# Kitan Field Development – Final Environmental Impact Statement

| Validity Status | Rev. Number | Date | Description | Prepared by | Checked by | Approved by | Contractor Approval | Company Approval |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| EX | 02 | 29/09/10 | Issued for use | CD | RP | ES | | |
| CD | 01 | 28/01/10 | Issued for use | SG/JN | RP | ES | | |
| CD | 00 | 17/12/09 | Issued for internal review | SG/JN | RP | | | |

Revision index

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|---|---|---|
| Eni JPDA 06-105 | Project name<br>Kitan Field Development | Company identification<br>**000177_DV_EX.HSE.0206.000**<br>Job N. ___ |
| | | Contractor identification<br>Contract ___ |
| | | Vendor identification<br>……………………………………<br>Order N.……………………… |

| Facility Name | Location | Scale | Sheet of Sheets |
|---|---|---|---|
| KITAN | TIMOR SEA | 1:1 | 1 / 139 |

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|---|---|---|
| Document Title<br>Kitan Field Development – Final Environmental Impact Statement | Supersedes N.………………<br>Superseded by N.………… | |
| | Plant Area | Plant Unit |

## REVISION HISTORY

| Rev. | Date | Nr. of sheets | Description |
|---|---|---|---|
| 01 | 27/01/2010 | 137 | First Issue |
| 02 | 29/09/2010 | 139 | Revised after government review |
| | | | |
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## TABLE OF CONTENTS

## FIGURES

## TABLES



**APPENDICES**

**ABBREVIATIONS**

| | |
|---|---|
| ADIOS2 | Automated Data Inquiry for Oil Spills |
| ALARP | As low as reasonably practicable |
| AMSA | Australian Maritime Safety Authority |
| ANP | Autoridade Nacional do Petroleo (National Petroleum Authority) |
| AQIS | Australian Quarantine Inspection Services |
| ARPA | Auto radar plotting aids |
| bbls | Barrels |
| BOD | Biological oxygen demand |
| BOP | Blowout preventer |
| BTEX | Benzene, toluene, ethylbenzene and xylenes |
| CoA | Commonwealth of Australia |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| DA | Designated authority |
| DEWHA | Department of Environment, Water, Heritage and the Arts |
| DNMA | Direcção Nacional do Meio Ambiente (National Directorate of Environment) |
| DWT | Dead weight tonnage |
| EBM | Ester-based muds |
| EEZ | Exclusive Economic Zone |
| EIS | Environmental impact statement |
| EMP | Environmental management plan |
| Eni | Eni JPDA 06-105 Pty Ltd |
| ESD | Emergency shutdown |
| FPSO | Floating production, storage and offloading facility |
| GDP | Gross domestic product |
| GPI | Gas performance indicator |
| GSP | Gross state product |
| HSE | Health, safety and environment |
| IMP | Incident management plan |
| IMS | Integrated management system |
| ISGOTT | International Safety Guide for Oil Tanker Terminals |
| KCl | Potassium chloride |
| JPDA | Joint Petroleum Development Area |
| JVP | Joint venture partners |
| LAT | Lowest astronomical tide |
| MEMP | Marine environmental monitoring programme |
| MODU | Mobile offshore drilling unit |
| MSDS | Material safety data sheet |
| NOx | Nitrogen oxides |
| NT | Northern Territory |
| NWBM | Non-water-based muds |
| OBM | Oil based mud |
| OCIMF | Oil Companies International Marine Forum |
| ODS | Ozone depleting substances |
| OIM | Offshore Installation Manager |
| OIW | Oil in water |
| OSCP | Oil spill contingency plan |
| OSV | Offloading support vessel |
| PAH | Polycyclic aromatic hydrocarbons |
| PER | Preliminary environmental report |
| PFW | Produced formation water |
| PHPA | Partially hydrolysed polyacrylamide |
| ROV | Remotely operated vehicle |
| SBA | Social baseline assessment |
| SBM | Synthetic-based muds |
| SERN | Secretaria de Estado dos Recursos Naturais (State Secretariat for Natural Resources) |
| SIRE | Ship Inspection Report Programme |
| SO2 | Sulphur dioxide |
| TBT | Tri-butyl tin |
| VOCs | Volatile organic compounds |
| WBM | Water-based muds |

## EXECUTIVE SUMMARY

This Environmental Impact Statement (EIS) presents the outcomes of a detailed environmental impact assessment for the Kitan Development. It addresses the environmental and social impacts and management issues associated with drilling, construction and operation of the Kitan Development, including those associated with drilling production wells and installation and operation of a Floating Production Storage and Offloading (FPSO) facility and the associated subsea facilities. This assessment concludes that the Project can be developed and managed to achieve its objectives, without causing unacceptable environmental and socio-economic effects.

This document was first submitted as a Draft EIS to the Timor-Leste Autoridade Nacional do Petroleo (ANP; National Petroleum Authority) in February 2010. The Draft EIS was reviewed by Timor-Leste and Australian environmental authorities, in a process coordinated by the ANP. Review comments were provided to Eni, and additional information or clarifying comments have been incorporated where necessary into this document, the Final EIS.

This Final EIS will be issued for public comment in Australia and Timor-Leste for a period of six weeks, and any issues affecting environmental management of the Kitan Development will be incorporated into environmental management plans for the relevant development phases, as appropriate. These plans will be reviewed and approved by the ANP as part of on-going environmental regulation of the project.

## INTRODUCTION

### Background

Eni-JPDA-06-105 Pty Ltd (Eni) proposes to develop the Kitan oil field in deep offshore waters (~310m water depth) of the Joint Petroleum Development Area (JPDA) in the northern Bonaparte Basin of the Timor Sea. The field is located in Permit JPDA 06-105 (Figure ES1), approximately 170km from the southeast coast of Timor-Leste and 550km northwest of Darwin, Australia. The reservoir is located ~3,300m below the seafloor.

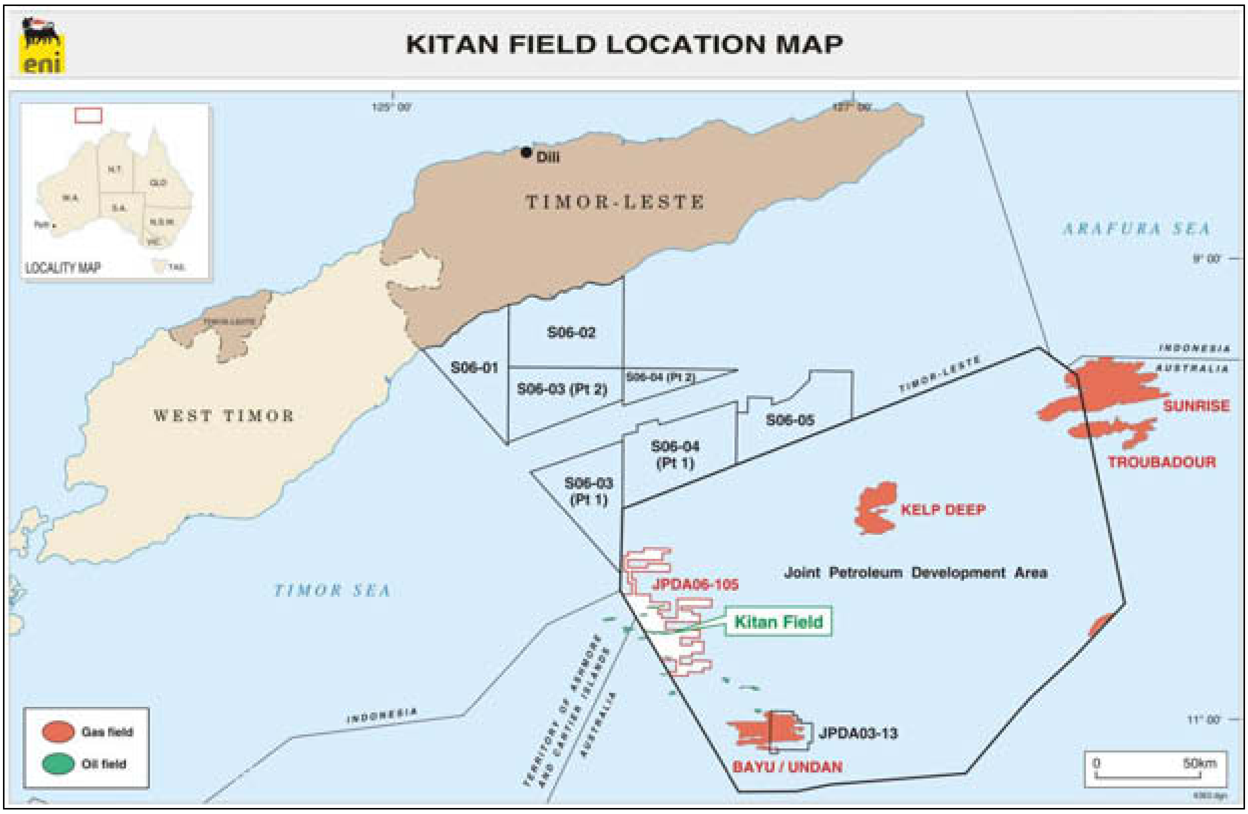



Figure ES1: Location of the proposed Kitan Development

**The Proponent**
The Kitan Development is a joint venture between Eni (40%), INPEX Timor Sea Ltd (35%) and Talisman Resources JPDA 06-105 Pty Ltd (25%).

The designated operator is:
Eni-JPDA-06-105 Pty Ltd
40 Kings Park Road
West Perth,
Western Australia
Tel: +61 8 9320 1111

**Legislative framework**
The JPDA is administered under the Timor Sea Treaty and its annexes; the Petroleum Mining Code. The Autoridade Nacional do Petróleo (ANP) regulates petroleum operations in the JPDA on behalf of the Government of Timor-Leste and the Commonwealth of Australia (CoA). This EIS was prepared in accordance with the *Interim Administrative Guidelines for the Joint Petroleum Development Area (2003)* and the Regulations issued under Article 37 of the Petroleum Mining Code.

**THE PROJECT**
**Overview**
The main activities associated with the Kitan Development are:

- drilling of three subsea production wells into the oil reservoir;
- installation of subsea well heads and flowlines to carry reservoir fluids from the wells to the FPSO vessel,
- installation of moorings;
- installation and commissioning of the FPSO;
- production and export of crude oil from the FPSO to trading tankers; and
- decommissioning of the facilities at the end of field life.

The development concept for the field, at start-up (first oil production) is for three wells, each completed with subsea equipment, tied back to a dedicated FPSO. The FPSO will be located approximately 3km north from the centre of the field, in ~344m water depth. The FPSO will be permanently moored at the field. The conceptual layout of the Kitan Development is shown in Figure ES2. The planned subsea infrastructure will provide the flexibility to allow the tie-in of future subsea production wells.

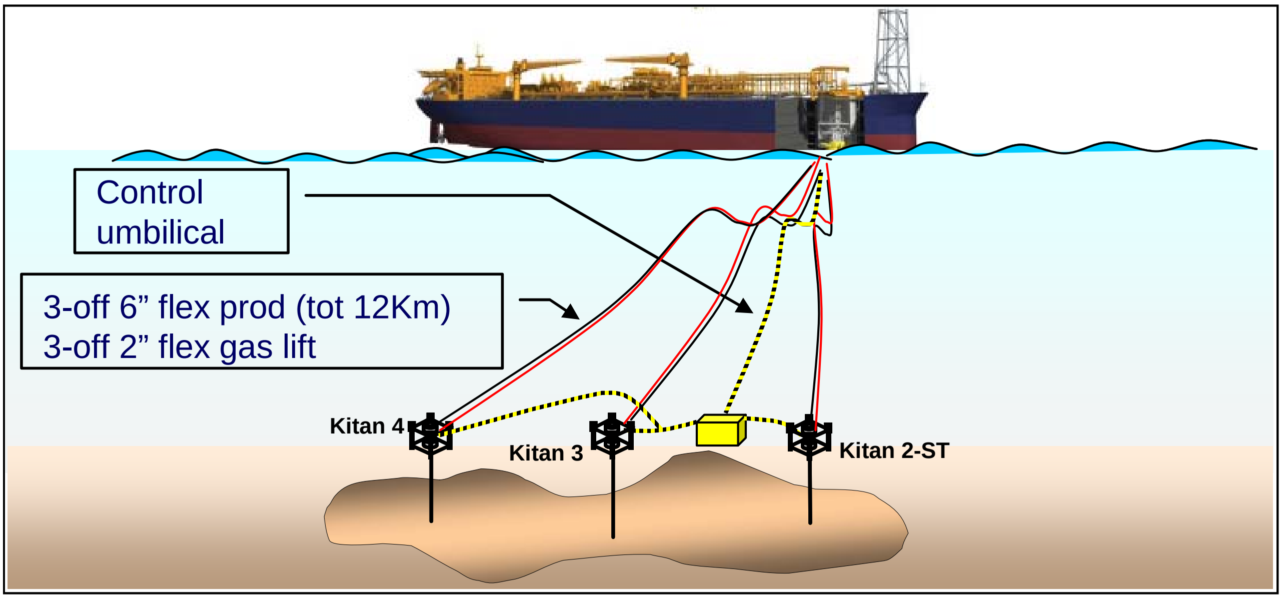



**Figure ES2: Conceptual layout of the Kitan Development**

**Drilling**
Drilling will be required for a number of production wells. The wells will be drilled and completed using Transocean Limited's, Transocean Legend, a conventional semi-submersible mobile offshore drilling unit (MODU). Low toxicity water-based drilling muds (WBMs) will be used where possible. For the top hole section of the wells seawater will most likely be used with high pressure sweeps of seawater and prehydrated bentonite clay. Non-water based muds, e.g. synthetic-based muds, may be considered if WBMs are found not to be technically suitable.

**Installation and commissioning**
Installation and commissioning stages will involve placing subsea flowlines on the seafloor and connecting and testing the equipment, including flowing oil through subsea flowlines and production equipment on the FPSO prior to start of production. With the exception of drilling and well construction activities, virtually all components of the proposed development will be fabricated and assembled away from the proposed development location. Connection and commissioning of facilities will be carried out to the maximum extent possible at the fabrication yard to minimise the duration and complexity of offshore activities. Typically only installation, hook-ups, testing and commissioning activities are required at site prior to the commencement of operational activities. Systems that cannot be fully commissioned until reservoir fluids first flow onto the facility include the production separation systems, gas compression systems, fuel gas systems, flare systems and crude oil storage and offloading systems.

**Production**
The Kitan field will produce to Bluewater Energy Services' Glas Dowr FPSO (Figure ES3). FPSOs represent proven technology and are commonly used around the world. A number are already in use on the North West Shelf of Australia and in the Timor Sea and Eni has extensive experience in FPSO design and construction, as well as commissioning and operation in Australia's offshore oil and gas industry. FPSOs provide a number of benefits including:

- well established technology;
- proven operating performance in similar environments;
- location of all facilities a considerable distance offshore;
- straightforward decommissioning; and
- low visual impact because of their ship-like appearance.

Figure ES4 shows the FPSO's oil production process. Peak crude oil production is expected to be ~40,000bbl/day (~6,300m$^3$/day). Gas from the reservoir will be separated from the well fluids by processing equipment on the FPSO. Gas from the separators will be recompressed and dehydrated, allowing use as fuel gas and for artificial lift purposes, with any surplus gas being flared. PFW volumes are initially small but increase significantly towards the end of field life. The current design is for PFW during all stages of the project to be discharged overboard after treatment to meet the 24hr average discharge standard of 15mg/L oil-in-water (OIW). OIW separation systems, consisting of hydrocyclones and gas induced flotation units, will be used to treat PFW prior to discharge.

The offloading of crude oil from the FPSO to trading tankers will take place approximately every two weeks in the initial high production period, and then become less frequent as production rate declines. Offloading procedures are expected to be similar to those used for other FPSOs. Trading tankers will be vetted prior to being permitted by Eni for use to offtake oil from the FPSO.


**Figure ES3: Bluewater Energy Services B.V. – FPSO Glas Dowr**

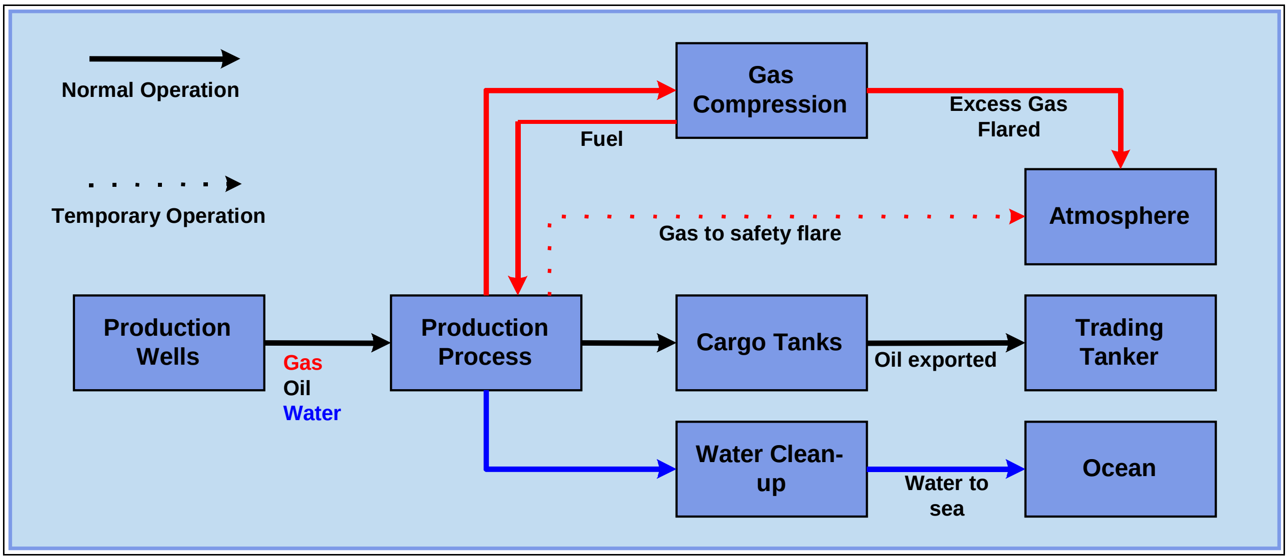



**Figure ES4: Production process**

**Decommissioning**
Decommissioning of the Kitan Development will be carried out at the end of field life in accordance with legislation and industry guidelines, using technology and practices in place at that time. The time of decommissioning is expected to be in the order of seven years after start-up. A detailed decommissioning plan will be prepared and submitted to the relevant authorities prior to commencement of decommissioning activities. The aim is to decommission to as near as practicable original conditions. That aim will be facilitated by the use of the FPSO, whose decommissioning simply involves disconnection from the mooring and moving away from the location.

## STAKEHOLDER CONSULTATION
Stakeholder engagement and consultation are essential components of a successful environmental impact assessment (EIA) process. The EIA process provides Eni with a means of describing and explaining to stakeholders and other interested groups what the project is, the likely potential effects and how any significant effects that may result from the project will be controlled and managed. The EIA process also allows interested persons to voice any concerns over the project for consideration by Eni and relevant regulatory authorities.

During development of the Draft EIS, Eni conducted a scoping exercise to identify key stakeholders and potential issues. Initial consultation was conducted with the ANP, who facilitated communication with other interested parties, such as the Secretaria de Estado dos Recursos Naturais (SERN; State Secretariat for Natural Resources) and the Direcção Nacional do Meio Ambiente (DNMA; National Directorate of Environment). Early discussion with the ANP was important in establishing relationships, identifying potential environmental effects, learning where concerns and issues exist from the stakeholders' perspective and in obtaining feedback on the proposed approach and technical aspects of the EIS.

After submission of the Draft EIS in February 2010, feedback from the Timor-Leste and Australian environmental authorities and one non-government organisation (La'o Hamutuk) was provided to Eni, in a process coordinated by the ANP. Following incorporation of these comments, Eni produced this document, the Final EIS. The Final EIS will be issued for public comment in Australia and Timor-Leste for a period of six weeks, with any new stakeholder issues raised incorporated into environmental management plans for the Kitan Development as appropriate.

Consultation with the ANP and other stakeholders will continue throughout the life of the project.

## ENVIRONMENTAL SETTING
### Physical environment
The climate of the Timor Sea is monsoonal with a wet "summer" and a dry "winter". The wet season commences between September and November as the southeast trade winds (SE Trades) weaken over Northern Australia and land temperatures rise. Mean annual rainfall in the region is 1,700mm. Almost all rainfall occurs between November and April, the greatest falls being in January and February. Mean air temperature ranges between a mean of 26.9°C in July and 28.4°C in December and vary little during the year. Regional sea surface temperatures range from 26ºC to 31ºC.

Wind direction is predominantly northeast to southeast in winter months and southwest to west in summer months. A tropical cyclone period prevails over the region from November to April. Surface currents reflect seasonal wind regimes, with summer easterly to north-easterly currents, and winter westerly to south-westerly currents. The Timor Sea region is influenced by the Pacific-Indian Ocean throughflow which contributes to the westward-flowing South Equatorial Current.

The Kitan Field is located on the continental slope in an area of uniformly smooth seabed ranging in depth from 330m to 383m, with an average slope of 1:120. To the northwest, the continental slope continues to decline steadily reaching depths in excess of 2,000m in the Timor Trough. To the south, the Sahul Shelf extends approximately 300km out from and runs parallel to the northern Australian coastline. A system of shoals occurs to the south and south west of Kitan (Figure ES5). The system stretches for approximately 60km in a northeast/southwest direction along the outer edge of the Sahul Shelf and comprises 11 major shoals. The banks rise sharply above the continental slope from more than 300m to between 16m to 30m below the sea surface.

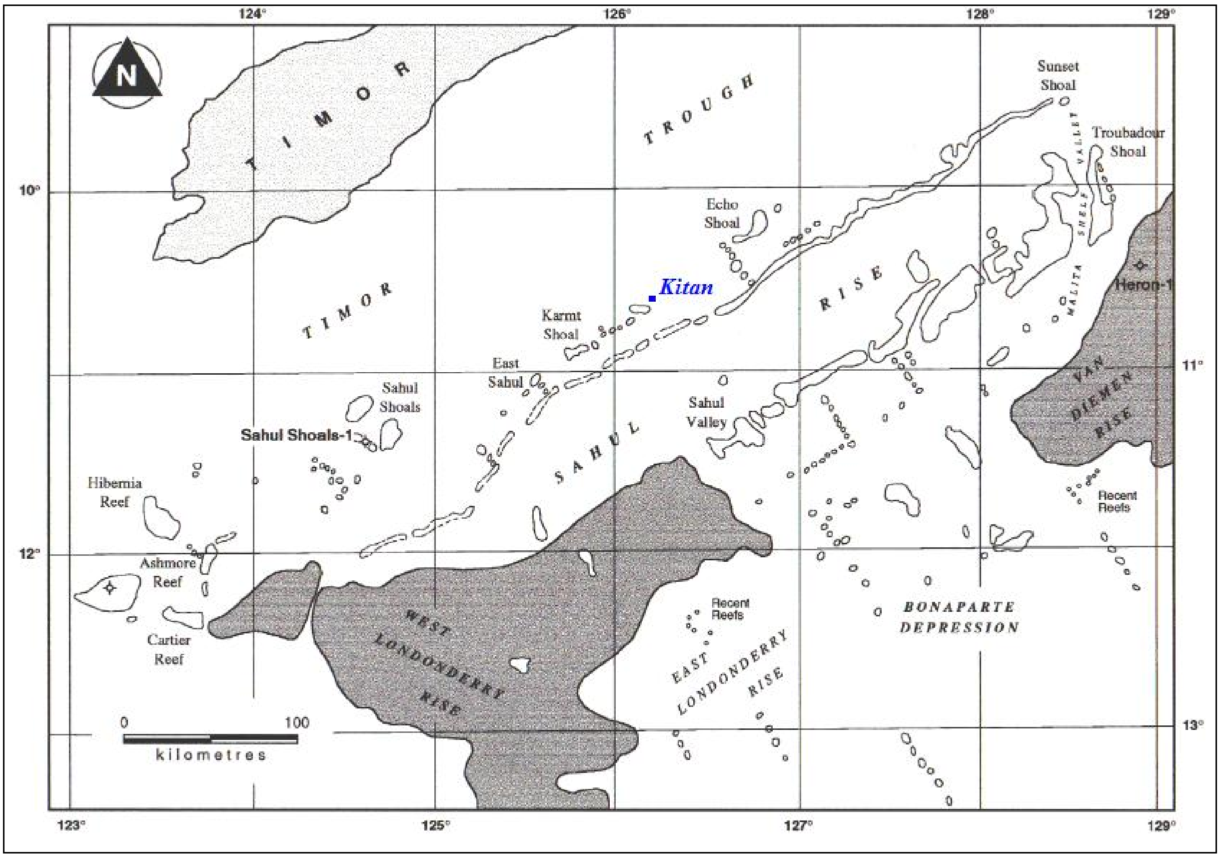



**Figure ES5: Regional bathymetry**

**Biological environment**

The Kitan Development area lies in deep water on the edge of the continental shelf. The seabed in the vicinity is relatively flat with soft sediment and characterised by a sparse invertebrate assemblage. Based on the similarity of seabed sediments and bathymetry, the benthic habitat of the Kitan Development area is expected to be widespread along the vast continental slope area of similar depth. Benthic sampling conducted at Kitan indicated that benthic infauna of the area is of low abundance and is generally characteristic of the region, dominated by polychaetes and crustaceans.

The closest submerged bank is Big Bank Shoals, which lies approximately 3km to the south. The submerged banks of the region vary in their habitat and species composition but are generally characterised by mixed Halimeda algae, sponge and soft coral communities with some hard corals on the more consolidated sediments. The benthic communities on the top of Big Bank Shoal are dominated by large areas of calcareous sand and rubble with a low percentage cover of algae, isolated sponges and isolated small coral bommies. Areas of high live coral coverage have been identified in approximately 25 to 30m depth on the northern and western sides of Big Bank. These represent the closest sensitive habitat to the proposed development.

Information is limited regarding marine fauna in the area, and confirmed records of cetacean species in the area are sparse. Twenty-two whale and dolphin species could potentially occur in the region surrounding the Kitan Development. Of these, the Blue Whale (*Balaenoptera musculus*) and Humpback whale (*Megaptera novaeangliae*) are listed as endangered and vulnerable respectively, under Australian legislation and international conventions.

Five species of sea turtle may be expected to occur in Timor Sea waters either feeding or migrating between feeding and nesting grounds. These are the Flatback (*Natator depressus*), Hawksbill (*Eretmochelys imbricata*), Green (*Chelonia mydas*) and Leatherback (*Dermochelys coriacea*) and Loggerhead (*Caretta caretta*) turtles. Fifteen species of seasnake are recorded from the Timor Sea and it is possible that some species inhabit shoals in the vicinity of the Kitan Development. The number and variety of fish species present in the region has not been quantified, although studies have identified a large variety of demersal fish which are common to the area. A variety of seabirds are expected to pass near Kitan or use the Timor Sea waters as part of their main habitat. The bird species utilising the area most frequently are offshore species such as shearwaters, petrels and terns.

**ENVIRONMENTAL IMPACTS AND MANAGEMENT**

A high level risk assessment of the Kitan Development found that of sixteen broad hazard categories, five were considered to be high risk, seven were medium risk and four were low risk. These risk classifications were considered in the absence of any risk reduction measures. The five hazards considered to be of high risk related to:

- crude oil or diesel spills;
- produced formation water (PFW) discharge;
- drilling-related discharges;
- atmospheric emissions; and
- solid and hazardous wastes.

Oil spills are the most significant potential threat to the environment from FPSO development projects, which involve the production, storage and transfer of large volumes of crude oil. Oil spills can potentially occur from a number of sources ranging from major spills such as from a well blow-out or storage tank rupture, which are extremely rare events, down to smaller leaks and spills from equipment and piping. The proposed development will be managed to avoid or minimise the potential for accidental releases of all substances, however, the potential exists for accidental release of hydrocarbons.

The potential exists for either Kitan crude oil or diesel to be spilled at some time during the life of the project. Kitan crude is a light oil that evaporates readily. Oil weathering studies have indicated that 85% would evaporate within 5 days of release to the marine environment, with the residual 15% remaining as a thin sheen on the sea surface. In contrast, diesel is classified as a light persistent oil. Diesels are expected to undergo a rapid spreading with moderate evaporative loss in tropical waters and, consequently, slicks are likely to break up. Oil weathering studies have indicated that 50% would evaporate within 5 days of release to the marine environment, with the residual 50% becoming entrained into the water column. Oil spill trajectory modelling of Kitan crude oil and diesel spills indicated that oil would not make contact with any land surface and would evaporate and weather at sea, even in the case of an extended well-blowout incident. Three-dimensional modelling indicated that both Kitan crude oil and diesel would remain in the surface waters so the probability of sensitive marine organisms on the nearby Big Bank Shoals being exposed to oil is extremely low.

Eni's safeguards to be implemented for the minimisation of environmental impacts associated with non-routine (accidental) discharges include:

- procedures to reduce the likelihood of oil spills occurring;
- procedures to minimise the volumes spilled; and
- actions to be taken minimise the environmental consequences in the event of a spill occurring, i.e. spill response.

Eni and its contractors will have appropriate oil spill response procedures in place throughout all phases of the project. The oil spill response procedures would be tested regularly to ensure their adequacy in responding to credible oil spill scenarios. Any release of crude oil or diesel into the marine environment would be recorded as an environmental incident and treated accordingly by Eni's incident investigation and corrective and preventative action processes.

PFW will be discharged overboard from the FPSO, at an expected maximum discharge rate of 35,000 bbls per day (~5,600m$^3$/day), after treatment to meet required discharge standards. Under normal operations, PFW will be treated to free OIW concentration of <15mg/L (24 hour average). A small number of chemicals will be added to the production process for increasing and/or decreasing emulsification, inhibiting scale formation, reducing corrosion and preventing growth of bacteria. These production chemicals are soluble in PFW to varying extents and are ultimately discharged with the PFW. Discharged PFW will also contain dissolved compounds from the geological formation, such as organic acids, low molecular weight hydrocarbons and salts, and finely dispersed oils.

Once PFW is discharged to sea, it is subject to dilution, dispersion and physical, chemical and biological degradation. The environmental effect of PFW has been subject to a large number of separate studies. The majority of studies and reviews carried out to date have focussed on acute ecotoxicity effects. The results drawn from these have generally been to conclude that PFW is not very toxic and that acute ecotoxicity effects to marine organisms are unlikely to occur. PFW will be continuously monitored and discharge will be diverted to a slops tank if it exceeds the set concentration limits. In addition, a quantitative risk assessment of PFW will be conducted prior to the discharge of PFW from the Kitan FPSO. The risk assessment will include an investigation into the ecotoxicity and bioaccumulation characteristics of the PFW.

Discharges to sea of drill cuttings and drilling mud during drilling of the development wells are likely to result in localised short to medium-term environmental effects. These are mainly turbidity plumes generated in the water column at each well site, localised smothering of seafloor habitats, alteration of sediment characteristics, and depletion of oxygen in surface sediments. The nature of effects on seafloor animals will relate to the toxicity, persistence and biodegradability of synthetic-based drilling mud. Drill cuttings and associated drilling mud are expected to settle rapidly to the seafloor within a distance of 300m from the discharge point. Consequently, the concentration of drill cuttings and drilling mud on the seafloor at any point beyond a distance of approximately 300m of the discharge point will be low, and insufficient to cause alteration to sediment characteristics to any extent that would affect sediment fauna composition and abundance. Impacts on the nearby Big Bank Shoals are expected to be negligible.

Air emissions from the Kitan Development are considered unlikely to have a significant impact on air quality at the local and regional scales as they are expected to be quickly dissipated into the surrounding atmosphere. Furthermore, the project area is remote from any land mass and far from sensitive receptors. Therefore, air emissions are not expected to contribute significantly to pollution and the deterioration in air quality.

The most significant aspect relating to air emissions is the project's contribution to greenhouse gases. Power generation will be the largest source of greenhouse gas emissions. The Kitan Development is estimated to produce 1.51Mt of GHG from flaring and exhaust emissions during operations over its projected seven year production life (Eni 2009c). Of this, 0.913Mt (60%) are predicted to be produced from exhaust emissions and 0.597Mt (40%) from flaring. The project's contribution to GHG from flaring occurs primarily in the first year and declines sharply in years 2 and 3. Negligible quantities of GHG are produced from flaring from years 4 through to 7.

