

reaches shore and the oil reaches the coastline over a period of just over two days (49 hours).

Figure 5.12 *Trajectory of Instantaneous Spill of 100 tonnes crude at Well M1.*

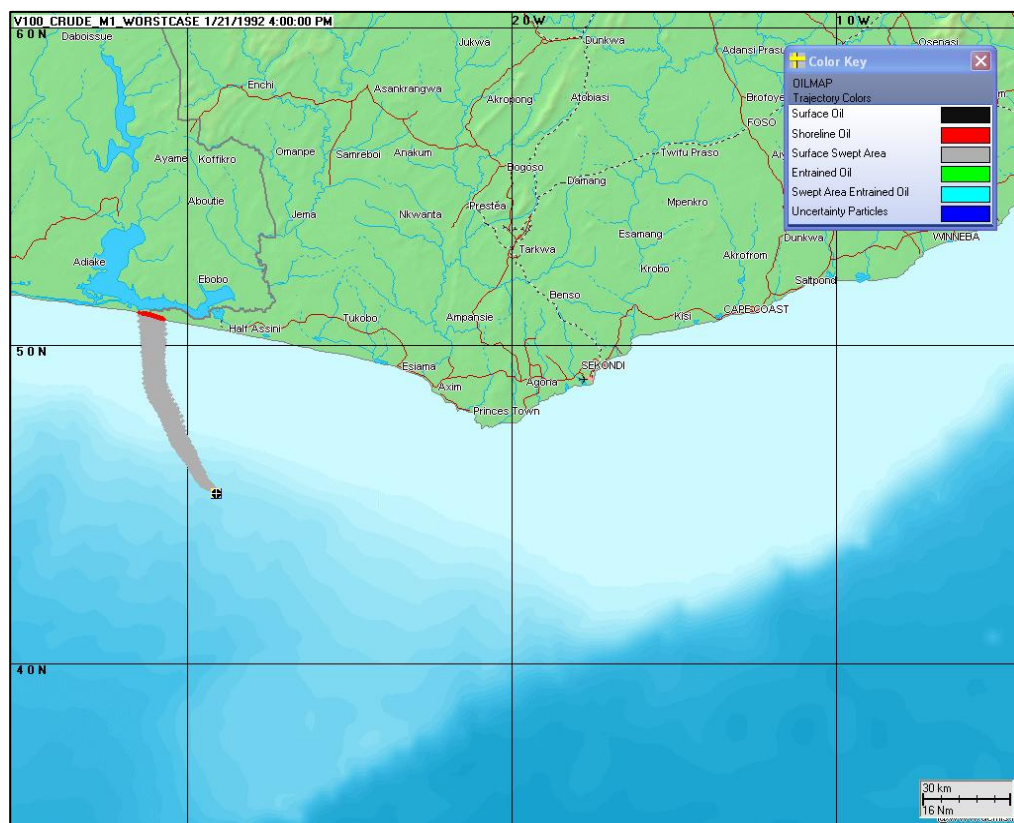
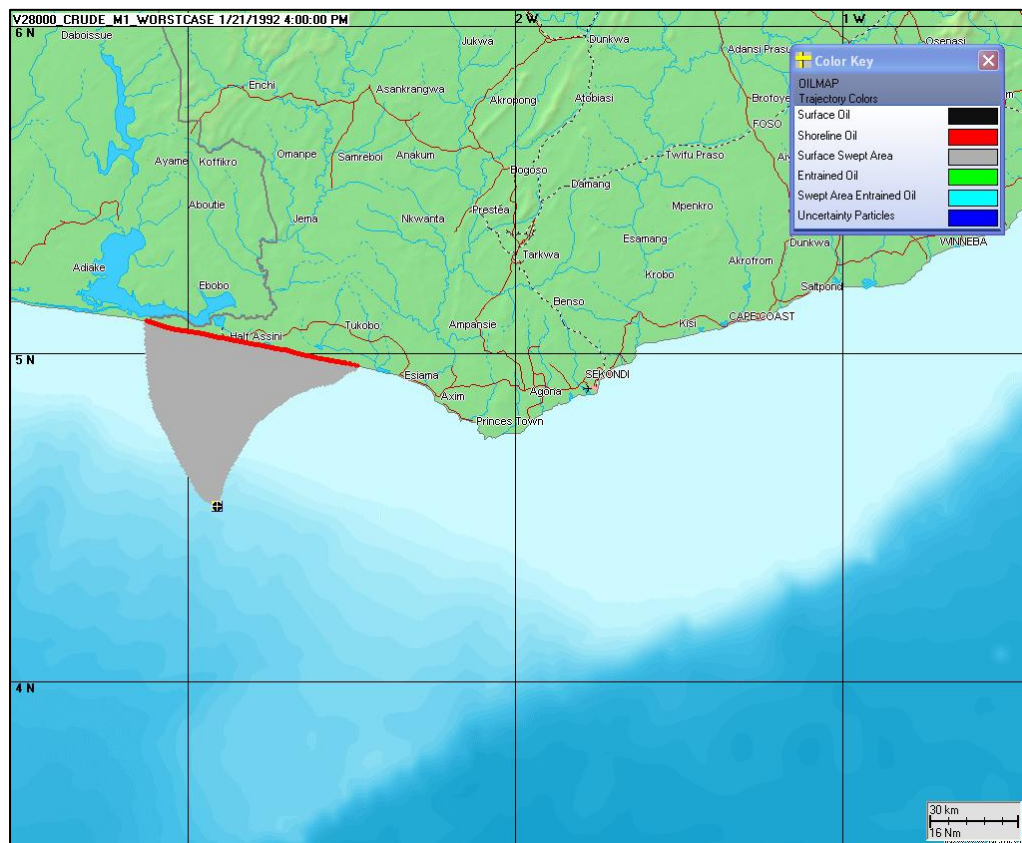
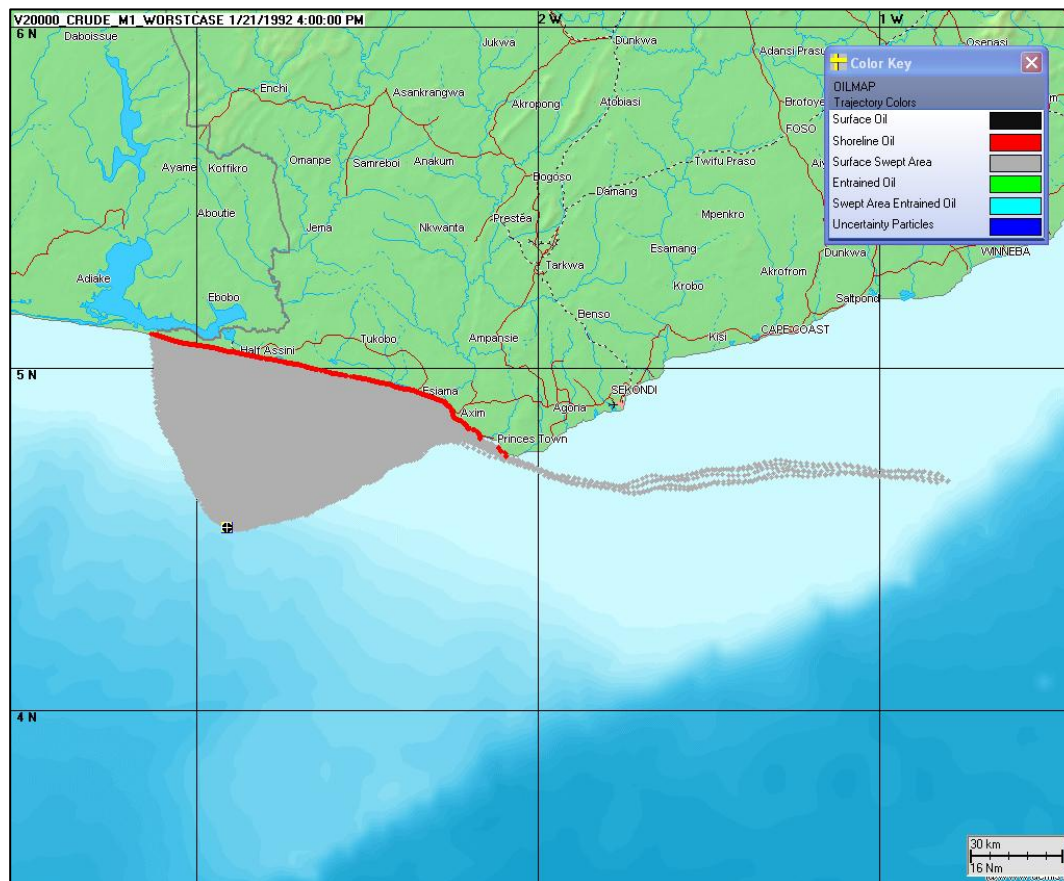


Figure 5.13 *Trajectory of 48-hour spill of 28,000 Tonnes crude at Well M1.*



- The 168-hour duration 20,000 tonnes of crude spill (*Figure 5.14*) shows the largest oiled footprint of all the scenarios due to winds shifting slightly over the long duration of the release. Approximately 125 km of shoreline are potentially impacted by the spill. Oil reaches the shore (approximately 49 hours) while oil is still being released at the well site.

Figure 5.14 *Trajectory of 168-hour spill of 20,000 Tonnes Crude at Well M1*



Modelling Conclusions

The key conclusions from the results of the stochastic and deterministic (trajectory / fate) modelling can be summarised as follows.

- The stochastic modelling showed that for all the eleven scenarios the predominant transport of spilled oil is to the east.
- The probable footprint for the area of sea and coastline potentially impacted from an oil spill varies with the spill size; ranging from no shoreline impact predicted for small spills of 10 tonnes of diesel to more than 100 km for large crude oil spills of 1,000 tonnes or more.
- Spilled oil could reach the Ghana shoreline in 1 to 2 days although the average time to reach shore is 2.5 to 4.5 days.

- The shoreline with the highest probability of being oiled is the stretch of coast 100 km west of Cape Three Points. East of Cape Three Points a longer reach of shoreline could potentially be oiled, but the probability of oiling is generally 1 to 15%.
- For a very large spill (ie 20,000 tonnes) there is a significantly higher probability that oil would beach on the stretch of coastline (40 to 50%) approximately 100 km west of Cape Three Points. Although it is possible that a larger area of coastline east of Cape Three Points would be exposed to oil beaching it should be highlighted that the probability of this area being affected is only 1 to 10%.
- The deterministic (trajectory/fate) modelling simulation showed that the first oil reached the shoreline approximately 45 hours after the spill began.
- The extent of shoreline oiling was directly related to the duration and volume of the oil release. An instantaneous relatively small spill (100 tonnes) resulted in 10 to 12 km of shoreline impacted. Longer duration spills of much larger volume result in up to 125 km of coastline being oiled.
- None of the oil spill modelled indicated that transboundary impacts on neighbouring countries were likely

5.6.6

Assessment of Impacts of Oil Spills

Introduction

As stated in *Section 5.6.1* the potential environmental impact of an oil spill is related to the likelihood of a spill occurring and the magnitude of the consequence (taking into account sensitivity/value of receptor and size of spill). The previous sections discussed the potential likelihood of various spill scenarios in terms of the size of the spill and probability of the oil reaching the coastline. The remainder of this section discusses the potential consequence of oil spills in terms of the impact on receptors and their sensitivity to impacts from oil spills.

In the event of a large oil spill, the most sensitive components of the ecosystem in offshore and coastal environments are seabirds, marine mammals and turtles, due to their close association with the sea surface. In the event of spilled oil reaching the coast other notable sensitive receptors include coastal habitats, fish and fishing activities and people whose livelihoods depend on coastal resources.

Potential Impacts

In the event of an oil spill the initial impact will be on the marine environment offshore Ghana. While localised impacts to water quality will occur, the more significant impacts will be on marine biodiversity, and in particular those

species that frequent the sea surface, including sea birds, 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 vacate the area in the event of a spill.

