant changes are made to the planned Project activities through the Project Management of Change (MOC) procedure (see Chapter 8).

8.3 Provisional Monitoring Plan for Specific Mitigation Measures

The provisional Monitoring Plan is presented Table 8.1. 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 to be developed prior to commencement of the Pecan Phase 1 Project.

Table 8.1 Provisional Monitoring Plan for Specific Mitigation Measures

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Physical Footprint		
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 Project (FPSO and MODU locations and transit corridors to port). Relevant contractor personnel to be trained to identify marine mammals and turtles in the Project area and report sightings on daily basis.	Continually throughout Project life (i.e. during drilling, commissioning, operations and decommissioning) from support vessels attending the FPSO and on regular passage between Takoradi port and the FPSO.
	Monitor flight paths to ensure compliance with flight restrictions (route, speed, height) for helicopter operations. Monitor vessel location to ensure compliance with stipulated shipping routes.	Daily, per helicopter and vessel trip
Impacts of subsea infrastructure on benthic environment	Undertake a scan of the seabed prior to the installation of subsea infrastructure to ensure that it is not placed on any significant seabed features. 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 Remotely Operated Vehicle (ROV) or Automated Underwater Vehicle (AUV) prior to installation of subsea infrastructure. One-off scan of seabed by ROV/AUV once flowlines and other subsea equipment have been installed.

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Navigation and Fishing		
Impacts on commercial navigation and fisheries from the MODU, FPSO and support vessels.	Continuous monitoring of safety 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 CLOs and assign specific remedial actions and responsibilities.	Auditing with Incident/Accident Reporting Procedure. Monthly audit of equipment inspection reports. Monthly review of interaction/grievance records and audit of actions arising throughout Project.
Discharges to Sea		
Impacts of drill cuttings on benthic environment	Monitor the performance of the cuttings treatment for residual oil on cuttings. Undertake seabed sampling programme to investigate the impact of drill cuttings discharges and recovery over time. Monitoring to include benthic sampling (macro-fauna abundance and biodiversity, sediment particle size distribution, sediment chemical analysis for metals and hydrocarbon content). Methodology to follow international good practice.	Daily sampling of treated cuttings. Seabed sediment sampling at two representative well sites prior to drilling and after drilling is completed. Detailed survey programme and number of replicate samples and analysis required to be developed as part of the full Pecan Phase 1 Monitoring Plan.
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. Reporting to Ghana authorities as per frequency requirements.

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Chemical use (including discharges of hydraulic fluid from subsea equipment, including BOP)	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 and where applicable, the HOCNF classification as per OSPAR/EPA guidelines for each chemical will be reported.	Monthly data reporting throughout Project. Reporting to Ghana authorities as per frequency requirements.
Desalination process	Monitor salinity (%) and volume of desalination brine discharged (m^3)	Daily flowmeter records; Monthly data reporting throughout Project. Reporting to Ghana authorities as per frequency requirements..
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 (ppm) • pH of treated wellbore clean-up fluids (pH 5 or more).	Volumes, average oil in water content and pH of fluids to be discharged reported daily with reference to discharge standards during discharge operations. Data to be reported daily during discharge operations and collated per well and reported Ghana authorities as per frequency requirements..
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 Monthly reporting to Pecan Energies Reporting to Ghana authorities as per frequency requirements..
	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).	Monitoring frequency in accordance with Ghana regulations. .

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
FPSO black water (treated sewage), grey water and food waste	Monitor for maximum residual chlorine concentration to meet MARPOL standards and visual observations to check for no floating solids, foam or discolouration of surrounding water.	Daily sampling for chlorine and daily visual inspections and recording throughout Project.
	Monitor volume of sewerage discharged	Daily monitoring throughout life of Project. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
	Estimate total quantity of macerated food waste discharged overboard (kg or m^3) based on POB (persons on board)	Daily estimate. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
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. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
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. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Drilling fluids, drill cuttings and cement	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. Analyse Hg, Cd and As concentration in stock barite. Calculate volume of drill cuttings (m^3) created by each well.	Daily monitoring during drilling operations. Composite sample analysed for each new bulk delivery. Weekly reporting to Pecan Energies. End of well reporting to Ghana authorities.
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. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
Emissions to Air		
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. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
Onshore Fuel Consumption	Helicopter: Aviation fuel use shall be monitored and recorded. Project Vehicles: Diesel and petrol 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 based on litres of fuels used. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
FPSO Fugitive Emissions and venting	Monitor the volume of hydrocarbons used, handled, stored and 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. A fugitive emission study. Annual monitoring. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements.

Potential Impact	Monitoring	Frequency of Monitoring and 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. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements.. For drilling, end of well reporting to Ghana authorities
Waste Management		
Waste types, volumes and segregation	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. Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..
Waste storage, transport and treatment	Inspect waste storage areas on Project and waste contractor's sites for compliance with Project standards. Assess state of containment, bunding, presence of leaks and 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.
Resource Use		
Water Use	Drilling/Process freshwater consumption Drinking water consumption, own generated and from public sources Fresh water generation.	Monthly reporting to Pecan Energies. Reporting to Ghana authorities as per frequency requirements..

Potential Impact	Monitoring	Frequency of Monitoring and Reporting
Accidental Spills		
Spills of hazardous materials	FPSO, MODU, and Support Vessels Report and investigate all leaks and spills, including type and quantities of substances spilled (e.g. oil and chemicals) and actions a taken.	Ongoing throughout life of Project. Immediate reporting to Pecan Energies. Reporting to Ghana authorities within 24 hours.
Stakeholders, Employment and Social Investment		
Stakeholder understanding of the Project	CLOs undertaking 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.	Monitoring on-going throughout life of Project.
Human resources strategy for creation / transfer of employment opportunities	Monitor employment levels and local staff content against targets for Pecan Energies and its contractors.	Quarterly review of HR data and recruitment and organisational development plans.
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.
Project Performance Evaluation	Monitor Social Investment Project execution targets via assessment meetings attended by beneficiaries and contributors (NGOs, District Assemblies).	Annual reviews on-going throughout life of Project.

9. Decommissioning and Abandonment

9.1 Introduction

At the end of the economic life of the Pecan Development, 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.

9.2 Regulatory Requirements

According to EPA Guideline on Environmental Assessment and Management, 2011, prior to commencement of production, the Operator will submit a decommissioning and well abandonment plan to the EPA. Thereafter, the plan will be revised every three years and the current copy submitted. The 2016 Petroleum Act (Act 919) also states that a licensee or Contractor who operates a petroleum facility shall submit a decommissioning plan to the minister and the minister shall seek the advice of the commission. A Final Decommissioning Plan will be submitted to the PC and the Ministry of Energy for review, no earlier than 5 years and no later than 2 years before planned decommissioning. This will include evaluation of the decommissioning options. The Decommissioning and Abandonment Plan ((DAP) will provide the basis for decommissioning cost estimates

There are a number of International Conventions pertaining to the decommissioning of oil and gas projects which cover both the removal of installations (i.e. to remove navigation and fishery hazards) and disposal of wastes (i.e. to prevent pollution).

- The UNCLOS, 1982, to which Ghana is a signatory, permits the partial removal of structures provided that IMO criteria are met regarding safety of navigation.
- 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. Although Ghana is not a signatory to OSPAR, the EPA offshore Oil and Gas Development Guidelines (Section 4.1.5) states that internationally-recognised guidelines and standards issued by the International Maritime Organization (IMO) and decisions issued by OSPAR should be followed for the decommissioning of offshore facilities.
- The following requirements are therefore relevant to the Pecan Project.
- No installation or structure should be installed after January 1, 1998 unless the facility is designed to be entirely removed.
- An OSPAR decision recognises entire removal of the facility from the offshore locations for re-use, recycling, or final disposal on land as the preferred option for the decommissioning of offshore facilities. Alternative disposal options may be considered if justified based on an alternative options assessment. This assessment should consider facility type, disposal methods, disposal sites, and environmental and social impact, including interference with other sea users, impacts on safety, energy and raw material consumption, and emissions. A preliminary decommissioning plan for offshore facilities should be developed that considers well abandonment, removal of oil from flowlines, facility removal, and sub-sea pipeline decommissioning along with disposal options for all equipment and materials. This plan can be further developed during field operations and fully defined in advance of the end of field life. The plan should include details on the provisions for the implementation of decommissioning activities and arrangements for post decommissioning monitoring and aftercare. All decommissioning plans should be submitted to the regulator for approval before the commencement of any plan of development of petroleum operations.

- The Basel Convention, 1989 and Bamako Convention, 1998 in relation to the control, movement and disposal of hazardous wastes.

A preliminary Decommissioning Plan has been produced by Pecan Energies (Pecan Decommissioning Plan and Estimated Shutdown and Removal Costs (PECAN1-AKE-Z-TA-0003) and the requirements are summarised below.

9.3 Decommissioning Methods

General Approach

The selection of appropriate decommissioning methods and procedures for individual components of the Pecan 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.

Plugging and Abandonment of Production and Injection Wells

As part of the decommissioning process all Pecan subsea wells will be plugged and abandoned using a MODU or well service vessel, depending on the requirements. The purpose of well abandonment is to prevent potential hydrocarbon release into the environment after the field has been decommissioned. To achieve this, a series of cement and mechanical plugs are planned to be installed in each well. The wells have been designed to enable cost effective abandonment operations in accordance with recognised industry practices.

Figure 9.1 illustrates the proposed Plug and Abandonment (P&A) schematics for generic Pecan producer and injector wells, respectively. The specific P&A requirements for each well will be detailed in the DAP.

The general well decommissioning and abandonment approach is outlined below.

- Flush the wellbore of hydrocarbons back to the FPSO.
- ‘Kill’ the well with a high-density fluid (i.e. weighted brine).
- Cut the well casing at seabed level and remove the production tree.
- Recover the production tubing and the Tubing Head Spool.
- Set and test the mechanical and first cement plug.
- Set and test the second cement plug.
- Set environmental cement plug at wellhead.

It is estimated that the decommissioning of each well will require approximately fourteen days.

Subsea Equipment

Removal of subsea structures will be evaluated in view of the ultra-deep-water location and other activities in the area. If the subsea structures are removed, they will be transported to shore for potential re-use, recycling or disposal. If subsea facilities or ancillary items are to be left in situ, this will be supported by risk assessment. Given the deep-water location it is currently proposed that all risers, flowlines, umbilicals, cables and pipelines etc, after being cleaned, flushed and disconnected, will be left on seabed.

FPSO Processing and Storage Facilities

The 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 international and local regulations.

Once the FPSO is released from the mooring system the lines and chains from the FPSO mooring system will be recovered. The mooring suction piles will be abandoned in place.

Support Infrastructure

Onshore 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 Pecan Energies operations in Ghana. Light vehicles, aircraft and support vessels leased to support the project will be demobilised once decommissioning has been finalised.