The potential environmental effects of other atmospheric emissions, such as nitrogen oxides, sulphur oxides, volatile organic compounds, cargo tank vents and fugitive emissions, will be assessed in the environmental management plans (EMPs) for the Project. Appropriate management measures will be determined during the detailed design phase of the development, as part of the Operational EMP.

The effects of unintentional discharge of solid or hazardous wastes to the marine environment would vary depending on the nature of the material involved. For example, solid wastes such as plastics are persistent in the environment and have been implicated in the deaths of a number of marine species including marine mammals and turtles. This is due to ingestion, inhalation or physical entanglement. Hazardous wastes such as waste solvents, excess or waste chemicals, oil contaminated materials (e.g. sorbents, filters and rags), and batteries would expect to have localised toxic effects. Eni's management of solid and hazardous wastes is to transfer it onshore for recycling or disposal. Any release of solid and hazardous wastes into the marine environment would be recorded as an environmental incident and treated accordingly by Eni's incident investigation and corrective and preventative action processes.

More detailed risk assessments will be conducted for each phase of the project as the detailed planning advances. The risk assessments will facilitate the development of separate EMPs for each phase of the project. The output of the risk assessment will be documented in a risk register to be maintained for the Kitan Development.

**SOCIO-ECONOMIC SETTING**

Timor-Leste is situated approximately 160km north of the proposed development. In mid 2008, the population of Timor-Leste was estimated to be 1.1 million. Unemployment in 2008 was estimated to be 20% in rural areas and 40% in urban areas. Timor-Leste is an agricultural based economy, primarily focused on subsistence farming. In 2008, 90% of the population was dependent on agriculture as a livelihood. Although 90% of the workforce is employed in agriculture, it contributes only 32% to GDP, whereas industry and services account for 13% and 55% of GDP respectively. The construction industry, and the sector which provides its supplies, is the largest employer in the private wage paying sector. The oil and gas industry is an emerging industry of major significance for the economy and people of Timor-Leste.

The nearest Australian city to the Kitan oil field is Darwin in the Northern Territory (NT). The NT's gross state product (GSP) is about AU$13.4 billion. Key activities in the NT economy include mining, defence, alumina production, liquefied natural gas production and government services. The mining industry in the Territory remains the single largest contributor to its economy, with tourism, agricultural and fisheries also being important.

**SOCIO-ECONOMIC IMPACTS AND MANAGEMENT**

In general, the oil and gas industry may be expected to provide the following benefits to Timor-Leste:

- expansion of the economy over time due to increased service and supply requirements of the oil and gas industry;
- potential support towards the development of social development initiatives aimed at improving the quality of life of local communities; and
- vocational education and training opportunities to develop a skilled workforce.

The development of oil and gas resources in offshore waters has begun to supplement government revenues and has started to create jobs. Eni's Production Sharing Contract (PSC) includes clear obligations for Eni to maximise the use of goods and services sourced from Timor-Leste. Accordingly, Eni has developed a Local Content Plan for the Kitan Development (Eni 2009a). The purpose of this plan is to describe Eni's processes for maximising the use of goods, services and labour from Timor-Leste, associated with the Kitan Development and other exploration activities within the contract area JPDA-06-105, in accordance with the provisions of the Production Sharing Contract (PSC). Eni's commitments towards incorporating local content into the Kitan Development include:

- requiring, as a part of the tendering process, for Eni's major contractors to develop local content plans for training employment of Timor-Leste nationals and procurement of goods and services;
- implementing initiatives to develop the capacity of local suppliers;
- providing professional and vocational training of Timor-Leste nationals; and
- preferentially employing suitably skilled and qualified Timor-Leste nationals.

Eni has undertaken a social baseline assessment (SBA) to support the ongoing implementation and review of the Local Content Plan. The SBA will provide a useful set of baseline socio-economic indicators, from which Eni can draw guidance in the implementation of Eni's local content commitments. Given the dynamic nature of exploration and production services and labour markets, the SBA and the Local Content Plan would be reviewed on a periodic basis, throughout the project development and execution phase to ensure their currency and relevance.

**SUMMARY OF MANAGEMENT MEASURES AND COMMITMENTS**

Eni is committed to undertaking its petroleum exploration and production activities in a manner that is consistent with the principle of sustainable development. Eni aspires to the goals of zero harm to its people, its host communities and the environment. In keeping with these goals and aspirations, Eni will apply the most economically effective, environmentally sound technology and procedures to designing, constructing, operating and decommissioning of the Kitan Development to ensure optimal management of all emissions, discharges and wastes.

Furthermore, Eni is committed to ensuring that the development of the Kitan oil field will be undertaken in a manner that minimises impacts on the surrounding biophysical and social environments. Accordingly, Eni proposes to implement the management measures and commitments summarised and presented in Table ES1.

**Table ES1: Summary of Commitments for the Kitan Development**

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 1. | Integrated Management System | Provide a risk-based management system for the identification and control of impacts. | • Implement Eni's HSE Integrated Management System for the Kitan Development that embraces the ISO 14001 standards. | All Phases |
| 2. | Environmental Management Plans | Provide operational control documentation for the management of environmental impacts associated with drilling, installation and commissioning, production and decommissioning. | • Develop and implement a separate EMP for each phase of project, i.e.:<br>◦ Drilling;<br>◦ Installation and commissioning;<br>◦ Production; and<br>◦ Decommissioning.<br>• The EMPs will incorporate the environmental and social management measures detailed in Chapters 5 and 6 of this EIS where relevant.<br>• The EMPs will be developed in consultation with the ANP. | All Phases |
| 3. | Risk assessment | Ensure project risks are fully identified and understood and management measures and controls are implemented accordingly. | • Conduct detailed environmental and social risk assessments for each phase of the project.<br>• Maintain the findings of each risk assessment in a project Risk Register.<br>• Incorporate any additional management measures identified during the detailed risk assessments into the relevant EMPs. | All Phases |

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 4. | Marine Environmental Monitoring Program. | Ensure that Eni's management measures for the Kitan Development are effective in minimising environmental harm. | • Develop and implement a marine environmental monitoring program for the Kitan Development.<br>• A baseline study will be conducted prior to the implementation of the Kitan Development project to provide a suitable basis for long-term monitoring (note: this was completed in May 2010 [Gardline 2010]).<br>• The baseline study and marine environmental monitoring program will include measurements of water column and sediment physico-chemical parameters.<br>• The baseline study and marine environmental monitoring program will be developed in consultation with the ANP. | Prior to Drilling |
| 5. | Operational Monitoring Program | Ensure that Eni's management measures for the Kitan Development are effective in minimising environmental harm.<br>Ensure that the Kitan Development complies with applicable legislation and regulations.<br>Enable the implementation of contingency measures, if required. | • Develop and implement an Operational Monitoring Program for the Kitan FPSO.<br>• The Operational Monitoring Program will be developed in consultation with the ANP. | During Production |
| 6. | Decommissioning | Carry out decommissioning at the end of field life in accordance with legislation and industry guidelines, using technology and best practices in place at that time, with the aim to return the site to as near as practicable original conditions. | • Develop and implement a detailed Decommissioning and Abandonment Plan will be prepared and submitted to the relevant authorities prior to commencement of decommissioning activities. | Prior to Decommissioning |
| 7. | Socio-economic development | Ensure that opportunities for Timor-Leste businesses and communities are maximised in line with Eni's resource requirements for the Kitan Field Development. | • Implement Eni's Local Content Plan (Eni 2009a) for the Kitan Field Development.<br>• Periodically review the Kitan Field Development baseline socio-economic assessment and update the *Local Content Plan* as required.<br>• Conduct ongoing stakeholder consultation to identify opportunities and build capacity to source goods, materials, services and labour from Timor-Leste during the life of the development. | All Phases |

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 8. | Emergency Planning and Response | Ensure that adequate emergency response procedures and resources are in place to minimise the environmental impacts of an incident e.g. oil spill. | • Develop and implement an Incident Management Plan (IMP) and an Oil Spill Contingency Plan (OSCP) for the Kitan Field Development.<br>• The IMP and OSCP will be developed in consultation with the ANP, Eni's contractors, other petroleum operators in the region and appropriate emergency response authorities and resource centres.<br>• The IMP and OSCP will be tested and reviewed at least once during the drilling and installation and commissioning phases of the project.<br>• The IMP and OSCP will be tested and reviewed annually during the drilling and installation and commissioning phases of the project. | All Phases |
| 9. | Training and awareness | Ensure that all personnel are aware of their responsibilities towards the management of environmental and social impacts. | • Provide training to all Eni and contractor personnel on the requirements of Eni's Environmental Management Plans, specifically<br>◦ the environmental and social sensitivities of the project;<br>◦ Eni's management objectives and commitments; and<br>◦ obligations of all personnel towards the management of impacts in their areas of responsibility.<br>• Provide training to all Eni and contractor personnel on Eni's OSCP. | All Phases |
| 10. | Auditing | Ensure that Eni's environmental and social performance objectives for the Kitan Field Development are met. | • Conduct environmental compliance audits against the drilling and installation and commissioning EMPs at least once during these project phases.<br>• Conduct environmental compliance audits against the production EMP at least annually during the production phase of the project.<br>• Conduct compliance audits annually against the Local Content Plan. | All Phases |

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 11. | Stakeholder consultation | To maintain open and transparent communication between Eni and its stakeholders. | • Consult with stakeholders throughout the development of the project EMPs and the Local Content Plan.<br>• Deliver a presentation on the project operations to the key stakeholders at least once a year. | All Phases |

**CONCLUSION**

The Kitan Field Development will take place in deep offshore waters. The environmental setting is deemed conducive to the development of petroleum related activities given that no sensitive resources are located in the vicinity of the project area or will be impacted upon. None of the impacts identified are categorised as presenting a high residual environmental risk during either construction or routine operations. Any potential impacts can be managed through Eni's HSE management system and specific EMPs for each phase of the project.

Eni believes that by implementing the management strategies and commitments detailed in this EIS, the Kitan Field Development can be implemented without compromising the environmental values of the area, in particular the marine biota inhabiting the surrounding pelagic and benthic continental shelf habitats and the nearby Big Bank Shoals. Furthermore, it believes that the project will provide long-lasting economic benefits to the communities and national economies of Timor-Leste and Australia.

# 1.0 INTRODUCTION

## 1.1 Background

Eni-JPDA-06-105 Pty Ltd (Eni) proposes to develop the Kitan oil field in Joint Petroleum Development Area (JPDA) in the northern Bonaparte Basin of the Timor Sea. The field is located in Permit JPDA 06-105 (Figure 2.1), approximately 160km from the southeast coast of Timor-Leste. It was discovered in 2008 and is operated under a Production Sharing Contract (PSC) with the Timor-Leste Government.

## 1.2 Project proponent

The proponent of this proposal is Eni-JPDA-06-105 Pty Ltd. Eni's contact details are:

Eni-JPDA-06-105 Pty Ltd
40 Kings Park Road
West Perth,
Western Australia
Tel: +61 8 9320 1111

Eni is the Operator of the PSC covering the Kitan field and is also Operator or the Project on behalf of the Joint Venture Partners (JVPs):

- Eni JPDA 06-105 Pty Ltd (40%);
- Inpex Timor Sea Ltd (35%); and
- Talisman Resources JPDA 06-105 Pty Ltd (25%).

The nominated proponent contact for this proposal is:

Rob Phillips
Senior Environmental Advisor
Eni Australia Ltd
Tel: +61 8 9320 1541
E-mail: rob.phillips@eniaustralia.com.au

## 1.3 Scope and Objectives of this Environmental Impact Statement

The scope of this Environmental Impact Statement (EIS) for this Project covers activities involved in developing and producing from the offshore field. The document has been developed based on the Draft EIS, submitted to the Timor-Leste Government in February 2010, with comments and feedback received from stakeholders incorporated into this final version.

As operator of the PSC, Eni has prepared this EIS with the following objectives:

- to provide information from which interested individuals and groups can gain an understanding of the Project, its environmental and social setting, potential environmental and social effects of the project and proposed measures to mitigate and control any impacts;
- to provide a forum for stakeholder consultation and informed comment about the proposal; and
- to provide a framework within which decision makers may consider the environmental hazards and effects of the proposed development in parallel with economic, technical and other factors.

In line with the objectives above, technical detail has been kept to a minimum, wherever possible, in the EIS. The reader is referred to the source documents cited throughout the document for detailed accounts of particular environmental features.

### 1.4 Project Area

The immediate Project area is the offshore Kitan oil field, where most activities, such as drilling of wells, installing equipment and producing oil, will be focused. It includes the probable approach and departure routes for trading tankers visiting the field from adjacent commercial shipping lanes.

The notional Project area is set wider than the Kitan field location recognising that possible incidents, such as oil spilled from the facility, or possibly from a tanker during offloading operations, could potentially affect the Timor Sea on a regional scale, depending on factors such as spill size, direction and movement. The likelihood and potential effects of such incidents are discussed in detail in Section 5.4.

Within the notional Project area, there are a number of producing oil and gas fields (Bayu Undan, Northern Endeavour). There are also a number of prospects that could be developed in the future, in addition to the Kitan field.

### 1.5 Legislative Framework and Environmental Approval Process

#### 1.5.1 Framework

The JPDA is administered under the Timor Sea Treaty and its annexes; the Petroleum Mining Code. Specific requirements are detailed in the Interim Regulations issued under Article 37 of the *Petroleum Mining Code – Specific Requirements as to Petroleum Exploration and Exploitation in the Joint Petroleum Development Area*.

The Autoridade Nacional do Petróleo (ANP) regulates petroleum operations in the JPDA on behalf of the Government of Timor-Leste and the Commonwealth of Australia (CoA).

#### 1.5.2 Environmental Assessment Process

The environmental assessment process is defined in the *Interim Administrative Guidelines for the Joint Petroleum Development Area 2003* and Clauses 305 and 501 of the Interim Regulations.

Initially a Preliminary Environmental Report (PER) was submitted to and assessed by the ANP. Subsequently, the ANP determined that an EIS was required. In February 2010, a Draft EIS was submitted to the ANP, who coordinated a review by relevant Timor-Leste and Australian environmental authorities. Comments were provided to Eni, and additional information or clarifying comments have been incorporated where necessary into this document, the Final EIS.

This Final EIS will be issued for public comment in Australia and Timor-Leste for a period of six weeks, and any issues affecting environmental management of the Kitan Development will be incorporated into environmental management plans for the relevant development phases, as appropriate. These plans will be reviewed and approved by the ANP as part of on-going environmental regulation of the project.

#### 1.5.3 Other Legislative Requirements

Most activities will be conducted within the JPDA. However, movement of trading tankers, supply vessels and emergency services may occur in Australian Commonwealth, Western Australian (WA) and Northern Territory (NT) waters. All activities conducted in the JPDA will comply with legislative requirements established under the JPDA regulatory framework, whilst shipping activities in Australian waters will operate under the relevant WA, NT or CoA legislative requirements.

The most significant international conventions and Australian statutes and regulations are:

- MARPOL 73/7 and annexes (the International Convention for the Prevention of Pollution from Ships);
- *Australian Maritime Safety Authority Act 1990*;
- *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*;
- *Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)*;
- Convention on Civil Liability for Oil Pollution Damage 1969 and 1992 (CLC 69 and 92);
- Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC);
- Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989 (Basel Convention);

- Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971 and 1992 (Fund 71 and 92); and
- Convention on the Prevention of Marine Pollution by Dumping of Waste and Other Matter 1972 (London Dumping Convention).

The *EPBC Act* is the main CoA environmental law applicable to the proposed Kitan Field Development. It provides a framework for the protection of wildlife (e.g. migratory bird species and protected species of marine reptiles, fish and cetaceans) for activities undertaken in CoA waters and by Australian persons (including companies) outside of CoA waters. The *EPBC Act* is administered by the CoA Department of Environment Water Heritage and the Arts (DEWHA).

A review of the *EPBC Act* significance criteria for CoA protected matters indicated that the proposed Kitan Field Development was unlikely to impact upon a matter of Australian national environmental significance (Table 1.1). Therefore, Eni considers the proposed Kitan Field Development to be of low environmental impact and similarly not to be a controlled action under the *EPBC Act*.

**Table 1.1: Assessment of the proposed Kitan Field Development against *EPBC Act* matters of national environmental significance**

| Matter of National Environmental Significance (DEWHA 2010) | | Assessment of this Programme |
|---|---|---|
| World Heritage Properties | World Heritage property is either:<br>• an Australian property on the World Heritage List kept under the World Heritage Convention; or<br>• a property declared to be a World Heritage property by the Commonwealth Environment Minister. | There are no World Heritage Properties in or near the proposed Kitan Field Development. |
| National Heritage places | The National Heritage List includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation. | There are no National Heritage Properties in or near the proposed Kitan Field Development. |
| Ramsar wetlands of international significance | A Ramsar wetland is either:<br>• an Australian wetland on the List of Wetlands of International Importance kept under the Ramsar Convention; or<br>• a wetland declared to be a Ramsar wetland by the Commonwealth Environment Minister. | There are no Ramsar wetlands in or near the proposed Kitan Field Development. |
| Nationally listed threatened species and ecological communities | Threatened fauna and flora categorised as follows are matters of National Environmental Significance:<br>• extinct in the wild;<br>• critically endangered;<br>• endangered; and<br>• vulnerable.<br>Three categories exist for listing threatened ecological communities:<br>• critically endangered: if it is facing an extremely high risk of extinction in the wild in the immediate future;<br>• endangered: if it is not critically endangered and is facing a very high risk of extinction in the wild in the near future; and<br>• vulnerable: if it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future. | Threatened species potentially occurring in the vicinity of the proposed Kitan Field Development are discussed in Section 4.5.11.<br>The Kitan Field Development is considered unlikely to significantly impact on any threatened species due to its remote location and open oceanic setting. |

| Matter of National Environmental Significance (DEWHA 2010) | | Assessment of this Programme |
|---|---|---|
| Listed migratory species | Listed migratory species include species listed in:<br>• Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;<br>• The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA); and<br>• The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA).<br>Listed migratory species also include any native species identified in an international agreement approved by the Commonwealth Environment Minister. The Minister may approve an international agreement for this purpose if satisfied that it is an agreement relevant to the conservation of migratory species. | Listed migratory species potentially occurring in the vicinity the proposed Kitan facility are discussed in Section 4.5.11.<br>The Kitan Field Development is considered unlikely to affect migratory behaviour or otherwise interfere with a migratory species due to its remote location and open oceanic setting. |
| Commonwealth marine areas | The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone (EEZ) and/or over the continental shelf of Australia, that is not State or Northern Territory waters. | The proposed Kitan facility is situated in the JPDA and regulated under the Timor Sea Treaty. The JPDA is beyond the limit of Australia’s EEZ. |

| Matter of National Environmental Significance (DEWHA 2010) | | Assessment of this Programme |
|---|---|---|
| Nuclear actions (including uranium mining) | A nuclear action is:<br>• establishing or significantly modifying a nuclear installation;<br>• transporting spent nuclear fuel or radioactive waste products arising from reprocessing;<br>• establishing or significantly modifying a facility for storing radioactive waste products arising from reprocessing;<br>• mining or milling uranium ores, excluding operations for recovering mineral sands or rare earths;<br>• establishing or significantly modifying a large scale disposal facility for radioactive waste, whether a disposal facility is considered large scale will depend on factors including the activity of the radioisotopes to be disposed of, the half-life of the material, the form of the isotopes and the quantity of isotopes handled; or<br>• decommissioning/rehabilitating a facility/area in which an activity described above has been undertaken; or<br>• any other type of action set out in the EPBC Regulations. | The Project is not a nuclear action. |

## 2.0 PROJECT DESCRIPTION

### 2.1 Introduction

This chapter provides information on the key technical elements of the Kitan Field Development, primarily to assist the reader with the assessment of environmental and social effects presented in Sections 0 and 6.0 of the EIS.

Information presented here reflects current understanding of the field layout and development concepts proposed. Some technical design details and the final locations of surface and sub-surface facilities at the field will not be finally decided until later in the Project Schedule (see Section 2.4).

As Operator of the Project on behalf of its JVPs, Eni is applying health, safety and environment (HSE) standards, management systems, processes and work practices similar to those it uses in Australia for this type of offshore development.

### 2.2 Description of the Field

#### 2.2.1 Location

The Kitan Field Development is located in permit area JPDA 06-105, situated in the northern Bonaparte Basin in waters of the JPDA (Figure 2.1). The permit covers an area of 123km$^2$ and has a water depth ranging from 100m to 800m. The centre of the field, in ~310m water depth, is characterised by a relatively even seafloor, with a shallow slope dipping (<1°) to the north.

The Kitan Field Development is located approximately 170km from the southeast coast of Timor-Leste, 170km southeast of Suai, 240km south of Dili and 550km northwest of Darwin.

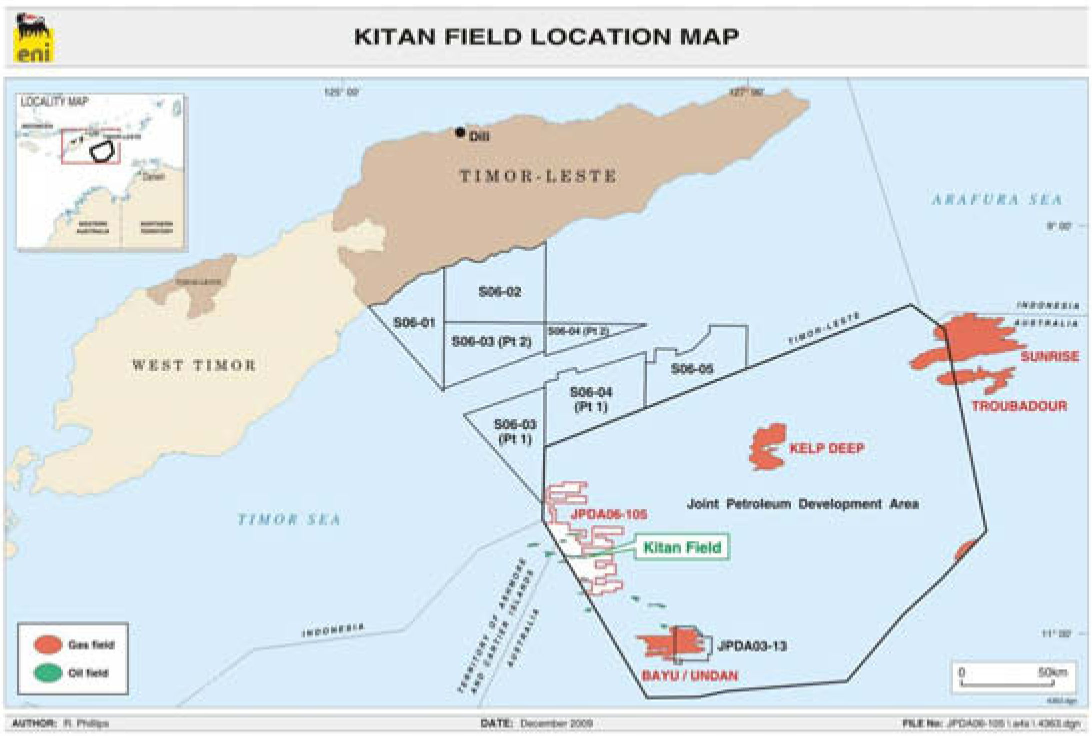



**Figure 2.1: Kitan Field Development Location**

### 2.2.2 Field structure

The Kitan field is an east-west trending tilted fault block, dipping to the south and bounded to the north by an east-west trending fault (Figure 2.2). The reservoir is located ~3,300m below the seafloor.

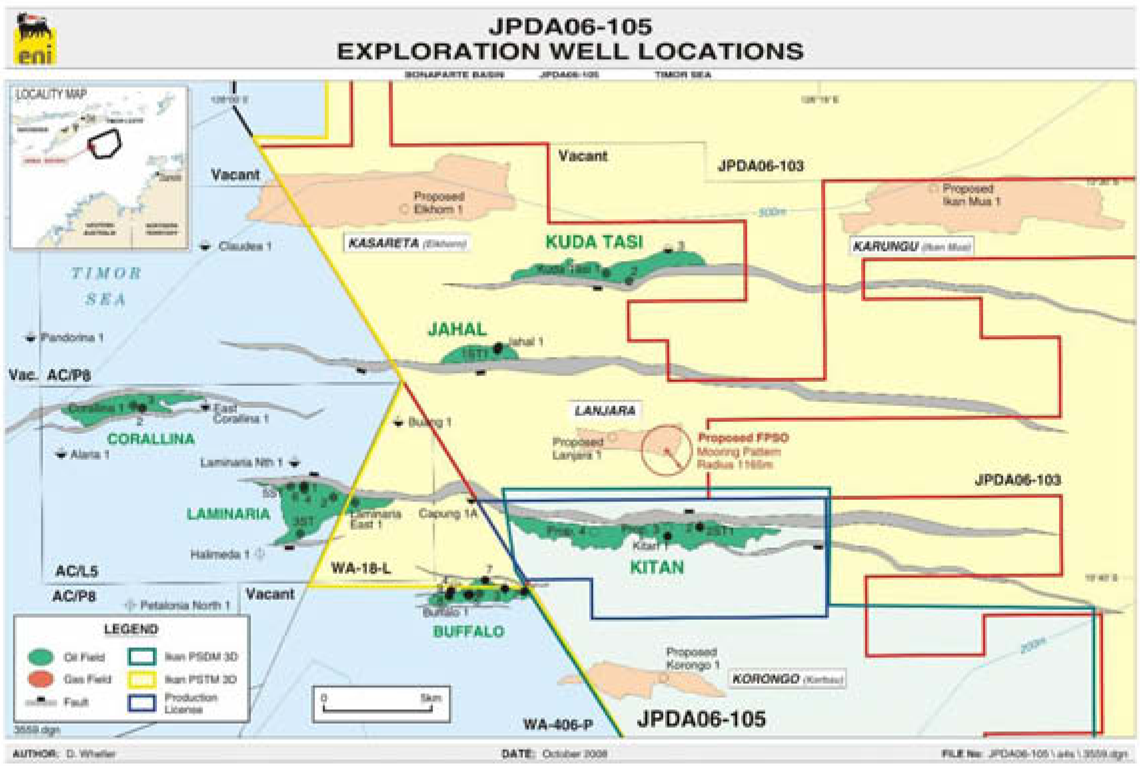



**Figure 2.2: Kitan Field Structure**

### 2.2.3 Kitan Field Development Concept

The Kitan Field Development concept is for an offshore stand-alone facility comprising:

- production wells;
- subsea flowlines; and
- a Floating Production Storage and Offloading (FPSO) facility (Figure 2.3).

The development concept for the field, at start-up (first oil production) is for three wells, each completed with subsea equipment, tied back to a dedicated FPSO. The FPSO will be located approximately 3km north from the centre of the field, in ~344m water depth. The FPSO will be permanently moored at the field. The conceptual layout of the Kitan Field Development is shown in Figure 2.4 and the coordinates of the Kitan FPSO and oil wells are shown in Table 2.1.

Oil from the production wells will be carried from the flexible flowlines and risers to the FPSO. Produced formation water (PFW), separated from the oil, will be treated to the standard specified for safe, environmentally responsible discharge from the FPSO.

The field development concept has provision for installing additional wells following start up. The current design is for a field life of approximately seven years.

**Figure 2.3: Bluewater Energy Services B.V. – FPSO Glas Dowr**

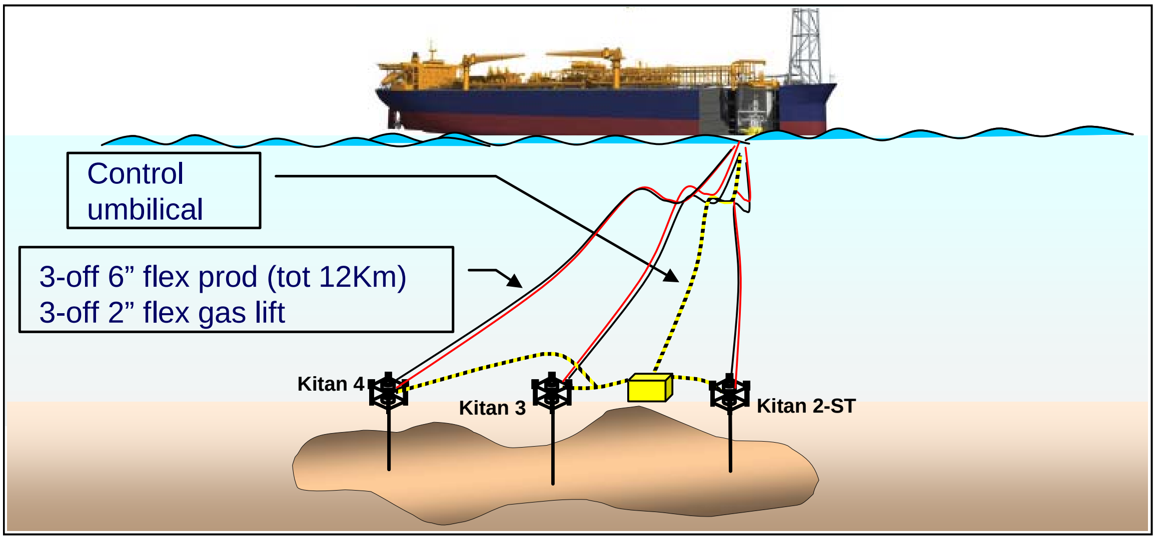


**Figure 2.4: Conceptual layout of the Kitan field**

**Table 2.1: Coordinates of the Kitan FPSO and production wells**

| Well | Easting | Northing |
|---|---|---|
| FPSO (assumed) | 191815 | 8825599 |
| Kitan-2ST | 193346 | 8822025 |
| Kitan-3 | 191853 | 8821996 |
| Kitan-4 | 188430 | 8821800 |

Note: Coordinates are provided in reference to the UTM system GDA94/MGA Zone 52 (EPSG 28352), GRS 1980 spheroid

### 2.2.4 Development Concept Alternatives

Several alternative development concepts were considered for the oil-production aspect of the project, including:

- an on-site FPSO operated by Eni;
- tie-back of the subsea production stream to the existing Northern Endeavour FPSO operated by Woodside; and
- tie-back of the subsea production stream to the existing Bayu Undan facility operated by Conoco Phillips.

The on-site FPSO concept was selected due to a range of factors that included simpler abandonment and decommissioning, smaller footprint on the seabed and more localised exposure to ocean and weather conditions, technical maturity of the design, and commercial considerations such as expansion capability and flexibility, operator experience and schedule. The FPSO concept provides opportunity for possible future tie-back of other fields, and reassignment of the equipment at another field elsewhere at the end of the project life.

Alternative development concepts were also considered for treatment of produced gas, which will flow at a high rate (relative to fuel gas consumption onboard the FPSO) during the first year of the field life. This flow rate is expected to decline in years 2 and 3 and reach negligible volumes in years 4 through to 7. Short-term disposal alternatives for this produced gas included:

- flaring;
- re-injection into a disposal well;
- export to the Bayu Undan facilities; and
- export to Timor-Leste.

Given the short timeframe during which gas would be available, and the infrastructure required to deliver the product to shore (e.g. pipelines, onshore processing plant), the option to export gas to Timor-Leste was not considered viable. The other three options were investigated from the perspectives of air and water emissions and capital expenditure. The study indicated that the re-injection option reduced greenhouse gas (GHG) emissions from flaring by 21%, and the gas export option reduced GHG emissions by 27%. However, the re-injection option was estimated to increase project capital expenditure by 100% and the gas export option by 160%, due to the extensive additional infrastructure required (Eni 2009c).

Eni’s preferred option for gas disposal is to flare the gas directly from the FPSO. Gas disposal from Kitan Field Development was the subject of extensive consultation with the ANP, and Eni received the ANP’s endorsement to proceed with this development option in September 2009.