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

This section summarises the potential impacts on the most sensitive receptors that would likely be exposed to impacts from a major oil spill. However, it should be noted that this assumes a 'worst case' spill that reaches the coastline. Such a spill has been identified in this assessment as being a very remote possibility and which may not beach depending on the prevailing meteorological and oceanographic conditions.

The focus of the discussion relates to the stretch of shoreline approximately 100 km west of Cape Three Points (ie between the Domini Lagoon and Cape Three Points) which the modelling showed had the highest probability of being oiled in the event of an oil spill. East of Cape Three Points a longer reach of shoreline could potentially be oiled, but the probability of oiling is generally less than 15%.

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 Esiam Beach, qualify as internationally important wetlands under the Ramsar criteria of supporting 20,000 waterfowls or 1% of the population of a waterfowl species. Of these only Esiam Beach falls within the area at most risk of an oil spill which is a sandy beach thought to support over 10,000 birds.

However, there are several other lagoons and wetlands including Domini Lagoon, Amunsure Lagoon, Ankobra (Ankwao) Estuary, Kpani-Nyila Estuary and the Ehnuli Lagoon which are important bird feeding and breeding areas and support significant numbers of waterfowl including common tern, egret, common sandpiper, ringed plover and grey plover. As a whole, the stretch of coastline west of Cape Three Points is considered highly sensitive for coastal bird species.

Direct mortality of birds in the event of an oil spill is often the most widely perceived risk. While impacts to birds can occur offshore in the marine

environment, the more pronounced impacts are often experienced if oil reaches coastal waters. Spills affecting coastal waters near major bird colonies during the breeding season can be particularly severe since birds are feeding intensively and often dive through the surface oil to feed on fish. Birds are affected by oil pollution in the following three key ways.

- Stains of oil on the plumage may destroy the insulating and water repelling properties which may ultimately cause the death of the bird.
- Toxic effects after the ingestion of oil during preening, ingestion of oiled prey, inhalation of oil fumes or absorption of oil through skin or eggs.
- Indirect effects resulting from destruction of bird habitats or food resources.

Coastal bird species and habitats in Ghana are considered highly sensitive to potential impacts resulting from an oil spill that reaches the coastline.

Marine Mammals

The area offshore Ghana is known to support significant marine mammal populations including certain protected and sensitive species such as humpback and fin whales and Atlantic spotted dolphins. While the seasonal distribution of these species is not well understood it is likely that during the months of September and October a number of species of whale and dolphin pass through the offshore area.

Marine mammals are generally less sensitive to oil spills than seabirds as they will tend to detect the area around a surface oil slick and avoid any breaching or feeding behaviours that may bring them into direct contact with oil. However, marine mammals are still sensitive to impacts from oil spills, and in particular from the hydrocarbons and chemicals that evaporate from the oil, particularly in the first few days following a spill event.

Symptoms of acute exposure to volatile hydrocarbons include irritation to the eyes and lungs, lethargy, poor coordination and difficulty with breathing. Individuals may then drown as a result of these symptoms. Studies conducted following the Exxon Valdez tanker oil spill identified direct mortality of marine mammals (primarily seals, with increased pup mortality reported in areas of heavy oil contamination compared to un-oiled areas) resulting from exposure to oil⁽¹⁾.

Although it is likely that certain species of marine mammals occur in the area offshore Ghana, it is considered that they are less sensitive (compared to turtles and birds) to any impacts resulting from an oil spill as they will generally avoid the area affected.

(1) Furness & Monaghan 1987

Marine Turtles

Marine turtles spend most of their life at sea, but during the breeding season they go ashore and lay their eggs on sandy beaches. The sandy beaches of Ghana support the breeding of the green turtle, the leatherback and the olive ridley turtle. The shoreline west of Three Cape Points is made up of several sandy beaches which act as turtle nesting sites; including the coastline between Domini Lagoon and Amunsure Lagoon and Essiama Beach. The turtles come ashore to nest between August and March. During this period turtles swim to shore and push themselves onto the dry beach where they dig nests, lay dozens of eggs, cover the nests and return to the sea (Armah *et al* 2004).

Turtles are sensitive to the effects of oil spills at all life stages – eggs, post hatchlings, juveniles and adults. Several aspects of sea turtle biology place them at particular risk. These include a lack of avoidance behaviour, indiscriminate feeding around the sea surface and large pre-dive inhalations at the sea surface. Potential direct impacts from oil spills to sea turtles include:

- increased egg mortality and developmental defects;
- direct mortality due to oiling in hatchlings, juveniles and adults; and
- negative impacts to skin, blood, immune systems and salt glands.

In addition, sea turtles are sensitive to potential secondary and longer term impacts, which are generally less obvious than the short term impacts immediately following a spill. These impacts include:

- behavioural effects (eg disorientation) resulting from loss of smell sensors;
- contamination of food supply and reduction in available food levels; and
- influences on sea turtle development and behaviour caused by subtle changes in sand temperature colour and albedo⁽¹⁾ when spills impact the shoreline (eg because sex determination in turtles is temperature dependent, shifts in sand temperature caused by oiling could potentially change hatchlings sex ratios).

In the event of an oil spill that reaches the coastline, sea turtle populations, particularly in the vicinity of nesting beaches along the Ghanaian coastline, may be highly sensitive to impacts.

Coastal Habitats

The modelling work has predicted that in the event of a very large (ie 20,000 tonnes) oil spill there is a 40 to 50% probability that oil would beach on the stretch of coastline approximately 100 km west of Cape Three Points. While it is unlikely that under any scenario oil would beach along this entire stretch of coastline, it is not possible to determine with any accuracy the particular coastal areas that would be likely to be affected by a spill as this would

(1) The 'Albedo' of an object is the extent to which it diffusely reflects light from the Sun.

depend on the size of spill, currents, winds and other physical factors at the time. Therefore this section only 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, Amunsure Lagoon, Ehnuli Lagoon) and estuarine wetlands (Ankobra estuary and Kpani-Nyila 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 cursor*) which is active when the tide is low and retires to its burrow on the beach when the tide rises. However, sandy beaches serve as important nesting sites for sea turtles and in some cases (such as Esiama Beach) are important sites for coastal bird species.
- Rocky shores occur as rocky out-cropping alternating with sandy bays. The rocks are substrate for a wide variety of species of macro algae, barnacles and snails. Ecologically, algae mats on rocky shores serve as important micro-habitats for epifauna (ie crustacean, macro-invertebrates) and fish.
- The coastal lagoon habitats are particularly important ecosystems. They support mangrove habitats and significant populations of fish, shrimps, crabs and mollusc species; in addition they are important nursery sites for many fish species. Coastal lagoon habitats also support significant numbers of waterfowl species.
- Estuarine areas and wetlands occur at Ankobra (Ankwao) and Kpani-Nyila estuaries and support 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 act as important nursery habitats for fish and feeding areas for waterfowl species (Armah *et al*, 2004).

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 number of species, including fish nurseries and bird feeding areas. If an oil spill beached in these areas toxic concentrations of oil may develop in the shallow water and due to the long persistence time of the oil effects may be encountered for a long period. If oil enters into an open lagoon or wetland natural removal rates are slow because there is no wave action to remove the oil and oil components tend to adhere to the flat substrate preventing removal by tides.

In lagoons or wetlands that support mangrove stands oil slicks may enter the mangroves when the tide is high and are deposited on the aerial roots and sediment surface as the tide recedes. The oil clogs the pores in the aerial roots and if many roots are oiled, the respiratory system collapses and the trees die.

Given the ecological sensitivity of much of the coastline west of Cape Three Points it is considered that the coastline is highly sensitive to impacts in the event of a large oil spill.

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, fish are not considered highly sensitive to impacts from oil spills. Adults are mobile and generally able to detect heavily contaminated areas or areas of low water quality. In open waters, fish have the ability to move away from an area of pollution, and are therefore either unaffected by oil or affected only briefly. Oil contamination in open waters below an oil slick is generally low (only a few ppm or below) (IPIECA, 2000) and there is no evidence to suggest that fish are significantly affected by oil in open water.

Fish kills may occur as a result of high exposure to emulsified oil in shallow waters (such as in lagoons) and oil pollution may clog fish gills causing asphyxiation. At the population level effects can be short lived due to the death of affected individuals and the persistence of healthy individuals unaffected by contamination. Non-lethal negative effects are more usual and fish can be affected in the long term in some circumstances, especially when oil spills into shallow or confined waters. Fish exposed to elevated concentrations of hydrocarbons absorb contaminants through their gills, accumulating it within their internal organs which can lead to long-term, sub-lethal effects. In addition, spilled oil in confined and shallow waters such as lagoons poses a threat to fish eggs and larvae which can not actively avoid or escape a pollution event. Fish eggs and larvae are mostly in the upper

planktonic layers, and hence are affected by all early stages of a spill and heavy mortalities often result. Lethal effects on the population as a whole are rare but long term, sub-lethal effects are possible, particularly if a major spawning area is affected.

In terms of the vulnerability of fish stocks to impacts from an oil spill, while fish in open waters are not particularly sensitive, the species found in coastal lagoons (such as Ehnuli, Amunsure and Domini lagoons) are highly sensitive. These areas are spawning grounds and nursery areas for young and small fishes. Thus, oil spills in these areas will have implications for localised populations, particularly breeding adults, eggs and larvae.

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 Essiama beach.

Coastal lagoons and estuaries are also important sources of fish and shellfish for both subsistence and commercial purposes. Along the coastline west of Cape Three Points several coastal lagoons (eg Ehnuli, Amunsure and Domini) provide important local fisheries throughout the year.

In the event of an oil spill that reaches either coastal waters, or beaches within coastal lagoons, fisheries are usually suspended by the regulatory authorities to avoid contamination of fish being lifted through the slick on the surface waters and to prevent gear contamination. Fishing is difficult or impossible in areas directly affected by an oil spill. Vessels and gear will be smeared in oil and the catch might be spoiled. The fishermen might for a period be forced to stop or temporary move to other fishing grounds nearby free of oil slicks. These fisheries closures will directly affect fishing communities along the coastline by preventing them from maintaining their livelihood during the period of closure, resulting in a reduction in both food and economic resources.

In addition, tainting of fish can impact fisheries affected by oil spills. Tainting of fish will reduce the quality of the fish landed and sold to traders. As a result these fish may fetch a lower price than others unaffected by tainting.

Given the importance of the artisanal fishing industry along the coastline west of Cape Three Points, and the presence of particularly sensitive fisheries such as lagoons, fisheries are considered highly sensitive to impacts resulting from an oil spill that reaches coastal waters.

Tourism and Recreation

The major coastal tourism attraction sites in Ghana are in Keta, Ada, Ningo, Prampram, Tema, Labadi, Accra, Winneba, Kromantse, Cape Coast, Elmina, Brenu-Akyinim, Komenda, Sekondi-Takoradi, Axim and Busua. In this area, there are 28 waterfront hotels with approximately 1,000 beds registered by the Tourist Board of Ghana. Furthermore, there are a similar number of minor resorts and campsites at waterfronts. In the area west of Cape Three Points, Axim would represent the main sensitivity with regard to tourism activities (Armah *et al* 2004).

In the event of an oil spill beaching near tourist destinations or hotels, the direct access to the shore and the options of swimming, fishing or utilising water sport facilities will be hampered or made impossible. Also rumours of an oil spill affecting the coast might result in cancellations of hotel bookings, even in other areas along the coast not directly affected by oil. In the longer term, the perception among tourists of a polluted coastline might adversely impact the tourism industry. At current levels of tourism the area is not considered highly sensitive economically for local communities, however, any oil spills would have a detrimental impact on the areas' reputations and the potential for future growth.