9.4 Discharges and Waste

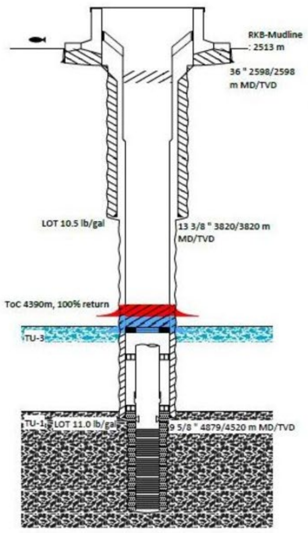
Pecan Energies WMP will be updated to include specific requirements for managing decommissioning waste. Solid hazardous and non-hazardous waste generated during the decommissioning phase will be managed in accordance with the WMP. Although the FPSO contractor will be responsible for decommissioning of the FPSO, Pecan Energies will ultimately remain responsible for ensuring that wastes generated from the decommissioning activities are managed in compliance with Ghanaian waste legislation and international requirements.

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.

9.5 Post-Decommissioning Surveys and Reporting

A post-decommissioning survey will be developed and implemented to verify that decommissioning requirements were followed. A final layout plan will be developed indicating where infrastructure was located and what infrastructure remains on the seabed post decommissioning. The remaining structure will be identified in Admiralty Charts

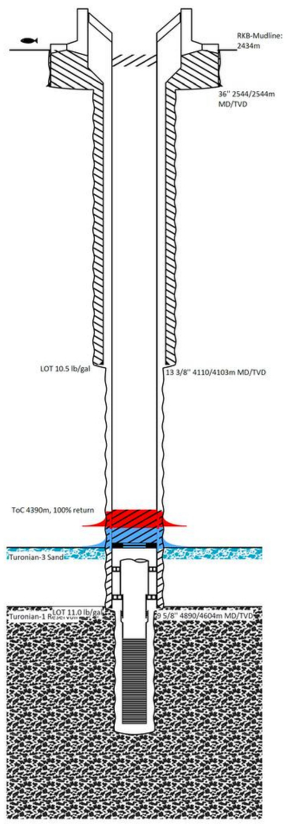
A close-out report will be submitted to the relevant authorities describing what activities occurred during the decommissioning process and the state of the environment once all activities have ceased.



Permanent abandonment
Permanent abandonment
Planned

Element	Qualification	Monitoring
Primary barrier elements		
Mechanical tubular plug	Tagged and pressure tested to 1000 Psi above LOT	Not accessible
Cement plug	Job record	Not accessible
Production casing	Pressure test to 1000 Psi above LOT	Not accessible
Production casing cement	Formation test, job performance or bond log	Not accessible
Formation (in-situ)	FIT or LOT	Not accessible
Secondary barrier elements		
Cement plug	Tagged	Not accessible
Production casing	Pressure test to 1000 Psi above LOT	Not accessible
Production casing cement	Formation test, job performance or bond log	Not accessible
Formation (in-situ)	FIT or LOT	Not accessible
Healthy well, no or minor issue		

Note:
Assumptions:
1. Wellhead remains in place
2. Production casing cement evaluation performed and proved acceptable during drilling phase
3. Tu-3 is water bearing



Permanent abandonment
P&A
Planned - Current

Element	Qualification	Monitoring
Primary barrier elements		
Mechanical tubular plug	Tag & Pressure test to 1000 Psi above LOT	Not accessible
Cement plug	Placed as a continuous plug with secondary barrier cement plug	Not accessible
Production casing	Pressure test to 1000 Psi above LOT	Not accessible
Production casing cement	Formation test, job performance or bond log	Not accessible
Formation (in-situ)	FIT or LOT	Not accessible
Secondary barrier elements		
Cement plug	Tagged	Not accessible
Production casing	Pressure test to 1000 Psi above LOT	Not accessible
Production casing cement	Formation test, job performance or bond log	Not accessible
Formation (in-situ)	FIT or LOT	Not accessible
Healthy well, no or minor issue		

Note:
Assumptions:
1. Wellhead remains in place and wellhead cap is installed
2. Cement Evaluation Logs performed during Drilling Phase for WAG
3. Turonian-3 is water bearing
4. Environmental cement plug at wellhead.

Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 9.1 Permanent Abandonment for Producer (top) and Injection (bottom) Wells

10. Outline Environmental and Social Management Plan

10.1 Introduction

This outline Environmental and Social Management Plan (ESMP) summarises the measures that are required to manage the potential environmental and social impacts of the Project. The avoidance, minimisation and mitigation measures described in this section address the potential project-related impacts, including unplanned events, identified through the impact assessment process, presented Chapter 5.

The specific objectives of this outline ESMP are as follows.

- Describe Pecan Energies proposed approach to manage potential impacts and risks based on the mitigation hierarchy.
- Describe the proposed monitoring activities designed to verify that the mitigation measures are implemented and are effective.

This outline ESMP will inform the Project ESMP to be developed by Pecan Energies to cover the implementation of the Project following its approval.

The Project ESMP will:

- list the commitments made in the EIA (Commitments Register) to mitigate potentially adverse impacts, enhance positive benefits and document roles and responsibilities for ensuring that they are implemented;
- identify and outline relevant policies, processes, procedures and management plans required to implement the identified mitigation measures;
- provide the basis for monitoring the effective implementation of the identified mitigation measures and ascertain their efficacy; and
- assist in ensuring compliance with all Applicable Standards (i.e. relevant national legislation, lender standards, Pecan Energies standards and GIIP).

The Applicable Standards will be referenced in Project design documents, along with relevant design standards.

The overall objective of the Project ESMP will be to ensure that mitigation measures identified and committed to in this EIA and in any subsequent studies (e.g. risk assessments undertaken for work packages during detailed design) are translated into practical management actions, which can be adequately implemented, resourced, monitored and reported against through all phases of the Project.

10.2 Scope of ESMP

The ESMP will be applied to all phases of the Project including onshore logistics; drilling; offshore construction, installation and pre-commissioning; production; and decommissioning.

The ESMP will apply to the activities of Pecan Energies and its Representatives within the Project's Area of Influence (AoI). The AoI, in accordance with the definitions provided in IFC PS1, includes the following areas.

- The area affected by the Project activities and facilities that are directly owned, operated or managed (including by contractors).

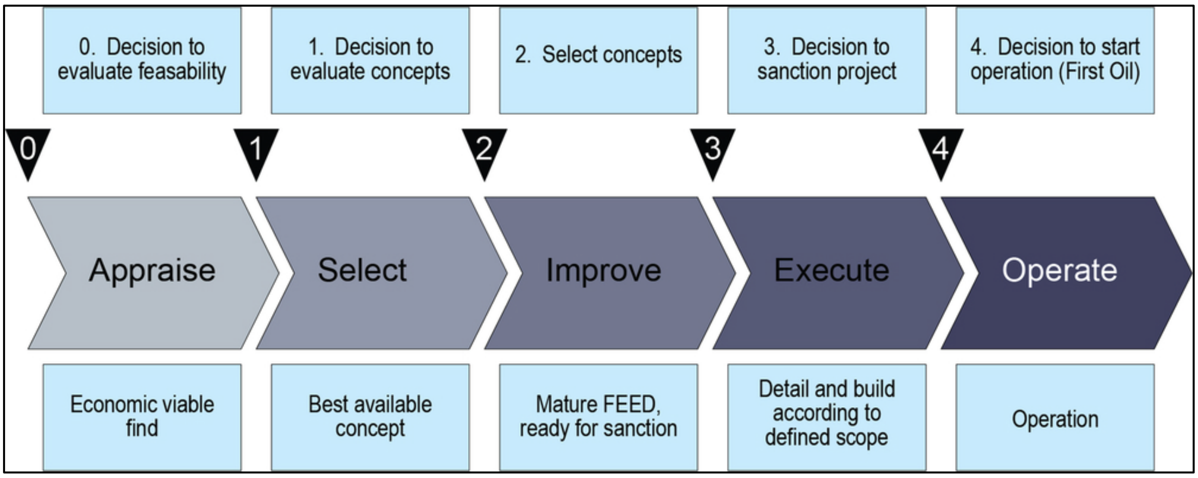
- Indirect Project impacts on biodiversity or on ecosystem services upon which Affected Communities'[1] livelihoods are dependent.
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the Project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.
- Labour and health and safety risks and impacts associated with primary supply chains.

Where Pecan Energies can reasonably exercise control over risks and impacts associated with primary supply chain facilities the approach to managing these issues in the Project ESMP will focus on health and safety, human rights and labour conditions[2]. These measures will include supplier screening, contractual conditions, capacity building, and auditing and review. Large contract primary supply chain facilities, such as the FPSO conversion yard, will have a Pecan Energies representative on site during project works.

The project execution will be managed from Pecan Energies head office. Site offices will be established at key suppliers' sites including Ghanaian suppliers' sites. When the main offshore activities (marine, hook-up and commissioning) are executed, parts of the project management team will be located in Accra.

10.3 Project Management Overview

The project will be managed with Pecan Energies as Operator on behalf of the JV Partner group throughout the project execution phase. The project execution will be assured by implementation of Pecan Energies Project Development Process (Figure 10.1), comprising Appraise-Select-Improve-Execute-Operate with 5 decision gates (DG0-DG1-DG2-DG3-DG4), with supporting guidelines.



Source: Pecan Energies, 2023. DWT/CTP –Plan of Development.

Figure 10.1 Project Development Process

10.4 Ownership of the ESMP and Cascade to Contractors

The ESMP will be owned and implemented by Pecan Energies and cascaded to its contractors.

[1] As identified in the Stakeholder Engagement Plan (in line with IFC PS1 requirements)
[2] With specific reference to paras 27 and 29 of PS 2 and para 30 of PS6 covering use of child and forced labour and purchasing primary production from areas where threats to natural / critical habitat are known.

As the Operator, Pecan Energies has overall responsibility to ensure that all mitigation measures are implemented. Primacy for the delivery of many of these measures will rest with the contractors appointed by Pecan Energies to undertake the physical activities (e.g. drilling, offshore supply logistics).

The following main contracts are:

- Well Construction Service Contracts - well design, construction and logistics.
- Drilling Contracts - drilling and completion of wells.
- SPS EPC Contract – fabrication of subsea wellhead equipment, manifolds and installation.
- SURF Contractor - fabrication and installation of subsea structures, flowlines and risers and control umbilicals.
- Subsea Life of Field (SLOF) Contract - maintenance and management of spare parts and required onshore logistics and service base for the subsea scope
- FPSO Bare Boat Charter Contract – Leasing contract of the FPSO from the owner
- FPSO O&M contract – Contractor for operation and maintenance of the FPSO.

Contractors will be required, through the Contracting Procedures, to develop and implement their own documented environmental management controls to deliver the commitments made in the ESMP and to comply with the Applicable Standards. Where contractors' plans and procedures have primacy, the roles and responsibilities for implementing mitigation measures will be identified in bridging documents detailing how they will interface Pecan Energies ESMP.

This cascade of commitments from the Operator into contractor documentation and management systems, plans and procedures are illustrated in Figure 10.2. Pecan Energies will be responsible for reviewing and approving the contractor's documentation prior to the commencement of the Project.

Interface management within the Project will be undertaken by applying a top-down/bottom-up approach for identifying interface issues (top-down analysis) and ensuring their resolution and closeout (bottom-up synthesis) consists of the following steps:

- Determination of interface networks.
- Identification of interface parties.
- Identification of interface areas.
- Determination of interface issues.
- Identification and planning of interface items.
- Monitor and control activities.
- Resolve and close out interface items and issues.