## 2.3 Proposed Development

### 2.3.1 Overview of Development Activities

The main activities associated with the proposed Kitan Field Development are:

- drilling of three subsea production wells into the oil reservoir;
- installation of subsea well heads and flowlines to carry reservoir fluids from the wells to the FPSO vessel,
- installation of moorings;
- installation and commissioning of the FPSO;
- production and export of crude oil from the FPSO to trading tankers; and
- decommissioning of the facilities at the end of field life.

All facilities and hardware components will be fabricated and assembled remotely and transported to the site. The installation, hook-up, testing and commissioning of equipment and facilities will be undertaken at the field location. Sections 2.3.2 to 2.3.9 provide further information about the different stages of development, from drilling of wells through to production and offloading of oil for export from the FPSO.

### 2.3.2 Drilling of Wells

The wells will be drilled and completed using Transocean Limited's *Transocean Legend*, a conventional semi-submersible mobile offshore drilling unit (MODU) (Figure 2.5). The MODU would be operated by approximately 60 personnel and supported by two or three vessels whilst on location.

**Figure 2.5: Transocean Limited's *Transocean Legend***

Drilling will occur in sections of decreasing hole diameter (Figure 2.6). During drilling, mud is pumped down the drill pipe to the drill bit. On completion of the upper hole sections, steel pipe (casing) is inserted into the hole and the annular space between the casing and hole filled with cement. The upper sections will be drilled without a riser, using water-based mud (WBM) and high viscosity prehydrated gel (PHG) sweeps. During riserless drilling operations, the drilling muds and cuttings will be discharged directly to the seafloor.

A high-pressure wellhead (103 MPa) will be installed for each well. Once the wellhead is in position, the blow-out preventer (BOP) is latched to it. In this instance, the BOP is installed on the seafloor and connected to surface by the riser, which allows for rig movement at the ocean surface and for drilling mud to be circulated from the wellbore back to the rig.

Once the riser is installed, the remaining hole sections will be drilled. With the riser in place, drilling mud is circulated for reuse, with mud returned to equipment on the rig where it is processed using cuttings shakers to remove drill cuttings. In addition, a centrifuge system will be installed to centrifuge the cuttings from the reservoir section.

The bottom section of the wells will be drilled using a partially-hydrolyzed polyacrylamide (PHPA) water-based gel with potassium chloride (KCl). Both the PHG and PHPA gels have low toxicities, degrade rapidly in the marine environment and are routinely accepted for use by the regulatory authorities (Hinwood et al, 1994). Other additives may be used in very small amounts for bacterial control, corrosion inhibition, or when special mud properties are required. Drilling discharges are discussed further in Section 5.6.

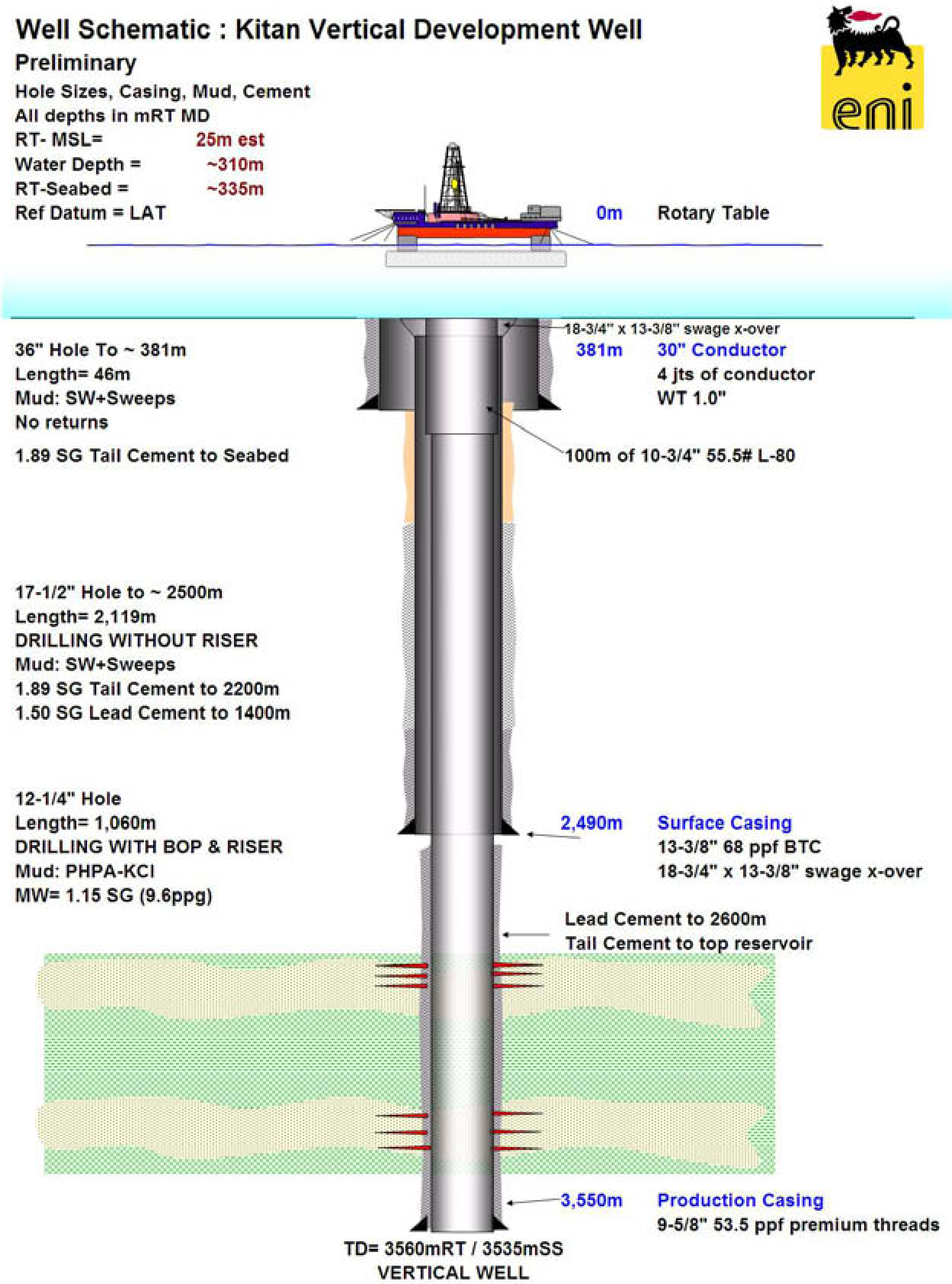



**Figure 2.6: Conceptual Well Design**

While drilling, the specific gravity of drilling fluid (and hence pressure) will be maintained above the formation pressure, allowing for little opportunity for any hydrocarbon influx from the reservoir. In fact, the higher pressure differential will cause the invasion of drilling fluid into the reservoir and push the hydrocarbon further away from the well bore.

To assist in reducing the concentration of emulsified hydrocarbons trapped in drill cuttings, the drilling fluid will be formulated with MUL-FREE de-emulsifier. This chemical will prevent formation of emulsions and hence assist with flushing the sands with drilling fluids filtrate (ahead of the drill bit). The cuttings generated will have a negligible hydrocarbon content.

Once the well has been drilled and cased a horizontal-type “Christmas Tree” (an assembly of valves, spools, and fittings) is fitted; an internal tubing string and sub-surface safety valve is then installed. Drilling mud is displaced with packer fluid and the tubing filled with diesel. The well contents can then be flowed to a flare on the rig to clean up the well. The riser and BOP are removed and the well contents flowed to a flare on the rig, or the FPSO, for clean-up. Following this, the well is usually shut in awaiting hookup to the production facilities.

Completions in all wells will be designed to last for field life with no planned interventions. However, well interventions may be required in response to an unplanned event such as a Tubing Retrievable Safety Valve failure, gas lift failure or tubing leak. These circumstances could require use of a drilling rig to temporarily re-enter the field. This will also be the case for additional production wells that may be required to develop the field over its life. Further wells will involve similar drilling processes and activities to those described above.

### 2.3.3 Installation and Commissioning

Connection and commissioning of facilities will be carried out to the maximum extent possible at the fabrication yard to minimise the duration and complexity of offshore activities. Installation and commissioning stages involve placing subsea flowlines on the seafloor and connecting and testing the equipment, including flowing oil through subsea flowlines and production equipment on the FPSO prior to start of production.

Flowlines will most likely be installed directly onto the seafloor using a Dive Support Vessel (DSV). A hydrostatic pressure test of flowlines and riser will be performed, normally during pre-commissioning. Flowline hydrotest water is typically discharged overboard.

### 2.3.4 Hook-up to FPSO

Flowlines, risers and other subsea connections can be hooked up to the FPSO once the wells are completed, the wellheads are in place and the mooring and riser turret are installed.

The FPSO will be permanently moored, with risers and mooring lines connected direct to the turret on the FPSO. The flow of oil, gas and PFW can occur without interruption as the FPSO weathervanes around the turret system.

The mooring will be installed in 3 bundles with 120° sectors between the bundles. The orientation of the bundles will take into account the dominant directionality of the environment.

### 2.3.5 FPSO Configuration, Equipment and Utilities

**Classification**

The FPSO is classed under Lloyd’s Register Rules and Regulations for the Classification of Floating Offshore Installation at a Fixed Location. It has been assigned the class notation of “OI 100AT Floating Production and Oil Storage Installation, OMC, IGS”.

**Configuration**
The Glas Dowr is an AFRAMAX size tanker barge. It is a double hull tanker. Although not originally built as an FPSO, the Glas Dowr has been extensively modified to meet the requirements of the UK Health and Safety Executive 4th Edition Guidelines on Design, Construction and Certification of Offshore Installations and it has obtained Certifying Authority approval from Lloyd's.

The FPSO is equipped with fully segregated ballast tanks arranged in the wing sides, double bottoms, and in the fore and aft peak so as to provide a surrounded protective location of the crude oil storage tanker.

It will have a crude oil production capacity of 50,000 barrels per day (bbl/d) and a maximum storage capacity of 647,750bbl. The FPSO will be designed for extended at-sea service, with a design life of 15 years (10 years on the field without dry-docking). The hull specifications are: ~342m length, ~55m width and 21m depth, with a dead weight tonnage (DWT) of ~105,000 tonnes.

**Power systems**
The FPSO will provide its own fuel gas from the associated gas. Alternative fuel arrangements will be required for start-up and prolonged shutdown periods.

Current design specifications are for medium voltage electrical power to be supplied by 3 x 5.2MW and 1 x 5.4MW gas turbine-driven generators and 1 x 6.3MW diesel generator. Diesel will also be required to fuel the auxiliary and emergency diesel generators.

**Cooling and heating systems**
Some process systems may require heating or cooling. Final specifications are yet to be decided. The heating circuit may comprise a closed system utilising a water/glycol mixture as the heating medium. The cooling circuit may comprise direct or indirect seawater cooling. It is not anticipated that the cargo tank will require heating. However, slop tank heating will be required to ensure good oil/water separation.

**Navigation and communications**
Standard marine navigation and communications systems, navigation beacons, ship-to-ship radio and anti-collision radar systems will be in place. Additional safeguards will also be implemented e.g. gazetting of the FPSO location onto navigational charts and creation of safety exclusion zones.

Safety zoning is likely to include a cautionary zone providing a safety perimeter around the field. Inside the cautionary zone, further safety restrictions will be applied via designation and gazetting of exclusion zones from the outer edge of the FPSO, FPSO anchors, flowlines and other subsea equipment. Similar exclusion zones will apply around production and injection wells installed on the seafloor. A further safety exclusion zone will apply around the FPSO for offtake operations. This zone takes consideration of weathervaning and excursion of the mooring system as well as the combined length of the FPSO, hawser, offtake tanker and offtake support vessel during tandem mooring.

All vessels will require appropriate notification and permits to be in place, and will have to adhere to strict procedures for entering and moving within and around safety exclusion zones. The consent of the designated person in charge of the FPSO will be required for entry into safety exclusion zones.

**Accommodation**
Accommodation aboard the FPSO will comply with Safety of Life At Sea requirements. The FPSO will accommodate ~80 operational crew and production and maintenance personnel during routine operations.

**Flare**
A safety flare system will be provided in line with normal design of offshore oil and gas facilities to provide safe, rapid disposal of pressurised gas from process equipment in the event of emergency or process upset. The flaring system will be capable of flaring the entire associated gas production stream on a continuous basis. The flare system is also required during commissioning, initial

production, process restarts, maintenance, and equipment down-time. During normal operations, a pilot flare will be run continuously as a means of safe ignition.

**Diesel and Chemical Storage**

The diesel storage system will be similar to that used on other FPSOs. Segregated and bunded storage will be provided for hazardous materials on the FPSO. A wide variety of chemicals may be stored and used on the FPSO, including:

- acids and solvents;
- glycol;
- surface active agents and detergents;
- defoamers;
- lubricating fluids and greases;
- hydraulic oils/fluids;
- paints;
- inhibitor chemicals (e.g. corrosion and scale inhibitors);
- specialised cleaning fluids; and
- cooling system treatment chemicals.

Chemicals will be selected in accordance with international standards (eg United Kingdom Offshore Operators Association) and As Low As Reasonably Practicable (ALARP) principles, to ensure those with lowest levels of toxicity are used.

Periodically, the FPSO will require stocks of materials to be replenished. Bunkering involves the transfer of bulk materials such as diesel fuel and process chemicals via hose from a supply boat. Equipment and procedures for bunkering are yet to be specified, and will be selected to minimise the potential for a spill. For example, unique couplings will be used on bunkering lines to minimise the risk of cross contamination. Dry-break couplings are likely to be used to reduce the potential for mud loss when hoses are decoupled, and procedures will define sea-state conditions under which bunkering will not commence, or will be stopped. In addition, procedures will define weather conditions within which bunkering can safely occur.

**Drainage**

International standards will be applied to FPSO drainage systems. Drainage systems include open and closed drains, bilge and oil recovery systems and slops tanks. Deck drainage will comprise mainly washdown water and rainwater. Small onboard oil leaks that may occur from time-to-time will be contained using absorbents, while those in high risk leak areas will be directed to a sump (or similar collection system) connected to an oil/water separation system. In the event of high rainfall, overflow systems provide for discharge of rainwater direct to sea.

Drainage procedures will be in accordance with Timor-Leste legislation, and in compliance the MARPOL 73/78 Convention. Eni's environmental goal is zero spillage hence active prevention of hydrocarbon spills is a prime objective. This will be stringently managed in accordance with ALARP principles with regards to operational procedures and selection of appropriate design components, equipment configuration and material selection for the FPSO systems.

**Waste management**

All wastes will be transferred onshore for disposal. The waste will be transferred to a dedicated waste management facility for recycling and re-use (if applicable), or alternatively appropriate treatment and disposal, in line with all relevant regulatory requirements.

**Transfers via helicopters and supply vessels**

The FPSO will have a helideck and vessel tendering and associated equipment. Facilities and equipment will be constructed and operated to required industry standards for the safe transfer of personnel and supplies.

**Safety systems**

A Safety Case regime will apply for the Kitan Field Development, and risks managed so that they are tolerable and ALARP according to Eni's risk evaluation criteria (discussed in Section 0). Full safety requirements and procedures will be specified in an *HSE Management Plan* to be prepared by the FPSO Contractor.

Safety systems will include escape equipment, fire/gas/smoke detection and protection systems, and back-up power systems. An inert gas blanketing system will be included, with adequate redundancy, for loaded and empty cargo and slop tanks and this system will be used during cargo discharge. The fire protection system will consist of passive controls (such as equipment coatings) and active controls, such as deluge, and water, foam, carbon dioxide ($CO_2$) extinguishers. The most appropriate system for each area will be selected based on detailed risk assessments. Ozone-depleting substances may be used for these systems but avoided if possible. Safety requirements will include training of key personnel in hazard management, fire fighting and emergency response.

**Emergency and contingency planning**

Emergency and contingency plans, including oil spill contingency plans (OSCP), will be developed specifically for the unique location and operating characteristics of the Kitan Field. A security risk assessment will be completed and outputs from this will be incorporated into the design process, emergency response procedures and other relevant procedures.

The Kitan Field Development will be designed to meet regulatory requirements with respect to extreme weather events. The Development's capacity to withstand extreme weather events will be assessed by engineering studies and verified separately by an independent agency.

The FPSO will also have an emergency response centre and a fully equipped emergency response team room holding all necessary emergency equipment.

### 2.3.6 FPSO commissioning

FPSO commissioning requires well fluids to be flowed initially through subsea equipment and flowlines to the FPSO and processing equipment to allow gas, water and crude oil systems to become functional as an integrated process. Most systems on the FPSO will be pre-commissioned prior to the facility arriving in Timor-Leste waters. While commissioning is taking place, discharges and emissions may be higher than the operational design criteria until steady-state conditions are established. The FPSO will be supported in the field by at least one supply vessel during the commissioning period.

### 2.3.7 Production

Key elements of the production process are illustrated in Figure 2.7, which shows the main components and flows of gas, oil and water, from the wells through to final oil export. Peak crude oil production is expected to be ~40,000bbl/day (~6,300$m^3$/day). However, the oil profile is expected to have considerable variation across the reserves range and over time (Figure 2.8). As production declines, "spare" production capacity may become available on the FPSO to accommodate possible tie-back opportunities until the area has been fully developed.

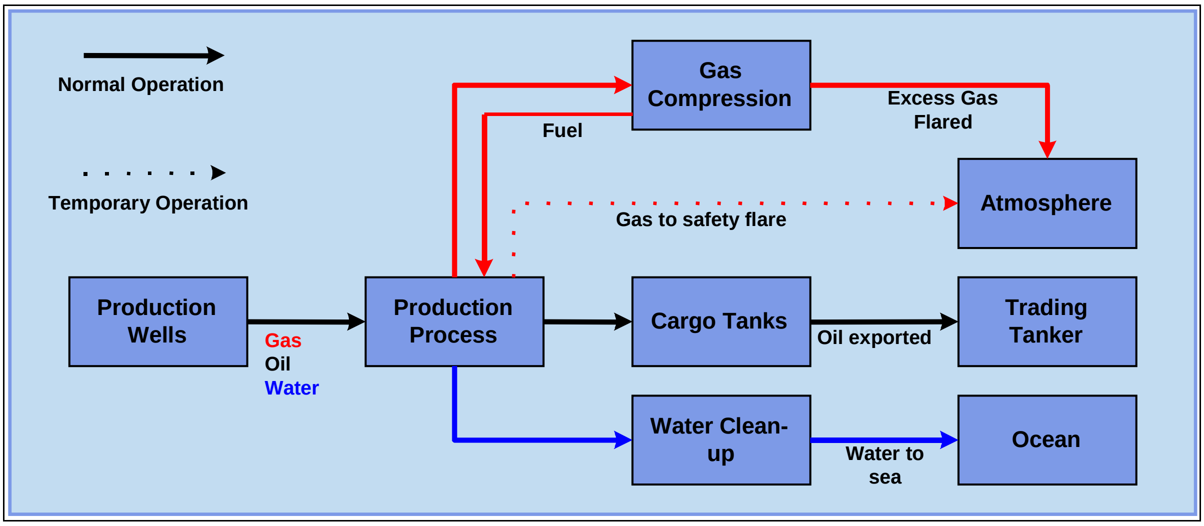



**Figure 2.7: Production process**

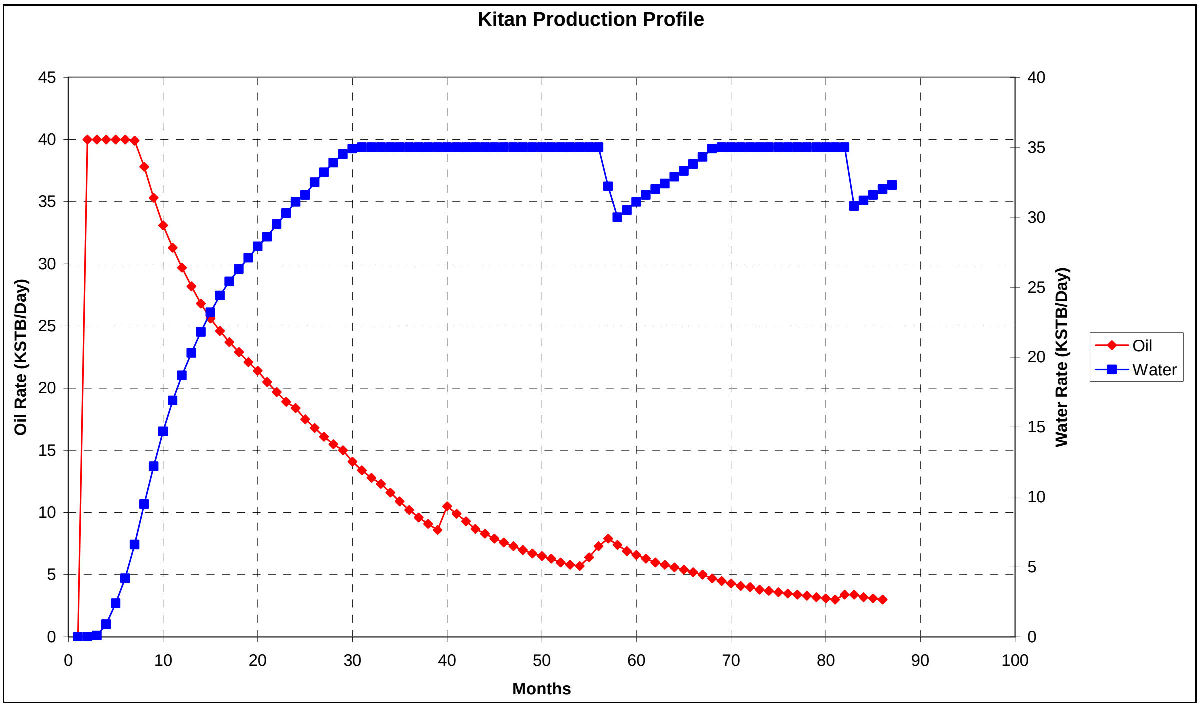



**Figure 2.8: Indicative production profile for the Kitan Project**

As shown in the production profile (Figure 2.8), PFW volumes are initially small but increase significantly towards the end of field life. The current design is for PFW during all stages of the project to be discharged overboard after treatment to meet required discharge standards. Oil/water separation systems, consisting of hydrocyclones and gas induced flotation units, will be used to treat PFW prior to discharge. The OIW content will be continuously monitored to ensure compliance with discharge standards.

Gas from the reservoir will be separated from the well fluids by processing equipment on the FPSO. Gas from the separators will be recompressed and dehydrated, allowing use as fuel gas and for artificial lift purposes, with any surplus gas being flared.

### 2.3.8 Offloading

**Offloading operations**

Oil stored on the FPSO will be offloaded to trading tankers for export. A typical tanker size will be a Suezmax (120,000 - 200,000 DWT), but the FPSO will have the capacity to offload to Very Large Crude Carrier tankers (200,000 - 350,000 DWT). The base case design is based on ~28 offloading events (offtakes) per year, at intervals of ~14 days in the early, high production period, with this becoming less frequent as production declines. All trading tankers, will be vetted and approved by Eni prior to arrival at the FPSO.

The offloading of crude oil to trading tankers will likely involve a tandem mooring system, as illustrated in Figure 2.9. The arrival of a trading tanker will be scheduled in advance of need. A qualified pilot will supervise the procedure, either boarding the trading tanker prior to its approach to the FPSO or being maintained on board the FPSO. Eni's preferred operating philosophy is to implement a production and offloading pattern whereby the FPSO's centre tanks are filled first, and emptied last, thereby reducing the possibility of a wing tanks containing oil in the unlikely case of a hull penetration.

A *Terminal Handbook* will be developed for the FPSO, listing all offloading operations requirements to be met. An offloading support vessel (OSV) similar to that shown in Figure 2.9 will provide support for the pilotage operation, static tow support and oil spill response. OSVs are normally crewed by ~5 to 10 personnel. When the FPSO is ready for offloading, the trading tanker will be met ~2km to 4km from the FPSO by the OSV, which will assist the trading tanker in connecting mooring lines, hawser and offloading hose. The hawser will comply with the Oil Companies International Marine Forum (OCIMF) requirements. A full safety inspection will be conducted before cargo loading begins. Whilst the trading tanker is loading, regular inspections will be undertaken. The pilot will be fully empowered to suspend loading operations and remove the trading tanker from the FPSO in the event of safety violations.

Crude oil will be transferred via an offloading hose or "floating" hose. The offloading hose will have a double acting breakaway coupling and will normally be stored free floating. Total offloading time will be around 36 hours, including 24 hours for transfer of a 950,000bbl cargo. Once the cargo has been transferred, the trading tanker is disconnected and moves off location.


**Figure 2.9: FPSO Offloading Operation**

**Trading tanker vetting**

Trading tankers will be obliged to comply with detailed vetting procedures by regulatory and certifying authorities, including International Maritime Organisation and a classification society. Substantial evidence is required as part of the vetting process, including compliance with safety and environmental standards. Other considerations include:

- compatibility of engineering aspects of the trading tanker with the FPSO;
- evidence of a physical inspection of the trading tanker completed within the previous 12 months by a certified OCIMF Ship Inspection Report Programme (SIRE) inspector;
- certification fully in place to meet relevant international conventions including International Safety Management certificate, MARPOL 73/78 and classification society registration; and
- satisfactory insurance and oil pollution cover.

Permission will be required from Eni before a tanker can be used for offtake of oil from the FPSO. Eni uses comprehensive and extensive shipping databases and other information to assess tankers. These include casualty record, class history, operational performance, owner audits, port state inspections, ship operator assessment, SIRE inspections and structural analysis.

### 2.3.9 Ballast water management

Tanker vetting procedures will require all trading tankers to have segregated ballast water tanks to minimise the potential of hydrocarbon contaminated ballast water being discharged. Drilling rigs and installation vessels will also be vetted.

Vetting procedures will also cover requirements for ballast water exchange, in line with Annex II of MARPOL 73/78, to avoid the introduction of exotic pests. Installation vessels and drilling rigs will employ similar procedures to meet MARPOL 73/78 requirements.

### 2.3.10 Decommissioning

Decommissioning of the Kitan Field Development will be carried out at the end of field life in accordance with legislation and industry guidelines, using technology and practices in place at that time. The aim is to decommission to as near as practicable original conditions. That aim will be facilitated by the use of the FPSO, whose decommissioning simply involves disconnection from the mooring and movement away from the location.

A detailed *Decommissioning and Abandonment Plan* will be prepared and submitted to the relevant authorities before decommissioning commences. This will include decisions related to removal of subsea structures. The *Decommissioning and Abandonment Plan* will be based on the following principles:

- only equipment that presents an insignificant environmental hazard will be chosen to remain;
- any equipment left behind on the seafloor, which could be a hazard to fishing, will be notified to authorities, marked on charts, and communicated to all relevant stakeholders; and
- decommissioning techniques should reflect current industry guidelines[1], and should be pragmatic, simple and cost effective.

In practical terms this means that the following decommissioning and abandonment philosophy will apply:

- FPSO, including turret: disconnect and sail away.
- Moorings: cut and recover at seafloor.
- Anchors: leave on seafloor unless cost effective to recover.
- Wells: recover Christmas trees, recover tubing strings, cement across perforations and to surface.
- Risers: purge and leave on seafloor.
- Pipelines: purge and leave on seafloor.
- Umbilicals static: leave on seafloor – flush contents into flowlines.
- Umbilicals risers: recover to surface.

[1] In the absence of specific guidelines for the JPDA, this may include the Australian Department of Resources, Energy and Tourism *Decommissioning Australia's offshore oil and gas facilities: a discussion paper*

## 2.4 Development Schedule

The development of the Kitan field will be completed using proven international contractors. The time taken to complete complex offshore projects depends on many factors that can both shorten or lengthen the time to “first oil”. The sequence of key activities is shown in Figure 2.10. It is based on average durations, however, earlier or later dates for “first oil” are possible.

Activities early in the schedule include appraisal and facilities engineering studies, development of the draft Field Development Plan (FDP), drilling of an Appraisal and Early Development Well (A-EDW) to further appraise the field, and commencement of selection of the FPSO contractor. This is followed by preliminary engineering leading into Front End Engineering and Design (FEED) studies, procurement of Long Lead Items (LLI) and procurement and conversion of the FPSO. The latter is done concurrently with procurement of sub-sea hardware and equipment and the start of the drilling of production and injection wells. On the schedule shown, installation of sub-sea hardware and equipment commences in the 2nd half of 2010, with “first oil” expected on 1 October 2011.

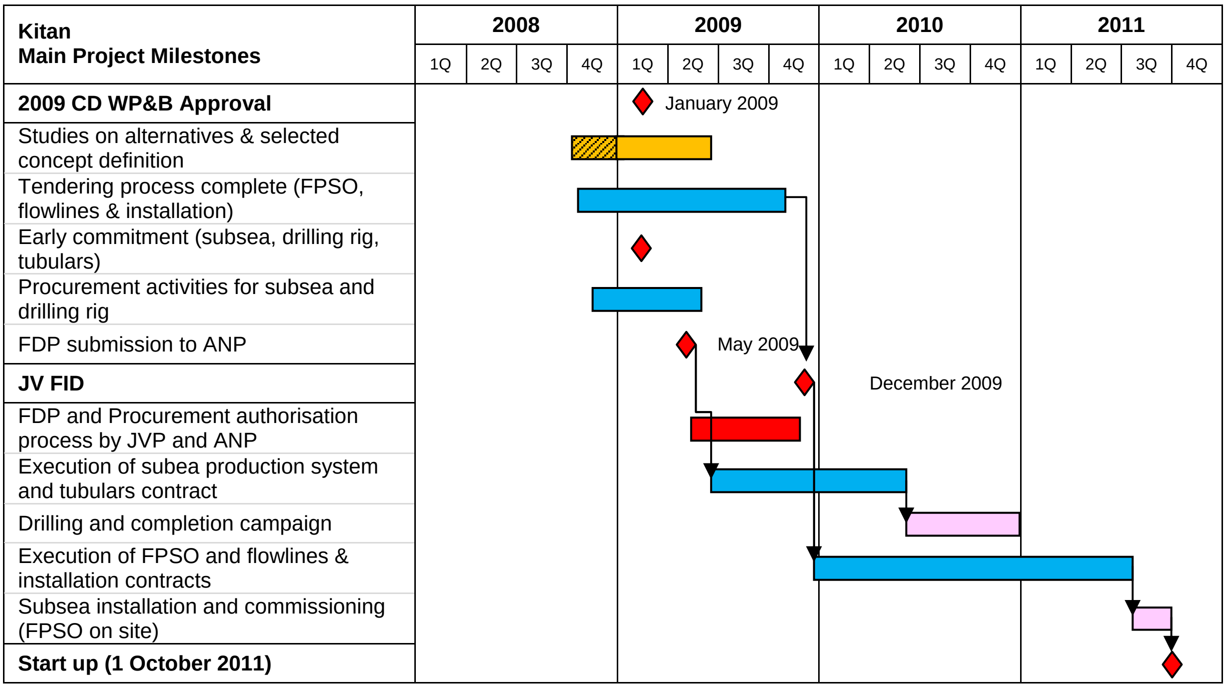



**Figure 2.10: Development Schedule**

# 3.0 CONSULTATION FRAMEWORK

## 3.1 Overview

A Stakeholder is defined as an organisation, institution or individual(s) that has an interest in the Project and therefore has a stake in its outcome. The EIA process provides Eni with a means of describing and explaining to stakeholders and other interested groups what the project is, the likely potential effects and how any significant impacts that may result from the project will be controlled and managed.

The timely acceptance of the EIA process and the resulting EIS from the Timor-Leste Government and from other stakeholders is accommodated through statutory consultation requirements, and through Eni willingly engaging with those who may be potentially affected. Stakeholder engagement and consultation are essential components of a successful EIA process. Given that the EIS will be the primary source of information on which government decision-makers will assess the potential environmental hazards and effects of the proposal, stakeholder consultation, review and feedback are critical.

## 3.2 Scoping Process

Eni conducted an extensive scoping process prior to developing the draft EIA for the Project. This scoping involved:

- reviewing relevant legislation and guidelines;
- reviewing EIS documents prepared for other Floating, Production, Storage and Offtake (FPSO) developments, particularly in Australia;
- reviewing environmental, economic and social values and sensitivities of the JPDA offshore waters;
- identifying key information gaps;
- defining stakeholders and key issues; and
- development of a PER.