5.6.7 Mitigation Measures

Introduction

Mitigation of oil spills takes two forms: spill prevention and spill response. The primary mitigation measure for avoiding the impacts of an oil spill is to prevent any such spill taking place in the first place. This is done through both technology applications as well as operational controls. In the event of a spill, the project will implement systems to respond, contain and cleanup spills. These systems will be designed with the capacity to handle even the worst case scenario.

Spill Prevention

To minimise the risk of potential spills, Tullow has designed the project facilities with a range of inherent measures designed to reduce the risk of oil spill. Oil spill prevention measures that will be implemented as part of the design of the project will include the following.

- Blow-Out Preventers (BOPs) permanently installed on the subsea wells during well completions, and the use of a double mechanical barrier system during production and injection operations using the subsea Christmas trees and other barriers.
- A system of wells, subsea flowlines, risers and FPSO topsides designed to international process codes and with alarm and shutdown systems to

maintain the system within its design criteria at all times. The system will be tested, inspected and maintained to ensure performance standards.

- The FPSO deck and drainage system will be designed to contain spills (as well as leaks and contaminated wash-down water) to minimise the potential for overboard release.
- Specific procedures will be developed for offloading crude from the FPSO onto the shuttle tankers (see *Section 3.5.6*). 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.

Spill Response

Despite the prevention measures and management procedures built into the design of the project there is always a risk that an oil spill can occur. In response to such as event Tullow has established an Oil Spill Contingency Plan (OSCP) which has a set of procedures which set out the strategy and specific actions that will be taken in the event of an oil spill. In summary the OSCP describes:

- response strategies for minor, medium and major spill scenarios;
- spill alert and notification procedures;
- available spill response equipment supplies and services;
- response organisation and key job functions of the participants in spill response;
- types and frequency of spill response training and practice exercises; and
- procedures for removal of waste resulting from the spill cleanup.

The actions that will be required for the OSCP in the event of an oil spill vary according to the size of the spill. Oil spills are defined according to three 'Tiers'. This classification is in alignment with the International Petroleum Industry Environmental Conservation Association (IPECA) which advocates a response to oil spills such that the planned response engages resources commensurate with the severity of the spill with the higher the Tier the higher the collateral response required. *Table 5.16* illustrates the various Tier categories that are set out in the OSCP.

Table 5.16 Tier Classification by Volume

Spill Event	TIER			
	0	1	2	3
All spills to land/ water < 0.5 bbl ^{100 litres}	●			
Inland spill 0.5 ^{100 litres} ~ 20 bbl ^{4000 litres} (max.)		●		
Near-shore spill 0.5 ^{100 litres} ~ 100 bbl ^{20,000 litres}		●		
Near-shore spill > 100 bbl ^{20,000 litres}			●	
Spill contained onboard Rig/ Vessel	●			
Offshore spill 0.5 ^{100 litres} ~ 1,000 bbl ^{200,000 litres}		●		
Offshore spill 1,000 bbl ^{200,000 litres} ~ 2,500 bbl ^{500,000 litres}			●	
All spills > 2,500 bbl ^{500,000 litres}				●

Source: Tullow Oil: Ghana Oil Spill Contingency Plan (Dec. 2008).
For Reference: 1 tonne oil = approximately 1,200 litres or 7.3 barrels.

The OSCP has been informed by the oil spill modelling study so that the response strategy and location of equipment takes into account the areas most at risk and the response times required to mobilise resources and equipment in the event of a spill.

The Tullow OSCP interfaces closely with the Ghana National Oil Spill Contingency Plan. The role of Tullow is to support the EPA towards the successful conclusion of any oil spill with a Tullow interest. For example, in cases where Tullow has strict primacy (100% interest) Tullow will employ all such reasonable dedicated response resources as are available to mitigate the impacts of the oil spill. However, in cases where Tullow does not have primacy ie third party spills; Tullow must be prepared to offer proactive support to help remedy the emergency situation. Proactive support includes offering all such resources available to Tullow that would be considered for stand-by/ mobilisation if Tullow had primacy. Proactive support will stop short of taking overall command.

The resources available to provide a suitable response to any oil spill from the project, and the responsibility for leading spill response, are set out in the OSCP as follows for each Tier of spill.

- **Tier 1:** The response to all Tier 1 spills will remain the responsibility of Tullow. Tullow will hold the appropriate level of Tier 1 oil spill response equipment and trained personnel so as to facilitate an immediate response in the event of a Tier 1 spill and to assist with Tier 2 spill events. The equipment held on the FPSO or other vessels where appropriate are likely to include portable skimmers, booms, deck storage, floating storage and dispersant spray sets for spills of approximately 5 tonnes. Response time will be dependant on the position of the vessel in relation to an oil release,

however, if the oil spill source is at or close to the FPSO then response will be rapid

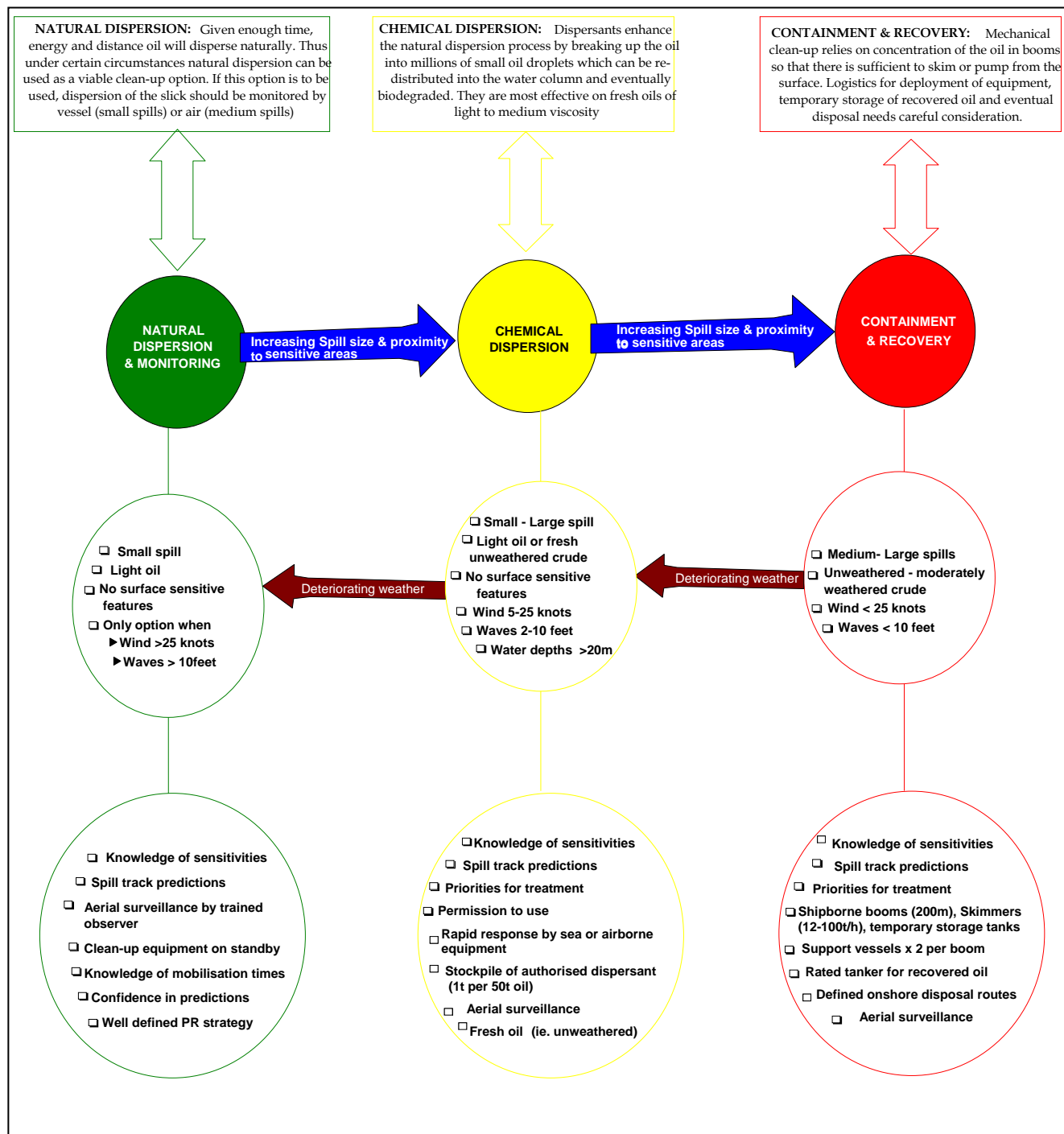
- **Tier 2:** In the event of a Tier 2 spill event the initial response would be the responsibility of Tullow and would be organised from the FPSO. However, if the magnitude of spill warrants a further response it would engage mutual aid resources which may be leveraged from industry partners within Ghana and the Oil Spill Response⁽¹⁾ (OSR) West and Central Africa surveillance & spraying aircraft from Accra airport. Mobilisation time to the spill site is approximately 3 hours.
- **Tier 3:** In the event of a spill situation which is clearly beyond Tullow's immediate response capability, both mutual aid resources which may be leveraged from industry partners within Ghana and the OSR call-out guarantee from the Oil Spill Response Base in Southampton, UK. Mobilisation time of a Hercules Aircraft to Takoradi is 17 hours, with second aircrew involved so there is no requirement for a crew rest. Worst case scenario is 27 hours, which would include a 10 hour crew rest and 5 hours refuelling.

It is important to note that, in Tier 2 and 3 spill situations, the response strategy set out in the OSCP is intended to align with the Ghana National Oil Spill Contingency Plan and comply with its requirements. The intention is that in any major spill situation there is cooperation between Tullow, other offshore oil and gas operators and the Government of Ghana in order to ensure a coordinated and effective response to a spill. The oil spill modelling included Tier 1 spills (scenarios 1 to 4), representing the most frequent spill sizes and Tier 3 spills (scenarios 5 to 8) representing the most serious spill sizes. In this context, site specific response scenarios will be developed within the OSCP revision process.

The Tullow OSCP sets out the actions required in the event of oil spills in the marine environment (*Figure 5.15*) and in cases where the oil spill reaches the coastline (*Figure 5.16*). The Jubilee project will hold \$1 billion of oil spill pollution insurance to cover the costs of clean up in the event of an oil spill.

(1) Oil Spill Response (OSR) is a Global Tier 3 Oil Spill Response Organization, owned by its oil industry member shareholders, for the benefit of its members. Tullow Ghana maintains 2 contracts with OSR: 1. An Associate Membership contract with OSR, which guarantees immediate response to a Tier 3 oil spill from Southampton, UK. 2. A Regional Tier 2 contract providing access to an aircraft based in Sao Tome which can both spray dispersant and detect and quantify oil at sea using specialist remote sensing cameras.

Figure 5.15 OSCP Strategy Guide to Combat Marine Oil Spills



Source: Tullow Oil: Ghana Oil Spill Contingency Plan (Dec. 2008)

Figure 5.16 OSCP Strategy Guide to Shoreline Clean-up Options

[illegible]

Source: Tullow Oil: Ghana Oil Spill Contingency Plan (Dec. 2008)

5.6.8 Residual Impacts

The QRA for the project illustrates that relatively small spills (ie less than 10 bbls) are the most likely to occur (approximately once every 10 years) whereas progressively larger spills become increasingly unlikely to occur (ie a 1,000 bbl spill is only predicted to occur every 100 years) and major spill events, such as ship collision, FPSO hull damage, blowouts and cargo tank explosions would only be expected once every 10,000 years (ie 1.02E-04). The most likely source of a small spill would be a leak from the transfer hose during oil unloading operations.

The results of the oil spill modelling study indicated that, for all spill scenarios, the most likely fate of the oil would for it to be transported to the east of the release point (ie towards the Ghana coastline). The shoreline with the highest probability of being oiled is the stretch of coast 100 km west of

Cape Three Points. For a very large spill (ie 20,000 tonnes) there is a 40-50% probability that oil would beach on the stretch of coastline; however for smaller spills the probability is less. It should be noted that this assumes that no oil spill response measures are taken.