The Project has developed an Interface Management Procedure and has implemented an Interface Management System, Web Interface Register (WIR), for handling interface issues between the different interfacing parties, as appropriate.

Contractors, sub-contractors and suppliers will define their own procedures and tools for managing their internal interfaces, between their own suppliers, vendors and sub-contractors. Pecan Energies will perform audits to ensure adequate interface management processes and tools are established and operating effectively within contractors and its sub-contractors and suppliers.

Figure 10.2 Project Environmental Management Overview

10.5 Roles and Responsibilities

The effective implementation of the ESMP is dependent on established and clear roles, responsibilities, and reporting lines between Pecan Energies and its contractors.

To effectively execute and manage the Project activities, the project management team will comprise delivery teams with the following defined roles and responsibilities.

- Reservoir Development
- Drilling & Wells
- Subsea
- FPSO
- Operations Readiness
- Completion and Commissioning

In addition, there will be supporting functional teams covering:

- Health, Safety, Security and Environment (HSSE);
- Corporate Social Responsibility (CSR)
- Quality Assurance (QA) and Risk;
- Project Services;
- Project Assurance and Improvement; and
- Engineering.

Figure 10.3 provides an overview of the Pecan Energies project management team. A summary of the HSSE and QA roles and responsibilities envisaged at this stage of the Project is presented in Table 10.1.

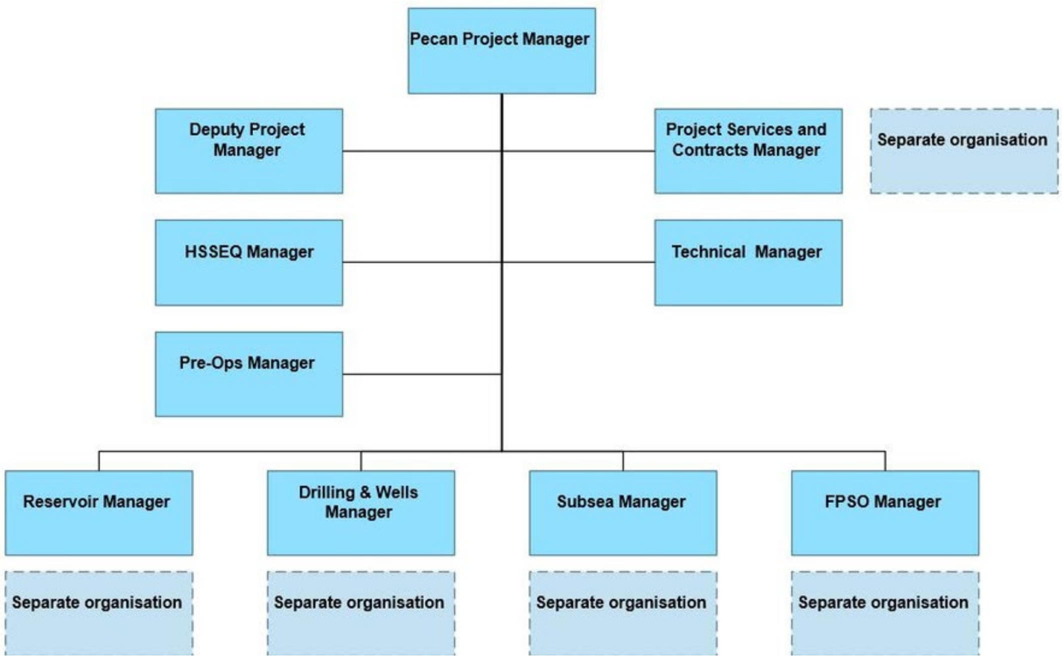


Figure 10.3 Pecan Energies Project Management Team

Table 10.1 Summary of Project HSSE and QA Roles and Responsibilities

Role	Responsibilities
HSSE Manager	Provides the strategic direction and resources necessary to conduct or facilitate the HSSE risk management activities.
CSR Manager	Provides the strategic direction and resources necessary to conduct or facilitate the social risk management activities and value creation for the projects AoI.
CLO	Community Liaison Officer will be the daily point of contact with public. The CLO will inform members of the communities about key activities in the Project as well as receive grievances from public, if any.
Risk Advisor	Facilitates, documents, maintains and guides the implementation of the risk management process.
HSSE Leads (e.g. Field Development, Drilling & Wells)	Provide HSSE support to their assigned Work Streams throughout the design, construction and commissioning of the project. Duties include process modelling and procedure writing, responding to HSSE requests from the Project team and HSSE Manager as well as travelling to field locations as necessary to interface with contractors and others.
Tender Team HSSE Coordinator	Ensure that relevant HSSE aspects are taken into account at all stages of the procurement process including preparation of tender documents, assistance during clarifications, evaluation, negotiation and recommendation for award.
Environmental Advisor	Provides support on environmental issues throughout the design, construction, commissioning and operation of the project. Provides advice on permit requirements and discharge/emission limits.
Regulatory Advisor	Assures that the project is aware of current and proposed regulations, including requirements for permits and licenses.
Technical Safety Advisor	Provides safety design and process safety expertise and ensures alignment with Pecan Energies requirements. Provides technical safety expertise, particularly in the areas of safety design (e.g. blast/fire modelling), vent and release systems and overall project risk.
Other HSSE Specialists (Human Factors, Industrial Hygiene, Medical, Emergency Preparedness, Aviation, Marine etc.)	Provides HSSE support in their subject matter areas throughout the design, construction, commissioning, and operation of the project. Duties include process modelling and procedure writing, responding to HSSE requests from the project team and HSSE Manager as well as travelling to field locations as necessary to interface with contractors and others.

10.5.1 Pecan Energies

Pecan Energies is accountable for ensuring that contractors and suppliers appointed to deliver the Project also deliver relevant commitments made in the ESMP. Using a team of Technical and HSSE professionals, Pecan Energies will tender and appoint companies to deliver the Project. The contractor selection processes will include the review of contract specific HSSE aspects.

10.5.2 Contractors

The contractors will mobilise sufficient resources to deliver their activities for the Project in accordance with the commitments laid out in the contract requirements. All contractors will identify and define roles, responsibility and authorities, and ensure that human, technical and financial resources are provided to enable this implementation.

10.6 Outline of Proposed Management Plans

This section presents an outline of the key management plans to be developed as part of the Project ESMP. These are based on the mitigation measures and management actions required to address the potential impacts identified through the assessment presented in Chapter 5 and summarised in the preceding table. Where relevant, these plans will cross-reference activity-specific policies or procedures to be developed by Pecan Energies and/or Contractors.

The following specific plans will be developed as part of the Project ESMP and which will incorporate the mitigation measures presented in this EIA. Further details of these plans are presented below.

- Waste Management Plan.
- Chemical Management Plan.
- Greenhouse Gas and Energy Management Plan.
- Traffic Management Plan (including onshore and marine traffic).
- Stakeholder Engagement Plan (including Grievance Mechanism).
- Pecan Local Content Plan.
- Workers Management Plan.
- Recruitment, Employment and Training Plan.
- Community Health, Safety and Security Management Plan.
- Decommissioning Plan.
- Emergency Preparedness and Response Plan for Ghana operations (including Oil Spill Contingency Plan).

In addition, there will be a number of other plans to address standard operational requirements. These will include the following.

- Audit and Verification Plan.
- Project Monitoring Plan.
- Cultural Heritage Plan (including Chance Finds Procedure).
- Onshore Security Plan.
- Safety Zone Management Plan.
- Ballast Water Management Plan.
- Supply Chain Management Plan.
- Resource Efficiency and Conservation Management Plan.
- Retrenchment Plan as part of Pecan Energies Ghana Ltd. Employee Handbook.

10.6.1 Waste Management Plan

Scope

The WMP will be developed to address the approach to the management of hazardous and non-hazardous solid and liquid wastes generated both onshore and offshore through all phases of the project. The WMP will apply to Pecan Energies and all its contractors (FPSO, MODU, support vessels and onshore office and storage areas).

Objectives

- To avoid or minimise potential impacts to the natural environment and the health and safety of personnel and communities from Project generated wastes streams.
- The plan will address the collection, storage, transport, treatment and final disposal of wastes.
- The responsibilities of all waste handlers under Duty of Care will be outlined as well as the requirements for data management and waste transfer manifests.
- The WMP will be updated if there are material changes to the planned activities that introduced new waste streams, in the event of any changes to Pecan Energies policies and national and international legislation.
- The WMP and all associated facilities will be audited and the WMP updated to address deficiencies and opportunities for improvement.

10.6.2 Chemicals Management Plan

Scope

The Chemical Management Plan will address the selection, handling and disposal of chemicals and hazardous material in liquid and solid form during all phases of the project and for all activities onshore and offshore. It will link to the Waste Management Plan and the Emergency Preparedness and Response Plan.

Objectives

- The Project will seek to use of the lowest feasible chemical contents in the NADF.
- Select chemical additives that have the lowest hazard quotients (under the OSPAR Harmonised Mandatory Control Scheme) or are categorised as PLONOR as long as it does not compromise on safety or operability.
- Prevent the uncontrolled release of any hazardous materials during transport, handling, storage and use.
- Control planned discharges to be within Ghana/Project discharge standards and Project Environmental Permits.
- Ensure all personnel responsible for handling chemicals are competent and undergo specific training for tasks that involve the use of hazardous chemicals.

10.6.3 Greenhouse Gas and Energy Management Plan.

Pecan Energies will develop an Energy Management plan for its operations and all main contractors will be required to have an Energy Management System and management plan with the aim to reduce greenhouse gas emissions.

10.6.4 Traffic Management Plan

Scope

The Traffic Management Plan (TMP) will address potential risks and impacts related to vessel and vehicle movements within the Project AoI. It will include all phases: drilling, installation, operation and decommissioning and will address marine traffic routes and activities within the 500 m exclusion zones and 5 nm advisory area as well as traffic to and from Takoradi port and any onshore office and storage locations.

Objectives

The objective of the plan is to avoid or minimise potential impacts associated with vessel collision and accidents between Project-related vessels and commercial vessels as well as with road users. The plan will set out potential impacts and describe how they will be mitigated. The objectives of the plan are as follows.

- Define vessel transit routes, speed restrictions and exclusion/advisory areas for vessel passage.
- Define the safety exclusion zones and advisory areas regarding offshore infrastructure
- Provide for 24-hour monitoring of all Project vessel movements.
- Collate information on the identity and type of vessels that regularly use the area.
- Engage fishing communities to raise awareness of marine traffic risks (linked with Stakeholder Engagement Plan).
- Bridge with relevant Contractors HSE plans and ensure that Risk Assessments, competence of crew, training and compliance auditing are included.
- Control the movement of Project-related vehicles between Takoradi port and onshore Project areas (such as waste storage/management sites) to minimise impacts on traffic disruption and road user delay.
- Avoid and address damage to public roads and other transportation infrastructure.
- Ensure that vehicle operators are properly trained and monitored.