The PER formed the basis of early consultation with stakeholders. It identified the main issues and scope of the EIA to be conducted for the proposed development. The objectives of the PER were to:

- provide an overview of the environmental regulatory framework;
- identify sources of information regarding the existing environment, data gaps and proposed studies to ensure coverage of these gaps;
- provide a summary description of the project; and
- obtain early input from stakeholders in the identification of environmental effects, and with regards to the proposed scope and content of the EIS.

## 3.3 Stakeholder Engagement

In line with its *External Relations and Stakeholder Management Plan* (Eni 2007), Eni undertook a stakeholder identification workshop for the Kitan Field Development on Tuesday, 12 August 2008. Key stakeholder groups relevant to environmental and social impacts were identified at that workshop and a Stakeholder strategy was developed (Eni 2009b).

Initial consultation was conducted with the ANP, who facilitated communication with other interested parties, such as the Secretaria de Estado dos Recursos Naturais (SERN; State Secretariat for Natural Resources) and the Direcção Nacional do Meio Ambiente (DNMA; National Directorate of Environment). Early discussion with the ANP was important in establishing relationships, identifying potential environmental effects, learning where concerns and issues existed from the stakeholders' perspective and in obtaining feedback on the proposed approach and technical aspects of the EIS.

Issues discussed with the ANP included:

- exploration and development activities;
- shipping related issues;
- air and marine support for the proposed development;
- structural integrity of the FPSO and subsea equipment;
- oil spill management;
- environmental monitoring programs and results of environmental impact assessment studies.

After submission of the Draft EIS in February 2010, feedback from the ANP, DNMA and non-government organisation La'o Hamutuk was provided to Eni, facilitated by the ANP. Comments made and clarifications requested by these stakeholders have been incorporated into this Final EIS document. Consultation with these and other stakeholders will continue throughout the life of the project.

### 3.4 Opportunity for Stakeholder Comment

The stakeholder review process for the Draft EIS was facilitated by the ANP, who provided the document to key government and stakeholder groups in Timor-Leste and Australia, and gathered comments from these groups on behalf of Eni.

This Final EIS will be issued for public comment in Australia and Timor-Leste for a period of six weeks, and any stakeholder issues affecting environmental management of the Kitan Development will be incorporated into environmental management plans for the relevant development phases, as appropriate.

On an on-going basis, all comments on the Project can be directed to the nominated proponent contact for this proposal detailed in Section 1.2.

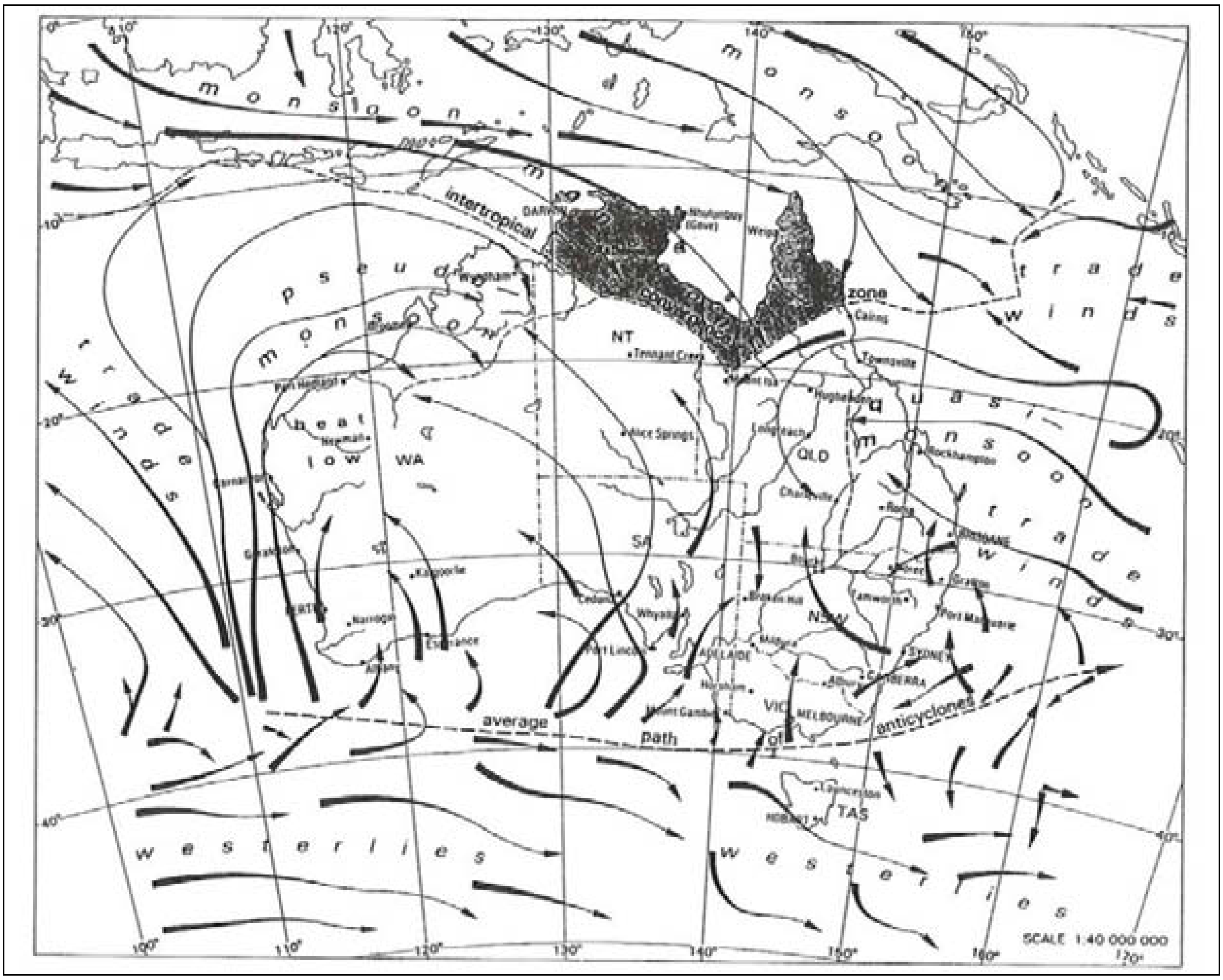
# 4.0 EXISTING ENVIRONMENT

## 4.1 Climate

The climate of the Timor Sea is monsoonal with a wet “summer” and a dry “winter”.

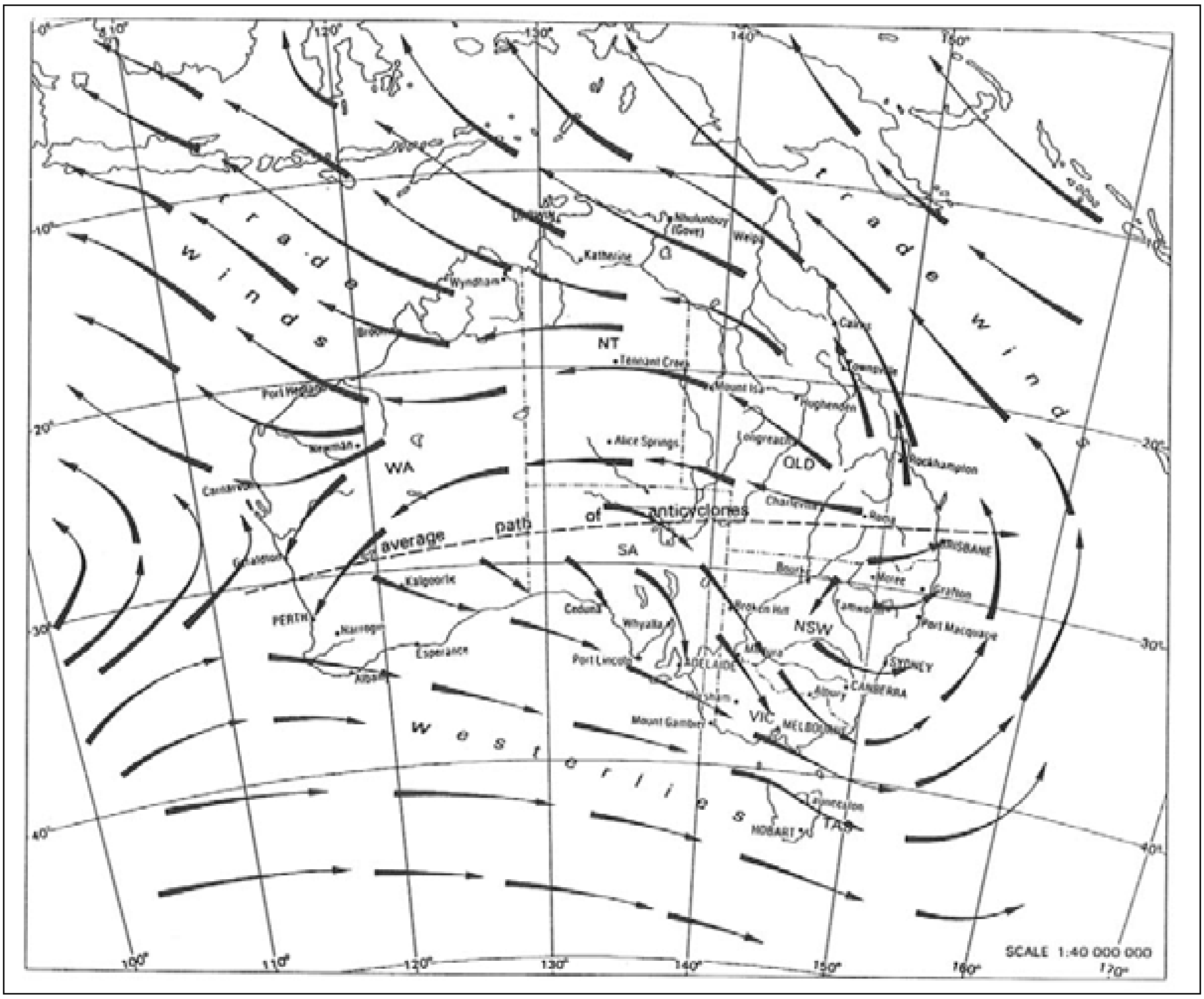
The wet season commences between September and November as the southeast trade winds weaken. This results in two or more semi-permanent heat lows forming over the centre of the Australian continent. The early part of the wet season is marked by frequent thunderstorms. As the season progresses, moist ocean air from the north and northwest around Indonesia streams into the lows and several days of heavy rain may occur. The general atmospheric circulation for the wet season is illustrated in Figure 4.1.

As dry season (winter) approaches, the dry southeast trade winds become re-established over northern Australia and the monsoon retreats. Figure 4.2 illustrates the typical atmospheric circulation for the dry season.




Source: Swan *et al* 1994

**Figure 4.1: Generalised atmospheric circulation over the Timor Sea and Australia in wet season (January)**




Source: Swan *et al* 1994

**Figure 4.2: Generalised atmospheric circulation over the Timor Sea and Australia in dry season (July)**

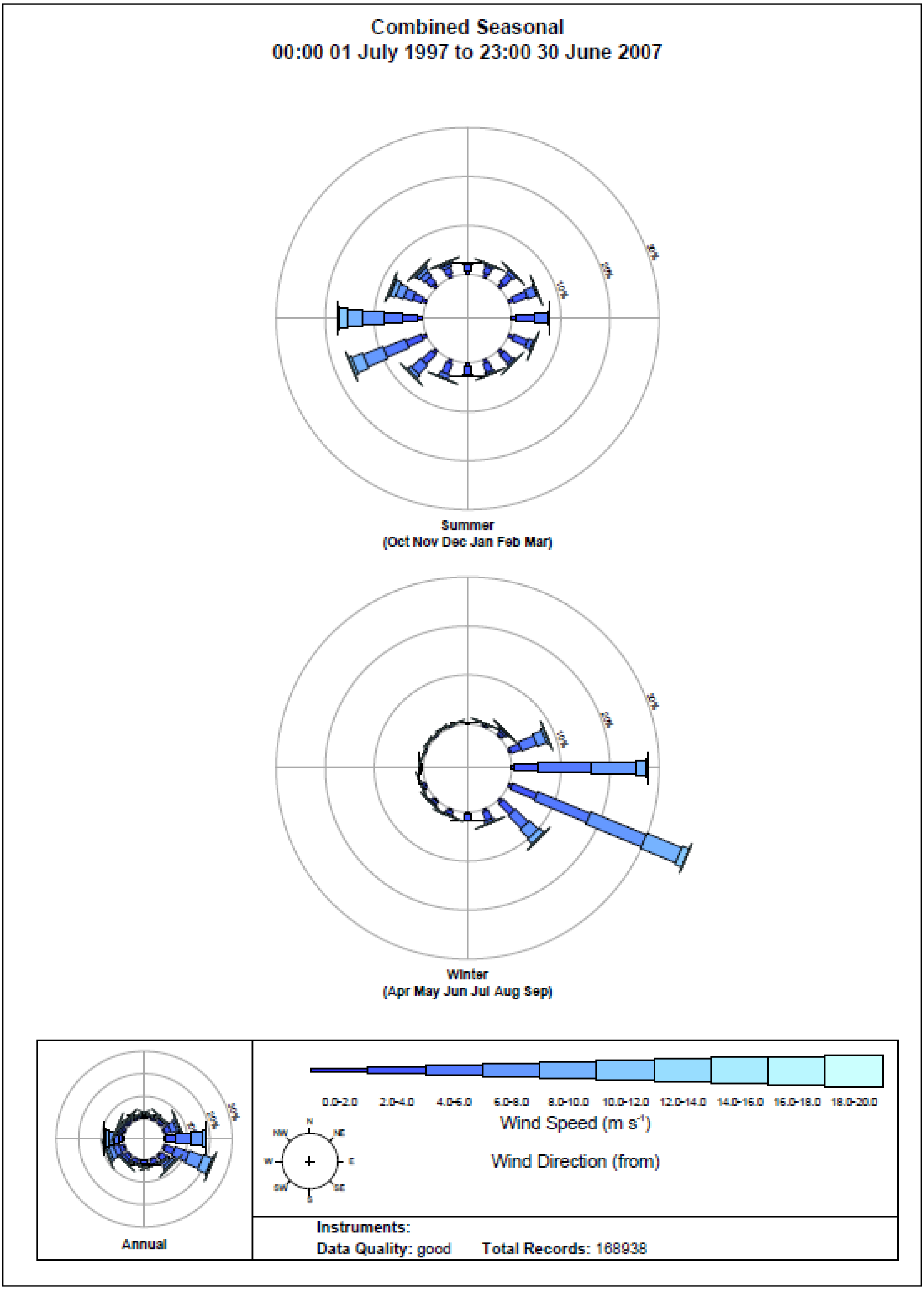
### 4.1.1 Rainfall and Temperature

Mean annual rainfall in the region is likely to be around 1,700mm, according to data collected at the Challis Field, 200km to the southwest of the Kitan Field (BHPP 1987). Almost all rainfall occurs between November and April, the greatest falls being in January and February. The frequency and severity of thunderstorms produce a large variation in the monthly rainfall. Rainfall during the dry months is sporadic and light.

There is little seasonal variation in air temperature. Mean air temperatures are 27°C in July and 28°C in December (BHPP 1987).

### 4.1.2 Wind Patterns

Figure 4.3 shows the seasonal wind roses for the Kitan Field. These display the expected seasonal variation in prevailing wind direction, with westerlies (southwest-northwest) persisting from October to March, followed by a fairly rapid shift to easterlies (northeast-southeast) in late March or early April that then persist until October before the return to the westerlies. Brief transitional periods occur in April and September/October when the wind direction and wind speed are slightly more variable (Saipem Energy Services 2009).



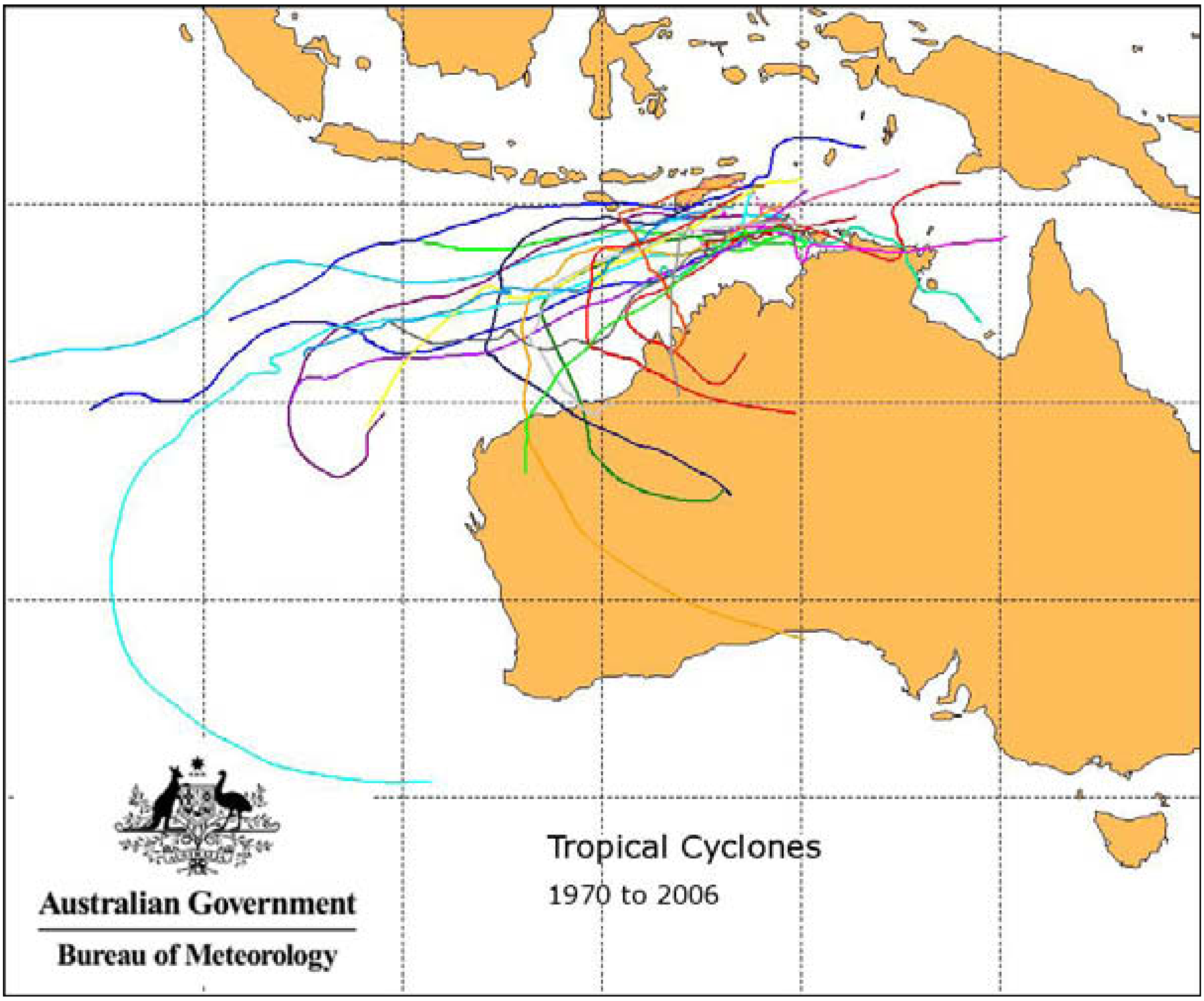

Source: Saipem Energy Services 2009

**Figure 4.3: Wind Roses for the Timor Sea**

### 4.1.3 Tropical Cyclones

Tropical cyclones generally form south of the equator in the eastern Indian Ocean and in the Arafura and Timor Seas during the wet season. In the Timor Sea, most of the storms are tropical lows or tropical cyclones in an early stage of development, passing to the south of the Kitan Field. The principal months for tropical cyclone occurrence are from November to April. No cyclones have been recorded for the months May to October.

Historical data on the frequency of cyclones in the area shows that on average 0.7 storms per year pass within 110 nautical miles of the Kitan Field and 3.7 storms pass within 540 nautical miles (BoM 2010). Figure 4.4 shows the cyclone tracks logged over a 26 year period that cross within 200km of the Kitan Field.




Source: BoM 2010

**Figure 4.4: Tropical cyclones crossing within 200km of the Kitan Field (1970 to 2006)**

## 4.2 Oceanography

### 4.2.1 Currents and Tides

Surface currents reflect seasonal wind regimes, with summer easterly to north-easterly currents, and winter westerly to south-westerly currents. The typical “rule of thumb” for current speed is 2% to 4% of the wind speed. Local wind-driven surface currents may attain maximum speeds of 0.7m/s during extreme monsoonal or Trade Wind surges. More typically speeds would be in the range of 0.2m/s to 0.4m/s.

Near-surface tidal currents in the region are anti-clockwise rotational, directed towards the south-southeast during mid flood and towards the north-northwest during mid ebb. Speeds will range from about 0.2m/s on neap tides to 0.4m/s on spring tides.

The main forces contributing to surface water motions in the Kitan area are:

- general oceanic circulation;
- astronomical tides; and
- wind stress.

The Pacific Indian Throughflow flows south through the Indonesian Archipelago and into the Eastern Indian Ocean This current may introduce a small southwesterly component to the current regime in the Kitan area. The throughflow appears to be subject to the pronounced interannual variations of El Nino-Southern Oscillation events. Current speeds vary depending on the season. Lowest speeds would occur in April at the end of the northwest monsoon when winds blow towards the Pacific whilst highest speeds would occur in September associated with the southeast monsoon (Wijffels *et al* 1996).

The tides in the vicinity of Kitan are semidiurnal (two highs and lows each day) with a slight diurnal inequality (difference in heights between successive highs and low). There is a well defined spring-neap lunar cycle, with spring tides occurring two days after the new and full moon.

Table 4.1 provides the standard tidal levels for the Jabiru field, located approximately 200km southeast of Kitan. Highest astronomical tide is 3.46m above lowest astronomical tide (LAT) and the mean ranges for spring and neap tides are 2.07m and 0.29m respectively.

**Table 4.1: Standard tide levels expected in the Kitan Field**

| Tidal state | Level (m above LAT) |
|---|---|
| Highest Astronomic Tide | 3.46 |
| Mean High Water Springs | 3.12 |
| Mean High Water Neaps | 1.97 |
| Mean Sea Level | 1.82 |
| Mean Low Water Neaps | 1.68 |
| Mean Low Water Springs | 0.39 |

Source: Saipem Energy Services 2009

### 4.2.2 Sea and Swell

Waves at Kitan comprise contributions from:

- Southern Ocean swells;
- summer monsoonal swells;
- winter easterly swells; and
- locally generated seas.

The most persistent swell arrives from the west and southwest with typical heights of 2m in dry season and 1m in wet season. Since longer period swell suffers less dissipation, periods of long-travelled swell commonly reach 18 seconds and occasionally exceed 20 seconds. Shorter period swell (6 to 10 seconds) may result from tropical cyclones, dry season easterlies over the Arafura Sea and the eastern portions of the Timor Sea and wet season westerlies over the western portions of the Timor Sea.

Local wind generated sea is highly variable but typically ranges in period from 2 seconds to 6 seconds with heights of up to 6m in strong persistent forcing at some locations (Swan *et al* 1994).

### 4.2.3 Bathymetry

The Kitan Field is located on the continental slope in an area of uniformly smooth seabed ranging in depth from 330m to 383m, with an average slope of 1:120 (Figure 4.5). To the northwest, the continental slope continues to decline steadily reaching depths in excess of 2,000m in the Timor Trough (Figure 4.6). To the south, the Sahul Shelf extends approximately 300km out from and runs parallel to the northern Australian coastline. It is bounded to the northeast by the Van Diemen Rise, to the southwest by the Londonderry Rise and to the north by a series of shoals described by Edgerley (1974) as a "broken barrier reef".

A system of shoals occurs to the south and south west of Kitan (Figure 4.6). The system stretches for approximately 60km in a northeast/southwest direction along the outer edge of the Sahul Shelf and comprises 11 major shoals ranging in size from 0.05km$^2$ to 40km$^2$, with an average size of 4.6km$^2$ (Heyward *et al* 1997). The banks rise sharply above the continental slope from more than 300m to between 16m to 30m below the sea surface. The nearest, Big Bank Shoals, is located approximately 6km southwest of Kitan FPSO position and 2km southwest of the nearest production well. Big Bank Shoals rises to within 22m of the sea surface at Lowest Astronomical Tide (LAT).

The nearest emergent reefs, Ashmore, Cartier and Hibernia, are located on the southwest end of Sahul Shelf. The nearest, Hibernia reef, is more than 300km to the southwest of Kitan (Figure 4.6).

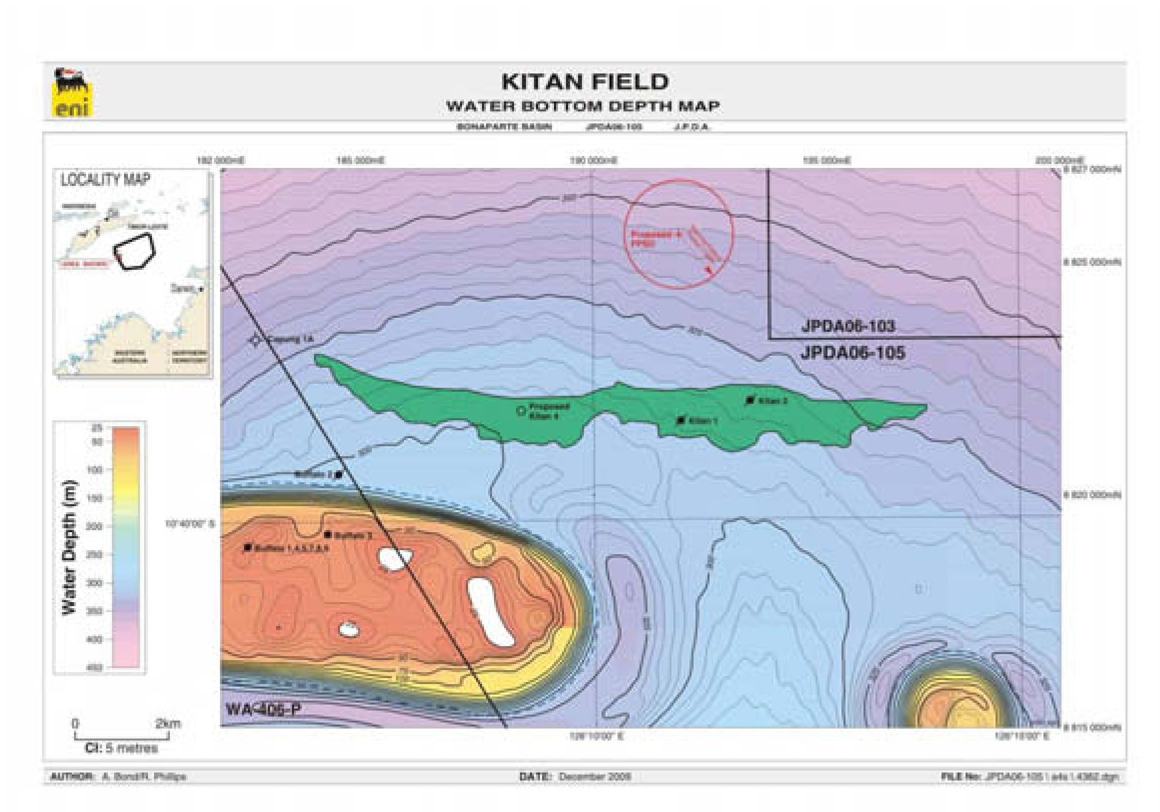



Figure 4.5: Bathymetry of the Kitan Field

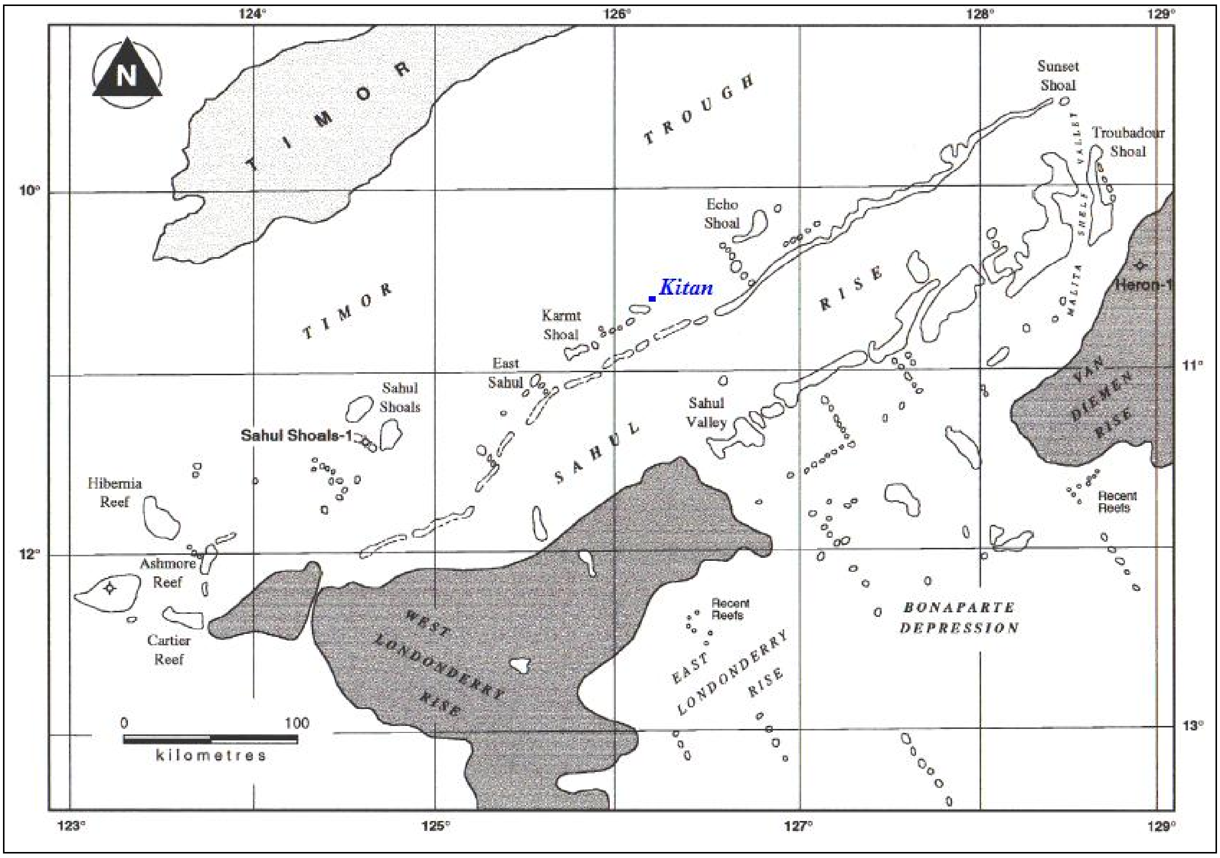



Figure 4.6: Regional bathymetry

### 4.2.4 Seawater Profile

A baseline environmental survey of the JPDA 06-105 permit area was conducted by Gardline Marine Sciences Pty Ltd (Gardline) in May 2010 (see Appendix E for complete report). Physico-chemical characteristics of the seawater column were sampled at three sites using a YSI 6600 multi-parameter probe, which measured pH, temperature, conductivity and dissolved oxygen (DO). Profiles were taken during day and night at all sites, down to water depths of 200m.

Surface seawater temperatures recorded were between 29.0 and 29.6°C. Subsurface temperatures were steady to approximately 60m depth. Below this, temperatures dropped steadily, indicating a consistent thermocline among all sampling sites. At depths close to 200m, temperatures reached as low as 12.4°C. This pattern of vertical stratification is typical of tropical seas (Gardline 2010).

The other parameters showed similar stratification:

- salinity levels were lower in the surface mixed layer (34.0–34.2ppt) and showed a consistent halocline from around 60m, with increasing salinity at depth (up to 34.6ppt at 190m depth).
- surface DO concentrations were above 6.0 mg/L, supportive of marine life, then showed a consistent decline to 60 m depth, after which concentrations decreased substantially to as low as 3.5 mg/L at 190 m depth.
- pH levels were consistent at around 8.1 in the well-mixed surface waters down to 60m, and then decreased to below 7.8 at 190 m (Gardline 2010).