There are a number of potentially highly sensitive coastal receptors along the stretch of coastline east of Cape Three Points that are most at risk in the event of a spill. These include coastal lagoons and wetland habitats that support significant bird populations and act as fish nursery grounds, turtle nesting sites on sandy beaches and extensive artisanal fishing grounds. These receptors would be adversely impacted in the event of an oil spill that reaches the coastline. In this context, site specific response scenarios will be developed within the OSCP revision process.

Although highly unlikely, in the event of a very large oil spill (ie more than 20,000 tonnes), significant impacts could occur on the basis that:

- a large spill would likely reach the Ghanaian coast and result in oil beaching, despite the proposed oil spill response measures proposed by Tullow;
- the stretch of coast most likely to be affected by an oil spill (west of Cape Three Points) is considered highly sensitive to impacts from oil beaching as a result of the ecological sensitivities and extensive fishing activities along that affected area of coastline; and
- if oil beaches these sensitive receptors will be exposed to adverse impacts that will be difficult to mitigate effectively.

While the residual risk of oil spills from the project remains, the overall impact of oil spills is considered *Moderate* significance (but reduced to ALARP levels) on the basis that:

- the most likely spills associated with the project would be small scale (ie less than 10 tonnes) that are unlikely to reach the coast due to the distance offshore and the fact that these can be mitigated via the project oil spill response measures;
- large oil spills are highly unlikely to occur (ie a probability of 1 in 10,000 years).

Tullow has in place an oil spill response system which includes Tier 1 oil spill response equipment, and a system for cooperation between Tullow, other oil and gas operators in Ghana and the Government of Ghana that, if implemented effectively, would reduce the probability of oil reaching the coast and would therefore reduce the impacts significantly. In Tier 2 and 3 spill situations, the response strategy set out in the OSCP is intended to align with the Ghana National Oil Spill Contingency Plan and comply with its requirements. Tullow has contracted Oil Spill Response Limited for Tier 2 and Tier 3 support.

5.7 SOCIOECONOMIC AND HUMAN IMPACTS

5.7.1 *Introduction*

This section addresses the socioeconomic and human impacts which could arise from the project. These include those impacts that may be reasonably expected to affect Ghana at a national level and those that are likely to be experienced at a more regional and local scale, for example, impacts on human activities in the offshore environment and in the vicinity of the shore base and port.

During the consultation process macroeconomics, social investment and employment opportunities were the key issues of concern raised (see *Annex A*).

5.7.2 *Scope of Assessment*

In defining the scope of the EIA assessment, there are a number of key considerations which influence the resolution of the assessment of the impacts on socioeconomic and human activities. These considerations are outlined below.

- The project operations are primarily located offshore and there will be few direct interactions with other human activities other than limited numbers of other marine users who operate in the area such as commercial vessels passing through the area and deepwater fishermen targeting pelagic fish such as tuna.
- The majority of the deepwater offshore infrastructure will be transported to the field by sea from international locations, and the shore base operations in Ghana will be limited to routine project support, supply runs, equipment and materials storage, and waste handling.
- Information on how the government would use the revenue that would accrue to them is not defined and is outside the control of the project so the direct socioeconomic benefits cannot be fully determined in this EIA.

The key impacts are addressed under the following main headings.

- Macroeconomic impacts resulting from payment of revenues to the Government of Ghana as taxes, royalties, fees and bonuses from the sale of oil.
- Impacts to individuals, families and communities from direct and indirect employment and related training and career development opportunities from the project and impacts from the expansion of the local workforce in Takoradi.

- Impacts from procurement of goods and services for the project from individuals and companies.
- Impacts on fisheries.
- Impacts on commercial shipping.
- Impacts from onshore operations.

5.7.3 *Assessment Methodology*

As far as possible, the assessment of the significance of impacts has been determined on the basis of the following criteria:

- the estimated magnitude of impact;
- the duration of impact;
- the sensitivity of the receptors; and
- the likely importance to stakeholders.

For those impacts within Tullow's control (eg direct employment by Tullow) the assessment uses quantitative data to support an assessment of residual impacts wherever possible. Where the impact is beyond the direct control of Tullow it is not always possible to assess the effectiveness of proposed mitigation measures. In these cases the assessment is necessarily qualitative in nature. The assessment recognises that some socio-economic impacts may be positive for some of the people affected and negative for others.

5.7.4 *Macroeconomic Impacts*

This section examines the macro level socioeconomic impacts that may be associated with the project from payment of revenues to the Government of Ghana and other sources of community funding or revenue.

Potential Impacts

Oil production from the Jubilee field is expected to commence in the forth quarter of 2010 and in terms of output it is expected to reach a plateau between 2011 and 2013 of approximately 115,000 bbls per day. From then, production will continue at a steadily decreasing rate until 2031 with a total recovery estimated of 278 million barrels of oil recovered over 20 years. It should be noted that additional development may increase the volume of oil produced during this time significantly (see *Chapter 3* for oil production forecast).

The oil production from this project could comprise most of Ghana's oil revenue and will contribute significantly to Ghana's revenue through:

- taxes, royalties and other fees paid by Tullow and all other members of the Jubilee JV;
- direct equity share of the sale of oil by GNPC.

Potential impacts at a national level relate largely to the revenue generation from oil production and the impact this will have on the country. The level of revenues from the oil industry and transparency on how it is used was identified as a key issue from stakeholder consultations.

The revenues generated by the project would be a valuable source of finance for the government and would contribute to the Ghanaian economy directly through reducing the Ghana balance of payments with respect to energy imports and could facilitate investment in the country's socioeconomic development and growth (eg development of infrastructure such as road network, power grid, water network, solid and liquid waste and telecommunications) through central government funding. In addition, the revenue could stimulate investment loans providing further sources of revenue. With the development of Jubilee field there is also the potential for larger scale development of the oil and gas industry in Ghana.

Revenues from the Jubilee field have the potential for positive benefits at a national level over the long term (20 years), although maximum revenue would likely be concentrated in the first 5 to 10 years of production. Revenue from oil can be unpredictable as it depends on world market prices and the management of these revenues requires good fiscal discipline. Consequently, the benefits of oil revenue will depend on the policies and actions adopted by the Government of Ghana. The potential impact is assessed as of *Moderate* significance.

In addition to its direct equity share of production and taxation of the JV parties, the government will receive further revenues through other taxation such as personal income tax and withholding duties on imported services paid by employees, contractors and supporting services to the project (see *Section 5.7.5*).

Mitigation Measures

The use of Ghana's oil-generated revenues is the responsibility of the Government of Ghana. Where Tullow can influence expenditure at the macroeconomic level is through the establishment and financial support for projects through its own Corporate Social Responsibility (CSR) strategy and in sponsoring training programmes/education in the oil industry.

Tullow is developing a CSR framework strategy and plan which will provide details of Tullow's commitment to creating and enhancing positive impacts of its activities. Expectations from stakeholders are that social investment from the project will involve community organisations and NGOs and that spending will be transparent and focussed on key priorities for affected communities. From the preliminary work undertaken on the strategy the key focus areas for the CSR strategy are likely to be health, education, employment and natural resource governance. Details of these programmes will be subject to further consultation with government agencies and local communities but are likely to build on the support to water supplies from water wells,

vaccinations and school refurbishment projects that have already been carried out since 2007. These programmes will be designed to provide positive benefits to individuals and communities.

Residual Impacts

Overall the socioeconomic impacts at a macroeconomic level are predicted to be positive, long term and at a national level and therefore of *Moderate* significance. However, as Tullow cannot control the use of these revenues it is not possible to predict the extent of the positive residual impacts on Ghana. Tullow will have control only over the funding of its CSR programme and how the money is spent and this is expected to have a positive impact at regional and district levels.

5.7.5 *Employment*

This section addresses economic opportunities for individuals and companies through direct and indirect employment associated with the project activities.

Potential Impact

The project expects to employ up to 760 staff at its peak during installation, reducing to approximately 307 during the operational phase. Tullow expects to employ 150 to 175 personnel in Ghana just after first oil in 2010. Initially it is expected that there will be approximately 50% national staff and the remainder expatriates in mainly management and technical specialities.

Contractor support services also provide employment opportunities covering the FPSO operations, well engineering activities, maintenance and support across the spectrum of disciplines including offices and shorebases. These will include the following.

- Modec, who will operate the FPSO under the lease agreement, will employ approximately 110 personnel (working on rotational pattern). It is expected that by 2011 there will be about 46% nationals, increasing to around 90% nationals after 5 years.
- There is forecast to be 30 or 40 further jobs for Ghanaian personnel in the logistics services that will be contracted through aviation and marine supply vessels.
- MODUs either completing the Phase 1 development drilling program or carrying out well maintenance, will have a direct crew of 100-120 persons on-board, which will provide national employment opportunity typically of 30-40 persons.
- Services and contractor support to the operation provides further opportunity over time.

Direct employment by Tullow and indirect employment through contractors and suppliers will have a positive impact on those people employed, their families and their local communities from wages and other benefits. There will also be minor benefits to the wider economy through income taxes paid by employees and spending of earnings. In general, the oil industry is not a large employer, especially after the project installation phase, in relation to the revenues it can generate, therefore, the spread of money through wages into the wider local economy is less than that experienced for similar sized industries such as manufacturing or service-based industries.

The skills developed through training received and experience gained when employed in the oil and gas sector will be transferred to other sectors of the economy and will provide positive benefits. It will also make Ghanaians more competitive in the international market place, facilitating increased opportunities and skills transfer. Overall the impacts from direct and indirect employment will be long term, localised and relatively small scale and is assessed as being of *Minor* significance.

While employment is generally a positive benefit there are the following potential negative effects.

- Demand for skilled labour causes skills drawdown from other sectors as people take jobs in the oil and gas sector ie loss of staff from government and loss of engineers from other sectors.
- Due to lack of skilled labour to meet the specific project staff requirements and the relatively low numbers of staff required, the project is unlikely to meet the high community expectations of employment opportunities.

Mitigation Measures

Tullow is developing a Human Resource Strategy for the recruitment, training and development of national staff in its operations (known as 'nationalisation'). Training programmes and work experience would enhance both the quality of employment and the longevity and sustainability of jobs. The strategy will include methods for effective communication of employment opportunities, selection, evaluation and appropriate induction and dedicated staff training programmes. This strategy is being rolled out to national and international contractors and service providers who are required to provide details of their own national employment and training plans. Communication on employment opportunities will also be provided by the Community Liaison Officers to local communities in the coastal. Districts of Western Region and monitoring of employment and labour practice will be undertaken by Tullow.

Through training, mentoring and job shadowing programmes for national staff the number of Tullow national personnel is expected to be 80 to 90% within 2 to 5 years (ie 2012-2015) all positions across seniority and technical positions. The total staff number is likely to stay relatively constant over the following years although the expatriate numbers should further decline as

senior appointments are made and consolidated to national staff. Modec expect that by 2011 there will be about 46% nationals, increasing to around 90% nationals after 5 years.

Tullow is currently training seconded staff from GNPC at various locations, including overseas and has commenced graduate and apprentice recruitment and training across all departments. In recognition of the current skills shortage in some areas Tullow is also investigating appropriate support for education and training eg support to polytechnics and universities in funding, sponsoring students and bursaries. Some of this work will be carried out through the CSR programme and Tullow is in early consultation with education establishments in the Takoradi area to upgrade engineering and apprenticeship courses which could provide direct employment to the oil industry as well as to wider heavy industry in Ghana such as mining.