10.6.5 Stakeholder Engagement Plan

Scope

Pecan Energies has defined a Stakeholder Engagement Plan to 'seek to develop strong partnerships with government agencies, traditional authorities, district assemblies, youth groups, non-governmental organisations, community-based organisations, civil society, fishing communities and other relevant stakeholders'.

Objective

The objective of the Stakeholder Engagement Plan is to identify the relevant stakeholders, distribute accurate project information in an open and transparent manner, form partnerships to promote constructive interaction, record and address public concerns and manage stakeholder expectations.

The key principles guiding the approach to stakeholder engagement are as follows.

- To be open and transparent with stakeholders.
- To be accountable and willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities.
- To have a relationship with stakeholders that is based on trust and a mutual commitment to acting in good faith.
- To respect stakeholders' interests, opinions and aspirations.
- To work collaboratively and cooperatively with stakeholders to find solutions that meet common interests.
- To be responsive and to coherently respond in good time to stakeholders.
- To be proactive and to act in anticipation of the need for information or potential issues.
- To engage with stakeholders such that they feel they are treated fairly, and their issues and concerns are afforded fair consideration.

- To communicate in a manner that is culturally appropriate and understandable to the affected persons.
- To be inclusive and accessible to stakeholders so that they feel able to participate; to receive and understand information; and to be heard.

As part of the Pecan Energies Stakeholder Engagement Plan, the Company has implemented a Grievance Mechanism to receive, investigate and respond to concerns and complaints/grievances from stakeholders as it relates to onshore and offshore activities in the Western Region of Ghana and beyond. All external grievances and enquiries will be appropriately addressed, and records maintained in a grievance register. There will be two forms of the register: a hardcopy registers at the community level and an electronic register for aggregating and tracking all complaints/grievances. The electronic register will be an internet cloud-based system that can be accessed anywhere and is capable of generating different types of reports, ranging from trending issues, geographical hotspots, frequency, resolved and unresolved complaints/grievances etc. The grievance register will be administered by the Pecan Energies CLOs.

Stakeholders within Project affected communities who consider themselves affected by Pecan Energies operations will be able to register complaints in this register at no cost.

To efficiently address high risk grievances or complaints, a Pecan Energies Grievances Committee will:

- investigate and resolve all high-risk complaints/grievances in a transparent, timely and efficient manner; and
- ensure that all grievance resolutions are communicated to the complainant(s) before being implemented.

The Committee shall be required to resolve complaints/grievances within a maximum of three months.

Pecan Energies whistleblowing channel is also open for external parties, such as suppliers and other business partners. The whistleblowing channel is a confidential, independently managed tool, available on Pecan Energies website, for employees and third parties to report concerns about possible illegal actions and breaches of Pecan Energies Code of Conduct.

10.6.6 Pecan Local Content Plan

Scope

Pecan Energies has developed a Local Content Plan to contribute to the competitiveness of local content and procurement opportunities. The aim of the plan is to enhance opportunities to optimise costs, quality, flexibility, networks, local knowledge and other considerations in the value chain.

The Local Content Plan has the following requirements for promoting local content.

"Pecan Energies will use a step-wise procurement and contracting methodology to maximize local supplier participation while incorporating required input, reviews and permits by the Petroleum Commission prior to bidding and award of contracts / agreements. In addition, all subcontractors will be required to outline their proposed Local Content Plan in their bid documents with the expectation that, if selected, their plan will be incorporated in the corresponding Contract. International (non-Ghanaian) subcontractors shall, consistent with the applicable requirements of local content regulations in Ghana, incorporate a Joint Venture with a Ghanaian contractor or form channel partnerships

and/or strategic alliances with fully indigenous Ghanaian entities. Subcontractor's Local Content Plan and structural set-up shall be consistent with Pecan Energies Local Content Plan."

Objective

The objective of this plan is to set out potential impacts and opportunities, and to describe how they will be mitigated or maximised. This includes ensuring the management and control of activities aimed at maximising workforce, goods and services on the project and developing capacity among the employees and the local suppliers but also the local communities and supply chain.

The objectives of this plan are as follows:

- Support the development of skills within the local community by employing local staff and creating business opportunities with local enterprises for economic development.
- Support the enhancement of skills of the local population through initiatives of training and capacity building.
- Train local businesses to produce goods and services that meet the standards and requirements of multinational operators.
- Align with the government regulations or investment agreements stipulating local content levels.
- Ensure timely and consistent renewal of relevant permits/licenses of subcontractors during execution of work scopes.
- Enhance engagement with stakeholders.

10.6.7 Workers Management Plan

Scope

A Worker Management Plan will be developed to address potential risks to worker rights, labour standards, and health and safety during the duration of the Project by summarising expectations and procedures to maintain quality working conditions and activities. The provisions established in this plan are supplemented by commitments contained in the Recruitment, Employment and Training Plan.

Objectives

The objectives of the Workers Management Plan are to as follows.

- Promote the fair treatment, non-discrimination, and equal opportunity of workers.
- Establish, maintain, and improve the worker-management relationship.
- Promote compliance with national employment and labour laws.
- Protect workers, including vulnerable categories of workers such as migrant workers, workers engaged by third parties, and workers in the client's supply chain.
- Promote safe and healthy working conditions, and the health of workers in relation to workers' accommodation camp and housing requirements.
- Avoid the use of child labour and forced labour.

10.6.8 Recruitment, Employment and Training Plan

Scope

An Employment and Training Plan, as part of the Local Content Plan will be developed to assess potential risks regarding recruitment processes as well as employment opportunities for the coastal communities within the AoI. The provisions established in this plan are supplemented by commitments contained in the existing Local Content Plan.

Objectives

The objectives of this plan will be to avoid or minimise potential impacts related to selection, hiring and induction training of workers as well as maximising benefits for the community related to employment and skill enhancement. This plan will set out potential impacts and consequences and describes how they will be mitigated.

The specific objectives of the Employment and Training Plan are to the following.

- Manage expectations in view of influx job-seekers from the region and other parts of the country.
- Promote fair and equitable labour practices for the fair treatment, non-discrimination and equal opportunity of workers.
- Establish, manage and promote a healthy management-worker relationship.
- Protect workers' rights including migrant and third party workers and vulnerable peoples, such as women, youth, elderly or disabled.

10.6.9 Community Health, Safety and Security Management Plan

Scope

Worker-community interactions, traffic movements and increased pressure on health resources may expose communities to risks and impacts arising from temporary or permanent changes in population. A Community Health Safety and Security Management Plan will be developed to avoid or minimise the risks and adverse impacts to community health (including safety and security) that may arise from project activities to ensure safe operations that protect communities. The management of community health is closely connected with worker health, worker behaviour and Project safety measures.

Objectives

The overall objective of the Community Health Safety and Security Management Plan is to outline how potential Project impacts on the health, safety and security of communities will be avoided or minimised. This includes ensuring that the safeguarding of project related personnel and property is carried out in a legitimate manner that avoids or minimises risks to the community's safety and security. The Plan will also outline how potential impacts will be managed and monitored, particularly with respect to community exposure to disease, hazardous materials management and safety.

The specific objectives of the Community Health Safety and Security Management Plan are the following.

- To establish effective mechanisms for protecting the health and safety of nearby communities from any Project-related health risks.
- Conduct pre-employment screening protocols and regular health screenings to employees.
- Raise awareness of employees and support them in the prevention of impacts on the community health safety and security, in conjunction with their own health care.

- Raise awareness of the communities about risks to their health and safety associated with project activities.
- Ensure that community safety protection measures are considered in construction activities management.

10.6.10 Decommissioning Plan

Scope

The Pecan Decommissioning Plan and Estimated Shutdown and Abandonment Costs (PECAN1-AKE-Z-TA-0003) addresses Pecan Energies approach for decommissioning the Pecan Development at the end of its production life. The plan will set out the objectives, risks and methodology for how each part of the Project infrastructure will be decommissioned. This included well plugging and abandonment processes that may occur while the field is still in production. A Best Practical Environmental Option (BPEO) approach will be adopted considering technical feasibility, health and safety, environmental performance and cost.

Objectives

- Develop a plan that demonstrates how all Ghana regulatory and International requirements and all Project commitments will be addressed and actioned prior to decommissioning.
- Consider the feasible technical options available at the time of decommissioning and update the plan accordingly.
- Complete pre and post decommissioning surveys to verify the objectives of the plan have been met.
- Undertake a health and safety risk assessment of all planned decommissioning activities.
- Undertake a consultation programme with other users of the area, e.g. fishing and commercial shipping interest and shore based communities.
- Ensure all project grievances are resolved and closed out.
- Update the Project WMP to address all wastes that may arise from the decommissioning activities.

10.6.11 Emergency Preparedness and Response Plan

Scope

The purpose of this Emergency Preparedness and Response Plan is to provide the framework to Pecan Energies and Subcontractors regarding measures and actions to be implemented to avoid or mitigate potential adverse emergency scenarios that may arise from project related activities as well as the guidelines for the Subcontractors to develop their own Emergency Plans.

Organisation

Emergency preparedness and response will be organised in three tiers (defined by Pecan Energies, following the industry standard approach[1]). Emergency response will be implemented by a series of teams and corresponding plans, as illustrated in Figure 10.4.

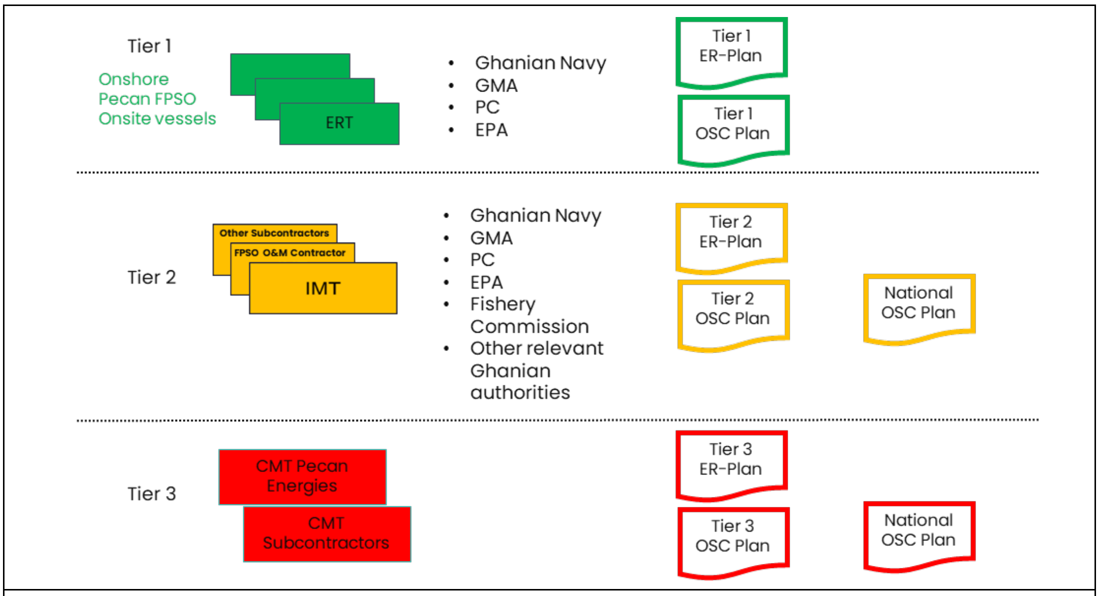
- *Tier 1* – Incidents contained at site/facility level and managed with resources available locally and in line with site/facility emergency response procedures. Managed by the Emergency Response Team (ERT) who initiate notification, local damage control and response/rescue.
- *Tier 2* – Incidents requiring resources from site/facility and additional support from in country personnel and resources. Personnel injuries are within country medical capabilities though medevac may be necessary. Local/regional media interest may develop. Managed by the Incident Management Team (IMT) at a tactical level. The IMT supports the ERT and is responsible for mobilising resources and providing the necessary technical and operational support to the incident. Primarily for offshore incidents but may support the ERT for larger onshore incidents.
- *Tier 3* - Will require the resources of the Crisis Management Team (CMT) where the situation is ongoing or escalating and where industry and media interest is likely. The CMT provides strategic level management for incidents addressing overall company interests, internal and external communication, financial and legal issues and personnel handling.