These results are consistent with those previously recorded by Creswell *et al* (1993) in the Timor Sea.

## 4.3 Seismicity and Tsunamis

The Timor Sea has been tectonically active for at least the past six million years where the Australian and Eurasian continental plates converge. Since the mid 1970s, hundreds of earthquakes have been recorded in the region. Many of the earthquakes in the Australian sector of the Timor Sea are of relatively low magnitude occurring around the edges of the Cartier and Timor Troughs. These troughs lie north of the proposed Kitan Field Development and to the south of Timor-Leste.

Subduction earthquakes, caused by one edge of a crustal plate being forced below the edge of another, associated with the Timor Trough dominate the earthquakes of the general area. Earthquake activity within the central Timor Trough and the island of Timor is a lot more intense, more frequent and generally of a magnitude greater than seven on the Richter Scale (AUSGEO 2003).

The Kitan Field is located to the southern boundary of the Timor Trough on the Australian continental plate, which is subducting to the north under Timor. The subduction zone is steeply dipping with the rate of activity along the subduction zone appearing to be greatest to the east (towards the Banda Sea) than to the west (towards Sumbawa). There appears to be an absence of seismicity to the north-west of the Kitan Field, although this may not be a long-term feature of the seismicity of the area.

At the Timor Trough, the subduction zone earthquakes are shallow at the offshore trench and are deepest to the north, with most subduction earthquakes occurring at depths down to approximately 200km. Few events occur between 300km and 500km depth, although some events do occur at depths exceeding 600km. Events deeper than 300km are too deep to create damage at the surface for major engineered structures.

## 4.4 Geology and Marine Sediments

The Kitan Field is situated 15km east of the Laminaria oilfield and 8km east-northeast of the Buffalo oilfield. The lead is defined on 3D seismic as an east-west-trending horst block. The structural closure covers an area of approximately 10km$^2$ with 215m relief. The objective reservoir comprises Callovian shallow marine sandstones of the Laminaria Sandstone.

A geophysical survey, including drop camera imaging, of the seabed around the location of the proposed FPSO carried out in August and September 2008, showed that the seabed was flat and featureless (Fugro 2008). There was no evidence of significant topographical features such as sand waves, pockmarks, rocky outcrops, canyons or similar. Box core samples revealed that the seabed consists predominately of soft carbonate clays. Sub-seabed profiling indicated that the shallow geology (down to approximately 20m) consists of well stratified clay/silt (Fugro 2008).

Sampling of marine sediments by Gardline (2010; see Appendix E) recorded fine silty sand with clay nodules throughout much of the JPDA 06-105 permit area. Poorly sorted coarse silt to very fine sand was recorded at the majority of sampling sites. Samples from the deeper sites to the north and northwest of the permit area contained higher fines contents. Mean particle size for the survey area was 66µm (±43 SD) (Gardline 2010).

Total organic carbon (TOC) was low for the sediment type, with an average of 1.8%. Total petroleum hydrocarbons (TPH) were not recorded within the limits of detection, indicating that the marine sediments in the area are free from anthropogenic contamination. Similarly, heavy metals such as cadmium, copper and lead were well below the National Oceanic and Atmospheric Administration's (NOAA) published apparent effects thresholds (AETs), indicating no threat of toxicity to marine biota (Gardline 2010).

Sediment metal concentrations in the permit area were indicative of background concentrations, and were not considered to have been affected by previous drilling activities nearby (Gardline 2010).

## 4.5 Biological Environment

### 4.5.1 Regional Overview

The marine fauna of the Timor Sea is part of the Indo-West Pacific biogeographical province (Figure 4.7). The majority of species are widely distributed in this region. Marine biology studies consider the tropical waters across the north of the Australian continent (extending from the north of Western Australia around to the Great Barrier Reef) to represent one continuous biological province (Wilson and Allen 1987).

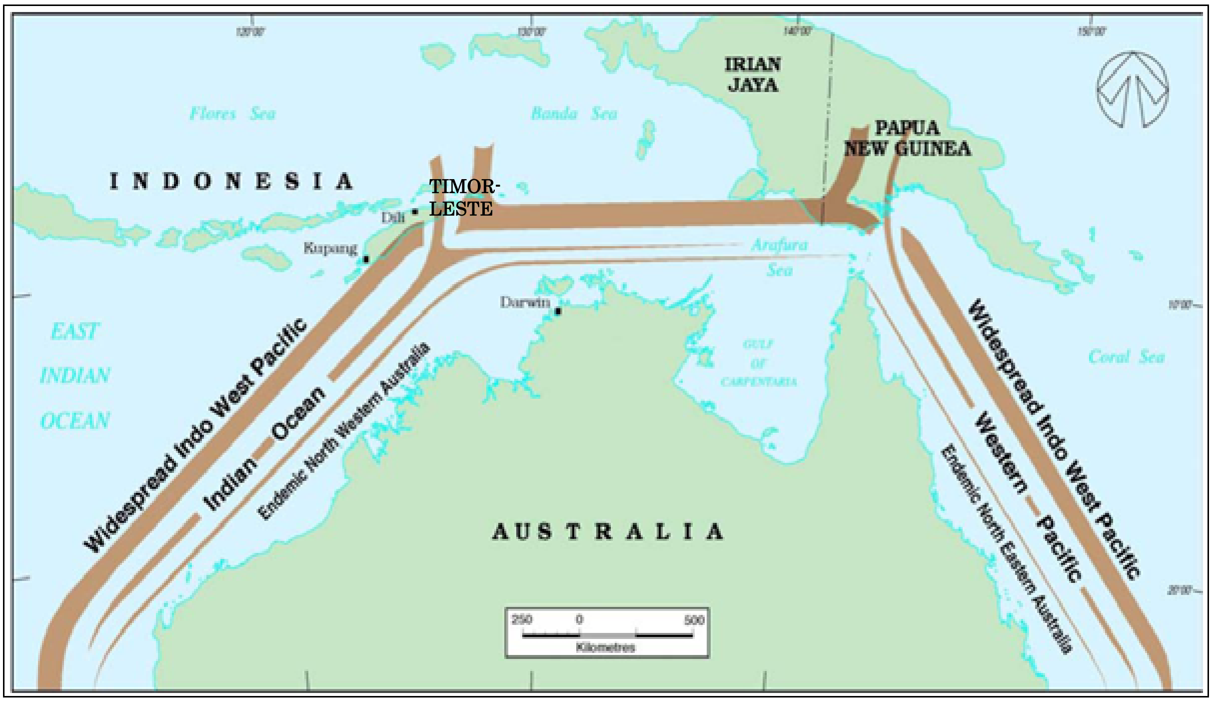



**Figure 4.7: Indo-West Pacific biogeographical province**

### 4.5.2 Continental Shelf

Across the northern continental shelf, the predominant animals living within seabed sediments (infauna) are polychaetes (burrowing worms) and crustaceans (e.g. prawns, shrimp and crabs). These two groups comprise 84% of the total species in sediment samples with a high diversity of species but a low abundance of each individual species (Heyward *et al* 1997). The remaining 16% of species include echinoderms (e.g. sea stars, sea urchins and feather stars), molluscs (i.e. gastropods and bivalves), nemerteans (ribbon worms), sponges and fish.

Epibenthic communities (animals living on or near the seabed) in deeper waters are generally low in fauna abundance and diversity. Heyward *et al* (1997) noted that with little sea floor topography and hard substrate, such areas offered minimal habitat diversity or niches for animals to occupy. The main taxa found in these areas include sponges and gorgonians (sea whips and sea fans). The absence of hard substrate is considered a limiting factor for the recruitment of epibenthic organisms (Heyward and Smith 1996).

Whilst the abundance may be low, the diversity of shelf slope invertebrates may be high. A wide variety of crustaceans including scampi, prawns, carids, bugs and crabs are regularly recorded from commercial deepwater trawl catches in the North West Shelf Trawl Fishery and that the additional non commercial crustacean captures included hundreds of species (Caton and McLoughlin 1999). The continental slope of the Timor Sea can be expected to support similar crustacean diversity.

### 4.5.3 Sea Mounts and Shoals

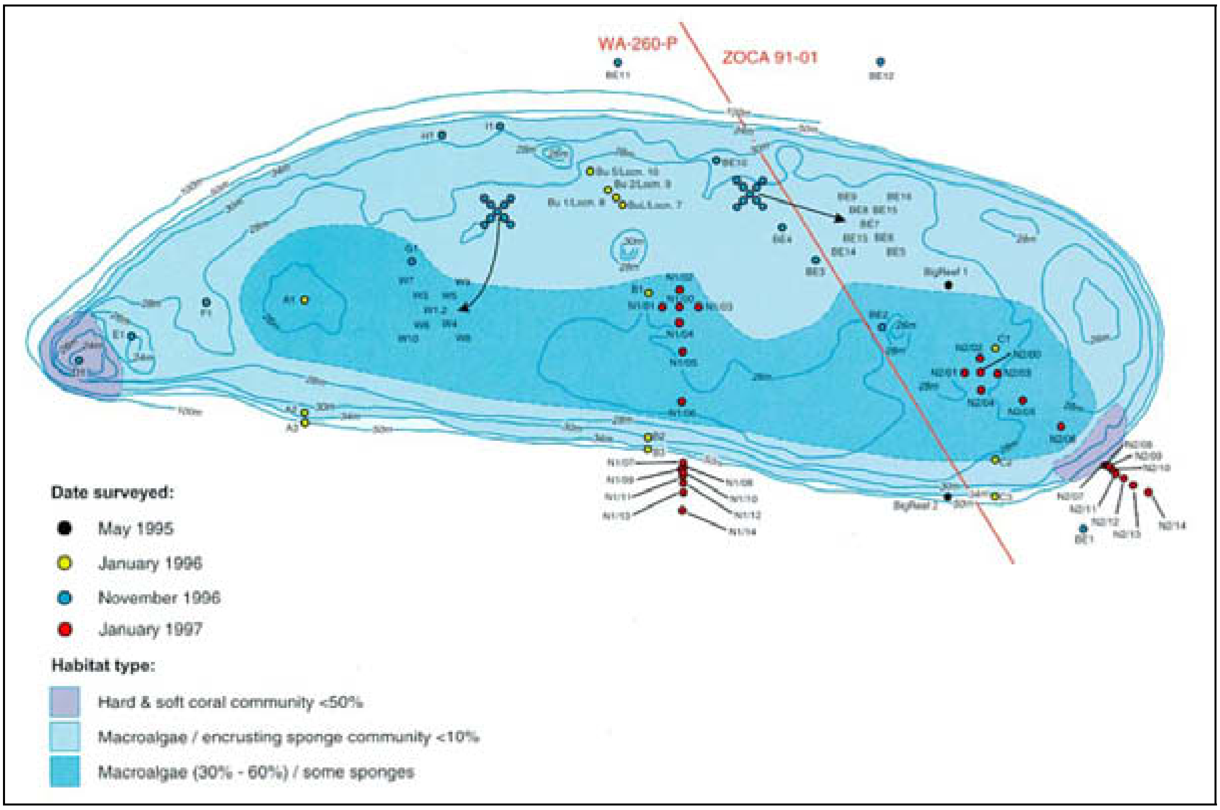
The proposed Kitan Field Development occurs in the vicinity of a number of mostly unnamed sea mounts and the Sahul Shoals. On shoals in less than 50m water depth (where adequate light may penetrate), epibenthic fauna can be abundant and diverse. These areas are of ecological significance due to their regional uniqueness and their patchy distribution in an otherwise broad area of featureless seafloor.

The major shoals and banks in the region (Figure 4.6) include:

- Karmt Shoals, approximately 45km to the southwest of the proposed Kitan facility;
- Big Bank Shoals, approximately 3km southwest of Kitan; and
- Echo Shoals, approximately 85km to the northeast of the proposed Kitan facility.

The nearest shoals to the Kitan Field Development, Big Bank Shoals were surveyed extensively by Heyward *et al* (1997). The Big Bank Shoals comprise thirteen banks which vary in their habitat and species composition, but are generally characterised by mixed *Halimeda* algae, sponge and soft coral communities with some hard corals on the more consolidated sediments. *Halimeda* or coral dominate ecosystems on the shallower banks and filter-feeding ecosystems dominate the deeper banks. It is not clear why some of these banks are coral-dominated while others are *Halimeda*-dominated. However, depth and light attenuation seem to play key roles.

The closest bank to the Kitan Field Development, Big Bank, is also the largest and rises from the Continental Slope to a plateau within 22 metres of the sea surface and extends 12 km by 3.5 km along an east-west main axis. The plateau of Big Bank was observed to contain areas of macroalgae, large areas of calcareous sand and rubble with a low percentage cover of algae, isolated encrusting sponges and isolated small coral bommies (Heyward *et al* 1997) (
Figure 4.8). Areas of high live coral coverage have been identified in approximately 25 to 30m depth on the northern and western sides of Big Bank.




Source: Heyward et al 1997

**Figure 4.8: Habitat map of Big Bank**

The base of Big Bank lies in water depths between 200m and 300m and has a fine, sandy substratum which is highly rippled (*Heyward et al* 1997). The abundance of sessile and epibenthic fauna was observed to be very low at these depths. The bank slopes are characterised by large erect sponges, gorgonians, bryozoans, ascidians and feather stars. This assemblage is typical of a relatively nutrient rich and strong current environment. Between 100m and 150m depth, the slope was observed to become steeper and the substratum appeared more consolidated. Macro-invertebrates are still rare and sponges and gorgonian corals dominate the epibenthic community at these depths, representing less than 8% coverage of the seabed overall. At 80 metres, macroalgae and *Halimeda* are first observed and overall live cover increases to 15% percent of the seabed. At 30m, the edge of the bank plateau is reached and both hard and soft corals as well as macroalgae and *Halimeda* become common, with overall cover exceeding 25%.

South of the Sahul Shelf system lies extensive shelf flats of depths varying from 70m to about 100m. These soft sand-silty seafloors are generally flat and undulating with a sparse assemblage of species. Species present are mainly polychaetes and crustaceans, with sponges, ascidians, echinoderm, gorgonians or soft corals depending on depth and local sediment characteristics (Lavering 1993, Marsh and Marshall 1983).

The emergent coral reefs and associated islands have high species diversity both within and between the reefs. However, the nearest of these emergent coral reef systems, Hibernia Reef, is about 300km to the south-west of the development.

### 4.5.4 Nutrient availability

Water quality sampling was conducted in the JPDA 06-105 permit area in May 2010 by Gardline (see Appendix E for full report). Nutrient concentrations were assessed in surface water layers down to 20m depth. The average total nitrogen concentration was 143µgl$^{-1}$, which may be indicative of seasonal upwelling of nutrients from the continental slope. This phenomenon may also have contributed to the development of benthic communities on the oceanic shoals south of the permit area, discussed in Section 4.5.3 above. However, phosphorous concentrations were very low, and the nitrogen:phosphorous ratio of <16:1 is considered to indicate a “nutrient-limiting” marine environment, typical of the Timor Sea (Gardline 2010).

Chlorophyll-a concentrations were low, from below the limit of recording ($0.1\mu gL^{-1}$) to $0.3\mu gL^{-1}$, and were consistent down to 50m depth (Gardline 2010).

### 4.5.5 Plankton

Zooplankton, which feeds on phytoplankton, provides an important food source to larger animals such as whales, fish and crustaceans. Within the region, zooplankton densities are greatest in an up-welling area between the north-west coast of Australia and Indonesia, generally during the July-August period related to the south-east monsoonal winds (Tranter 1962).

Sampling for zooplankton and phytoplankton was undertaken in the JPDA 06-105 permit area by Gardline in May 2010 (see Appendix E for full report). Phytoplankton were sampled at 23 locations using an integrated water pump procedure at 20, 15, 10 and 5m depths. Species abundances were highly dominated by the green algae chlorophyta, which consisted mainly of the genus Prasinophyte. Overall, the majority of species identified during the survey were similar to those recorded by earlier studies in the region (Gardline 2010).

Zooplankton were sampled at 32 locations, using a 150µm mesh plankton net towed vertically from 20m depth to surface. Samples were consistently dominated by copepod crustaceans, along with urochordata and foraminifera. Overall, the highest abundances of zooplankton were observed near the Kitan-4 drilling location, which was the closest sampling area to Big Bank Shoal (1.9km away). Nutrient enriched oceanic upwelling from the Timor Trough may be influenced by the steep bank, resulting in enhanced primary production for zooplankton (Gardline 2010).

Heyward *et al* (1997) also conducted plankton sampling at Big Bank Shoal, and found that zooplankton biomass was in the range of 65–155 $mg/m^3$, with diverse and abundant assemblages. Samples indicated a population of an average of 31,000 individuals representing 20 to 30 taxa, while abundance at sites away from the bank averaged approximately 17,000 individuals. Planktonic crustaceans that feed on phytoplankton were the most prevalent taxa. A copepod (Crustacean) from the Family Paracalanidae was the most abundant zooplankton encountered. These results are consistent with those of extensive surveys conducted by Tranter (1962). The higher abundance of zooplankton in samples over the Big Bank Shoals appears to be a feature of these shoal ecosystems.

### 4.5.6 Benthic Fauna

The Kitan Field lies in deep water on the edge of the continental shelf. The seabed in the vicinity is relatively flat with soft sediment and characterised by a sparse invertebrate assemblage. Benthic studies carried out in the Timor Sea, north-east of the Kitan Field, recovered very few organisms: 21 specimens in total (Pinceratto and Oliver 1996). Reports on benthic sampling conducted nearby have concluded that the fauna of the deep area is comprised of a low abundance, low diversity benthic infauna dominated by polychaetes and crustaceans, and generally characteristic of the region. A sampling programme conducted in the adjacent AC/P8 permit also confirmed the widespread distribution and low abundance of benthic fauna (Sinclair, Knight and Merz 1995). Similarly Heyward *et al* (1997) recorded low abundances and species diversity in continental shelf habitats near the Big Bank Shoals and surrounding region. These assemblages were dominated by polychaete worms and crustaceans, comprising over 84% of the species and 88% of the abundances recorded.

The benthic fauna at Kitan-1 and Kitan-2 wells were observed during ROV surveys undertaken during each drilling campaign. On each of the four 50m video transects at Kitan-1, the seabed was observed to be a flat, featureless plain comprised of fine sediments. Infauna were observed to be common as evidenced by burrows (probably created by polychaete worms). Epibenthic fauna such as hermit crabs and fish were also common (Figure 4.9).


Source: Sustainability 2008a and 2008b

**Figure 4.9: Typical view of seabed in the Kitan area showing demersal fish and epibenthic invertebrates**

Infauna around the Kitan Field was sampled in August/September 2008. Forty eight samples were collected. A total of 419 individuals were collected representing polychaete worms, crustaceans, molluscs, sipunculan worms and nematodes. Abundance was low, with an average density of 8.7 animals collected per sample. The maximum number of individuals collected per sample was 37, whilst some samples were devoid of infauna. A total of 31 taxa (samples sorted to order/family level) were collected but the number of taxa per sample ranged from 0 to 15. The infauna was dominated by polychaete worms (202 individuals) followed by crustaceans and nematodes (76 and 73 individuals respectively), sipunculan worms (32 individuals) and molluscs (16 individuals). The data support the findings of earlier studies that benthic continental shelf fauna communities in the region are low in abundance and diversity.

Additional infauna sampling was conducted by Gardline in May 2010, throughout the JPDA 06-105 permit area (see Appendix E for full report). Samples of the seabed were taken using a 0.1m$^2$ Day grab and revealed a low abundance of infauna, indicative of sparse communities. Taxa included polychaetes, crustaceans, molluscs and echinoderms. Overall, polychaete annelids were the most common fauna recorded, which is typical of soft-bottom communities from the continental shelf to the abyssal plains (Gardline 2010).

### 4.5.7 Whales and Dolphins

Targeted research on the whale and dolphin populations of the JPDA has not yet been conducted. Information on the distribution of a number of these species within the Indo-Pacific region is contained within a public database maintained by the Australian Department of Environment, Heritage, Water and the Arts (DEWHA). This database indicates that 22 whale and dolphin species could potentially occur in the JPDA (DEWHA 2010). Of these, the pygmy killer whale (*Feresa attenuata*), killer whale

(*Orcinus orca*) and false killer whale (*Pseudorca crassidens*), common dolphin (*Delphinus delphis*) and the bottlenose dolphin (*Tursiops truncatus*) are likely to occur near the Kitan Field. Humpback whales (*Megaptera novaeangliae*), which are known to utilise north western Australian waters during their annual migratory cycle, are not expected to migrate as far north as the JPDA.

### 4.5.8 Reptiles

The tropical Indo-Pacific region supports marine turtles and sea snakes. Marine turtles include the threatened flatback turtle (*Natator depressus*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*) and leatherback turtle (*Dermochelys coriacea*). The loggerhead turtle (*Caretta caretta*) also occurs in the region and is listed as endangered. Approximately fifteen species of sea snake have been recorded in the region (DEWHA 2010).

### 4.5.9 Fish

Fish densities are likely to be low in the open oceanic waters in which the Kitan Field is situated. However, waters with greater fish abundance are likely to occur in the shallow, coastal fringe and around reefs and shoals on the edge of the continental shelf (CSIRO 1999a). The broader area of the Timor Sea region supports pelagic fish species that are utilised in traditional and commercial fisheries.

The region supports large populations of cartilaginous fishes such as sharks and rays. The most prolific of the sharks are the whalers, represented by at least twelve species in the region. They are common in all environments and the oceanic white-tipped shark (*Carcharhinus longimanus*) occurs in the deeper offshore areas. Whale sharks may occur occasionally in the permit area, although little is known of their movements through the region.

### 4.5.10 Birds

Bird life in the vicinity of the Kitan Field Development is expected to be limited given the oceanic environment. A large variety of seabird species are expected to migrate across the region or forage within the coastal waters of the Timor Sea. Shoreline species may pass through these areas during migrations or enter for short periods during foraging.

In a systematic survey of seabird distribution in the eastern Indian Ocean (Dunlop *et al* 1995) it was found that seabird distributions were generally very patchy except near islands where shelter and anomalies in surface water concentrated food seasonally. For example, Ashmore Reef (located over 370km to the southeast of Kitan) is a significant staging point for wading birds migrating between Australia and the northern hemisphere, including forty-three species listed on one or both of CAMBA and JAMBA. Ashmore Reef supports extremely high concentrations of breeding seabirds, many of which are nomadic and typically breed on small isolated islands. CSIRO (1999b) recorded over 10,000 seabirds of nine species on Ashmore Reef and the surrounding area during a survey between September and October, 1998.

### 4.5.11 Conservation Significant Biological Resources

Seventy-four threatened and/or migratory fauna species that are protected under Australian legislation and other international treaties could occur in the vicinity of the Kitan Field (DEWHA 2010); these are listed in Table 5.2.

This list of animals includes three “endangered”, six “vulnerable” and 14 “migratory” species, as well as a large number of species that are protected under international conventions such as the Convention on International Trade in Endangered Species (CITES), Convention on Migratory Species (CMS), Japanese and Australian Migratory Bird Agreement (JAMBA), Chinese and Australian Migratory Bird Agreement (CAMBA), the International Union for the Conservation of Nature (IUCN) Red List or the United Nations Convention on the Law of the Sea (UNCLOS).

The three endangered and six vulnerable species (whales, turtles and the whale shark) are widely distributed oceanic species. While some of the whale and shark species may breed or feed in the JPDA, there are no known features that would make the area particularly attractive to these species

and the conditions are widely represented on the tropical continental shelf of Australia and elsewhere in the tropics. Turtles may occur in the area during their oceanic migrations, but there is no suitable habitat for turtle nesting for hundreds of kilometres.
Similarly, the 14 migratory species (which include whales, dolphins and one seabird) are widely distributed oceanic species. There are no particular seabed or oceanographic features around the Kitan Field that would attract any of these wide ranging species to the area, or provide critical habitat for feeding or breeding.

The remaining listed species are widely distributed whales, dolphins, pipefish, seahorses and seasnakes. Pipefish, seahorses and seasnakes are expected to occur around shallow-water habitats, such as reefs and shoals. Big Bank Shoal is located 3 km southwest of the Kitan Field, and is likely to provide habitat for seasnakes; the distribution of seahorses and pipefish in the area is unknown.

**Table 4.2: Protected species that could occur within a 100 km radius of the Kitan Field**

| Common name | Scientific name | Distribution | Conservation status |
|---|---|---|---|
| **Threatened Species** | | | |
| **Mammals** | | | |
| Blue whale | *Balaenoptera musculus* | Open ocean, world-wide distribution. Occasional visitor to region. | Endangered (EPBC Act)<br>Migratory* (CMS) |
| Humpback whale | *Megaptera novaeangliae* | Known migration path is not near Kitan Field. | Vulnerable (EPBC Act; CITES)<br>Migratory* (CMS) |
| **Reptiles** | | | |
| Loggerhead turtle | *Caretta caretta* | Global distribution in tropical, subtropical and temperate waters. | Endangered (EPBC Act; CITES)<br>Migratory* (CMS) |
| Leatherback turtle | *Dermochelys coriacea* | Global tropical and temperate distribution, largest populations in Atlantic, Pacific and Indian Oceans and Caribbean Sea. | Endangered (EPBC Act; CITES)<br>Critically endangered (IUCN)<br>Migratory* (CMS) |
| Green turtle | *Chelonia mydas* | Global distribution including tropical waters of Northern Australia. | Vulnerable (EPBC Act; CITES)<br>Migratory* (CMS) |
| Hawksbill turtle | *Eretmochelys imbricata* | Global distribution in tropical, subtropical and temperate waters, largest populations occur in Australian waters. | Vulnerable (EPBC Act; CITES)<br>Migratory* (CMS) |
| Flatback turtle | *Natator depressus* | Occurs in Australian and Indonesian waters, all known nesting beaches occur in Australia. | Vulnerable(EPBC Act; CITES)<br>Migratory* (CMS) |
| **Fish** | | | |
| Whale sharks | *Rhincodon typus* | Broad global distribution in tropical and warm temperate seas, both oceanic and coastal settings. | Vulnerable (EPBC Act; IUCN)<br>Migratory* (CMS; UNCLOS) |
| **Migratory Species** | | | |
| **Birds** | | | |
| Streaked shearwater | *Calonectris leucomelas* | Occurs throughout the Pacific Ocean, nests only in Japan. | Migratory* (EPBC Act; JAMBA; CAMBA)<br>Marine species (EPBC Act) |
| **Marine Species** | | | |

| Common name | Scientific name | Distribution | Conservation status |
|---|---|---|---|
| **Cetaceans** | | | |
| Antarctic minke whale, dark-shoulder minke whale | *Balaenoptera bonaerensis* | Mainly occurs in oceanic waters beyond the continental shelf break. Has not been recorded as far north as the Timor Sea. | Migratory*/ marine species (EPBC Act)<br>No category assigned, but possibly secure |
| Bryde's whale | *Balaenoptera edeni* | Temperate to tropical waters, both oceanic and inshore. | Migratory* (EPBC Act; CMS; CITES)<br>Marine species (EPBC Act) |
| Killer whale | *Orcinus orca* | Global distribution. | Migratory* (EPBC Act; CMS; CITES)<br>Marine species (EPBC Act)<br>No category assigned but probably secure |
| Sperm whale | *Physeter macrocephalus* | Global in deep waters in all oceans and confluent seas. | Vulnerable (EPBC Act; IUCN)<br>Migratory* (EPBC Act; CMS; CITES)<br>Marine species (EPBC Act) |
| Spotted bottlenose dolphin | *Tursiops aduncus* | Tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific Region and the western Pacific Ocean. | Migratory* (EPBC Act; CMS; CITES) |
| Pygmy killer whale | *Feresa attenuata* | Global in tropical and subtropical oceanic waters. | Migratory* (CMS) |
| False killer whale | *Pseudorca crassidens* | Global in deep tropical and temperate waters. | Migratory* (CMS) |
| Dwarf sperm whale | *Kogia simus* | Primarily occurs over the continental shelf and slope off tropical and temperate coasts of all oceans. | Cetacean (EPBC Act; CITES) |
| Pygmy sperm whale | *Kogia breviceps* | Global tropical and temperate oceans, mostly beyond the edge of the continental shelf. | Cetacean (EPBC Act; CITES) |
| Short-finned pilot whale | *Globicephala macrorhynchus* | Tropical and warm-temperate waters world-wide. | Cetacean (EPBC Act; CITES) |
| Minke whale | *Balaenoptera acutorostrata* | Tropical and temperate waters of the Southern Hemisphere. Has not been recorded as far north as the Timor Sea. | Cetacean (EPBC Act) |
| Melon-headed whale | *Peponocephala electra* | All deep oceanic waters between 35° N and 35° S. | Cetacean (EPBC Act; CITES) |
| Risso's dolphin | *Grampus griseus* | Tropical, subtropical, temperate and subantarctic waters between 60° N and 60° S. | Cetacean (EPBC Act; CITES) |
| Bottlenose dolphin | *Tursiops truncatus* | Global temperate and tropical waters. | Migratory* (CMS; CITES) |
| Spinner dolphin | *Stenella longirostris* | Pelagic zone of tropical, subtropical and, less frequently, in warm temperate waters in the Indian, Pacific and Atlantic Oceans. | Migratory* (CMS; CITES) |
| Striped dolphin | *Stenella coeruleoalba* | Temperate to tropical species. | Cetacean (EPBC Act; CITES) |

| Common name | Scientific name | Distribution | Conservation status |
|---|---|---|---|
| Spotted dolphin | *Stenella attenuata* | Pantropical oceanic tropical zones between about 40° N and 40° S. | Cetacean (EPBC Act; CITES) |
| Common dolphin | *Delphinus delphis* | Tropical, subtropical and temperate in offshore waters of the Atlantic, Pacific and Indian Oceans. | Migratory* (CMS; CITES) |
| Rough-toothed dolphin | *Steno bredanensis* | Deep oceanic tropical to subtropical waters. | Cetacean (EPBC Act; CITES) |
| Cuvier's beaked whale, goose-beaked whale | *Ziphius cavirostris* | Worldwide distribution in all temperate and tropical waters. | Cetacean (EPBC Act; CITES) |
| **Reptiles** | | | |
| Horned seasnake | *Acalyptophis peronii* | Tropical northern Australia, Coral Sea Islands, New Caledonia, Papua New Guinea, Thailand and Hong Kong. | Marine species (EPBC Act) |
| Dubois' seasnake | *Aipysurus duboisii* | Indo-Pacific: from Australia to New Guinea and New Caledonia. | Marine species (EPBC Act) |
| Leaf-scaled seasnake | *Aipysurus foliosquama* | East Indian Ocean; West Central Pacific; Southwest Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Olive seasnake | *Aipysurus laevis* | Indo-Pacific, tropical northern Australia, northwest Atlantic and the Mediterranean. . | Marine species (EPBC Act) |
| Stokes' seasnake | *Astrotia stokesii* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Spectacled seasnake | *Disteira kingii* | Indo-West Pacific, western and northern Australia | Marine species (EPBC Act) |
| Olive-headed seasnake | *Disteira major* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Turtle-headed seasnake | *Emydocephalus annulatus* | Indo-West Pacific, northern Australia, northwest Atlantic and the Mediterranean. | Marine species (EPBC Act) |
| Beaked seasnake | *Enhydrina schistosa* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Black-headed seasnake | *Hydrophis atriceps* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Slender-necked seasnake | *Hydrophis coggeri* | Northeast Atlantic, Mediterranean, Indo-West Pacifi, northwestern Australia | Marine species (EPBC Act) |
| Elegant seasnake | *Hydrophis elegans* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Plain seasnake | *Hydrophis ornatus* | Northeast Atlantic, Mediterranean, Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Spine-bellied seasnake | *Lapemis hardwickii* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Yellow-bellied seasnake | *Pelamis platurus* | Global tropical waters. | Marine species (EPBC Act) |

| Common name | Scientific name | Distribution | Conservation status |
|---|---|---|---|
| **Ray Finned Fishes** | | | |
| Corrugated pipefish, barbed pipefish | *Bhanotia fasciolata* | Eastern Indian Ocean and Western Pacific, north western Australian waters. | Marine species (EPBC Act) |
| Three-keel pipefish | *Campichthys tricarinatus* | Western Central Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Pacific short-bodied pipefish, short-bodied pipefish | *Choeroichthys brachysoma* | Indo-Pacific: Red Sea and East Africa to the Society Islands, north to the Philippines and Guam, south to northern Australia. | Marine species (EPBC Act) |
| Pig-snouted pipefish | *Choeroichthys suillus* | Western central Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Fijian banded pipefish, brown-banded pipefish | *Corythoichthys amplexus* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Yellow-banded pipefish, network pipefish | *Corythoichthys flavofasciatus* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Australian messmate pipefish, banded pipefish | *Corythoichthys intestinalis* | Western central Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Schultz's pipefish | *Corythoichthys schultzi* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Roughridge pipefish | *Cosmocampus banneri* | Indo-West Pacific, north western Australian waters. | Marine species (EPBC Act) |
| Ringed pipefish | *Doryrhamphus dactyliophorus* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Indian blue-stripe pipefish, blue-stripe pipefish | *Doryrhamphus excisus* | Indo-Pacific and eastern Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Cleaner pipefish, Janss' pipefish | *Doryrhamphus janssi* | Western central Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Tiger pipefish | *Filicampus tigris* | Eastern Indian Ocean and Western Pacific. | Marine species (EPBC Act) |
| Brock's pipefish | *Halicampus brocki* | Western Pacific, western and northern Australian waters. | Marine species (EPBC Act) |
| Red-hair pipefish, Duncker's pipefish | *Halicampus dunckeri* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Mud pipefish, Gray's pipefish | *Halicampus grayi* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Spiny-snout pipefish | *Halicampus spinirostris* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Ribboned seadragon, ribboned pipefish | *Haliichthys taeniophorus* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Beady pipefish, steep-nosed pipefish | *Hippichthys penicillus* | Indo-West Pacific, northern Australia. | Marine species (EPBC Act) |

| Common name | Scientific name | Distribution | Conservation status |
|---|---|---|---|
| Spiny seahorse | *Hippocampus histrix* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Spotted seahorse, yellow seahorse | *Hippocampus kuda* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Flat-face seahorse | *Hippocampus planifrons* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Hedgehog seahorse | *Hippocampus spinosissimus* | Indo-Pacific, tropical northern Australia. | Marine species (EPBC Act) |
| Tidepool pipefish | *Micrognathus micronotopterus* | Western Pacific, northwestern Australia. | Marine species (EPBC Act) |
| Pipehorse | *Solegnathus hardwickii* | Western Indian Ocean, tropical northern Australia. | Marine species (EPBC Act) |
| Indonesian pipefish, Gunther's pipehorse | *Solegnathus lettiensis* | Eastern Indian Ocean, Western Australia. | Marine species (EPBC Act) |
| Blue-finned ghost pipefish, robust ghost pipefish | *Solenostomus cyanopterus* | Indo-Pacific, northern Australia. | Marine species (EPBC Act) |
| Double-ended pipehorse, alligator pipefish | *Syngnathoides biaculeatus* | Indo-Pacific, northern Australia. | Marine species (EPBC Act) |
| Bend stick pipefish, short-tailed pipefish | *Trachyrhamphus bicoarctatus* | Indo-West Pacific, northern Australia. | Marine species (EPBC Act) |
| Long-nosed pipefish, straight stick pipefish | *Trachyrhamphus longirostris* | Indo-West Pacific, tropical northern Australia. | Marine species (EPBC Act) |

*Migratory = Listed migratory species include species listed in:

- appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- the Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA); and
- the Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA).