Residual Impacts

Employment opportunities are limited in the project development phase where there is a lack of locally available skills to meet the immediate requirements of the specialist roles. As the project moves into the operational phase, however, there will be the opportunity for progressively more Ghanaians employed through skills development and opening of positions that can be satisfied by the local skill base. The direct benefits from employment and training will also provide sustainable employment opportunities in the longer term as individuals take on new jobs and export these skills and experiences. Although the jobs will be long term and of good quality (training and career development opportunities) the residual, impacts from employment from the project are assessed to be of *Minor* significance given the limited number of jobs.

Residual negative impacts remain from the demand for skilled labour for this project causing a drawdown on skilled labour in other sectors, although this is at a small scale as it is a short-term effect and the number of employees required is small. There is also likelihood that long term employment expectations will not be met as the operation of the FPSO does not require significant numbers of personnel. The negative impacts from drawdown of skilled labour are assessed as *not significant* as a wider base of skilled staff will become available within a few years through training and as the industry develops.

Experience from other oil and gas projects indicates that the expansion of a large external workforce in a local community can lead to increased risk of negative social impacts, including traffic accidents, security incidents, alcohol and drug misuse, and prostitution. Given the scale of the workforce requirements at the shore bases in relation to the existing port activities no significant influx of external workers for work at the bases is expected.

This section addresses economic opportunities for individuals and companies through procurement of goods and services associated with the project activities. It should be noted that procurement also leads to indirect employment discussed above.

Potential Impacts

The majority of the fabrication work for the FPSO will be undertaken in Singapore with material sourced from international markets. Installation offshore will be carried out using specialist contractors and vessels also from sources outside Ghana. During the project lifetime there will, however, be local procurement of goods and equipment (ie food, fuel, chemicals and other consumables), logistics support (ie drivers, supply vessel crew, and plane and helicopter support, pilots and cabin crew), and services (ie onshore admin support, accommodation staff, security, catering, cleaning).

There will also be procurement of some engineering services in Ghana in the fabrication of suction piles (for the FPSO moorings) and pipe connectors (eg welding and assembling 1,000 tonnes of pipes). In the longer term there will be a requirement for equipment refurbishment, electrical testing and tool refurbishment.

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

It is noted that there are potential negative impacts from local procurement of goods and services strategy. The increased demand by Tullow and its contractors for certain goods and services (eg food supplies) may place pressure on supplies and services available for local people and industries. This can lead to shortages and/or price increases which could impact on local people's welfare and livelihoods. This has the potential of local impacts assessed as on *Minor* significance.

Mitigation Measures

To enhance the benefits from procurement of goods and services Tullow will adopt a procurement strategy covering the following key areas.

- A policy of procuring Ghanaian goods and services locally (within available capacity) and of helping to expand local businesses and strengthen their ability to respond to the needs of the oil and gas industry, thereby providing in the longer term a stronger and more experienced service industry.
- Adopting contracts with companies to establish longer term commitments to the businesses which will promote sustainable long term growth and help new businesses become established.
- Conduct contractor vetting and develop contract conditions to ensure the requirement for local content is passed to contractors, so goods and services are purchased locally where possible, and employment rights and conditions are respected.
- Working with suppliers to help them meet the required standards in areas such business awareness, employee rights, training, environment and health and safety.

To monitor and track the effects of the strategy of maximising local content over the project lifespan from contractors, Tullow will audit local content through facility visits and interviews. Tullow will also monitor pressures on local goods and services through community consultations to determine if project related demand is creating a significant negative impact on the communities.

Residual Impacts

A strategy of entering into long term contracts with suppliers and ensuring the local content requirement is passed down the supply chain will ensure long term and sustainable local businesses. The residual impact of procurement of goods and services is considered to be positive and is likely to be long term and at the district and regional level. In a national context the positive impacts are considered to be *Minor* significance.

5.7.7 *Impacts on Fisheries*

The Jubilee field is in a deepwater offshore area and the water depth at that location precludes trawling or other bottom fishing activities. Therefore, fishing for oceanic large pelagic species using passive gear (longlines) and active gear (pole and line, purse seines) is the only fishing activity in the area. Three tuna species are caught in Ghanaian waters (skipjack, yellowfin and bigeye) along with billfish such as swordfish and marlin. All these species are caught in the vicinity of the Jubilee field and fishing vessels are likely to

operate in the project area. It is noted during the drilling phase that fishermen operating from canoes travelled to the drilling sites to fish close to the MODUs too target the fish attracted to them.

Potential impacts on fisheries can arise from three main sources.

- Loss of access to the area of the FPSO and MODUs during completions, installation and operations due to presence of vessels, FPSO and MODUs and the safety exclusion zones.
- Attraction of fish to the FPSO, due to the FPSO acting as a FAD.
- Disturbance to fishing activities and damage to fishing gear from project support vessels and supply vessels transiting to and from Takoradi.

Potential Impacts

A legally enforceable 500 m safety exclusion zone around MODUs and 1,000 m around the FPSO (to provide sufficient coverage for the FPSO and an offloading tanker during offloading of oil) will be maintained to reduce the risk of collisions at sea and to ensure personnel safety. There will also be an advisory zone of 10 km radius centred on the middle of the Jubilee Unit Area (Well J09) that would cover the entire Jubilee Unit Area, indicating the presence of an oil production area where non-essential users are recommended to stay outside.

Fishing vessels will not be able to fish within the exclusion zones for safety reasons. This will result in a very small reduction in the available fishing grounds within the Ghanaian EEZ and will only affect those fishermen who fish in this offshore area. Given the area available to fish for the target species that occur in this offshore location, the exclusion from a small area (approximately 3.5 km²) around the project site is not likely to significantly affect catches. It is noted that the tuna catches are generally much higher in the open water areas south of the Jubilee field (see *Figure 4.6*).

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 (including the three tuna species) will not be available to the fishery while beneath the FPSO and within the exclusion zone. The attraction of fish to floating objects and their residence times are discussed in *Section 5.2.4*. 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 and therefore potential impacts on the fishery are considered to be of *Minor* significance.

Some fishing vessels use passive fishing gear not attached to a fishing vessel. Longlines in particular are used to target bigeye tuna in the eastern Atlantic, with the lines being set several meters below the surface and left for many hours. Thus there is the potential for this gear, which is left floating in the

open ocean, to enter the exclusion zone, become entangled in the subsea infrastructure or on the FPSO and be lost to the fishermen. It is understood that the majority of tuna catches off the coast of Ghana are taken by pole and line vessels and purse seine vessels which use gear attached to the vessel, therefore, the likelihood of interactions between these vessels and associated gear, the FPSO, MODUs and subsea infrastructure is considered to be low (ICCAT 2009). As a result, impacts from the presence of the FPSO and subsea structure on the livelihoods of offshore tuna fishermen using passive gear is expected to be *not significant*.

Vessel movements to and from onshore base during the installation and operational stages of the project have the potential to interact with fishing activity in the vicinity of the onshore bases and along utilised shipping routes. Near shore artisanal fishing activities could be adversely affected through disturbance of fishing activity and the potential for damage to fishing gear. During operations there will be on average one or two supply vessels a week operating between the port and the FPSO. During installation the number of vessels in the field will be higher, and an average of one port visit a day for food and water supplies, and for crew changes is expected. The infrequent nature of vessel movements during construction and the low frequency of vessel movements during operations mean the probability of an interaction between supply vessels and fishing activity is low. Potential impacts on fishing activities will be localised and small scale and are assessed to be of *Minor* significance.

Mitigation Measures

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

- Tullow will employ Community Liaison Officers (CLO) to liaise between fishermen and Tullow and to provide information to fishing communities, regarding Tullow's activities and the requirements to keep away from the operations for safety reasons. The CLO will also deal with any claims for gear damage.
- A vessel transit route will be agreed with the Ghana Maritime Authority and communicated to fishermen and other marine users through the Community Liaison Officer.
- Tullow and its contractors will notify mariners of the presence of the FPSO and other marine operations within the Jubilee field and the exclusion and advisory areas will be marked on nautical charts as cautionary advice to all sea-users.
- The exclusion zone will be monitored with the assistance of the agencies of the Government of Ghana, for the safety of the facility and other users of the area (eg fishermen) when potentially close to the FPSO or MODUs (when present). Measures will be implemented to ensure that those

engaged in maintaining the exclusion zones have received adequate training on the correct code of conduct and rules of engagement which will be based on the UN Voluntary Principles of Security and Human Rights.

- Interaction with fishermen and other users will be monitored through the CLO and the project's grievance procedure.

The magnitude of impacts on fisheries is expected to be low given the numbers of vessels likely to fish in the offshore, deep water area where the Jubilee field is located and the small areas where fishing activities will be excluded from. Improving the baseline information on fish stocks and fishing activities will be advantageous for the future fisheries management and will serve to ensure that Tullow is better informed as to the potential interaction between planned and potential future projects and the Ghanaian fishing industry. Tullow will work with the Directorate of Fisheries to identify opportunities to improve understanding of current fish stocks and fishing activity within the Ghanaian EEZ.

Residual Impacts

The likelihood of unanticipated interactions with offshore fishery vessels is expected to be low given modern communication and navigation aids and the frequency of vessel movements to and from the port and the Jubilee field. The area that fishermen will be excluded from is very small in comparison to the area used by their target species and available for fishing. Any fish residing under the FPSO will only be unavailable to the fishery for a short period of time. The magnitude of the impact is therefore low as only a very small proportion of the potential fishing grounds will be affected by the project. Residual impacts from the Jubilee project on the offshore fishing industry are assessed as of *Minor* significance.

5.7.8 Impacts on Commercial Shipping

Potential Impacts

Figure 5.17 presents data from commercial vessel movements off West Africa during 2005 showing the general shipping lanes used⁽¹⁾ in relation to the location of the Jubilee field (marked in red just north of the yellow line marking the shipping lane). It can be seen that most commercial shipping approaches Ghana from the south of the Jubilee field (a higher density routing starts some 8 nautical miles (13.5 km) south of the Jubilee FPSO).

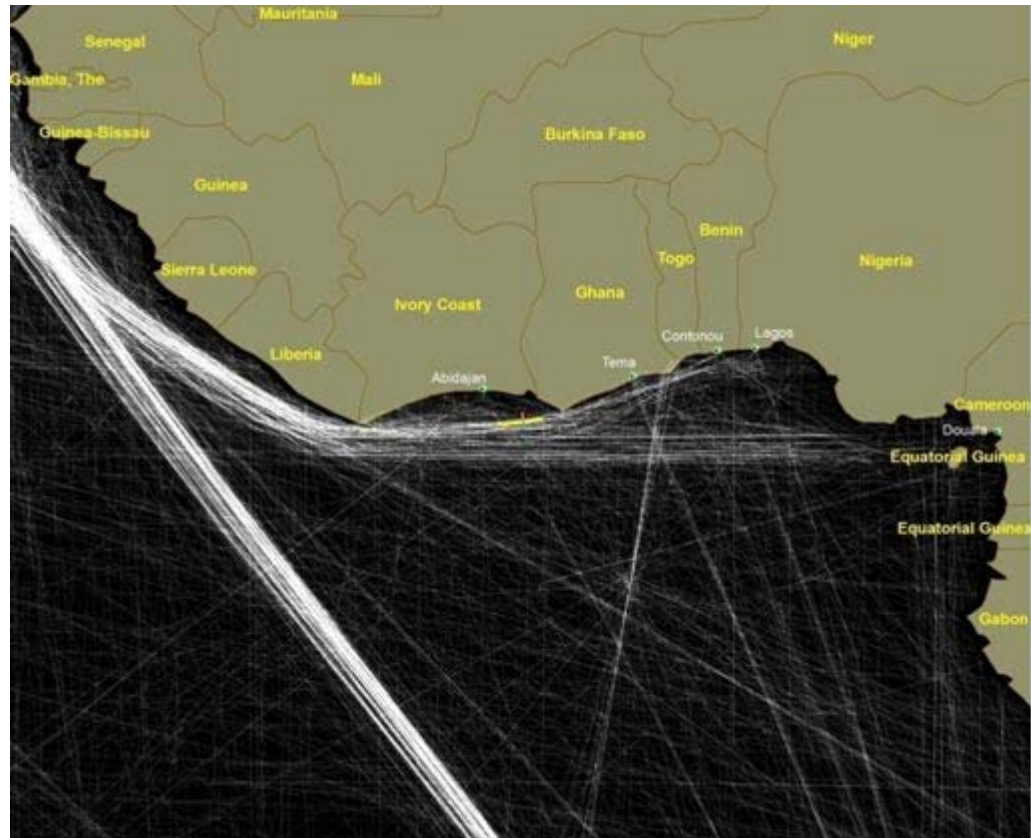
The main potential source of impacts to existing navigation and shipping traffic in the area are likely to arise as a result of the additional vessel movements associated with the project, in particular during the installation of the project offshore as more significant numbers of vessels will be involved.