The FPSO and drilling contractors will develop Tier 1 preparedness and emergency response for their facilities and create Emergency Preparedness and Response Plans, covering defined situations of hazard and accident, including on-site oil spill response. When multiple facilities operate in the same area, an area preparedness plan for mutual support between installations will be in effect.

Pecan Energies will arrange for vessels, guard services and liaison to support Tier 1 responses. Pecan Energies will develop and contract adequate Tier 2 and Tier 3 services and resources for supporting and safeguarding people, environment and assets involved in production, drilling, bases, facilities, transport and logistics. Use of these services and resources will be documented in Emergency Preparedness and Response Plans for Tier 1, Tier 2 and 3, covering relevant offshore and onshore scenarios, and harmonised with the subcontractors' Emergency Preparedness and Response Plans through bridging documents.

Emergency response across all three tiers will be coordinated with Ghanaian authorities and resources (see Figure 10.4). Emergency response arrangements will be documented and the subject of regular training and response exercises. Each tier will have 24/7 duty persons to facilitate immediate notification and mobilisation of staff, services and resources.

[1] OGP Report 526, 2015. Tiered preparedness and response: Good practice guidelines for using the tiered preparedness and response framework.



Source: Pecan Energies, DWT/CTP – Plan of Development 2023.

Figure 10.4 Emergency Response Structure

A summary of the Emergency Preparedness and Response Plans that will be developed at this stage of the project is provided in Table 10.2.

Table 10.2 Summary of Project Emergency Response Documentation

Plan	Scope
Ghana Emergency Preparedness and Response Plan	Tier| 1 Pecan Energies emergency response for onshore incidents.
Project Emergency Preparedness and Response Plan	Tier 2 IMT's emergency response describing the procedures to be followed in the event of an incident.
Management System Interface Document – MSID	Bridging document for Tier 2 resources.
Crisis Management Plan	Tier 3 CMT's emergency response describing the procedure for strategic handling and response to unwanted incidents affecting Pecan Energies.
Oil Spill Contingency Plan –	Describes the specific contingency planning, structure, arrangements and procedures for the offshore containment, collection and dispersing of pollution of the sea, arrangement and procedures for the onshore protection, collection and clean-up in the shoreline in the event of a spill.

Oil Spills

The FPSO and drilling contractors will be responsible for managing Tier 1 oil spills. These are local oil spills of limited volume to the marine environment that typically will be contained within the safety zone of the installation with local resources offshore.

The FPSO and drilling rigs will be constructed to minimise spills of bunker oil, diesel or hydrocarbons from routine operations and have adequate slop tanks and sewage and waste disposal systems. Stand-by vessels will have equipment onboard for containment, recovery and dispersion.

Pecan Energies will be responsible for managing Tier 2 and Tier 3 oil spills. Tier 2 oil spills are large spills outside the safety zone (500 m) from the offshore installation, but under control (source/flow has stopped). Tier 3 oil spills are large spills that are not under control. Tier 2 and 3 oil spills require support from third parties.

Tier 2 and Tier 3 emergencies will be managed by Pecan Energies IMT in Accra in collaboration with statutory agencies such as the Environmental Protection Agency, the Ghana Air Force, the Ghana Navy, Ghana Maritime Authority and Ghana Port & Harbour Authority as well as 3rd Party expertise and resources. Such expertise and resources include modelling/analysis/reporting, heavy equipment for containment and recovery, aircraft and vessel dispersion, shore protection, shore cleaning and extra manpower. Tier 2 resources are locally stored and Tier 3 resources are acquired from regional or global bases of the 3rd Parties.

Pecan Energies CMT, located at its headquarters in Oslo, Norway, will ensure the required support for the response operations managed locally by the IMT.

10.7 Inspection, Monitoring and Audit

Inspection and monitoring of the environmental impacts of the project activities will increase the effectiveness of the ESMP. The project will establish a schedule for HSSE audits /

inspections of the principal contractors and primary supply chain facilities. Contractors will be required to establish a similar schedule for its activities and those of any subcontractors and suppliers.

Through the process of inspection, monitoring and auditing, Pecan Energies will seek to ensure that the conditions stipulated within the ESMP and its applicable standards, procedures and guidelines are complied with.

Audits and verification on sub-contractors and suppliers will, wherever possible, be performed as a joint effort with the principal contractors.

Inspections, monitoring and audits will be documented and any corrective actions will be assigned owners and timescales for implementation. An action-tracking database will be used to coordinate the close out of corrective actions in a timely manner.

Inspection, monitoring and audit findings, along with their respective improvement programmes, will be regularly reported to the senior management.

Parameters that will be monitored include:

- Fuel consumption (estimating emissions to air from turbines and engines).
- Process water consumption.
- Black, grey and desalination water discharge.
- Completions and well workover fluids discharge (quantity and specified parameters).
- Slops discharge.
- Rig chemicals discharge: rig and Blow Out Preventor (BOP) maintenance chemicals i.e. non-drilling/completion chemicals.
- Waste (hazardous and hazardous quantities).
- Food waste (estimation of food waste generated and discharged based on personnel on board figures recorded on a daily basis).
- Drilling fluid use and discharge.
- Cement use and discharge
- Oil and chemicals spill.

Pecan Energies has an 'Investigate Incident' process which documents the requirements for investigating cause(s) and identifying corrective actions in response to accidents or environmental or social non-compliances.

10.8 Reporting and Review

HSSE reporting will be undertaken according to Pecan Energies HSSE Reporting Boundaries procedure and input provided for project reports and Key Performance Indicators (KPIs) when inside operational boundaries. Incidents and HSSE metrics defined to be inside company and project operational boundaries will be recorded and managed by Pecan Energies.

Contractor reporting requirements shall be agreed and described as part of their contract. The contractors will be responsible for the collection, analysis and onward reporting of HSSE data for their own and any subcontractor's activities. Contractor shall submit HSSE reports to Pecan Energies as part of the regular reporting to the Project.

All contractors and sites engaged in project-related activities shall report their HSSE performance to Pecan Energies on a regular basis and in a specified format. The reporting will be done in accordance with boundary definitions determined by the level of influence Pecan Energies will have on the activities conducted:

- Control – activities directly managed by Pecan Energies or at Pecan Energies sites.
- Influence – activities at sites managed by contractors with whom Pecan Energies has a contract.
- Monitor – activities at sites where Pecan Energies has no formal influence.

Pecan Energies representatives are required to report any suspicion of unethical conduct, which is in breach of the Code of Conduct and/or any applicable laws and regulations, to their line manager. Should the individual not wish to report to their line manager, other channels exist, such as reporting to a support function (Human Resources or Legal), an Executive Manager, Board of Directors or via the Whistleblowing Channel (found on Pecan Energies Intranet and website).

A procedure will be developed to facilitate the implementation of an Energy and Emission Accounting System.

10.9 Documentation and Record Keeping

Responsibilities will be assigned to relevant personnel for ensuring that the ESMP documentation is maintained, and that document control is ensured through access by and distribution to, identified personnel.

10.10 ESMP Review and Amendment

The ESMP will be reviewed and updated on an annual basis and when any changes are identified as necessary via the Management of Change process. Changes may be based on the project design, the environmental and social performance of the project, or updated to reflect changes in planned activities, legislation and company standards.

10.11 Management of Change

Pecan Energies has implemented a Management of Change (MOC) process, to ensure the following.

- All project changes are managed, controlled and traceable by a unified work process.
- Decisions are made in a timely manner and protect the Project economy.
- The impact of the change is fully evaluated, reviewed, authorised (both technically and financially) and documented before it is executed.
- Risks associated with a change are identified, assessed and mitigated to an appropriate level.
- Legal and regulatory compliance is maintained.
- Impacts on safety and operational risk (including environmental performance) are identified and assessed by Environmental and Safety specialists
- All affected parties and relevant stakeholders are involved in or informed about changes.
- Actions required to implement an approved change are identified, assigned to appropriate personnel and completed per schedule.

The MOC process shall be applied to the Project, as a minimum, when a proposed change has one or more of the following consequences.

- Changes that affect a defined list of key project documents once issued for use, such as the Basis of Design or Project Execution Plan.
- Scope change resulting in an increase of more than a defined financial amount, as referenced to the latest published Project cost estimate.
- Significant change to design intent such as changes to the stated HSSE and quality requirements, policy or targets, or organisational changes leading to a loss or transfer of specific knowledge or work experience.

10.12 Related Documentation

A number of existing Pecan Energies documents relate to the safe planning and execution of the Project and are listed in Table 10.3 and Table 10.4. These form part of the Pecan Energies Business Management System (BMS) and project management system.