Source: DEWHA 2010

### 4.5.12 Conservation Areas

There are no World Heritage Properties, Ramsar wetlands, Australian reserves or Timor-Leste reserves within a 300km radius of the Kitan Field. The coastal waters surrounding Timor-Leste are, however, considered to be included in the Coral Triangle which is a geographical term referring to the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste. According to the World Wildlife Fund, these waters harbour 76% of all known coral species, 37% of the world's coral reef fish species, and six of the world's seven species of marine turtle (WWF 2010).

Timor-Leste's first National Park, the Nino Konis Santana National Park, which includes 55,600 ha of the Coral Triangle, is located over 300km north-east of the Kitan Field.

The Ashmore Reef National Nature Reserve (which is also a Ramsar site) is located over 360 km southwest of the Kitan Field. The Cartier Island Marine Reserve, at Scott and Seringapatam Reefs, is 570 km south-west of the Kitan Field.

## 5.0 POTENTIAL BIOPHYSICAL IMPACTS AND MANAGEMENT

### 5.1 Introduction

This chapter describes the potential environmental impacts associated with each of the four phases of the Kitan Field Development: drilling; installation and commissioning; production and decommissioning. Section 5.2 describes Eni's risk assessment procedure and Section 5.3 provides a high-level summary of the risks posed by the Kitan Development to the biophysical environment across all four developmental phases. Sections 5.4 to 5.17 provide detailed discussions of the risks in terms of their source, characteristics, the potential environmental effect and their management. Detailed risk registers relevant to each phase of the Kitan Field Development will accompany the EMPs.

### 5.2 Environmental Risk Assessment

Eni's philosophy to managing environmental risks is to remove or mitigate the risk during the design phase. Managing risks through design is contingent upon identifying, at an early stage in the project, the sources and pathways by which environmental impacts can occur and the sensitivities of the receiving environment in which the project is situated.

Eni's risk assessment procedure was implemented in order to assess the expected or potential impacts associated with the Kitan Field Development. Eni's risk assessment methodology provides a systematic process for:

1. identifying each project activity and its associated environmental aspects;
2. identifying the environmental values/attributes at risk within and adjacent to the area;
3. defining the potential environmental effects of aspects identified in Step 1 on those values/attributes at risk identified in Step 2 above (as required by Clause 3 of Guideline 5 of the Interim Administrative Guidelines for the JPDA);
4. identifying the likelihood of occurrence;
5. identifying the consequences of potential environmental aspects; and
6. evaluating overall environmental risk levels using a likelihood and consequence matrix.

Figure 5.1 provides a generic representation of Eni's risk assessment methodology. Table 5.1 presents Eni's risk matrix showing likelihood, consequence and risk ranking classifications and Table 5.2 presents the environmental consequence descriptors.

A high-level risk assessment workshop was conducted in January 2010 by Eni's multidisciplinary team of project engineers and environmental scientists (Eni 2010). The risk assessment was based Eni's knowledge and understanding of risks and impacts gained through its previous drilling in the JPDA and operating its Woollybutt FPSO located on the North West Shelf, Western Australia. The combined experience of the workshop team ensured that all key environmental issues were identified, their significance was assessed and appropriate management measures put in place to ensure that the environmental impacts would be managed appropriately. The findings of the risk assessment were compiled into risk registers for each phase of the project.

Environmental risks will continue to be assessed as the project matures and the risk registers updated accordingly. Further risk reduction measures will be identified and incorporated into EMPs to be prepared specifically for each project phase.

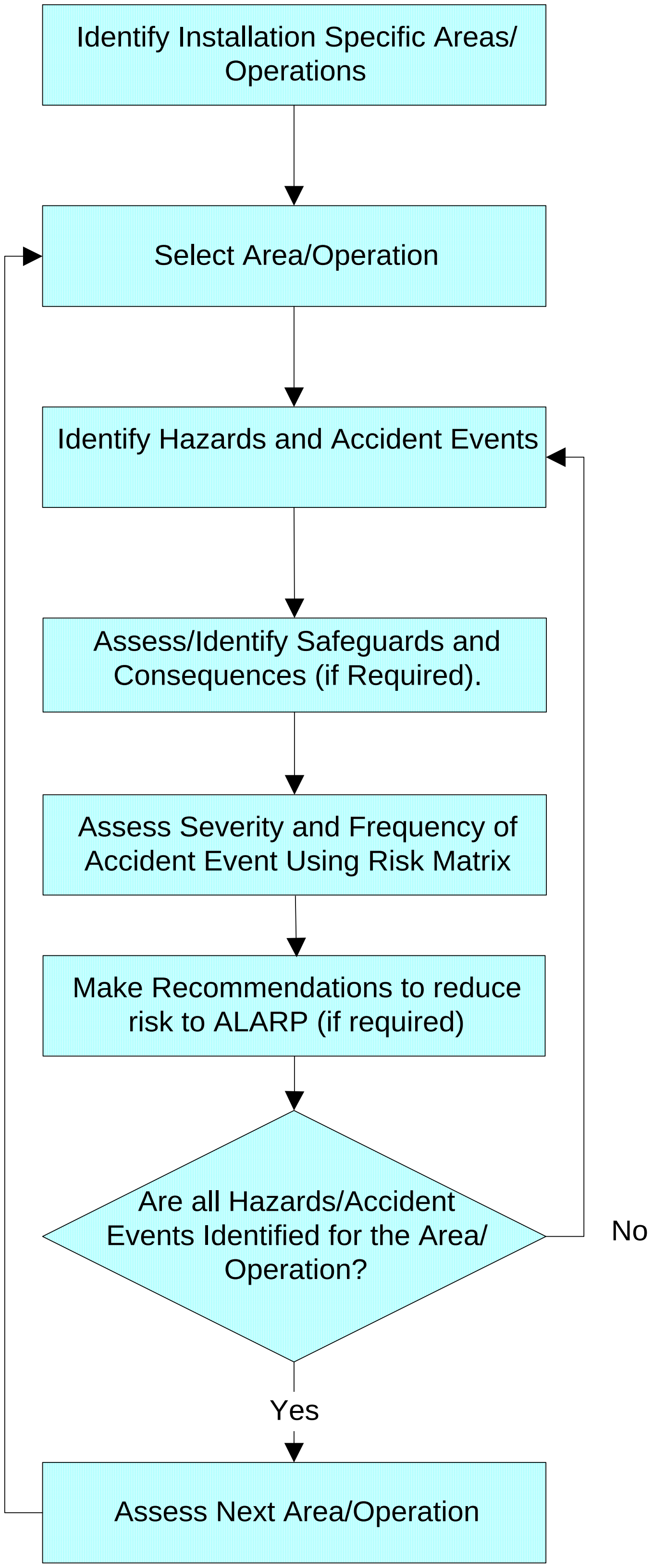



**Figure 5.1: Risk assessment methodology**

**Table 5.1: Eni Risk Matrix**

| *Consequence* | | | | | | | | | *Increasing Annual Frequency/Likelihood* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Severity** | **Reputation** | | **Labour** | **Community** | **Health & Safety** | | **Environment** | **Assets/Activities** | **0** | **A** | **B** | **C** | **D** | **E** |
| | **Stakeholder Relation** | **Company Image** | | | **Health** | **Safety** | | | Practically non-credible occurrence | Rare occurrence | Unlikely occurrence | Credible occurrence | Probable occurrence | Likely/Frequent occurrence |
| | | | | | | | | | Could happen in E&P industry | Reported for E&P industry | Has occurred at least once in Company | Has occurred several times in Company | Happens several times/year in Company | Happens several times/year in one location |
| **1** | Slight impact | Slight impact | Slight impact | Slight impact | Slight impact | Slight impact | Slight impact | Slight impact | | | **LOW** | | | |
| **2** | Minor impact | Minor impact | Minor impact | Minor impact | Minor impact | Minor impact | Minor impact | Minor impact | | | | **MEDIUM** | | |
| **3** | Significant impact | Local impact | Medium impact | Local impact | Significant impact | Significant impact | Local impact | Local impact | | | | | | |
| **4** | Major impact | National impact | Major impact | Major impact | Major impact | Major impact | Major impact | Major impact | | | | | **HIGH** | |
| **5** | Extensive impact | International impact | Extensive impact | Extensive impact | Extensive impact | Extensive impact | Extensive impact | Extensive impact | | | | | | |

**Table 5.2: Environmental Consequence Descriptors**

| Descriptor | Description |
|---|---|
| **Slight Impact** | Small discharges with confined and temporary impact on the area.<br>No noticeable impact on water/air/soil and biodiversity.<br>Negligible impact due to GHG emissions.<br>Good materials/energy/water selection and use.<br>Negligible financial consequences. |
| **Minor Impact** | Sufficiently large discharges to impact the environment but no long lasting effect.<br>Short-term, localised impact on water/air/soil and biodiversity (on a limited no. of non-threatened species).<br><1 week for clean up, 1-2 years for natural recovery.<br>Slight impact due to GHG emissions.<br>Adequate materials/energy/water selection and use.<br>Single breach of statutory or prescribed limit or single complaint. |
| **Local Impact** | Limited discharges affecting the neighbourhood and damaging the environment with longer effects.<br>Short term, more widespread impact on water/air/soil and biodiversity (on a higher no. of non-threatened species).<br><1 month for clean up, 2-5 years for natural recovery.<br>Limited impact due to GHG emissions.<br>Inadequate materials/energy/water selection and use.<br>Repeated breaches of statutory or prescribed limit or many complaints. |
| **Major Impact** | Large discharges with severe and long lasting environmental damage.<br>Medium-term, widespread impact on water/air/soil and biodiversity (on some threatened species and/or ecosystem function).<br>1-5 months for clean up, 5-10 years for natural recovery.<br>Extensive measures (financially significant) required to restore the impacted area.<br>Significant impact due to GHG emissions.<br>Poor materials/energy/water selection and use.<br>Extended breaches of statutory or prescribed limits, or widespread nuisance. |
| **Extensive Impact** | Large discharges with severe and persistent environmental damage.<br>Long-term, large-scale impact on water/air/soil and biodiversity (likely permanent species loss and impact on ecosystem function).<br>>5 months for clean up, >10 years for natural recovery.<br>Very poor materials/energy/water selection and use.<br>Major financial consequences for the Company.<br>Ongoing breaches well above statutory or prescribed limits. |

### 5.3 Summary of Risks to the Biophysical Environment

Table 5.3 presents a summary of the risks of the project to the biophysical environment based on the detailed risk registers for each phase of the project.

**Table 5.3: Summary of Kitan Field Development Project Environmental Risks**

| Hazard | Relevant Project Phase | Source | Inherent Risk |
|---|---|---|---|
| Oil, fuel and chemical spills | All Phases | Well blow out<br>Vessel collision<br>Fuel or chemical transfers<br>Leaks from equipment, pipework and storage facilities | High |
| Produced Formation Water discharge | Production | Discharge of PFW and associated production chemicals | High |
| Drilling emissions | Drilling | Discharge of drilling cuttings and associated drilling fluids<br>Discharge of bulk drilling muds at the completion of drilling<br>Use of displacement fluids | High |
| Atmospheric emissions ($SO_x$/$NO_x$ and greenhouse gases) | All Phases | Exhaust emissions from operating vessels during drilling, installation, production and decommissioning<br>Flaring and venting during production<br>Potential fugitive emissions of ozone depleting substances | High |
| Solid and hazardous wastes | All Phases | Potential escape of solid and hazardous wastes (e.g. waste oil, chemicals) from operating vessels during drilling, installation, production or decommissioning | High |
| Hydrotesting emissions | Installation and Commissioning | Discharge of hydrotest water and associated chemicals | Medium |
| Deck drainage | All Phases | Deck drainage and associated contaminants from operating vessels during drilling, installation, production and decommissioning | Medium |
| Laboratory wastes | Drilling<br>Production | Laboratory wastes generated during oil testing | Medium |
| Cooling water | All Phases | Discharge of cooling water and associated chemical additives from operating vessels during drilling, installation, production and decommissioning | Medium |
| Desalination brine | All Phases | Discharge of reject water (brine) from reverse osmosis plants from operating vessels during drilling, installation, production and decommissioning | Medium |

| Hazard | Relevant Project Phase | Source | Inherent Risk |
| --- | --- | --- | --- |
| Sewage, domestic wastewater and putrescible wastes | All Phases | Discharge of sewage, domestic wastewater and putrescible wastes from operating vessels during drilling, installation, production and decommissioning | Medium |
| Antifouling biocides | All Phases | Hull antifouling on operating vessels during drilling, installation, production and decommissioning<br>Antifouling on subsea infrastructure | Medium |
| Marine pests | All Phases | Ballast water discharge<br>Hull biofouling | Low |
| Physical disturbance to marine biota | All Phases | Physical presence of operating vessels during drilling, installation, production and decommissioning<br>Placement of subsea infrastructure on the seabed | Low |
| Noise and vibration disturbance to marine biota | All Phases | Noise and vibration generated during drilling, installation, production and decommissioning<br>Noise from aircraft during crew changes | Low |
| Disturbance to marine biota from artificial lighting | All Phases | Lighting from operating vessels during drilling, installation, production and decommissioning | Low |

## 5.4 Hydrocarbon Spills

### 5.4.1 Primary risk – Quantitative assessment

The “primary risk” of an oil spill is defined as the potential for hydrocarbons to be released to the environment, as a result of a loss of containment in processing, storage or transport infrastructure and equipment. (This is distinct from “secondary risk”, which represents the chance of subsequently causing a particular environmental impact, such as pollution of a shoreline). Primary risk is generally assessed using quantitative methods, whereby the likelihood that an incident could occur is measured by analysing the frequency with which similar incidents have occurred in the past, in real-life situations. Over decades of oil and gas development worldwide, comprehensive incident databases have evolved and are now used as tools to analyse the risks of oil spills from specific components of new facilities.

**FPSO operations**

A study by Metzger, Salmond and Tilstone (2010) reviewed the global safety performance of FPSOs operating in offshore marine environments in the North Sea, Africa, Asia, Australia, and the Americas. FPSOs have been used in the oil and gas industry since the 1970s, but have become much more prevalent in the last 10–15 years. Most of the safety and reliability studies on FPSOs focus on operations since 2000—this is an important point to note, as older incident data may not be reflective of the safeguards and technology available on new FPSOs today.

The study showed that spills of less than 1000bbl can result from offloading activities (transfer hose leaks) or FPSO swivel leaks and cargo piping leaks on deck, some of which may not reach the sea. As shown in Table 5.4, the predicted frequencies of occurrence for these spills are 4.8 x $10^{-1}$ per year (or roughly 1 event every 2 years) for offloading, and 2.9 x $10^{-2}$ per year (or roughly 1 event every 33 years) from FPSO leak sources.

Larger volume spill events occur less frequently, at 2.3 x $10^{-8}$ per year (less than once every million years) for tanker collisions with the FPSO, 4.0 x $10^{-4}$ per year (once every 2500 years) for merchant vessel collisions, and 6.6 x $10^{-2}$ per year (once every 15 years) for leaks from export tanker vessels (either at sea or in port).

**Table 5.4: Predicted primary risk of loss of containment from an FPSO**

| Spill scenario: | High-speed collision by visiting shuttle tanker | Collision by passing merchant vessel | Collision with other vessels due to mooring failure | Tanker vessel in transit (in port or at sea) | Offloading (hose failure) | FPSO storage equipment or riser failure |
|---|---|---|---|---|---|---|
| | **Total predicted spill frequency (number of events per year)** | | | | | |
| | 2.3 x $10^{-8}$ | 4.0 x $10^{-4}$ | 2.3 x $10^{-6}$ | 6.6 x $10^{-2}$ | 4.8 x $10^{-1}$ | 2.9 x $10^{-2}$ * (<100 bbl only) |
| **Volume (bbl):** | **Predicted spill frequency by spill size (number of events per year):** | | | | | |
| <10 | | | | | 2.4 x $10^{-1}$ | 1.3 x $10^{-2}$ * |
| 10–100 | | | | | 1.2 x $10^{-1}$ | 1.6 x $10^{-2}$ * |
| 100–1000 | | | | | 1.2 x $10^{-1}$ | 7.9 x $10^{-5}$ * |
| 1000–10 000 | 5.0 x $10^{-9}$ | 6.9 x $10^{-5}$ | | 2.5 x $10^{-2}$ | | |
| 10 000–50 000 | 7.8 x $10^{-9}$ | 1.3 x $10^{-4}$ | 8.3 x $10^{-7}$ | 2.3 x $10^{-2}$ | | 5.2 x $10^{-4}$ # |
| 50 000–100 000 | 3.5 x $10^{-9}$ | 7.1 x $10^{-5}$ | 8.3 x $10^{-7}$ | 9.7 x $10^{-3}$ | | 5.2 x $10^{-4}$ # |
| 100 000–500 000 | 5.8 x $10^{-9}$ | 1.2 x $10^{-4}$ | 7.0 x $10^{-7}$ | 9.1 x $10^{-3}$ | | 4.1 x $10^{-4}$ # |
| >500 000 | 5.2 x $10^{-10}$ | 1.1 x $10^{-5}$ | | | | 5.0 x $10^{-6}$ $ |

Green cells represent scenarios not assessed, where spill volumes were unrealistic or were above the total capacity of the equipment.

*Swivel leak, cargo piping leak on deck

# Process leak, riser leak, cargo piping leak

$ Foundering, structural failure

Source: Metzger, Salmond and Tilstone 2010

Given that the operational life of the Kitan Field Development is seven years, it would be reasonable to expect that oil spills of 1000bbl or less could occur during offloading activities from the FPSO around three or four times during the life of the project. However, spill scenarios such as vessel collisions and storage or riser failures would be unlikely to occur as part of the Kitan Field Development, based on the past performance of FPSOs around the world.

**Drilling and well production**

The International Association of Oil & Gas Producers (OGP) recently issued incident frequency data for offshore drilling and well production activities, using data sources representing the last 20 to 30 years of oil and gas operations. Two types of incidents were considered:

- “well releases”, where hydrocarbons flowed from the well at some point where flow was not intended, and the flow was stopped by use of the barrier system that was available on the well at the time of the incident
- “blowouts”, where formation fluid flowed out of the well or between formation layers after all the predefined technical well barriers failed.

Incident frequencies for activities relevant to the Kitan Field Development are listed in Table 5.5.

**Table 5.5: Predicted primary risk of loss of containment from offshore wells**

| Activity | Incident | Predicted spill frequency* | Units |
|---|---|---|---|
| Production drilling | Blowout | $4.8 \times 10^{-5}$ | Per well drilled |
| | Well release | $3.9 \times 10^{-4}$ | Per well drilled |
| Completion | Blowout | $5.4 \times 10^{-5}$ | Per operation |
| | Well release | $2.2 \times 10^{-4}$ | Per operation |
| Producing wells (excluding external causes) | Blowout | $2.6 \times 10^{-6}$ | Per well year |
| | Well release | $2.9 \times 10^{-6}$ | Per well year |
| Production wells (external causes) | Blowout | $3.9 \times 10^{-5}$ | Per well year |

* This data represents activities carried out to "North Sea standard", where operations are performed with BOPs installed, including shear ram, and following the two barrier principle

Source: OGP 2010

Given the expected seven year life-span of the Kitan Field Development, and the involvement of only three production wells, the likelihood of accidental well releases or blowouts is very low, based on this historical data. Safeguards in place to prevent a blowout are presented in Table 5.10.

### 5.4.2 Fate of Hydrocarbons in Water

When oil is spilled into the sea it undergoes a number of physical and chemical changes some of which lead to its removal from the sea surface, others which cause it to persist. Although spilled oil is eventually assimilated by the marine environment, the time taken depends upon factors such as the type and amount of oil spilled, its initial physical and chemical characteristics, the prevailing climatic and sea conditions and whether the oil remains at sea or is washed ashore.

Hydrocarbons usually comprise hundreds of mainly carbon based chemical structures. The relative balance of the constituent substances influences both their chemical and physical properties when mixed with water, which in turn affect their potential or environmental impact on marine biota.

**Kitan Crude Oil**

Kitan crude is a light oil with an API of 57° and a specific gravity of 0.75 (Table 5.6). The distillation cuts indicate that about 80% of the oil is volatile or semi-volatile (those boiling off at less than 265°C) meaning that it will evaporate readily. Kitan Crude is classified as a Group 1 oil (ITOPF 2002) and should the condensate be spilt to the sea, it would spread rapidly on the sea surface due to its low density, and would be readily lost through evaporation and dispersion into the water column. Intertek (2008) reports a low wax content meaning that stable emulsions are unlikely to form.

Modelling of weathering behaviour (Figure 5.2) using the Automated Data Inquiry for Oil Spills (ADIOS2) model predicts that 60 – 65% of a spill would be removed within the first 24 hours due to evaporation. Any residual condensate not evaporated or dispersed would be removed by photo- and bio-degradation over the longer term. Kitan condensate, therefore, will not be persistent in the marine environment in the event of a spill.

**Table 5.6: Properties of Kitan Crude (Intertek 2008)**

| Parameter | | Value | |
|---|---|---|---|
| API (°) | | 56 | |
| Specific Gravity | | 0.75 | |
| Kinematic Viscosity @ 20°C (cSt) | | 1.24 | |
| Pour Point (°C) | | < - 40°C | |
| **Distillation Cuts Temp(°C)** | **Vol %** | **Distillation Cuts Temp(°C)** | **Vol %** |
| 22 | 3 | 180 | 61 |
| 70 | 12 | 220 | 72 |
| 100 | 24 | 260 | 80 |
| 120 | 33 | 330 | 91 |
| 135 | 42 | 400 | 97 |
| 160 | 53 | | |

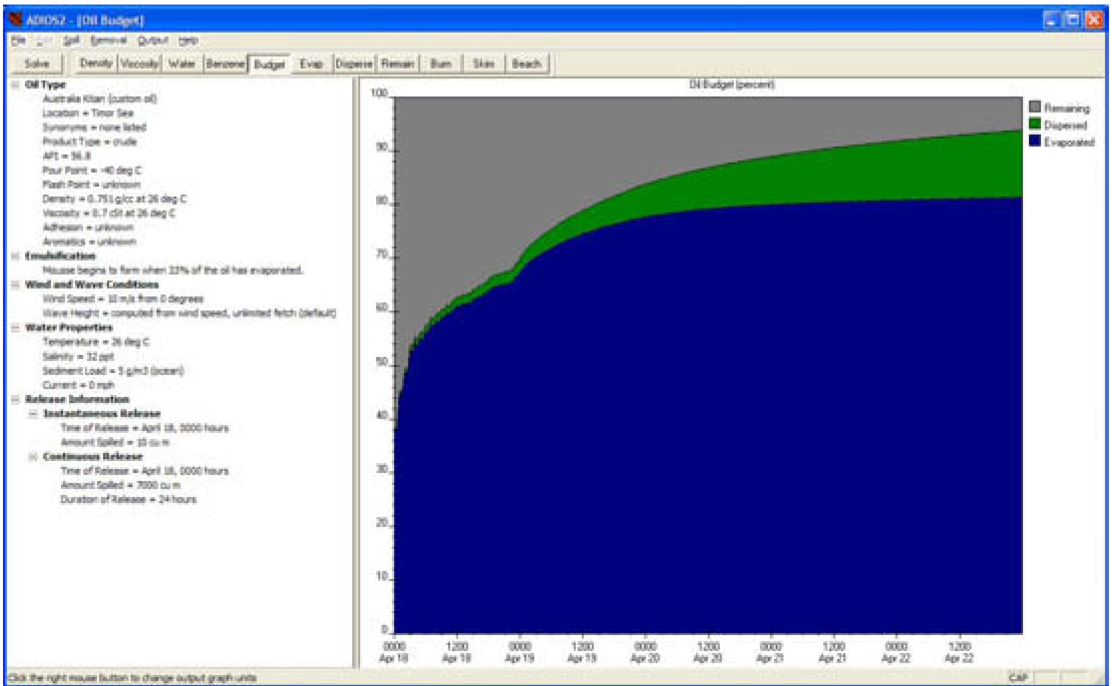



**Figure 5.2: Predicted weathering of Kitan oil for a continuous release of 7000m$^3$ spill over 24 hours for a 10ms$^{-1}$ wind**

## Diesel fuel

Diesel is a light petroleum distillate with an API of 30° – 32° and a specific gravity in the range 0.84 to 0.88 (Table 5.7). As such they are classed as Group II oils (ITOPF 2002); i.e. light persistent oils. Diesels are expected to undergo a rapid spreading with moderate evaporative loss in tropical waters and, consequently, slicks are likely to break up. Diesel oils tend not to form emulsions at the temperatures likely to be found in the Timor Sea and so these will not inhibit spreading of the slick or evaporation rates.

Weathering and dispersability studies on Australian marine diesel indicate that in the case of a spill approximately 50% of the mass will be evaporated under northwest conditions (Kagi *et al* 1988). Figure 5.3 shows the predicted weathering behaviour from the ADIOS2 model for a constant wind speed of 4m/s. Evaporation rates are initially high with just under 50% evaporating within the first 24 hours. Vertical dispersion rates are also high with the majority of diesel being removed from the sea surface within three days.

**Table 5.7 Properties of Diesel Fuel Oil (from ADIOS2 database)**

| Parameter | Diesel |
|---|---|
| API (°) | 30 - 32 |
| Specific Gravity (g/cc) | 0.84 to 0.88 |
| Kinematic Viscosity @15°C (cSt) | 4 |
| Pour Point (°C) | -14 |
| **Distillation Cuts Temp (°C)** | **Vol %** |
| 160 | 3 |
| 180 | 6 |
| 200 | 11 |
| 250 | 31 |
| 300 | 63 |
| 350 | 89 |

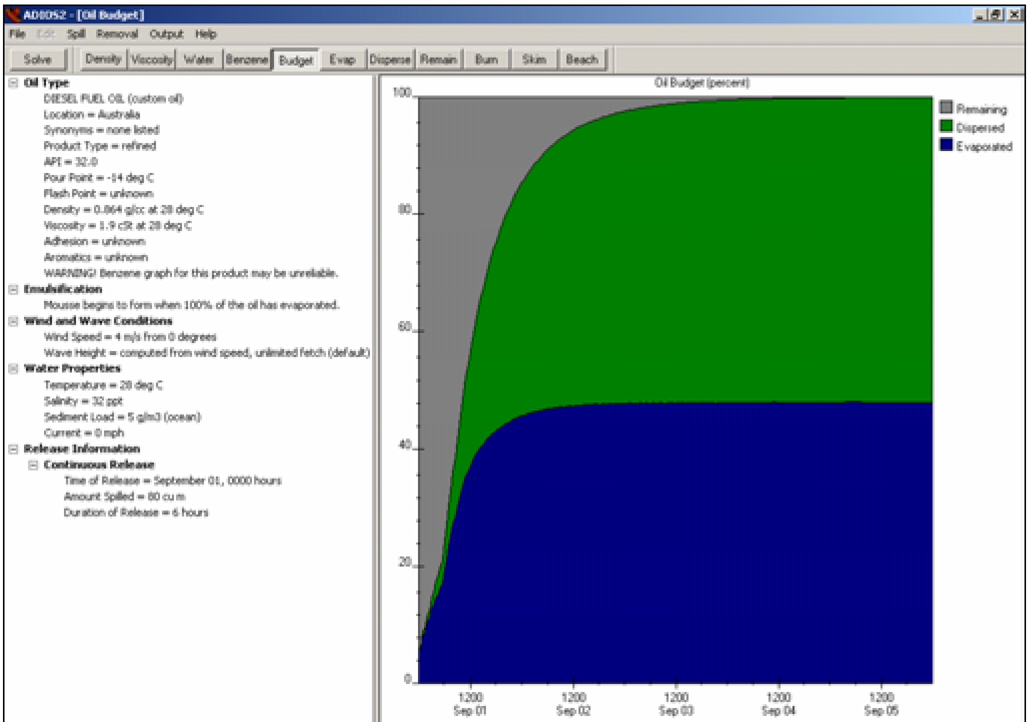



**Figure 5.3: Predicted weathering of diesel fuel oil for a continuous release of 80m$^3$ over 6 hours for a 4ms$^{-1}$ wind**

**<u>Toxicity of crudes and diesel</u>**

Toxicity of crude and refined products is primarily due to the volatile and water soluble aromatic hydrocarbons (benzenes, naphthalenes and phenanthrenes) and the higher molecular weight polycyclic aromatic hydrocarbons. The most toxic components in oil, although having the highest solubility in water, tend to be those that are lost rapidly through evaporation when oil is spilt. As a result, lethal concentrations of toxic components leading to large scale mortalities of marine life are relatively rare, localised and short-lived and only likely to be associated with spills of light refined products or fresh crude. At particular risk are animals and plants living in areas of poor water exchange.