(1)<http://www.nceas.ucsb.edu/GlobalMarine/impacts>

During routine operations an average of one or two supply vessel will sail into and out of Takoradi port on a daily basis.

The vessel collision risk assessment has been undertaken as part of the FPSO Safety Case showed that risks of collisions with the FPSO are very low and potential impacts are assessed as *not significant*.

Figure 5.17 *Shipping Lanes off West Africa*



Mitigation Measures

The use of established shipping lanes, particularly in approaches to harbours and heavily travelled coastal waters, and standard vessel navigation and communication equipment (radar, ship to ship radio) and the presence of standby vessels and offloading tugs at the FPSO location will reduce the risk of vessel collision with commercial vessels.

The exclusion zones, advisory area and notification and liaison measures outlined above to manage the potential impacts to fishing will be equally applicable to minimising the risk of collision between shipping vessels and project vessels.

Residual Impacts

Taking into account that the distance offshore where the majority of the project activity will be carried out is away from smaller coastal vessels and the fact that the area is not heavily used by commercial shipping, the magnitude

of impact of the project on other shipping traffic is considered to be low. The mitigation measures proposed will ensure that as much notice and warning as possible is provided to shipping vessels 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 *not significant*.

5.7.9 *Impacts from Onshore Operations*

Potential Impacts

Activities at the onshore supply and transport base have the potential for both positive and negative impacts on surrounding communities. The existing supply facilities at Takoradi port are sufficient for the Jubilee Phase 1 development although there will be relatively minor modifications within the port area such construction of a waste handling area for project wastes generated offshore. Future development of the port in the event of future oil and gas developments have the potential for greater positive and negative impacts but are outside the scope of this EIA.

While increased or sustained economic activity and employment at the onshore base will generally be a positive socioeconomic 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 potential exists for a negative impacts on the capacity of the utilities that supply the existing base and consequential impacts on surrounding communities that share these utilities. Consultations with the Ghana Water Company indicated that they foresee no problems in providing fresh water to the project as to date the supply has represented approximately 0.3% of their current rate of supply; 950,000 m³ per month to Takoradi. However to avoid potentially lowering of water pressure during peak demand periods (ie morning and evening), Tullow has installed a new 600m³ potable water tank on the main quay near to the drilling fluids storage area and will fill its tank during night hours when there is less demand from the general population.

There are plans to increase office capacity at the Air Force base for up to 65 people and there will be increased traffic levels from the transport of personnel to and from their accommodation in Takoradi to the heliport (typically 140 people per week). It is noted that the road to Tullow's offices and the Air Force base in Takoradi passes two schools so increased traffic would increase safety risks to pedestrians, though the actual access road to the base has recently been upgraded by Tullow to include a separate pavement and lighting. A second access to the base, avoiding the schools has also recently been upgraded.

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.

Mitigation Measures

The environmental and social performance at the shore based locations that Tullow operate in (port area and Air Force base) will be covered under Tullow EHSMS to ensure EHS policies and procedures are in line with Tullow's expectations, particularly regarding community impacts such as interactions with neighbours, noise abatement, traffic management and storage of wastes. A grievance procedure will be implemented and made known to the surrounding communities and the general public. Tullow Community Liaison Officers will disseminate information about the project to the community and process any suggestions, complaints or grievances received. Social investments as part of the CSR strategy will seek to address specific community issues arising from the project activities. Tullow will undertake periodic audits and reviews of its shore based operations to review site EHS performance and take corrective actions as required. This will require routine management meetings with the main operators of these locations and the agreement of common environmental and social management measures.

Residual Impacts

The residual social impacts from supply base operations are difficult to assess in detail as the impacts may result from activities undertaken across the entire site, rather than simply the activities associated with the project. It is recognised that some negative impacts on the local environment are likely to arise from the increased activity at the onshore base, including noise, traffic and generation of waste. At the supply base Tullow has some direct control and therefore can ensure that residual impacts are suitably managed through the EHS plan. Given the scale of impacts on onshore activities and the degree of control that Tullow has over its shore based activities the residual impacts are considered to be *not significant*.

5.8 CUMULATIVE IMPACTS

5.8.1 Assessment Approach

An assessment of cumulative impacts requires consideration of other plans or projects that may act in combination with the proposed project to cause environmental and social impacts. Cumulative impacts can result from individually slight but collectively significant activities taking place over a period of time. Consideration of other plans or projects in a cumulative impact assessment is usually restricted to those plans or projects occurring at the same time, those that have been consented but not yet completed, or those that are under consideration by the determining authority. Given the stage of development of the offshore oil and gas industry in Ghana, however, the scope of this cumulative impact assessment also considers potential future

offshore oil and gas exploration and developments that are not currently under consideration.

The resources and receptors that may be subject to cumulative impacts include those that have been identified as potentially impacted by the Jubilee Phase 1 project at the offshore project location, the onshore logistics bases and the transit routes between these, and coastal areas that could be affected in the event of a large oil spill.

The present activities that could give rise to cumulative impacts are addressed in *Section 5.8.2* and potential future activities are addressed in *Section 5.8.3* below. An assessment of potential cumulative impacts is provided in *Section 5.8.4*.

5.8.2 *Present Activities*

Jubilee Phase 1 Drilling

The main activity that is likely to result in cumulative impacts with the Jubilee Phase 1 development project is the previously consented drilling programme in the Jubilee field that is currently underway. The development well drilling programme comprises 17 wells and will build on the work undertaken during the exploration programme in 2007 and 2008. Two previously drilled exploration wells will be used as development wells and drilling the 15 new development wells commenced in 2009 and will continue until 2011. Details of the drilling programme and the associated impacts are provided in *Annex B*.

The latter stages of the development well drilling programme will occur in parallel with the Jubilee field Phase 1 well completion programme, facility installation and the early stages of production. The period of physical overlap would be up to 14 months (from arrival of FPSO at site to MODU demobilisation). There will also be cumulative impacts at the shore locations during this period due to increases in port activity, road transport, air transport and waste disposal.

Saltpond Oil Production

The Saltpond oil and gas field is approximately 100 km west of Accra and is located 12 km offshore Saltpond town in approximately 27 m of water. Six wells were drilled from a centrally located jack-up rig (Mr. Louie) which was later converted into a production unit and the field was put on stream in 1978. The field was shut-in in mid 1985 and was reopened again in 2000. Two wells are currently producing approximately 600 bbls of oil a day which are offloaded to storage vessels and then onto a tug (150,000 barrels capacity) for export to refineries. Gas is flared and the produced water is treated and discharged to sea.

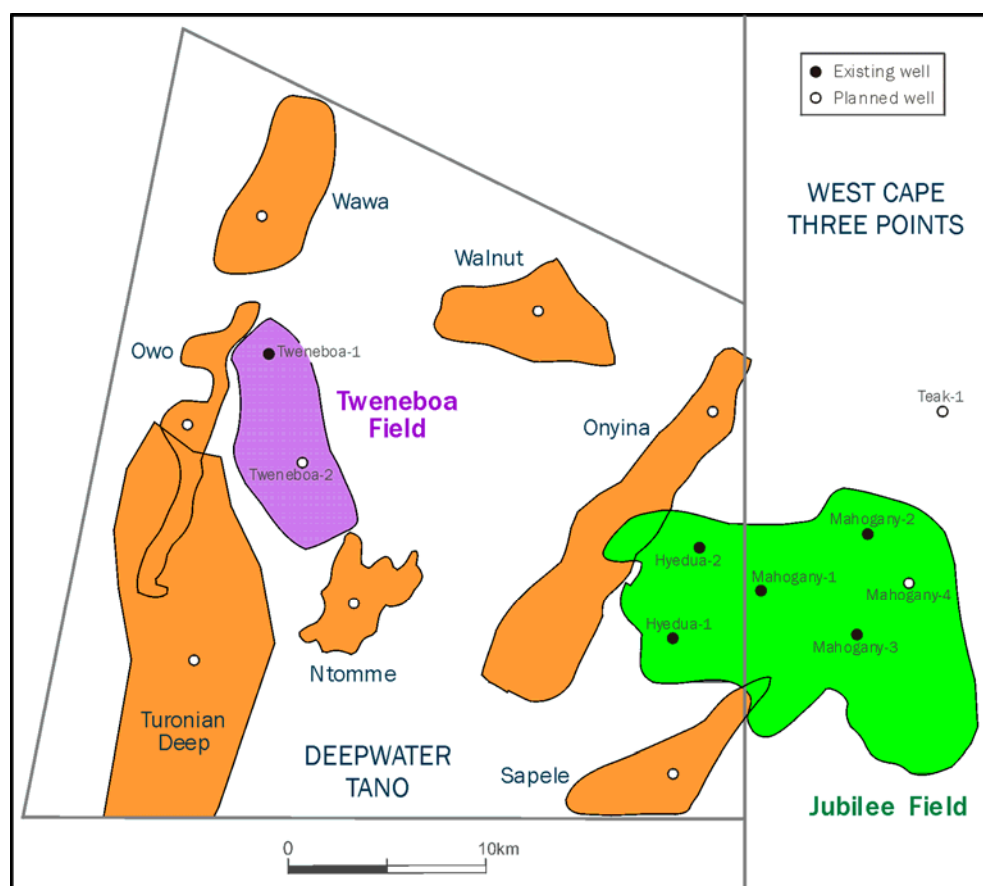
Deep Water Tano Proposed Drilling

Preliminary locations of twelve proposed exploration and appraisal wells within the Deepwater Tano Block are shown on *Figure 5.18*. Tullow proposes to drill these wells between 2009 and 2012 and the drilling programme would be subject to a separate application to the EPA. The well centres where the MODUs would be placed are shown and more than one well would be drilled from some of these well centres. The wells are all located at a distance of between 55 and 70 km offshore in water depths between 800 and 1,800 m.