Table 10.3 Pecan Energies Governing Documents and Business Processes

Document Number	Title
BMS-HSSEQ-PO-0001	Pecan Energies HSSEQ Policy
BMS-HR-PO-0001	Pecan Energies People Policy
BMS-HR-PO-0003	Pecan Energies Local Content Policy
BMS-CSR-PR-0001	Pecan Energies CSR Management Plan
BMS-CP-GL-0001	Pecan Energies Supplier Declaration
BMS-HSSEQ-GL-0001	ALARP Process
BMS-LC-PO-0002	Code of Conduct
BMS-CP-CR-0001	Pecan Energies Company Requirements for Contract And Procurement
BMS-HR-CR-0001	Pecan Energies Company Requirements for Management of HR
BMS-HSSEQ-CR-0001	Pecan Energies Company Requirements for Management of HSSEQ
BMS-RM-PR-0001	Pecan Energies Risk Management Procedure
BMS-HSSEQ-PR-0001	Pecan Energies Risk Tolerance Criteria Procedure
BMS-CSR-PR-0007	Pecan Energies Grievance Redress Mechanism
BMS-CSR-PR-0006	Pecan Energies Community and Social Compensations Procedure
BMS-CP-TC-0009	Supplier Qualification Questionnaire
BMS-HSSEQ-PR-0013	Pecan Energies Travel Procedure

Table 10.4 HSSE Relevant Pecan Phase 1 Project Governing Documents

Document Number	Rev.	Document Title
PECAN1-AKE-Z-FB-0008	-	DWT/CTP Plan of Development June 2023
PECAN1-AKE-Z-FD-0004	05	Metocean Basis of Design
PECAN1-AKE-Z-FD-0006	13	Project Basis Of Design – Pecan1
PECAN1-AKE-U-RA- 0001	08	Flow Assurance Report
PECAN1-AKE-Z-FD-0010	02	Geophysical Basis of Design
PECAN1-AKE-Z-FD-0007	09	Project Functional Requirements
PECAN1-AKE-Z-FD-0008	09	FPSO Functional Specification
PECAN1-AKE-U-FD-0001	03	Subsea Functional Requirements
PECAN1-AKE-O-FD-0001	08	Pecan Operation and Maintenance Philosophy
PECAN1-AKE-O-FD-0002	06	Pecan Subsea Operations and Maintenance Philosophy
PECAN1-AKS-U-FB-0005	05	Pecan Barrier Philosophy Subsea Production System
PECAN1-AKG-U-FD-0001	03	Pecan Commissioning Start-Up and Handover Philosophy
PECAN1-AKE-S-SA-0002	04	Technical Safety Requirements
BMS-CSR-PR-0002	03	Pecan Energies Stakeholder Engagement Plan
BMS-CSR-PR-0003	03	Ghana CSR Community Investments Plan
PECAN1-AKG-S-TA-0001	05	Ghana Security Plan
ECAN1-AKE-Z-GU-0004	03	Project Crisis and Emergency Response Strategy
PECAN1-AKE-S-TB-0001	04	Pecan HSSE Management Plan
PECAN1-OCO-S-RA-0002	01	FPSO HSE Philosophy incl. Working Environment

11. Summary and Conclusions

11.1 EIA Process

This EIA for the proposed Pecan Project was undertaken in accordance with the Ghanaian Environmental Assessment Regulations (LI 1652, 1999). 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 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 used to inform the impact assessment. These included a marine EBS and follow up survey of water and sediment chemistry, a fisheries study, key-informant and community-level consultations in the six coastal districts of the Western Region. 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 drill cuttings, produced water and wastewater discharges and the 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 Project and developing conditions for approval.

11.2 Summary of Impacts and Mitigation

Table 11.1 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.

11.3 Overall Conclusion

The findings of the EIA presented in Chapter 5 indicate that there are no issues of Major significance that could not be mitigated such that the Project was not acceptable from an environmental and socio-economic perspective. The significance of all impacts will be reduced to Moderate or Minor significance (or not significant) through design, use of control technology and operational management controls.

The only negative Moderate significance residual impacts results from greenhouse gas emissions.

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 5.

Granting of environmental authorisation for the 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 11.1 Summary of Mitigation Measures

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
Section 6.3	Seabed impacts on the benthic environment.	The 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, sediment disturbance and disruption to defined areas of the seabed and impacts on seabed habitats, component species and demersal fish that rely on these habitats.	*Small*, footprint and secondary disturbance will be localised and affects a very small area	*Low* given the generally featureless benthic habitat and relatively homogeneous benthic fauna across the survey area	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.	Not significant
Section 6.4	Underwater sound.	The Project will be the source of underwater sound from a number of activities including drilling, facilities installation and operation. Noise impacts will occur mainly to marine mammals but also to a lesser extent to turtles and fish.	*Small*, the area over which noise impacts will occur is very small compared with the area over which affected species range	*Medium* for marine mammals as they tend to exhibit behavioural responses to anthropogenic noise	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. 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 using vessels operating in the field.	Minor significance
Section 6.6	Lighting and flaring impacts mainly on birds, but also fish and turtles.	Lights (and flares where used) on the MODU, FPSO and support vessels could potentially attract, disturb and disorientate seabirds and turtles feeding or passing through the area. Attraction or disorientation could increase the risk	*Negligible*, given the distance from shore and therefore the low likelihood of sensitive	*Low to Medium* for birds and marine turtles	The requirements for lighting and use of flaring will be dictated by operational safety. As part of the lighting planning the following principles will be taken into consideration to reduce the effects of light pollution. • Avoid unnecessary light use;	Not significant

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
		(albeit low) of collisions with the MODU, FPSO and other vessels.	species (i.e. terrestrial birds and juvenile turtles) being present		• Closed flare with no pilot flame; • Avoid operational flaring except for: ○ during project start-up; ○ during well clean-up to drilling vessel; ○ during planned maintenance shutdown (on average 10 days annually); ○ when required for safety of persons engaged in petroleum operations in accordance with international petroleum industry practice; ○ during unplanned gas injection downtime..	
Section 6.7	Risk of collision with marine mammals and turtles.	Large fauna swimming at or near the sea surface are most likely to be at risk from collision with the Project vessels. Turtles and species of larger, slow-moving whales are usually considered to be most at risk from vessel collision.	*Negligible*, when considered alongside existing threats and risks to these animals.	*Medium* for turtles and marine mammals	Measures for reducing vessel-animal collision risk will include direct observation, communication and navigational responses, particularly speed restrictions when the risks of collision are expected to be high. Support and supply vessels will adopt observation as part of regular navigation, communication and navigational responses, to reduce collision risks with marine mammals and turtles.	Not significant
Section 6.5	Aerial noise impacts on natural populations.	Closer to sensitive receptors the main potential impacts will be from general port activities involving Project vessels and helicopter flights to and from the offshore Project area.	*Negligible* for port activities and negligible for helicopter flights as they will avoid	*Medium* for people living near the port and high for Amansuri Wetland IBA	Helicopter flight planning will make provisions to avoid sensitive areas of population and nature conservation. Pecan Energies will assure that the helicopter operator follows national and local regulations and restriction regarding flight routes.	Not significant

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
			sensitive areas			
Section 6.8	Drilling discharges (fluids and cuttings).	Impacts on sediment and water quality and associated benthic and water column fauna. Modelling shows that small areas near the MODU will be affected.	*Small*, in terms of amount of habitat affected compared with that available in the wider area.	*Low*, habitat affected is of low ecological importance	Solids control systems will be used, including dryers and centrifuges, to reduce oil on cuttings to a target of 2 to 5% based on the BAT assessment. 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.	Not significant
Section 6.9, Table 6.4	Well completion and workover discharges.	Potential effects on water quality and marine biota.	*Small,* temporary and localised	*Medium*, water column habitat affected is of medium ecological importance	Chemical selection and use will be advised by 'Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2011)'. Completion fluids will be tested for total oil and grease content to ensure that it is below the specification for discharge to sea (i.e. daily limit of 40 mgl-1 or 30 day average of 29 mgl-1 as per EPA (2011). If the fluids exceed the specification they will be retained on the vessel and shipped for onshore disposal. If acid is used during well completions or workovers, the spent acid will either be injected into the rock formation or neutralised prior to discharge to sea.	Not significant
Section 6.9, Table 6.4	Black and grey water discharge.	Discharges of black water (from toilets) and grey water (from washing, laundering, bathing and showering) and	*Small*, localised	*Medium*, water column habitat	Black water will be treated using a marine sanitation device that treats the waste and produces an effluent with a maximum residual	Minor significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
		macerated food waste. Potential effects on water quality and marine biota.		affected is of medium ecological importance	chlorine concentration of 0.5 mg l^{-1} and no visible floating solids or oil and grease. Under MARPOL grey water does not require treatment before discharge. Food wastes will be macerated to acceptable levels such that they will pass through a 25 mm mesh.	
Section 6.9, Table 6.4	Hazardous deck drainage from MODU and FPSO.	Residual hydrocarbon content after treatment. Impacts on water quality and marine biota.	*Small*, localised	*Medium*, water column habitat affected is of medium ecological importance	Hydrocarbon contaminated fluids will be routed to a hazardous drain tank with oil/water separation. The hazardous drain tank will be heated, as necessary, to aid oil / water separation and there will be provision for biocide treatment. Process fluids sent to the hazardous drain tank will not be recycled into the process unless approved. To manage the volume of fluids in the system, the main deck scuppers (holes to allow drainage) will have plugs that are typically opened manually during heavy rains to allow excess water to be discharged to sea. Drains will be provided with removable covers to prevent debris from entering the system.	Minor significance
Section 6.9, Table 6.4	Non-hazardous deck drainage discharge from various Project vessels.	Occasional impacts on water quality and marine biota in close proximity to the vessels.	*Negligible*, after treatment impacts localised and temporary	*Medium*, water column habitat affected is of medium ecological importance	Non-hazardous drains will be provided with removable covers to prevent debris from entering the drains systems. The system will have provision for biocide treatment.	Not significant
Section 6.9, Table 6.4	Bilge water discharge from	Occasional impacts on water quality and marine biota in close proximity to the vessels.	Negligible, after treatment	Medium, water column habitat	Treatment in the bilge water separator to achieve no free oil and maximum 15 ppm instantaneous reading oil water threshold.	Not significant

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
	various Project vessels.		impacts localised and temporary	affected is of medium ecological importance	If onboard treatment to the required standard is not possible the effluent will be retained onboard until it could be discharged to an approved reception facility.	
Section 6.9, Table 6.4	Ballast water discharge from various Project vessels.	Occasional impacts on water quality and marine biota near the vessels.	Negligible, after treatment impacts localised and temporary	Medium, water column habitat affected is of medium ecological importance	Project vessels will be designed with separate ballast tanks, according to class notation and MARPOL. Discharges will meet standards of no free oil and maximum 15 ppm instantaneous reading oil water threshold. Discharges will meet the requirements of the International Convention for the Control and Management of Ships' Ballast Water and Sediments. Project vessels will have onboard and implement a Ballast Water Management Plan. All ships using ballast water exchange will do so at least 200 nm from nearest land in water at least 200 m deep. The FPSO, MODU, supply and support vessels, installation vessels and incoming export tankers 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.	Not significant
Section 6.9, Table 6.4	Discharges of pre-commissioning treated seawater from flooding, cleaning and gauging flowlines, hydrotest and leak tests and pre-	Impacts on water quality and marine biota close to the seabed points of release. The larger volumes discharged during hydrotesting may lead at most to temporary, small, localised effects on benthic communities.	*Small*, localised	*Medium*, water column habitat affected is of medium ecological importance	Chemicals will be chosen to be minimise impacts on the aquatic environment in accordance with the Guidelines for Environmental Assessment and Management in the Offshore Oil and Gas Development (EPA 2011).	Minor significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
	commissioning gas system dewatering fluids.					
Section 6.9, Table 6.4	Discharges of production system commissioning fluids from FPSO.	A small-volume one-off discharge with impacts on temporary, small, localised effects water quality and marine biota.	Negligible, temporary and very localised	Medium, water column habitat affected is of medium ecological importance	Treated water will be processed on the FPSO via the oil in water (OIW) treatment system. Diesel / crude will be routed to the crude oil stock tanks.	Not significant
Section 6.9, Table 6.4	Releases of hydraulic fluid.	Occasional infrequent release of small quantities of low-toxicity fluids with temporary localised impacts on water quality and marine biota.	*Negligible*, temporary and very localised	*Medium*, water column habitat affected is of medium ecological importance	The subsea control system will use a water-based hydraulic fluid that is biodegradable with low toxicity and minimal impact to the marine ecosystem rated yellow according to the Ghana Guideline on Environmental Assessment and Management (EPA 2011).	Not significant
Section 6.9, Table 6.4	Discharge of cooling water from FPSO.	The discharge will introduce a temperature differential and residual chlorine with impacts on water quality and marine biota. Modelling shows adequate dilution within 500 m.	*Small*, on-going discharge with effects up to 500 m from FPSO	*Medium*, water column habitat affected is of medium ecological importance	Chlorine dosage will be kept to the minimum required to achieve disinfection and will be verified through monitoring.	Not significant
Section 6.9, Table 6.4	Discharge of produced water from FPSO.	Residual hydrocarbon content after treatment will have impacts on water quality and marine biota. Modelling shows the impacts will be over a small area. Mobile species will tend to avoid or be less exposed than plankton.	*Small* for plankton and *Negligible* for other fauna	*Medium*, water column habitat affected is of medium ecological importance	Produced water will be continually monitored and if oil in water (hydrocarbons) exceeds the daily limit of 40 mgl^{-1} or the 30 day average of 29 mgl^{-1} as per EPA (2010), the water will be routed to the off-specification tank for further treatment prior to any discharge.	Minor significance for plankton