The toxicity of Kitan oil has yet to be evaluated, however, it is likely to have similar toxicities to other North West Shelf oils. Toxicity testing of diesel by various organisations has identified it as being toxic to a variety of marine species. The range of reported toxic concentrations varies from 3 – 80 mg/L (CONCAWE 1996).

### 5.4.3 Secondary Risk – Oil Spill Trajectory Modelling

The “secondary risk” of impacts from an oil spill refers to the chance of spilled oil causing pollution to sensitive environmental receptors such as shorelines around islands, or shallow reefs. Weathering processes (such as evaporation) affect the persistence of an oil slick, and the prevailing winds and currents influence its direction. In turn, these factors affect the chances of spilled oil reaching sensitive receptors. If a spill occurs in a remote location far from islands and reefs, oil pollution effects on these types of sensitive areas might not occur at all.

**Oil Spill Modelling**

An oil spill trajectory modelling system was developed for the Kitan Project to predict the fate of oil spills. The modelling system comprises an oil weathering model, a three-dimensional oil spill trajectory model and a detailed hydrodynamic finite element model of the Timor Sea (Sustainability 2010; full report provided in Appendix B). The hydrodynamic model simulates the flow of ocean currents generated by astronomical tides, wind stress and incorporates residual oceanic circulation from a global hydrodynamic model. Modelled predictions have been verified against measured data, with the results confirming that the model is fit for the purpose of simulating hydrodynamics for discharge modelling. Wind forcing used in the model was based on modelled wind data from 10 years (1997–2007) of verified National Centre for Environmental Prediction ambient modelled data (Section 4.1.2).

The model was run in both deterministic and stochastic (statistical) modes, which are described as follows:

- In deterministic mode, a single simulation is undertaken to determine the fate and likely consequence of oil under a particular set of environmental (wind and wave) conditions. Results of the modelling are presented as contour plots showing hourly concentration of oil at sea.
- In stochastic mode, the model takes into consideration a large range of current and wind conditions. Multiple spill simulations (200) are undertaken using randomly selected start dates during the summer and winter seasons. Each of the 200 simulations generates a slightly different result due to the unique combination of tides, wind and oceanic circulation that might occur. The results are combined to generate contour plots showing the probability that hydrocarbons could impact a given location. It is important to note that the plots do not show the areas where oil will spread in one spill, but rather the total area that could be at risk from oil spills depending on the environmental conditions.

The oil spill scenarios considered in the modelling study are summarised in Table 5.8.

**Table 5.8 Summary of modelled oil spill scenarios**

| Scenario | Description | Oil type | Spill Volume ($m^3$) | Spill Duration |
|---|---|---|---|---|
| 1 | Well Blowout | Crude oil | >100 000 (1800$m^3$/day) | 56 days |
| 2 | Rupture of a crude storage tank on the FPSO | Crude oil | 7000 | 24hrs |
| 3 | Upper end of an accidental spill such as a transfer hose rupture or process leak | Crude oil | 100 | 6hrs |
| 4 | Lower end of a significant accidental spill | Crude oil | 10 | Instantaneous |
| 5 | Loss of fuel from a storage tank on a refuelling vessel | Diesel | 80 | 6hrs |
| 6 | Refuelling accident | Diesel | 2.5 | 1hr |

Even for the “worst case” spills (scenarios 1 and 5), oil is not predicted to reach the Timor-Leste coastline. Slicks could extend to the waters over Big Bank Shoal, Karmt Shoal and Echo Shoal, with varying likelihoods and timeframes depending on spill volumes (Table 5.9). However, vertical predictions within the oil spill model indicate that surface slicks will remain in the upper layers of the water column, without reaching the submerged benthic habitats of these shoals. Modelling results are described further below.

**Table 5.9: Summary of oil spill trajectory modelling results**

| Scenario | Description | Location | Maximum Probability of Reaching | Minimum Time to Reach |
|---|---|---|---|---|
| 1 | Well Blowout (>100 000m$^3$ over 56 days) | Big Bank | >80% | <6hrs |
| | | Karmt Shoals | 40% | 2 days |
| | | Echo Shoals | 1% | 2.5 days |
| 2 | Rupture of a crude storage tank on the FPSO (7000m$^3$ over 24hrs) | Big Bank | 70% - 100% | <6hrs |
| | | Karmt Shoals | <1% - 20% | 4 – 5 days |
| | | Echo Shoals | 0% | Not applicable |
| 3 | Upper end of an accidental spill such as a transfer hose rupture or process leak (100m$^3$ over 6 hrs) | Big Bank | 30% - 80% | <6hrs |
| | | Karmt Shoals | 0% | Not applicable |
| | | Echo Shoals | 0% | Not applicable |
| 4 | Lower end of a significant accidental spill (10m$^3$ instantaneous) | Big Bank | 30% | <6hrs |
| | | Karmt Shoals | 0% | Not applicable |
| | | Echo Shoals | 0% | Not applicable |
| 5 | Fuel Tank Rupture (80m$^3$ over 6 hrs) | Big Bank | 90% | <3hrs |
| | | Karmt Shoals | 3% | 3 days |
| | | Echo Shoals | 4% | 2.5 days |
| 6 | Refuelling Spill (2.5m$^3$ over 1hr) | Big Bank | 90% | <3hrs |
| | | Karmt Shoals | 1% | 3 days |
| | | Echo Shoals | 4% | 2.5 days |

**<u>Kitan Crude</u>**

The well blowout scenario assumes a continuous oil spill of 1,800m$^3$/day (~11,000 bbl/day). The trajectory of the resulting oil slick predicted by deterministic modelling is shown in Figure 5.4. This particular spill event involves north-westerly winds and shows the dynamic nature of the slick as it is transported by the ambient currents over the first 72 hours of the spill. Under certain hydrodynamic conditions the slick sweeps over Big Bank, however, the vertical profiles show that the oil remains at the surface and will not make contact with the sensitive benthic habitats and communities some 20m below the surface (Sustainability 2010).

Surface exposure probability contours from the stochastic modelling for the summer and winter seasons are shown in Figure 5.5 and Figure 5.6, respectively. In summer conditions, the outer (1%) probability contour extends 170km to the east and 90km to the west of Kitan (Figure 5.5), reflecting the main wind direction during this season. For this scenario, there is >80% chance that oil would reach the Big Bank Shoals and 10% chance of reaching the Karmt Shoals. The predicted minimum time to reach the waters over Big Bank

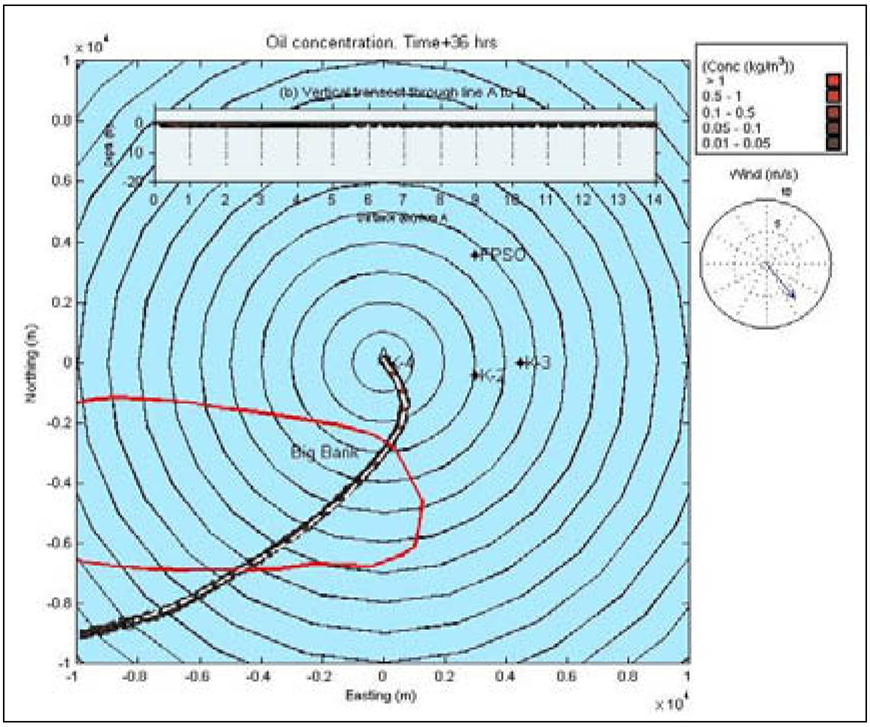
Shoals is less than six hours, by which time the spill would have been reduced to about 50% of its original volume through evaporation. The spill is not predicted to make contact with land (Sustainability 2010).

In winter conditions, the outer (1%) probability contour extends 170km to the west and 50km to the east of Kitan, reflecting the main wind direction during this season (Figure 5.6). For this scenario, there is >80% chance that oil would reach the Big Bank Shoals and 40% chance of reaching the Karmt Shoals. The predicted minimum time to reach the waters over Big Bank Shoals is less than six hours, by which time the spill would have been reduced to about 50% of its original volume through evaporation. The spill was not predicted to make contact with land (Sustainability 2010).

**Diesel**

The worst-case diesel spill scenario involves loss of fuel from a storage tank on a refuelling vessel, with $80m^3$ of diesel released over a 6 hour period. Figure 5.7 presents a series of plots from the deterministic simulation showing the trajectory of the slick under a north-easterly wind of around 10m/s. Over the first 27 hours, the slick is transported over Big Bank Shoals but vertical turbulence generated by waves mixes the oil particles to a depth of no more than 5m below the surface (Sustainability 2010).

Stochastic results for the summer and winter seasons are shown in Figure 5.8 and Figure 5.9, respectively. Once again it is apparent that the Timor-Leste coast is not impacted, with the 1% probability envelope extending about 100km to the east during the summer and the same distance to the west in the winter season (Sustainability 2010).



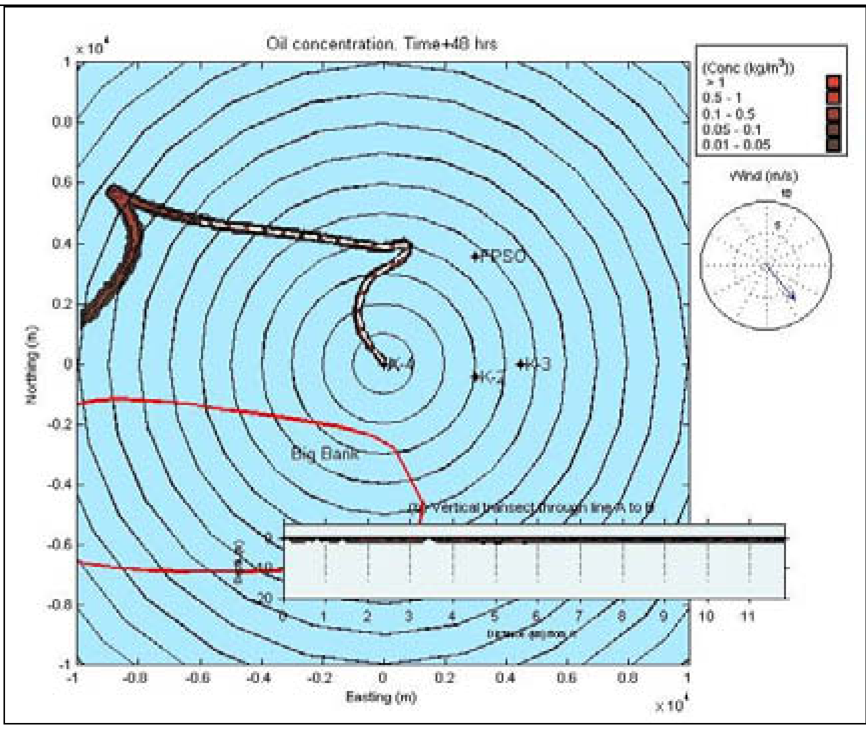
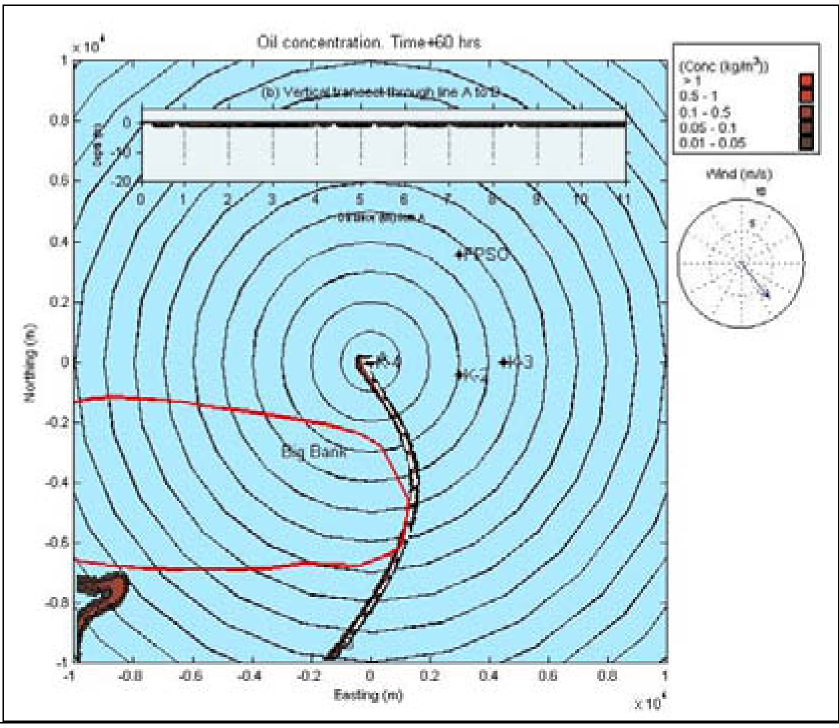




**Figure 5.4: Predicted trajectory of one hypothetical oil spill caused by well blowout (Scenario 1), over the first 72 hours**



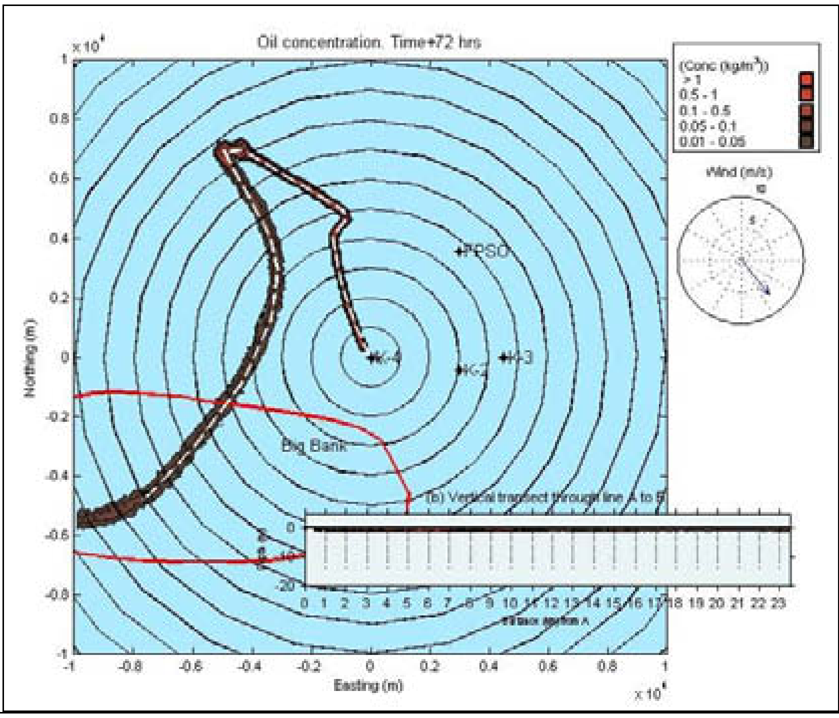
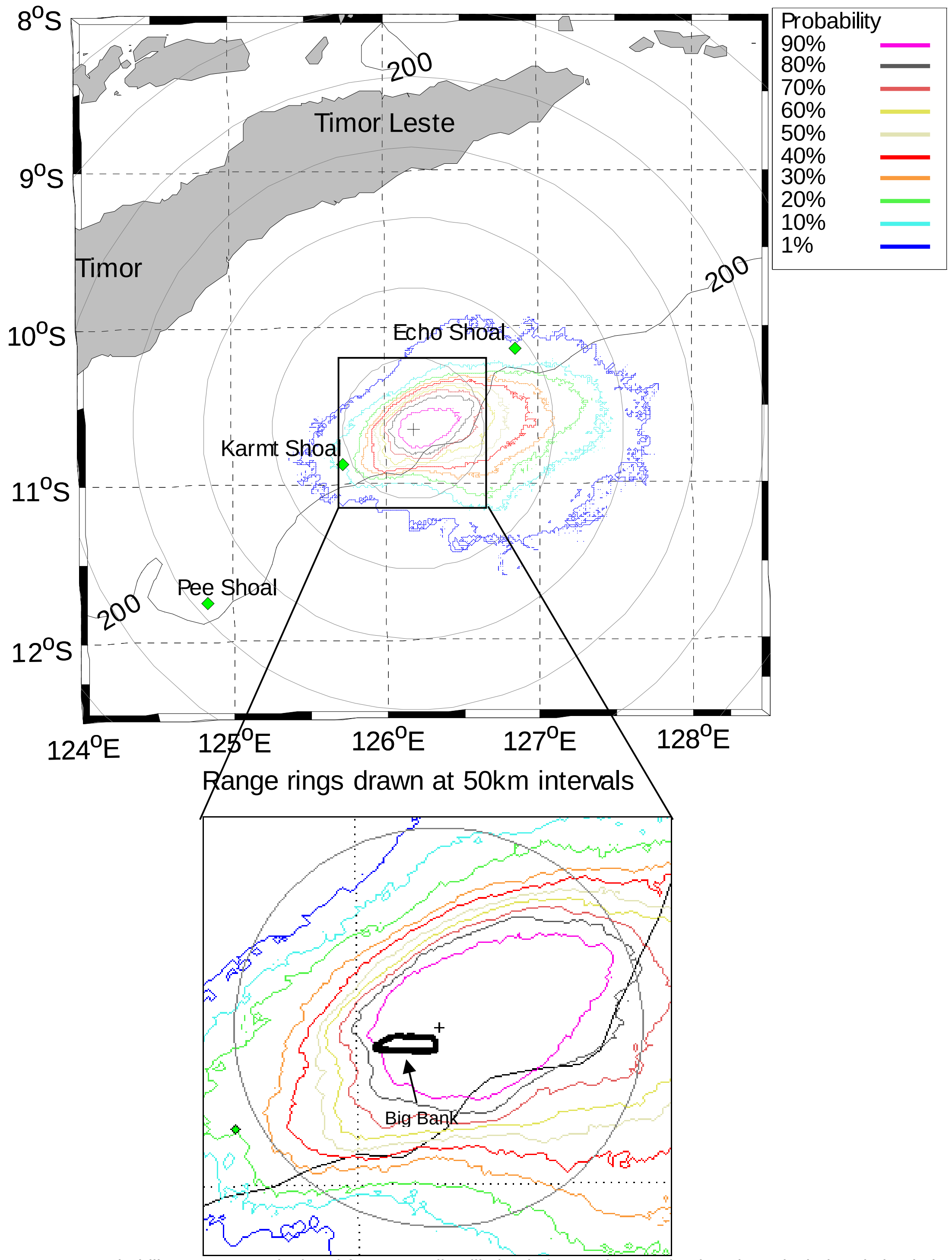
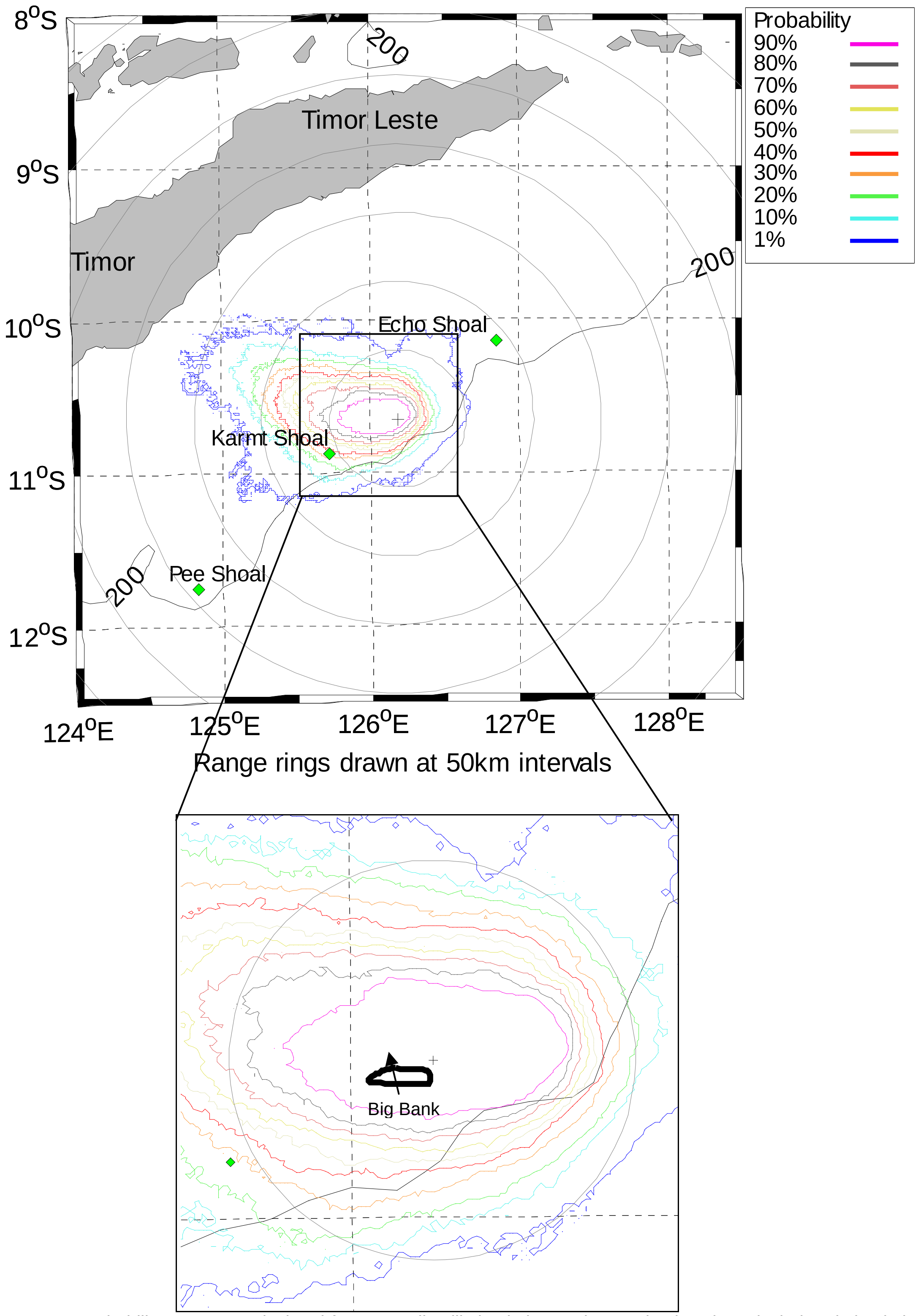




**Figure 5.4 (cont.): Predicted trajectory of one hypothetical oil spill caused by well blowout (Scenario 1), over the first 72 hours**



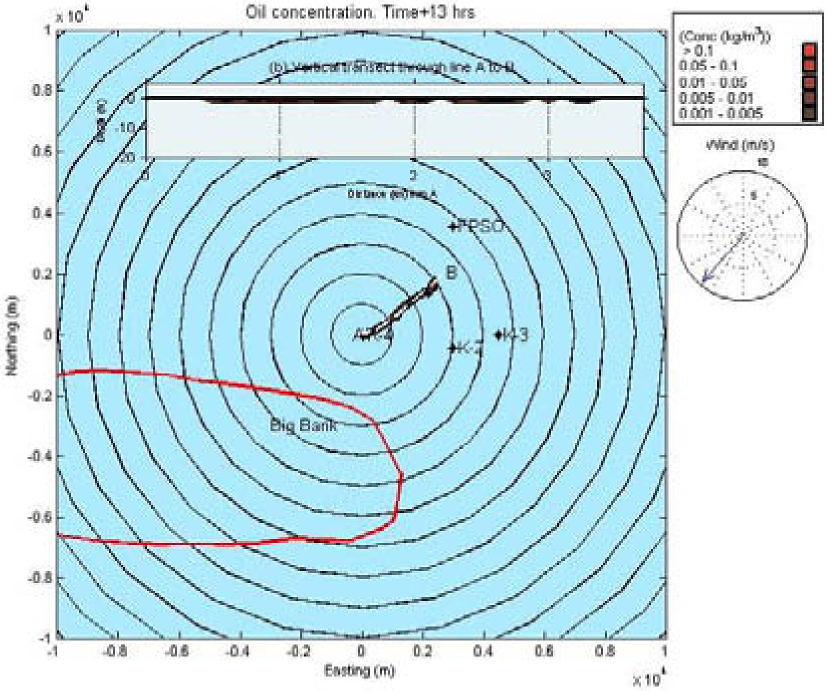

Notes: Probability contours calculated from 200 oil spill simulations using randomly selected wind and circulation data for the period

**Figure 5.5 Predicted probability of surface exposure to oil due to a 56-day well blowout (Scenario 1) in summer conditions**




Notes: Probability contours calculated from 200 oil spill simulations using randomly selected wind and circulation data for the period

**Figure 5.6 Predicted probability of surface exposure to oil due to a 56-day well blowout (Scenario 1) in winter conditions**



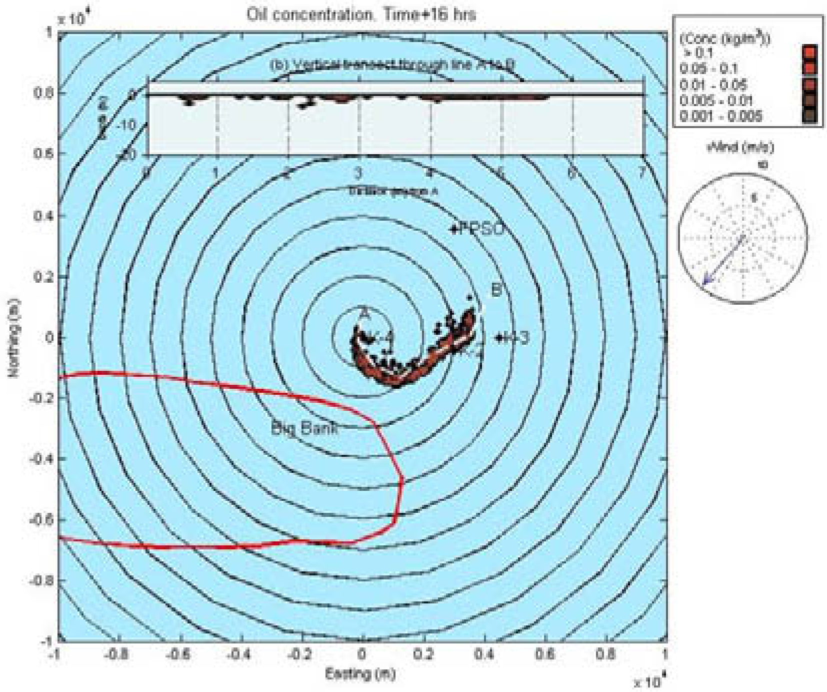
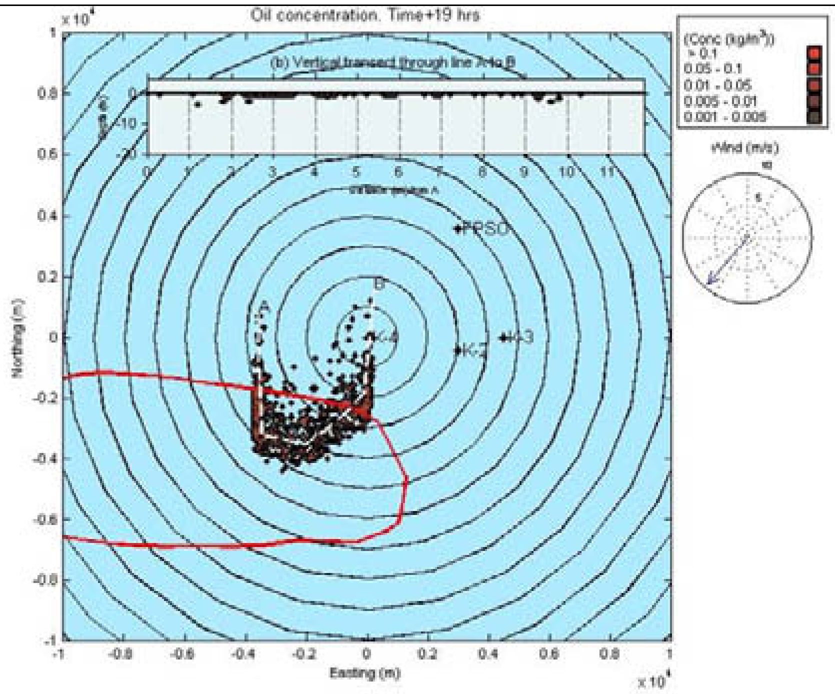




**Figure 5.7: Predicted trajectory of one hypothetical diesel spill of 80m$^3$ (Scenario 5), over the first 27 hours**



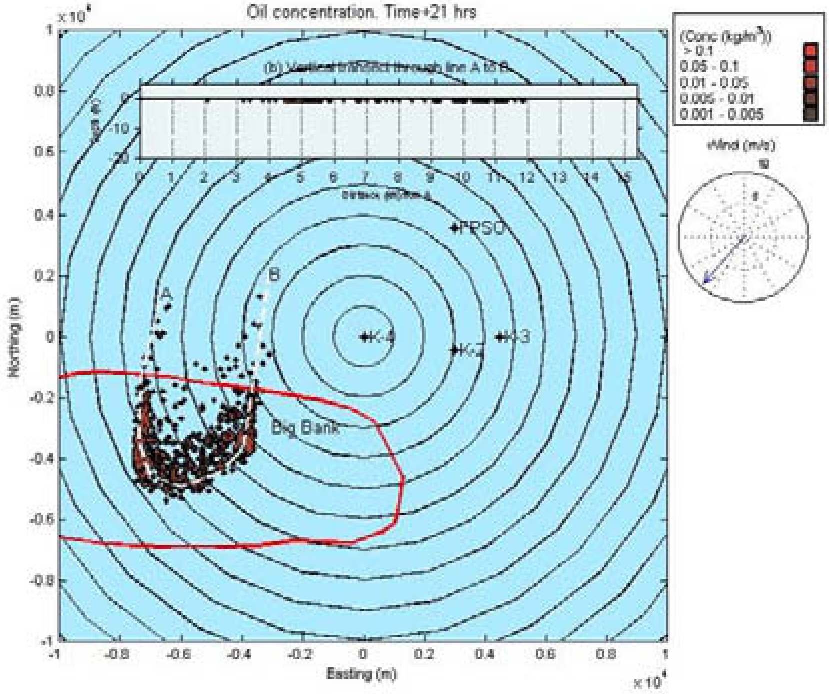
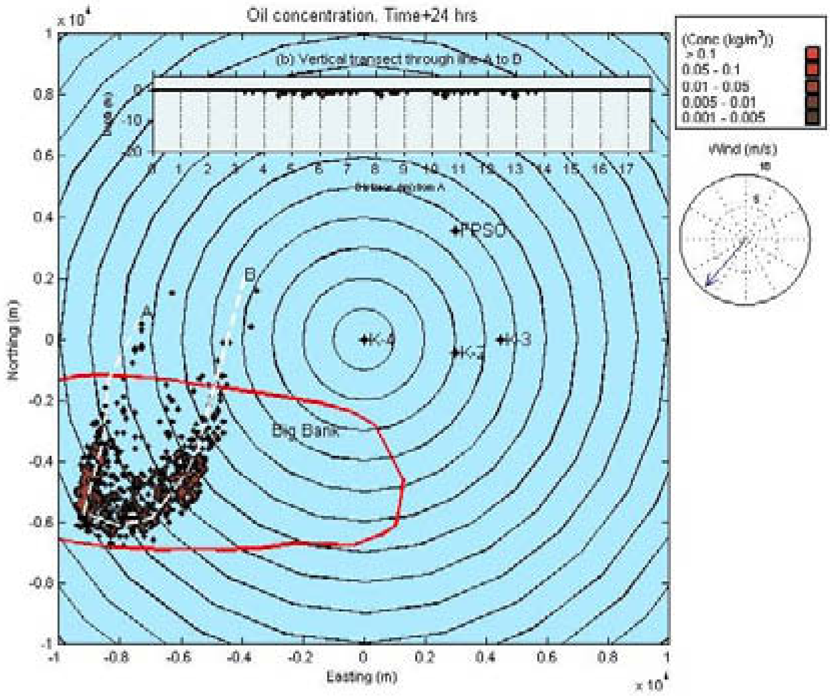