Westcape Three Points Proposed Drilling

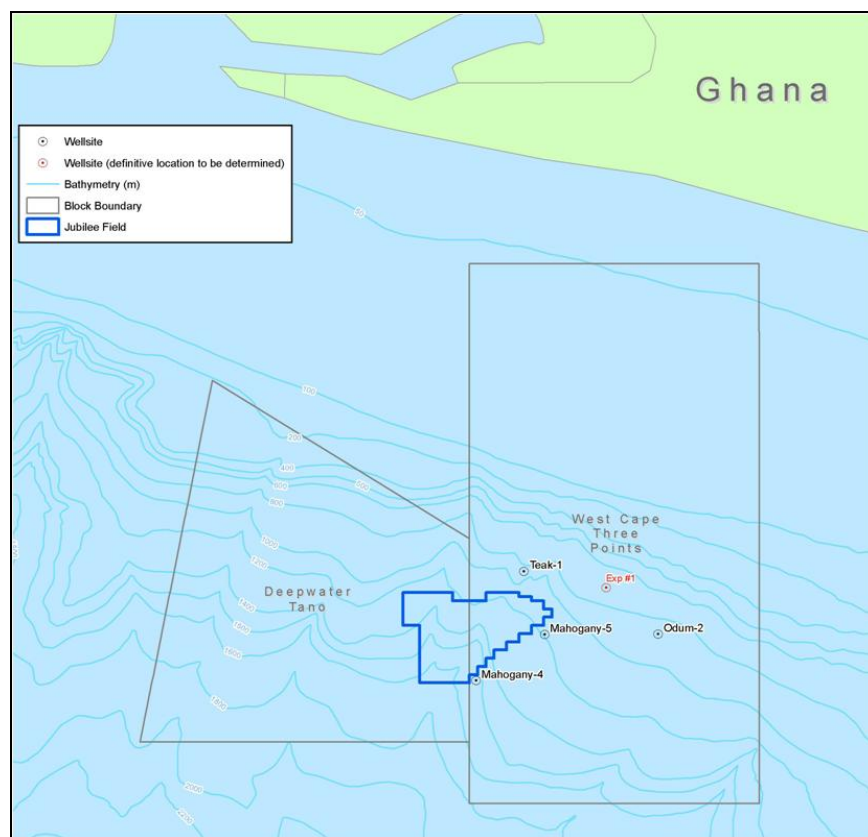
Preliminary locations of five proposed exploration wells (Mahogany-4, Mahogany Deep-2, Teak-1, Mahogany-5, and Odum-2) within the Westcape Three Points Block, east of the Jubilee field are shown on *Figure 5.19*. Kosmos Energy proposes to drill these wells between 2009 and 2012 in water depths of between 700 and 1,520 m.

Figure 5.18 Oil and Gas Activity in the Deepwater Tano Block



Source: Tullow Oil plc

Figure 5.19 Oil and Gas Activity in the West Cape Three Points Block



Source: Kosmos Energy

Other Activities

There are a number of other current operations or regularly performed activities in the general project area that have the potential for impact to the environment. These are summarised in *Table 5.17*. There are other on-going human activities that have the potential for contributing to impacts including: discharge of untreated waste and effluent to the marine environment; waste disposal; and releases of oils and fuels by marine vessels.

Table 5.17 *Other Activities Within the Project Area*

Activity	Description	Location
Artisanal Fishing	Fishing by traditional methods by local fishing communities	Along the coast mostly in nearshore areas and using beaches for fish processing and sale
Commercial Fishing	Fishing by commercial vessels using trawling and line methods	In deeper water areas using main ports (including Takoradi) for berthing
Shipping	Commercial ship traffic	In the Atlantic Ocean and near main ports
Tourism, and Recreation	Tourism, swimming, fishing and boating	In the nearshore areas and along beaches
Dredging	Maintenance dredging of Takoradi port area	Near Takoradi port
Manufacturing/ Refining	Oil and gas extraction, processing, and transport, both onshore and offshore	Various locations within the project area
Agriculture	Plantations and agricultural activities	Along coastline
Power Generation	Operation of power plants	At Takoradi power plant
Transport Infrastructure	Construction and maintenance of roadways such as road asphalt widening and new bridge construction	In Takoradi near the port and airport
Real Estate Development	Business and housing construction projects	In Takoradi and along coastline
Environmental Restoration	Shoreline stabilisation work or hydrologic restoration	Along the coastline near land developments

5.8.4 *Potential Future Activities*

The types and nature of reasonably foreseeable future development that may result in cumulative impacts with the Jubilee Phase 1 project was gathered through the EIA process from discussions with stakeholders, and through review and experience with similar developments worldwide.

These include:

- expansion of the Jubilee development;
- new offshore oil and gas exploration and production;
- oil and gas processing and other industrial development induced by oil and gas availability.

Expansion of the Jubilee Development

There may be further phases in the development of the Jubilee field. Future phases will depend on information obtained during the drilling programme and the Phase 1 production operations. It is not known what future development may occur but it is likely that new wells would be drilled and the FPSO production capacity increased to accommodate larger volumes of oil or an additional FPSO installed within the field.

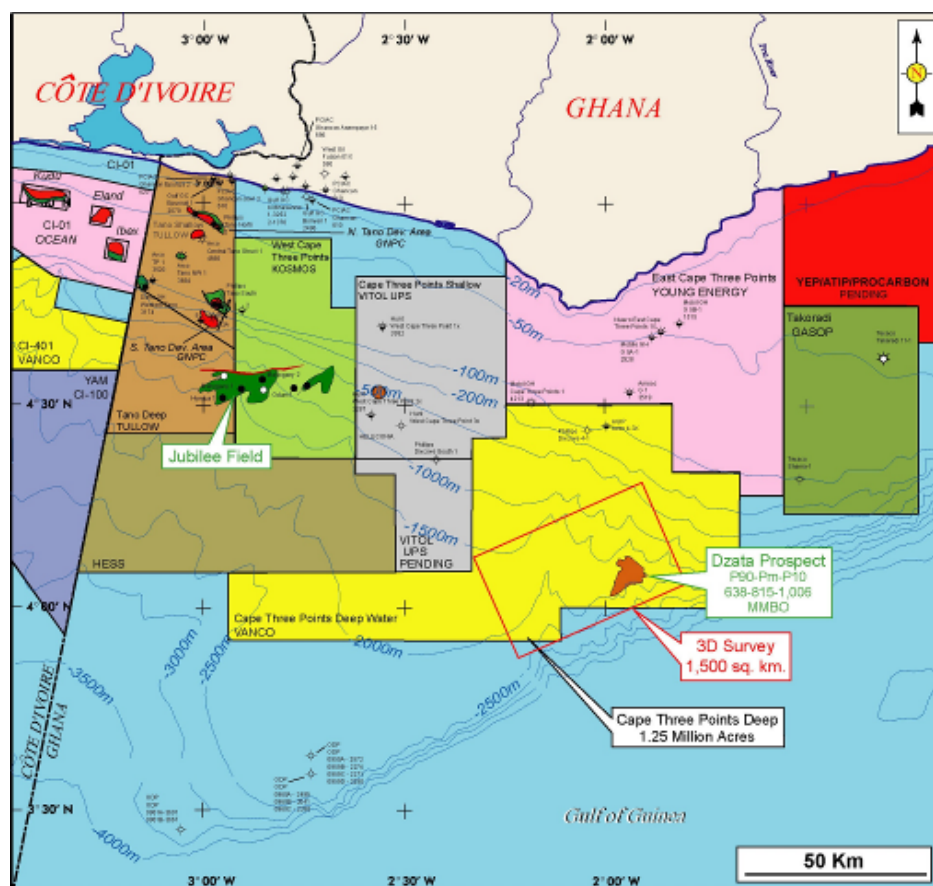
New Offshore Oil and Gas Exploration and Production

There is significant exploration activity in Ghanaian waters under the oversight by the Government of Ghana (see *Figure 5.20*). The activity currently is focussed on exploration drilling to identify hydrocarbon reserves and to prove production capability. If the exploration activity is successful then the future development of one or more of the identified reserves is likely to occur. The development could take an approach similar to the Jubilee development (ie FPSO) or it could take a different approach (eg platform and pipelines to onshore processing facilities). Oil and gas exploration and production is also occurring in Cote d'Ivoire to the west of Ghana, including relatively near to the Jubilee field (see *Figure 5.21*).

Oil and Gas Processing and Other Industrial Development

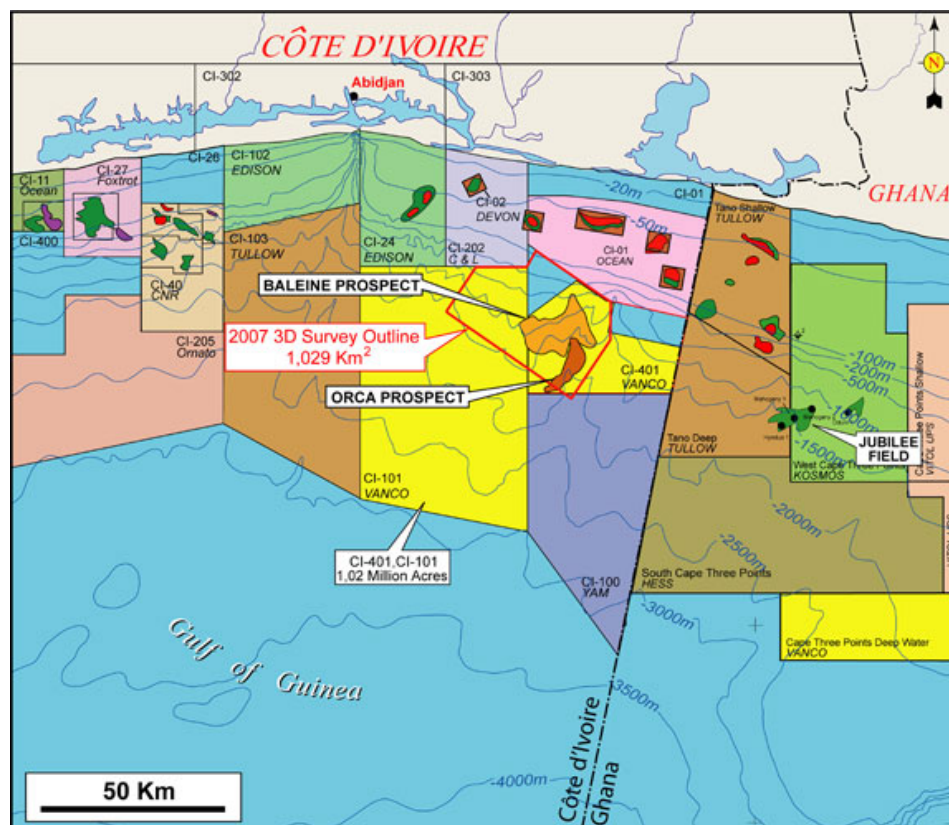
The Government of Ghana is investigating a potential project to transport associated and non-associated gas from the Jubilee field by subsea pipeline to an onshore processing facility. There the gas would be processed and treated and further transported for commercial use. Concepts being investigated include using the gas for a power plant located on the coast in the western part of Ghana or to transport the gas to the West African Gas Pipeline system. Future options for a refinery and other industrial plants are also possible.

Figure 5.20 Oil and Gas Licence Areas and Potential Prospects, Offshore Ghana



Source: Vanco Energy Company website. <http://www.vancoenergy.com.htm/>

Figure 5.21 Oil and Gas Licence Areas and Potential Prospects, Offshore Cote d'Ivoire



Source: Vanco website

The Phase 1 Jubilee project is scheduled for a minimum period of 20 years with the main well completion and installation activities occurring in the first 18 months. Short term impacts include disturbance from noise and vessel movements from the presence of a number of installation and support vessels during completions, installation and commissioning and seabed disturbance during installation of seabed infrastructure. Long-term impacts associated with the project include: effects associated with on-going emissions to water and air; risk of accidents including oil spills; restrictions on fishing and shipping in the vicinity of the FPSO; waste management; and changes to socio-economic conditions through employment and procurement.

Based on the impact assessment from the Phase 1 Jubilee field activities discussed in the preceding sections, cumulative impacts from other current and future project activities could potentially impact the following resources and receptors.

- habitats and species from physical presence of project infrastructure;
- water and air quality from effluents (including accidental spills) and emissions;
- waste disposal sites from waste arisings; and
- socio-economic and human impacts from interactions with other users (eg fishermen and shipping) and from employment and procurement.

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

Physical Presence

For a period of approximately 14 months, vessels and equipment for both drilling and FPSO installation and operation will be present at the offshore location at the same time. There will be safety exclusion zones around the FPSO and the MODU and there will be a number of installation and support vessels in the area operating with limited manoeuvrability. With effective communications within the project advisory area and enforcement of exclusion zones no significant cumulative impacts with other vessels are expected.

There will also be vessels travelling to and from Takoradi port and supporting both the drilling and the Phase 1 development operations. The use of these

shipping lanes and the control of vessel movements close to port by the port authorities will reduce the risk of vessel collisions and no significant cumulative impacts are considered to be likely.