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
Section 6.10	Emissions from vessel engines, impacts on air quality.	The Project will emit various pollutants to atmosphere as a result of combustion products (e.g. from power generation, vessels' engines) and from processes on board the FPSO. There is also the potential for fugitive emissions (e.g. volatile organic compounds during loading of oil to the shuttle tankers). However it is a large distance from sensitive coastal receptors. Emissions from shore-based activities will be negligible compared with existing terrestrial emissions.	*Negligible* impacts will occur on air quality at coastal receptors	*High*, for coastal community receptors	The FPSO and MODU, construction/installation and support/supply vessels will comply with MARPOL 73/78 Annex VI standards with regards to emissions to air. Annex VI sets limits on oxides of sulphur and nitrogen 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. The Project will use low NOx GTGs and use marine diesel fuel. Methods for controlling and reducing leaks and fugitive emissions, such as the use of hydrocarbon gas for crude oil storage tank blanketing together with a vapour recovery unit, will be implemented in the design, operation and maintenance of the FPSO. Routine flaring will be avoided and non-routine flaring will be kept to a minimum to maintain safe conditions or during short-duration activities such as commissioning, start-up, re-start and planned maintenance activities	Not significant
Section 6.11	Greenhouse gas emissions.	Project activities will emit varying amounts of Greenhouse Gases (GHGs) (e.g. carbon dioxide (CO_2) and methane (CH_4)), which contribute to global climate change. GHG emissions have been estimated for the Project and include well drilling and completions,	*Small*, average 0.8% increase in national CO_2 emissions	*High*, contributing cumulatively to climate change	The mitigation measures aimed at reducing GHG emissions to as low as reasonably practicable are generally built into the design of the FPSO and focus predominantly on: • efficiency of power generation; • optimisation of overall energy efficiency;	Moderate significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
		subsea and FPSO installations, commissioning and operations.			• reduction in flaring; and • reduction in venting.	
Section 6.12.2	Potential impacts on the marine and onshore environment from waste segregation and storage.	The Project during its various stages will produce a variety of wastes that will require handling both offshore and onshore. Inappropriate or inadequate storage of wastes could lead to impacts on the marine and terrestrial environments.	*Negligible*, all wastes will be strictly managed	*Medium*	There will be designated areas for the temporary storage and segregation of waste 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 will be through operational controls. The key procedures for controlling wastes from offshore and onshore will be set out in the Project Waste Management Plan (WMP) which will be developed based on the specific requirements of the Project. The WMP will cover both offshore (the FPSO, supply vessels, installation vessels and the MODU during well drilling and completions) and onshore (support base at Takoradi Port and supply base, offices and helicopter facilities at Takoradi Air Force base) Project facilities.	Not significant
Section 6.12.3	Potential impacts on the marine and onshore environment from transport of waste.	The Project during its various stages will require wastes to be transported to port and then from port to waste management facilities. Inappropriate or inadequate handling of wastes during transport could lead to impacts on the marine and terrestrial environments.	*Negligible*, all wastes will be strictly managed	*Medium*	Mitigation of potential impacts during waste transport will be by the way of operational controls. These will be documented in the WMP. Operational controls will include the following. • Waste will be transported in a safe manner, in accordance with the associated Safety Data Sheets (SDS) information for spent chemicals and other industry packaging and transport advice.	Not significant

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
					• 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 vessels and vehicles that are crewed/driven by appropriately trained and licensed operators. • Vessels and vehicles to be used for transporting wastes will be assessed and approved to meet minimum standards and Project vehicle policy. • Waste will only be transported by Project and EPA approved waste contractors.	
Section 6.12.4	Potential impacts on the environment (onshore) from the treatment and disposal of waste.	Even with the application of reuse and recycling as part of Project waste management procedures there will be residual hazardous and non-hazardous wastes that require disposal.	*Small*, wastes will be strictly managed	*Medium*	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. Waste tracking procedures as defined in the WMP will be implemented to provide traceability from source of generation to end point. Waste will be treated and disposed in accordance with procedures outlined in the Project WMP.	Minor significance
Section 6.14.2	Impacts on fishing activity due to the	The Project area is in a deep-water offshore area in a water depth that precludes trawling or other bottom fishing activities. Therefore, pelagic	*Negligible*, the safety zone is very small	*Medium*	CLO's will cover the coastal districts to liaise between fishermen and the Project and to provide information to fishing communities regarding Project activities and notifying them of	Not significant

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
	presence of the MODU and FPSO.	fishing methods are used in these areas, mainly targeting large oceanic species, using passive gear (longlines) and active gear (pole and line, purse seines).	compared with the area available for fishing.		the requirements to keep away from the operations for safety reasons. The CLOs will also deal with any complaints through Pecan Energies grievance mechanism.	
Section 6.14.2	Impacts on fishing activity due to the movement of vessels between Pecan field and shore.	Vessels in transit could interfere with fishing activity over a wider area, including smaller fishing vessels nearer to shore.	*Small*, any interference will be localised and small scale	*Medium*	Pecan Energies and its contractors will notify mariners and fishers of the presence of the MODU, FPSO and other marine operations within the 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 and enforced by Pecan Energies with the assistance of the agencies of the Government of Ghana.. Pecan Energies will develop a code of practice based on the UN Voluntary Principles of Security and Human Rights, and give training for those responsible for maintaining the safety zones. Fishery Liaison Officers (FLO) will be placed on the guard vessels to ease communication with potential intruders of the safety zone in the local language. A vessel transit route will be agreed with the GMA and communicated to fishermen and other marine users. Pecan Energies will 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.	Minor significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
Section 6.14.3	Benefits to Ghana nationally from increased Government revenue.	The primary economic impact of the operational phase of the Project will be the payment of taxes and royalties related to the income production by the Pecan Project.	*Medium*	*Medium*	Good governance and fiscal management are the key measures for Ghana's benefit from the economic gains by the royalties and taxes paid by the Project. The absolute value of oil will also be a key factor and it will depend directly on market prices. Pecan Energies 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.	Moderate significance (positive)
Section 6.14.4	Potential benefits from employment and skills development.	The Project is expected to contribute to the creation of direct and indirect employment opportunities in the Western Region. Given the nature of the Project's activities, the majority of the jobs will need to be filled with qualified and experienced personnel.	*Small* as few additional employment and training opportunities will be created	*Medium* due to the high-level expectations of the population at a regional level,	Pecan Energies will seek to enhance local employment and skills development from direct and indirect employment through the development of an Employment and Training Plan as part of the Local Content Plan (LCP). The plan will contain the following measures. • Pecan Energies will develop guidelines on recruiting and employment practices, training and succession practices, and reporting of training and employment activities, to ensure compliance with applicable requirements and to achieve Pecan Energies strategic employment and training local content objectives. • Pecan Energies will include the plan for recruitment, employment and training of local personnel in Ghana as a requirement to engage with Contractors and Subcontractors. • Where qualified Ghanaian personnel are available for employment to support operations, whether staffed directly or via third party, Pecan Energies will develop	Minor significance (positive)

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
					procedures to provide opportunities for employment/services as far as reasonably possible. Where possible, priority will be given to vulnerable groups such as women and youth. • The Project'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 via national or local media at an early stage to manage job-seekers expectations. • Relevant job opportunities will be specifically communicated via district and municipal authorities to communities in the coastal districts of the Western Region by the CLOs. CLOs will also provide information on job application procedures.	
Section 6.14.5	Opportunities to provide benefits through the procurement of goods and services.	During the lifetime of the Project there will be procurement of goods and equipment (e.g. food, fuel, chemicals and other consumables), and services (e.g. onshore administrative support, accommodation staff, security, catering, cleaning) from national and, where possible, local businesses.	*Small*, there will be a relatively low level of supply of goods and services (fuel, food, water, repair and maintenance services)	*Medium*, due to the risk of having unmet expectations for local employment and procurement of goods and services	Additional measures to be included into the LCP to enhance procurement of goods and services from companies in Ghana include the following. • Pecan Energies has policies and procedures to support the strategy. Contractors will also be required to support and implement the national content strategy and policies/ procedures that support it. • Pecan Energies has contract conditions that ensures the requirement for local content and procurement is passed to contractors, so that goods and services are purchased regionally or nationally where possible, and	Minor significance (positive)

EIS Reference	**Issue**	**Impact Summary**	**Magnitude (S/M/L)**	**Value/ Sensitivity (L/M/H)**	**Key Mitigation Measures**	**Impact significance**
					employment rights and conditions are respected. • Pecan Energies 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, e.g. through pre-tender workshops and training. • Pecan Energies will audit local content through site visits and interviews to monitor and track the effects of the contractors' strategy to maximise local content over the life of the Project. • Pecan Energies will ensure that the Grievance procedure in place will be accessible to all suppliers.	
Section 6.14.6	Protection of workers' rights.	Workers' rights, including occupational health and safety, will need to be addressed to avoid accidents and injuries, loss of man-hours, labour abuses and to ensure fair treatment, remuneration and working or living conditions. These issues need to be considered not only for those who are directly employed by Pecan Energies but also its contractors (including sub-contractors) and within the supply chain.	*Small*	*Medium*	Pecan Energies will develop a People Policy that includes the following measures. • Contracts will the right for the Project monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching the required standards, Pecan Energies policies or clauses in the contract. • Pecan Energies, contractors and subcontractors will put in place hiring mechanisms to ensure that no employee or job applicant is discriminated against on the basis of his or her gender, marital status,	Minor significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
					nationality, age, religion or sexual orientation. • Pecan Energies will provide training on workers' rights as part of their induction. Pecan Energies will also require contractors and subcontractors to provide training on workers' rights to its employees. • Pecan Energies, contractors and subcontractors will ensure that all their employees have contracts that clearly state the terms and conditions of their employment and their legal rights. • Pecan Energies, contractors and subcontractors will verbally explain contracts to all their workers where this is necessary. • Pecan Energies will undertake robust compliance monitoring of all contractors and sub-contractors. • Pecan Energies will review and monitor the outcomes of community engagement, media coverage and its workforce and community grievance mechanism regarding labour welfare issues. • Pecan Energies will update the Health, Safety, Security and Environment System including the following measures. • Pecan Energies will not accept forced labour, child labour or any form of human	