For other planned and potential offshore oil and gas developments in Ghanaian waters, including the proposed drilling programme in the Tano Deep Water and Cape Three Points licence blocks to the west and east of the Jubilee field respectively, the direct physical and indirect ecological impacts will be localised and will not have a significant cumulative impact with the Jubilee field development.

Noise impacts from other drilling and production activities are not expected to have significant impacts beyond 1 to 5 km from the source and cumulative impacts with other oil and gas developments in the Ghana EEZ area are not considered to be significant.

Air Emissions

Air emissions from the MODUs are primarily associated with power generation and as such emissions during drilling are similar to those during well completions described in *Section 5.4*. During the overlap period with development drilling and completions/installation activities the air emissions from drilling will act cumulatively with those from the Jubilee Phase 1 project. Future exploration activities and the development of other oil and gas production facilities offshore Ghana will increase the level of air emissions eg from well testing and production flares, construction plant, power generation and support vessels. Given the distance offshore of the Jubilee field local impacts on air quality are expected to be of *Minor* significance and no cumulative impacts from other activities are expected. Increases in support activities in Takoradi will result in increased traffic volumes with associated air quality impacts from emissions of SO_x, NO_x and CO, however, the scale will be small and cumulative impacts are assessed as *not significant*.

Emissions of GHG from the Jubilee project were assessed as of *Minor* significance. Further oil and gas developments will add to GHGs but it is not anticipated that this would not exceed *Minor* significance in the short or medium term. Future oil and gas developments and power plants will, however, increase the GHG emissions for Ghana.

Effluent Discharges

Offshore discharges into the marine environment from oil and gas developments will follow MARPOL requirements and good industry practice and will result in impacts of *Minor* significance. Given the high dilution and dispersion capacity of the deepwater offshore area no significant cumulative impacts from other offshore activities in the vicinity of the Jubilee field are expected.

In addition to the seabed impacts from the installation of the sub sea equipment described in *Section 5.2*, there will be impact from the drilling activities due to the disposal of drill cutting onto the seabed in the vicinity of the drill centres. These impacts are described in *Annex B* which concludes that seabed and marine ecology impacts will be very localised and of *Minor* significance. For potential future drilling in the Jubilee field the 15 unused well slots that are being installed as part of the Phase 1 project may be used and impacts will be similar to the current drilling programme. Given the extent of impacts and the nature of the receiving environment no significant cumulative impacts on marine biodiversity from the physical presence of MODUs and the Phase 1 development activities are expected.

Effluent discharges at the onshore logistics bases would only occur in the event of spillages and run-off from storage areas and are assessed as being *not significant* with control in place to ensure oil in water content of discharge waters is within standards. These discharges will act cumulatively with discharges from other activities ie port activities, however, the contribution from the Jubilee project is assessed as being *not significant* given the scale and likelihood of discharges and the controls in place.

Waste Management

Volumes of solid and liquid waste requiring onshore land disposal will be higher during the period where drilling activities and installation activities are being undertaken in the Jubilee field. The waste study undertaken as part of the Phase 1 development project also assessed the suitability and capacities of the existing facilities to deal with drilling wastes and identified a series of steps that the project will need to take to address the waste management issue (see *Annex F*). The waste disposal impacts from the project will act cumulatively with other requirements for non hazardous and hazardous waste disposal facilities, particularly those from other oil and gas developments. The limitations of current waste disposal facilities have been recognised by the project as a key issue that requires active management by Tullow in collaboration with other parties, including the Government of Ghana. With the generation of project wastes assessed as being of *Moderate* significance and the planned development of waste handling and disposal facilities for wastes from the Jubilee field, *no significant* cumulative impacts are expected from other activities.

Oil Spills

The project undertook a study of fate of oil or fuels if there were an accidental release into the environment (see *Annex D*). The model simulated release for both an accidental release of oil from a well during drilling and from the storage tanks on the FPSO. It also modelled accidental release of fuel from vessels in the Jubilee field.

There is the possibility that there would be cumulative effects from multiple spills occurring over time from a number of different sources. The oil spill

frequency modelling study (see *Annex C*) indicated that the probability of major spills, particularly those that could affect the coast or spills occurring simultaneously are very low.

In the event of a major oil spill from one or more locations a co-ordinated national oil spill response effort will be required. An oil spill contingency plan (OSCP) has been implemented by Tullow for the drilling and installation stages of the project, and work is in progress for the production stage. Contingencies for smaller scale spills, both offshore and in port and from vessels and MODUs include bunds, barriers, barrage, and recovery equipment (skimmers and absorbent). Tullow's membership of the oil industry Oil Spill Response Limited (OSRL) provides further access to international scale response capabilities including further trained personnel, equipment and dispersant capabilities.

Due to the high sensitivity of resources and receptors but the very low probability of large spills the residual impact from the Jubilee Phase 1 project was assessed as being of *Moderate* significance. Smaller spills with higher probabilities were assessed as being of *Minor* significance. The probability of multiple spills over time remains very low and *no significant* cumulative impacts from other planned activities are predicted.

Socio-economics and Human Activities

The Phase 1 Jubilee field development will provide significant economic benefits to the Government of Ghana. It is likely that future oil and gas industry developments will increase these benefits and in the longer term, a large scale increase in oil and gas developments in Ghana could lead to cumulative impacts of *Major* significance at the macro-economic scale. Employment and procurement impacts are likely to be more localised, nevertheless they are likely to be positive and significant. At this stage, cumulative macro-economic and employment impacts from other activities with the Jubilee Phase 1 Development project are considered as being *not significant*.

The perceptions of increased employment opportunities and other benefits as a result of the expansion of oil and gas industry activities and associated businesses will be raised and may increase the current rate of in-migration, particularly to Takoradi. Any influx of people could put a strain on facilities and services, such as health and education, currently available to residents. The majority of oil and gas workers will be based offshore and will make periodic trips to the shore on a work rotation basis. Many of the workers on the MODUs will be foreign nationals who will leave the country during their work break period so their impact to the local socio-economic environment is expected to be minimal. It is expected that the oil industry will meet the needs of its workforce by, for example, providing the required safe water and health services. However, regional development plans will have to provide for additional industries (eg power generation) that may develop in the region as

a result of the development of the oil and gas industry. Cumulative impacts on onshore facilities and services are assessed as being *not significant*.

During the Jubilee project there will be an increase in the number of vessels making port calls, mainly to Takoradi. The overall number and frequency is low and no significant cumulative impacts are expected with normal port management procedures in place.

Future offshore developments, particularly if these are in coastal waters, are likely to result in displacement of fishing activity. While individually not significant, if a large number of offshore platforms are installed, and the degree of associated shipping increases there may be cumulative impacts on some fisheries sectors.

5.8.6 *Mitigation Measures*

Tullow has the ability to mitigate potential impacts associated with the Jubilee Phase 1 development activities, its drilling programme and any future developments in the Jubilee field. It has a more limited ability to manage or influence activities by others, however, which may result in cumulative impacts. Management of impacts from a range of different activities will in large part depend on the measures put in place by the government, oil and gas companies and other stakeholders in the coming years. The general approach for mitigating and managing potential cumulative impacts will therefore require coordination of all the relevant industries, enterprises and agencies under the direction of the Government of Ghana.

Strategies that could help manage potential future cumulative impacts are outlined below. Tullow and its JV partners, as well as other oil and gas companies and interested parties, will contribute appropriately to these studies at various levels as they develop over the next few years.

- **Strategic Environmental Assessment (SEA).** A government led SEA would enable a comprehensive consideration of potential impacts that may result from the development of the oil and gas sector in Ghana. Such an assessment would ideally feed into the key elements of proactive planning (land use zoning, analysis of infrastructure, waste management, utility and social service needs). The assessment would require greater information on the types of development than is presently available.
- **Build Capacity of Local Administration.** The support provided to Regional and District government to build the capacity of its staff would determine the extent to which it is able to plan effectively for future development in the area. Administrative capacity building could include training, provision of equipment and the provision of technical support (eg information technology support). General capacity building is typically government led (sometimes through donor assistance) but industry can play an active role in developing technical capacity for oil and gas sector oversight.

- **Business Collaboration.** Companies operating in the Western Region and the Government of Ghana should collaborate to agree on common standards and approaches for managing cumulative impacts. This is especially relevant to companies operating in the oil and gas sector. This could be achieved through the establishment of a working group to develop cumulative impact management objectives, standards and measures, and to oversee the monitoring of impact management over time. The extent to which businesses collaborate on such matters as shared infrastructure and local vocational training schemes will be important.
- **Data Gathering and Monitoring.** A structured programme of data gathering and monitoring studies would allow for the proactive management of negative trends that could arise over time. This would require the establishment of a monitoring capability within local government and a set of indicators that would allow the positive and negative impacts associated with change to be tracked. Regional monitoring would need to be government led but industry can play a role in contributing any project related data or supporting the programme through technical assistance. Offshore, information on the cumulative impacts on biodiversity can be gathered through surveys of marine mammal and turtle distributions, post drilling seabed surveys and fish and fisheries surveys.
- **Developing and Enforcing Environmental Management Standards.** Environmental standards need to be reviewed and developed for new and existing industries and collectively applied by the government on all businesses operating in Ghana. This would benefit communities and industry and would influence the severity of impacts on environmental resources and receptors from illegal sources.
- **National Oil Spill Plan.** Collaboration of the oil and gas industry, shipping interests and the Government of Ghana to develop and support an integrated approach to oil spill response including shared resources and expertise and joint training and exercises.

5.8.7

Residual Cumulative Impacts

The offshore impacts from the Jubilee Phase 1 Development are generally localised and no significant cumulative impacts are expected from other current and planned projects. In the future emissions of Greenhouse Gases from the Jubilee field and potential additional offshore oil and gas developments is likely to result in a significant increase in national emissions given the relatively low level of current national emissions. Onshore, the potential exists for both positive and negative impacts, particularly if Takoradi develops as a base to serve a growing offshore oil and gas industry. 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 managed these impacts if the oil and as industry develops in Ghana.

The project activities will mostly occur within Ghanaian national waters. The FPSO will be permanently moored at the Jubilee field and the shore support base will be located at Takoradi port. The port of Abidjan in Cote d'Ivoire has served a support role in the past, particular for the supply of offshore drilling chemicals, however, these services are now being established in Ghana. Activities may interact with other national waters and international waters such as during transport of the FPSO and subsea infrastructure to the project location and export of crude oil from the FPSO to offloading destinations.

The following issues with the potential for transboundary impacts have been considered.

- Oil spill dispersion modelling indicates that any accidental oil release would generally disperse to the north and east as a result of ocean currents and wind flows. If oil were accidentally released it would not impact Cote d'Ivoire to the west or Togo to the east, in these circumstances.
- Air emissions from the FPSO would generally dissipate and reduce to insignificant levels at a short distance from the source.
- Project generated waste will be treated to acceptable levels and discharged or transported to an onshore location in Ghana for treatment and disposal. Any transboundary movement of hazardous waste that cannot be dealt with in Ghana would be subject to controls under the Basel Convention and Bamako Convention. There may be occurrences of marine vessels with ancillary association to the project using non-Ghanaian ports such as Abidjan for service. Control of any discharges, emissions or wastes from these vessels would be governed by MARPOL requirements. The number of such vessels is expected to be low.
- Migratory and mobile marine fauna (eg fish, whales, turtles and birds) will pass through the project area. No significant impacts on marine fauna are expected so no transboundary impacts are predicted.
- Foreign registered fishing vessels are reported to use the Ghanaian waters illegally. Enforcement is likely to increase during the project construction and operation phase due to the presence of project vessels and occasional visits by the Ghanaian Navy, and the use of the area by foreign-based fishermen is likely to decrease. The number of fisherman affected is not expected to be significant.

No significant transboundary impacts are expected to occur as a result of the project.