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
					trafficking including purchase of sexual services. • Surveillance programs for workers health status will be established and implemented. • Occupational health and safety training to all workers, including contractors and subcontractors will be provided. • In all contractor contracts, the Project will make explicit reference to the need to abide by national law, international standards and Pecan Energies policies in relation to health and safety, labour and welfare standards. • Contractor contracts will specify monitoring to be undertaken by the contractor, establish the right for the Project monitoring and auditing of all contractors and subcontractors and the consequences for the contractor if they are found to be breaching national legal requirements, international standards, policies or clauses in the contract. Contractor contracts will specify that the same standards will be met by their sub-contractors and suppliers.	
Section 6.14.7	Impacts on commercial shipping.	Additional vessel movements associated with the Project could arise as a potential source of impact on existing navigation and shipping traffic in the area. During the installation of the Project offshore more significant numbers of vessels will be involved and	*Small*	*Medium*	Pecan Energies will develop a Marine Traffic Management Plan to ensure appropriate protocols are followed during offshore vessel movements. This plan will also consider vessel movements associated with other Projects in the area as well as fishing and commercial shipping traffic. The plan will aim at reducing risk of	Minor significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
		impacts could be largest during this phase.			vessel collision and minimising inconvenience to other sea users through a number of Project-specific measures.	
Section 6.14.8	Potential impacts on community health, safety and security.	Onshore activities associated with the Project could affect the health, safety and security of the communities around the shore base facilities (e.g. worker-community, interactions, traffic movements, pressure on health care resources). Any community concerns or perceptions with regard to reduced health and physical safety by the community need to be addressed.	*Small*	*Medium*	Pecan Energies has developed a HSSE management approach outlining its responsibility for its personnel by means of systems and procedures to: • perform Industrial Hygiene sampling; • conduct medical surveillance; • exercise drug and alcohol control at the heliport; • assist in rehabilitation of personnel; and • record and monitor health certificates. The Pecan Energies HSSE management system is aligned with the objectives of IFC Performance Standard 4. CLOs will inform local fishermen from the coastal communities of the offshore activities, locations, vessel movements, routes and timing, as well as the safety reasons for keeping away from operational areas.	Minor significance
Section 6.14.9	Potential impacts from an influx of job seekers.	The expansion in communication, energy, transportation, water and sanitation, the social interactions of people and the development of the oil and gas industry over the past years, mainly based in Sekondi, Takoradi city, function as a pull factor to attract	*Small,* localised and small scale in relation to the extent of in-migration already	*Medium*	Facilitated by its Stakeholder Engagement Plan, Pecan Energies will seek to develop strong partnerships with government agencies, traditional authorities, district assemblies, youth groups, non-governmental organisations (NGO), community-based organisations (CBO), civil society, fishing communities and other relevant	Minor significance

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
		migrants into the city from different parts of the country. As the development of the oil and gas sector off the coast continues, additional influx of employment seekers can be expected into the Takoradi-Secondi municipality.	experienced in the Western Region		stakeholders. Pecan Energies will adopt a proactive approach to sharing information with stakeholders and gathering feedback on potential issues arising. In all relevant CSR projects, Pecan Energies will seek to actively engage affected stakeholders and local communities throughout the project cycle. If it is determined through feedback from stakeholder engagement / grievances that there is need for implementing measures to manage Project induced migration influx, appropriate measures shall be considered in consultation with the key stakeholders especially, the Regional Security Coordinating Council to minimize the negative impacts of rapid in-migration. This plan would consider the immediate measures to manage the negative impact and medium-long term approach to avoid recurrence of such impact.	
Section 6.14.10	Risk of heightened and unmet expectations regarding potential benefits.	People in the Western Region are anticipating that oil and gas developments in the region will provide employment opportunities. More specifically, the communities are expecting that jobs will be made available for the youth who are unemployed or who are employed but seeking alternate employment.	*Small*	*Medium*	Implementation of the Stakeholder Engagement Plan (SEP) will be the key mitigation measure to redress the incorrect public perceptions about potential Project benefits and for addressing public expectations related to development opportunities and investments.	Minor significance
Section 6.14.11	Impacts on local communities from	In addition to the expansion of the existing offices in Accra, the Project will establish a base within Takoradi port, comprising the use of a supply vessel	*Small*	*Medium*	The means to manage the potential impacts from use of the facilities in Takoradi port will be focused on the implementation of engagement activities as defined in the SEP and the grievance	Minor significance

EIS Reference	**Issue**	**Impact Summary**	**Magnitude (S/M/L)**	**Value/ Sensitivity (L/M/H)**	**Key Mitigation Measures**	**Impact significance**
	shore-based activities.	berth, offices and material storage and laydown areas. These will all be within the existing established complex. In addition, accommodation in Takoradi for Pecan Energies staff will be required. Existing facilities will be adequate to support the Project and therefore no new-build infrastructure dedicated to the Project will be required.			mechanism. Pecan Energies CLOs will disseminate information about the Project to the community and process any suggestions, complaints or grievances received. Pecan Energies will undertake periodic audits and reviews of its shore-based operations to review site HSE performance and take corrective actions as required. Periodic audits of third-party operations and facilities will also be carried out. This will involve routine management meetings with the main operators of these facilities and the agreement of common environmental and social management measures. A Traffic Management Plan will be developed including the following. • Engagement with local authorities to acknowledge the traffic patterns in the road network, optimise traffic routes, minimise traffic queuing to the extent practicable. • Some abnormal loads will need to be delivered from time to time. These will be scheduled wherever possible during off-peak periods. • Precautions will be taken by the Contractor to avoid damage to the roads. Any road damage will be repaired to an equal or better standard in a timely manner.	

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
					• Traffic flows will be timed, wherever practicable, to avoid periods of heavy traffic flow along main roads. • Measures to avoid damaging local infrastructure, control all vehicle movements and implement maintenance procedures. • Measures to define behaviours for safe driving as well as driver training and driver competence requirements. • The Project will establish a Grievance Mechanism to follow-up and close out any traffic related issues reported by stakeholders. • Regular road safety awareness campaigns in surrounding schools, markets etc. to sensitise other road users	
Section 6.14.12	Impact on Cultural Heritage.	Offshore, there are no historical records of wrecks sites in the Project area or evidence of wreckage from the site surveys undertaken. The location of shore-based offices will be within existing facilities at Takoradi port therefore there is minimal potential for impacts, therefore no mitigation is required.	*N/A*	*N/A*	*N/A*	Not significant
Section 6.15	Ecosystem Services	The potential impacts on Ecosystem Services are addressed in the various impact assessment sections and summarised in this table.	*N/A*	*N/A*	*N/A*	N/A

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
Section 6.16	Offshore cumulative impacts.	The offshore impacts from the Project are generally localised to the Pecan field area, and specifically at the FPSO and subsea infrastructure locations. The Pecan field is some distance from other offshore oil and gas activity and the potential for impacts on the same receptors is limited.	*N/A*	*N/A*	The mitigation measures implemented to address the individual Project impacts assessed in the EIA will address cumulatve impacts.	Not significant.
Section 6.16	Onshore/nearshore cumulative impacts.	Closer to shore the support and supply vessels for the Project will add to the general maritime traffic moving between oil and gas fields and shore bases and cumulative impacts on other sea users (including fisheries). Onshore, the potential exists for both positive and negative impacts, particularly if Takoradi continues to develop as a base to serve a growing offshore oil and gas industry.	*Small*	*Medium*	Strategic actions by government and industry will be required to manage nearshore/onshore impacts if the oil and gas industry develops further in Ghana.	Minor significance
Section 6.17	Navigation Risk.	The MODU and the FPSO present a theoretical hazard to passing third party shipping (as well as to supply, support and standby Project vessels and the visiting offloading tankers). Collision between vessels of sufficient energy could lead to injuries, fatalities, loss of assets and release of harmful materials (especially fuel oil or crude product oil) to sea. Based on the collision risk modelling and the extent of mitigation that will be applied, with passing third-party vessels	*N/A*	*N/A*	The FPSO hull will be modified with double side on the side where vessels are approaching. Large parts of the opposite side will be covered by riser installations. The FPSO already has a double-bottom hull. The Project vessels will adhere to standard navigational procedures while on station, together with Project-specific operational procedures in accordance with the International Guidelines for Offshore Marine Operations (G-OMO) guidelines. G-OMO is a standard global approach to encourage good practice and safe vessel operations in the offshore oil and gas industry. The guideline covers all relevant	The risks of collisions occurring are assessed as being low

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
		is very unlikely to occur in the first place and if a collision did occur it is unlikely to have sufficient energy to lead to significant effects on people and the environment.			aspects from vessel procurement, voyage planning, mobilisation, loading, outward voyage, approach to location, working at location, departure from location and inward voyage. A specific guide is prepared related to collision risk management within GOMO. The “Field operations Manual” for Pecan will be updated for Pecan to reflect the G-OMO guidelines as well as the local Metocean conditions. In terms of collision risk management at the field the following measures will also be implemented during drilling and production. • The ship traffic around the locations will be monitored by a dedicated stand-by vessel onsite equipped with AIS and ARPA radar (or similar). • A 500 m safety zone around the MODU and FPSO will be established. • The team directing operations on the (supply vessel) bridge will have the necessary experience for the planned operations. • Visiting vessels will be required not to use the FPSO as a final waypoint in their sailing plan and should set a course which is off set from the FPSO and at a tangent to the safety zone	

EIS Reference	Issue	Impact Summary	Magnitude (S/M/L)	Value/ Sensitivity (L/M/H)	Key Mitigation Measures	Impact significance
					• Entry to the 500m safety zone thereafter to the set-up position will be taken at a speed of 3 knots or less. • Prior to entering the safety zone of the MODU or FPSO, the pre-entry check list for the vessel will be completed. • Specific measures for the offloading tanker approach and offloading minimum set-off distance. • A riser exclusion zone prohibiting vessel movement close to risers will be established. • An operational limit will be established limiting visiting vessel operations to within the one-year weather state limit. Regarding passing third-party vessels, details of the planned drilling programme and production operations will be notified to other sea users through the "Notice to Mariners" system, as well as through NAVTEX and NAVAREA.	
Section 6.18	Oil spill and potential consequences to the marine and coastal environments (natural populations and humans uses).	The risk of an oil spill into the marine environment is inherent in all offshore oil developments. The likelihood (probability) of significant oil spills, i.e. those that can reach the shoreline or other sensitive areas from the Pecan Project area is very low with most oil spills associated with offshore	*N/A*	*N/A*	Mitigation of oil spill incidents 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 occurring in the first place. Avoidance of oil spill incidents is highly dependent on design and planning (including training and emergency response exercises). Pecan Energies will be	All four spill scenarios examined (which included a worst case) are rated as risk level: 'tolerable if as low as

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		installations being small and having only limited environmental effects. Oil spill scenarios for the Project have been modelled.			responsible for ensuring that oil spill risks have been fully considered and addressed to the extent that residual risks have been reduced to as low as reasonably practicable (ALARP). Pecan Energies will have 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 will be based on the standard 3-tiered response approach.	reasonably practicable'.

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