**Figure 5.7 (cont.) : Predicted oil spill trajectory and vertical oil concentration (kg/m$^3$) for a hypothetical 80m$^3$ spill of diesel (Scenario 5).**



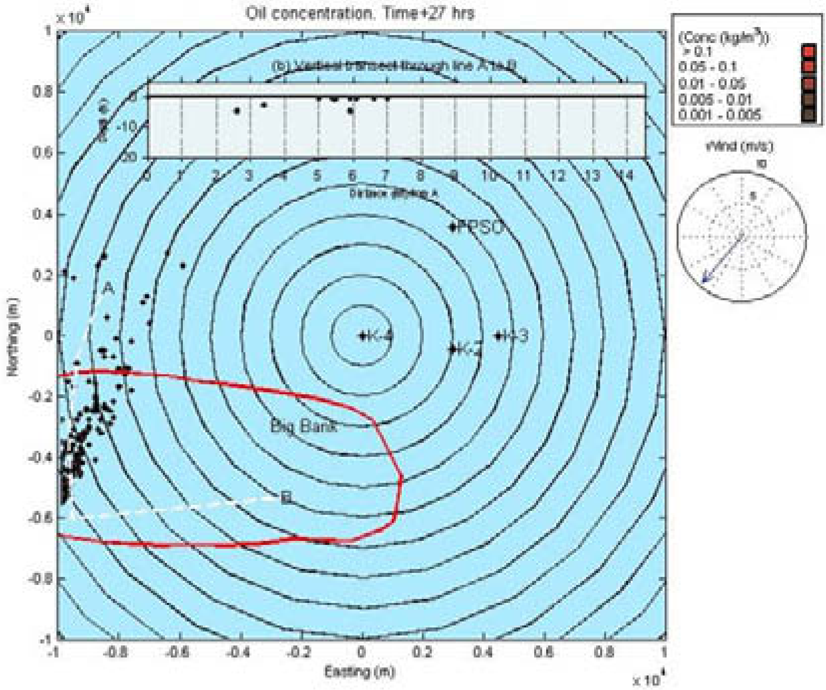
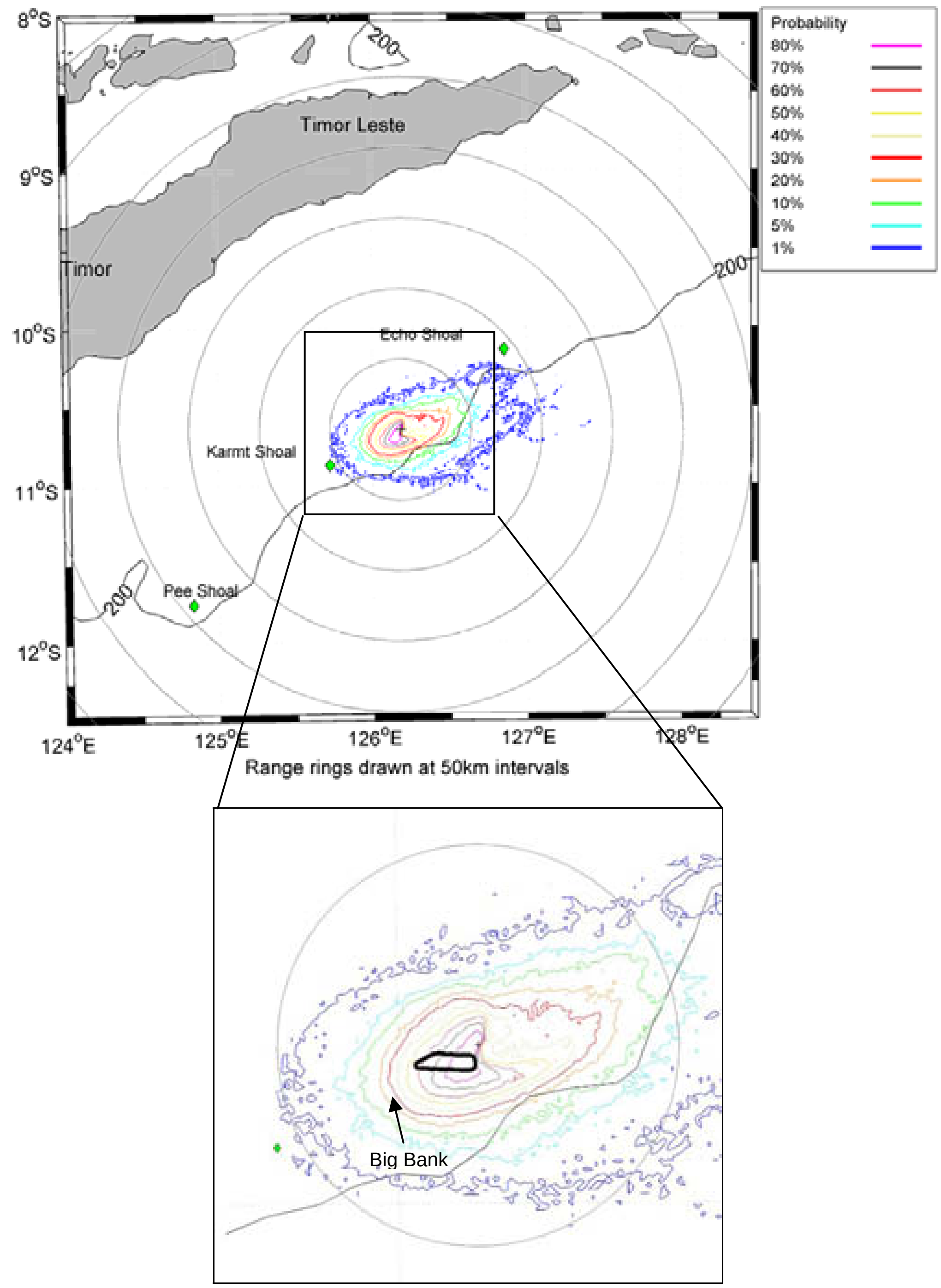
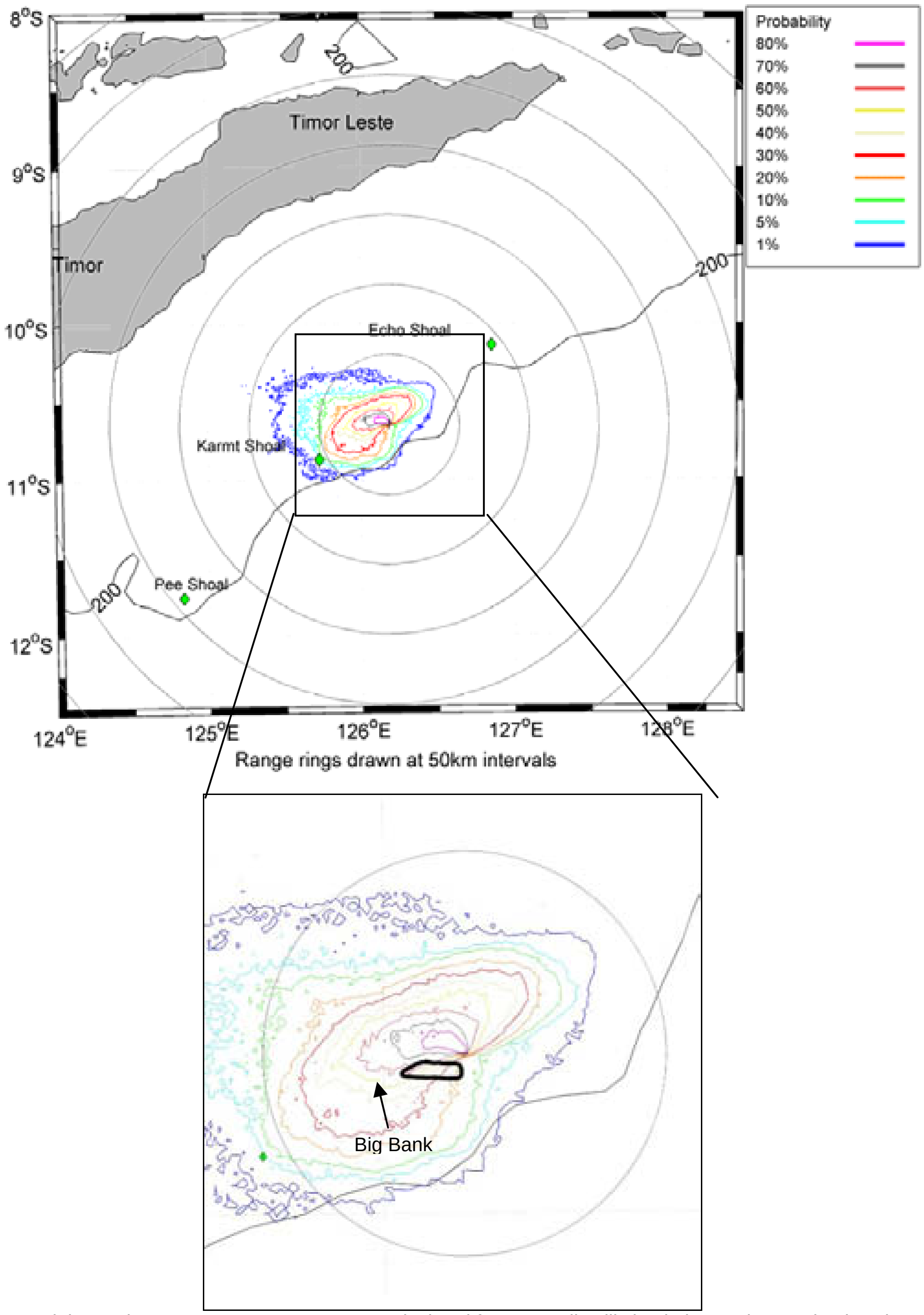




**Figure 5.7 (cont.) : Predicted oil spill trajectory and vertical oil concentration ($kg/m^3$) for a hypothetical $80m^3$ spill of diesel (Scenario 5).**




Notes: Minimum time to contact contours were calculated from 200 oil spill simulations using randomly selected wind and circulation data for the period of drilling

**Figure 5.8: Probability of surface exposure at Day 5 under summer conditions for an 80m$^3$ diesel spill (Scenario 5)**




Notes: Minimum time to contact contours were calculated from 200 oil spill simulations using randomly selected wind and circulation data for the period of drilling

**Figure 5.9: Probability of surface exposure at Day 5 under winter conditions for an 80m$^3$ diesel spill (Scenario 5)**

### 5.4.4 Potential Environmental Effects

Oil spill trajectory modelling has shown that any release of either Kitan crude oil or diesel from the proposed Development area is likely to degrade before it can make contact with a shoreline. Thus, nearshore marine communities and habitats of the Australian, Timor-Leste or Indonesian coastlines (e.g. corals, seagrasses, mangroves, turtle nesting beaches, intertidal and subtidal communities) are not threatened by the Kitan Field Development. Given the oceanic environment, the resources considered to be most at risk are pelagic phyto- and zooplankton, pelagic fish, cetaceans, marine turtles and surface-feeding seabirds.

Oil can affect marine biota in a variety of ways through acute toxicity, and sub-lethal chronic effects on morphology, physiology and behaviour, some of which may ultimately lead to mortality. Weathering influences the toxicity of oil and its constituents. Weathering processes include spreading, evaporation, dissolution, dispersion into the water column, formation of oil-in-water emulsions, photochemical oxidation, microbial degradation, absorption to suspended particulate matter and stranding on the shore or sedimentation to the sea floor. Relatively lighter, more volatile, mobile and water-soluble compounds will tend to evaporate fairly quickly into the atmosphere. The lighter components of oil are usually the most toxic but are also those most readily lost through evaporation and the rate of evaporative loss increases with temperature. Consequently, weathered oil is generally less toxic than fresh oil (Swan *et al* 1994) and so lethal concentrations of toxic components that could lead to death of marine organisms are relatively rare, localised and short-lived.

Swan *et al* (1994) reviewed the environmental effects of oil spills across a broad spectrum of marine organisms and communities. Their review indicated that the response of phyto- and zooplankton to oil varied between species. However, phyto- and zooplankton could be generally characterised as having a high tolerance and rapid recovery (no long-term effects). Thus, the risk of an oil spill occurring and persisting at toxic concentrations for a sufficient period of time to have long-term effects on phyto- and zooplankton is considered to be negligible.

Organisms inhabiting the water column such as cetaceans, marine turtles and fish may be exposed to oil in the event of an oil spill. Pelagic fish are highly mobile and capable of diving to avoid exposure to oil so the threat of significant effects are considered low. Cetaceans and marine turtles would be more likely to come into contact with oil as they return to the surface to breathe. The effects of oil on cetaceans and marine turtles would include oiling of parts of the body, irritation of the eyes, inhalation of volatile oil components and ingestion. Inhalation and ingestion are likely to have a more significant effect on individuals that come into contact with oil than surface contact (Swan *et al* 1994). Being mobile, however, these organisms would be expected to be able to move away from heavily oiled areas. It is difficult to predict with certainty the number of cetaceans or turtles that would be likely to be exposed in the event of an oil spill. However, in the open ocean environment of the Kitan Field Development, it is probable that only a small number of individuals would be exposed. In the event of an oil spill, Eni's priority would be to protect breeding and feeding areas to avoid impacts on populations.

Swan *et al* (1994) identify seabirds as being the most vulnerable organisms to an oil spill in oceanic environments. Oil spills can have a variety of effects including fouling of the plumage, ingestion of oil, effects on reproduction and physical disturbance. Many of the species that occur offshore are surface-feeding or plunge-diving pelagic birds, so that oil slicks would potentially interfere with feeding and increase exposure risk. Preening to remove oil would also expose the birds to direct ingestion of oil. Given the open oceanic location of the Kitan Field Development, remote from any land mass, the number of seabirds likely to be exposed in the event of an oil spill is expected to be low.

### 5.4.5 Management of hydrocarbons

Eni's safeguards to be implemented for the minimisation of environmental impacts associated with non-routine (accidental) discharges include:

- procedures to reduce the likelihood of oil and chemical spills occurring;
- procedures to minimise the volumes spilled; and
- actions to be taken to minimise the environmental consequences in the event of a spill occurring, i.e. spill response.

These safeguards are described in Table 5.10. In addition, Eni will develop an OSCP which will be submitted for approval to the Designated Authority. It details the practices and standards to be implemented in the event of an accidental hydrocarbon discharge.

**Table 5.10: Summary of Safeguards to Manage Oil, Fuel and Chemicals**

| Scenario | Description of Safeguards |
|---|---|
| Well failure (blow-out) during drilling | • Comprehensive understanding of the nature of hydrocarbon formations in Kitan oilfield gained during exploration drilling already conducted in the area, including information on reservoir pressures and oil characteristics. All eight wells drilled to date show a normal pressure regime down to total depth.<br>• Close supervision of the position and operation of the MODU by the Drilling Contractor and Eni Drilling Supervisor.<br>• Wells designed and engineered to approved standards, to ensure that well pressures remain well within the safety limits.<br>• Extensive pre-start audit of the drilling rig (*Transocean Legend*) to identify and fix any safety-critical maintenance issues.<br>• Extensive maintenance and servicing of blowout preventers (BOPs) prior to start of drilling program.<br>• Installation of BOP during drilling as a secondary well control barrier, to shut in wells in the event of accidental release.<br>• Regular testing of the BOP prior to commencing production and regularly during production.<br>• Casing sizes, lengths and cementing intervals selected to maximise well control. Standard safety margins allowed, to control any pressures that are higher than anticipated.<br>• Pressure testing the casing string.<br>• Adoption of industry standard operational and maintenance practices and procedures.<br>• Use of industry standard subsea equipment, including wellheads and flowlines.<br>• Continuously monitoring for abnormal pressure parameters during drilling and production. |
| Vessel collision | • Exclusion zone established around FPSO and subsea facilities.<br>• ANP notified of location of FPSO.<br>• Notice to Mariners issued alerting them of development and associated activities.<br>• FPSO not located in commercial shipping lanes.<br>• Automatic Radar Plotting Aids (ARPA) radar. |
| Refuelling incident | • Refuelling will be undertaken only during periods of calm weather and preferably in daylight hours.<br>• Transfer hoses will be fitted with 'dry break' couplings.<br>• Refuelling operations will be overseen by the vessel's Master or First Officer.<br>• Ensure that all refuelling activities are undertaken in accordance with FPSO procedures.<br>• Hoses are inspected, certified and maintained as per the integrity management system.<br>• Radio contact between the support vessels and the FPSO and/or drill rig.<br>• Spill response drills to be regularly carried out. |
| Leak from fittings and connections | • Pressure tested equipment.<br>• Low pressure switch on flowlines.<br>• Planned maintenance is undertaken and recorded. |

| Scenario | Description of Safeguards |
|---|---|
| Release from subsea flowlines | • Leak test of flowlines.<br>• Visual detection of oil on sea surface for small leaks.<br>• Detection by sudden drop in flow rate.<br>• Standard operating procedures control lifts over or near the flowlines including if FPSO is “weather vaning”. |
| Disconnect/reconnect of FPSO to risers | • FPSO Operating procedures with respect to disconnection.<br>• Designed to tolerate mechanical impact.<br>• Standard operating procedures control lifts over or near the flowlines including if FPSO is “weather vaning”. |
| Topsides piping or equipment (including separators) | • Planned maintenance is undertaken and recorded.<br>• Emergency shut-down (ESD) valves limit the size of the release.<br>• Various detection systems. |
| Loading/unloading manifold and cargo deck piping | • Inter tank transfers on FPSO will be manned operations.<br>• Watch keeper reporting would result in shutdown of export system.<br>• Low pressure detection on the run down line causing shutdown by ESD valve.<br>• Visual inspection 24 hours a day.<br>• Bund drains on deck.<br>• Scupper plugs.<br>• Hydro tested prior to use.<br>• Operating procedures.<br>• Operators to be competent in associated activities. |
| Leaks from FPSO storage tanks | • Double skinned hull.<br>• Management of supply vessels.<br>• Transfer to another tank.<br>• Ability to plug small leaks.<br>• Ballast tanks, not oil tanks, in area where boats unload.<br>• Centre tanks loaded before wing tanks.<br>• Exclusion zone.<br>• ARPA radar.<br>• Away from commercial shipping routes.<br>• Maintain vessel in Class.<br>• Pilotage procedures.<br>• Weather limitations on operations. |
| Export hose | • Dry break coupling installed.<br>• Watch keeping on both vessels.<br>• Monitoring of hawser loads.<br>• Hoses checked annually and certified as per FPSO’s Hose Management System.<br>• Hose pressure testing.<br>• Shutdown of export following leak detection.<br>• Spills of oil >80L reported to Eni immediately and within 2 hours of occurrence to ANP.<br>• Shutdown of export following leak detection. |

| Scenario | Description of Safeguards |
|---|---|
| Hydraulic fluid leaks | • Planned maintenance is undertaken and recorded.<br>• Low toxicity hydraulic fluids used.<br>• Manned operation (visual detection of release).<br>• Drip pans/bunds. |
| Chemicals | • Transfers will be undertaken only during periods of calm weather and in preferably daylight hours.<br>• Transfer operations will be overseen by the vessel's Master or First Officer.<br>• The skid under the chemical injection package drains to a dedicated drum which is then disposed of onshore.<br>• Chemicals will be labelled and transferred in accordance with the MSDS.<br>• Ensure absorbents and containers are available on the FPSO.<br>• Ensure staff are fully trained in spill response.<br>• Chemical spill records will be maintained.<br>• All hazardous materials handling and storage must be conducted in line with FPSO procedures and MSDS requirements<br>• AS 1940:2004 The storage and Handling of Flammable and Combustible Liquids or equivalent standard must be followed |

### 5.4.6 Spill Response

In the unlikely event of an oil spill, the environmental impacts of the spill will be mitigated by various oil spill response activities to be detailed in the OSCP for the Kitan Field Development. The OSCP will assign responsibilities, specify procedures and identify resources available in the event of an oil spill. Trained and experienced personnel, dispersants, materials and equipment stockpiles, and external agencies in the region will support the OSCP. No activities will be undertaken without the approved OSCP in place.

Key elements of the spill response are summarised below:

- all hydrocarbon spills to the ocean will be reported in accordance with the OSCP;
- procedures for oil and fuel spill intervention and response, as detailed in the approved OSCP, will be followed;
- spills in JPDA waters will be reported to the ANP and other relevant parties; and
- pre-agreement for dispersant application procedures will be sought from AMSA, ANP and other relevant agencies such that rapid response is possible.

Stocks of absorbent material and spill response equipment, including stocks of dispersants will be located on-site. The offshore support vessel will maintain oil spill procedures in accordance with the requirements of MARPOL 73/78 and also have oil spill response capability.

## 5.5 Produced Formation Water

### 5.5.1 Source and Characteristics

PFW will be discharged overboard from the FPSO, at an expected maximum discharge rate of 35,000 bbls per day (~5,600m$^3$/day), after treatment to meet required discharge standards. The OIW separation treatment system will include:

- a hydrocyclone unit;
- a gas induced flotation system; and
- a cooler.

Under normal operations, a free OIW concentration of <15 milligrams per litre (mg/L) (24 hour average) will apply. Assuming a 15mg/L OIW concentration, an average of 27 tonnes of free oil will be discharged to the ocean per year. This equates to 187 tonnes over the seven year life of the project.

A small number of chemicals are added to the production process for purposes such as increasing and/or decreasing emulsification, inhibiting scale formation, reducing corrosion and preventing growth of bacteria. These production chemicals are soluble in PFW to varying extents and are ultimately discharged with the PFW. Discharged PFW will also contain dissolved compounds from the geological formation, such as organic acids, low molecular weight hydrocarbons and salts and finely dispersed oils.

### 5.5.2 Fate of PFW discharged to sea

Once PFW is discharged to sea, it is subject to dilution, dispersion and physical, chemical and biological degradation. For the purposes of this assessment, the fate of PFW after discharge to sea has been predicted by computer modelling (Sustainability 2010). For this modelling, the PFW was discharged at the maximum rate of 35,000 bbls/day (~5,600m$^3$/day) and at 100% concentration. Predictions are then related to a threshold value determined from ecotoxicity tests undertaken on PFWs from other facilities to determine the impact.

Full model details, including information on wind and current data sets used and assumptions underlying their use, are presented in the source document (Appendix C). Simulations were carried out for a 24 day continuous release, to account for variability in wind and currents. Wind and currents from the transitional season were applied as this is the lowest wind period giving worst case mixing conditions.

Figure 5.10 show the predicted PFW concentrations at various times after commencement of the simulation. The location of the Big Bank Shoals in relation to the FPSO and the PFW plume is shown in the bottom left hand corner of each figure. After discharge, the PFW stream rises to the surface under its own buoyancy and spreads radially. The plume is then advected away from the discharge point by ambient currents whilst mixing both horizontally and vertically into the receiving waters. The PFW plume is predicted to extend up to 6km from the FPSO albeit as discontiguous patches and at the low concentrations of 0.01% – 0.1% of the initial concentration i.e. 1,000 times to 10,000 times dilution. The plume is also predicted to be constrained to within the top 7m of the water column.

Figure 5.11 shows the time series of PFW concentrations at 16 compass points, 200m from the discharge point. Maximum, mean and 95%ile concentration for 16 compass point are summarised in Table 5.11. Maximum concentrations are predicted to the east-northeast. Whilst the maximum concentration is 1.64% PFW, the mean and 95%ile concentrations are 0.03 and 0.19%PFW, respectively, highlighting the spatial and temporal variability of the plume.

**Table 5.11: Maximum, mean and 95%ile concentration at 200m from the discharge point.**

| | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max | 0.95 | 0.99 | 1.64 | 1.11 | 1.11 | 0.85 | 0.79 | 0.61 | 0.61 | 0.41 | 0.72 | 0.60 | 0.60 | 0.68 | 0.73 | 0.95 |
| Mean | 0.02 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 |
| 95%ile | 0.17 | 0.10 | 0.19 | 0.08 | 0.08 | 0.03 | 0.04 | 0.07 | 0.07 | 0.06 | 0.14 | 0.17 | 0.17 | 0.16 | 0.18 | 0.17 |

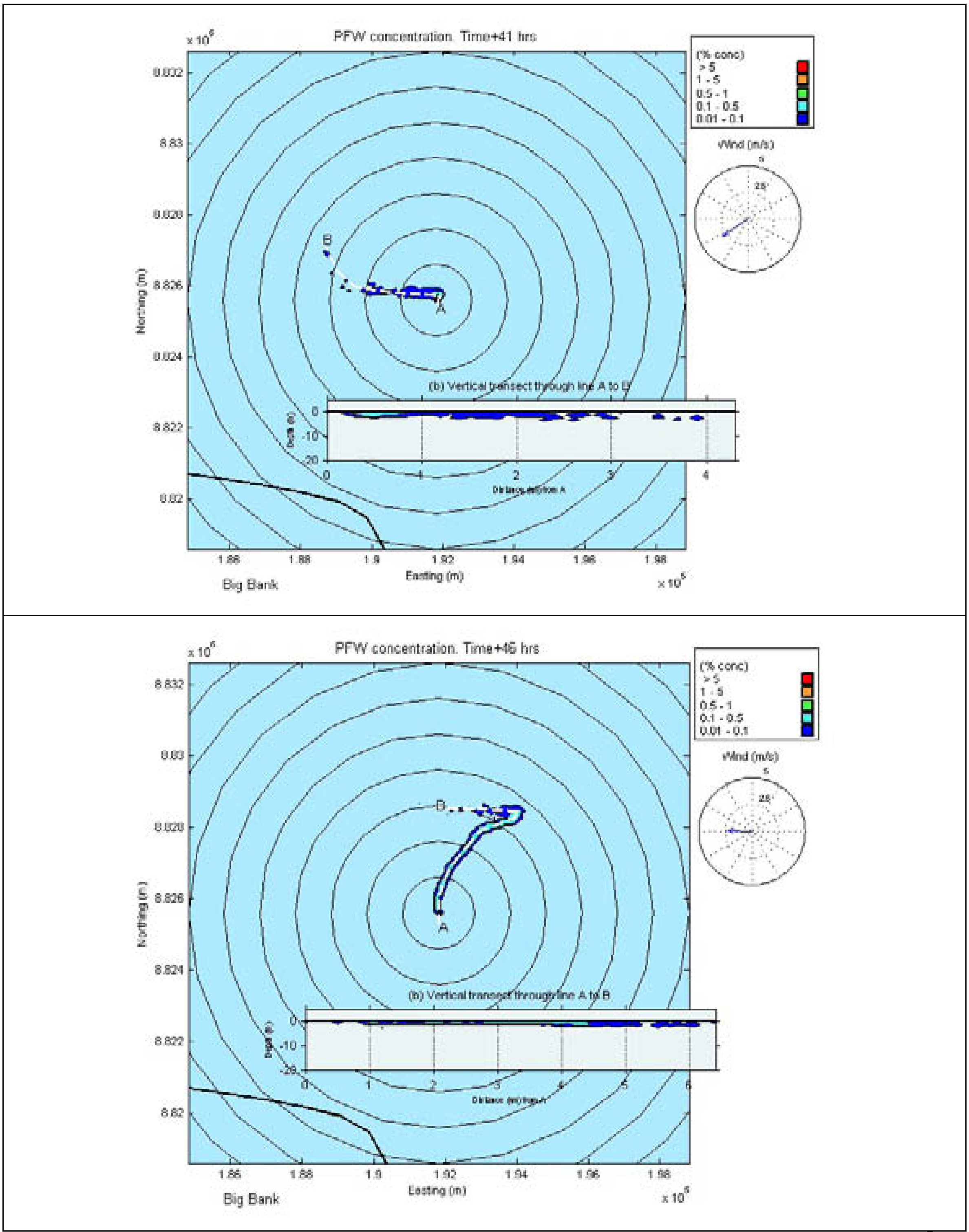
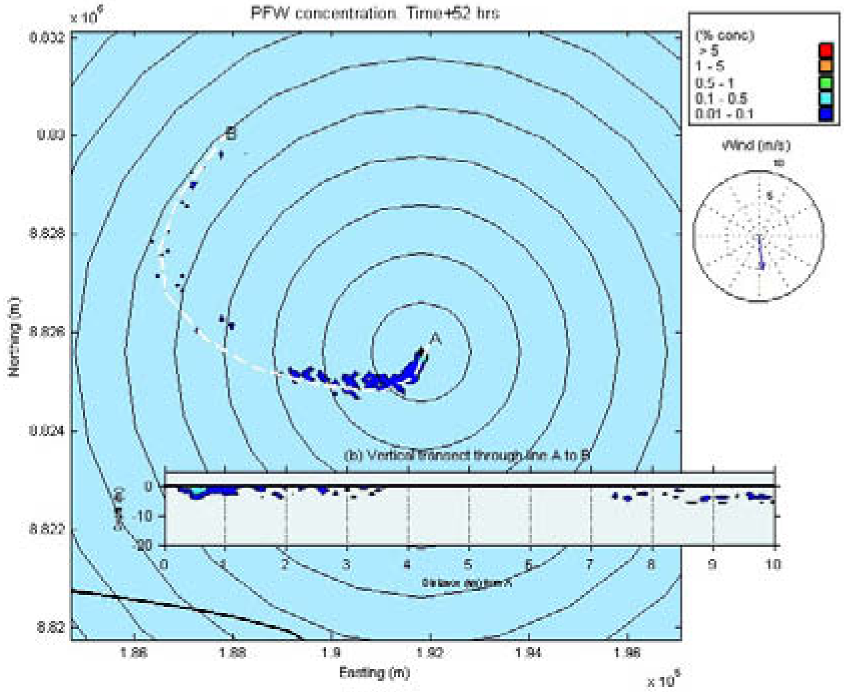



**Figure 5.10:Predicted PFW concentrations for maximum design discharge rates (5,600m$^3$/day).**



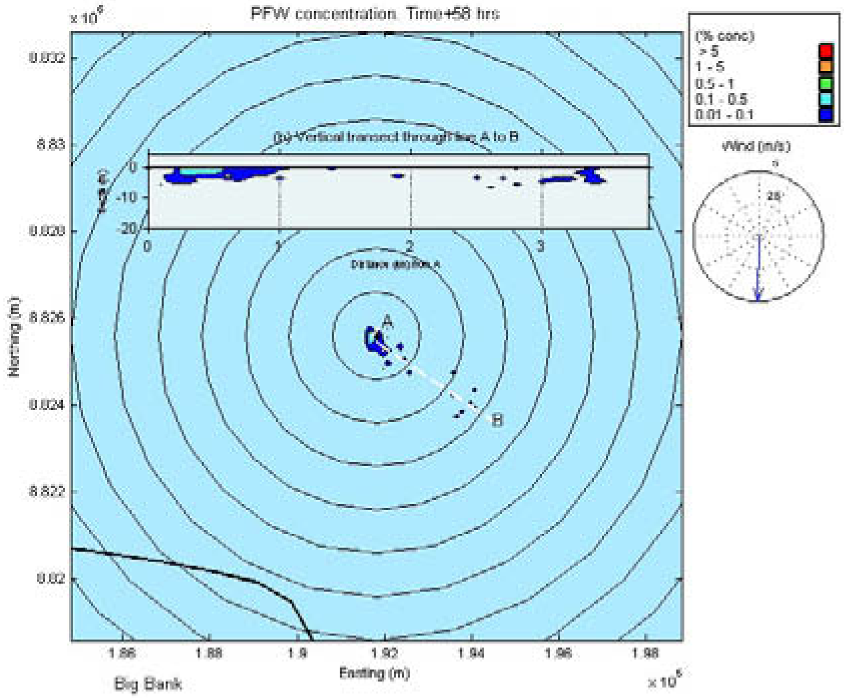
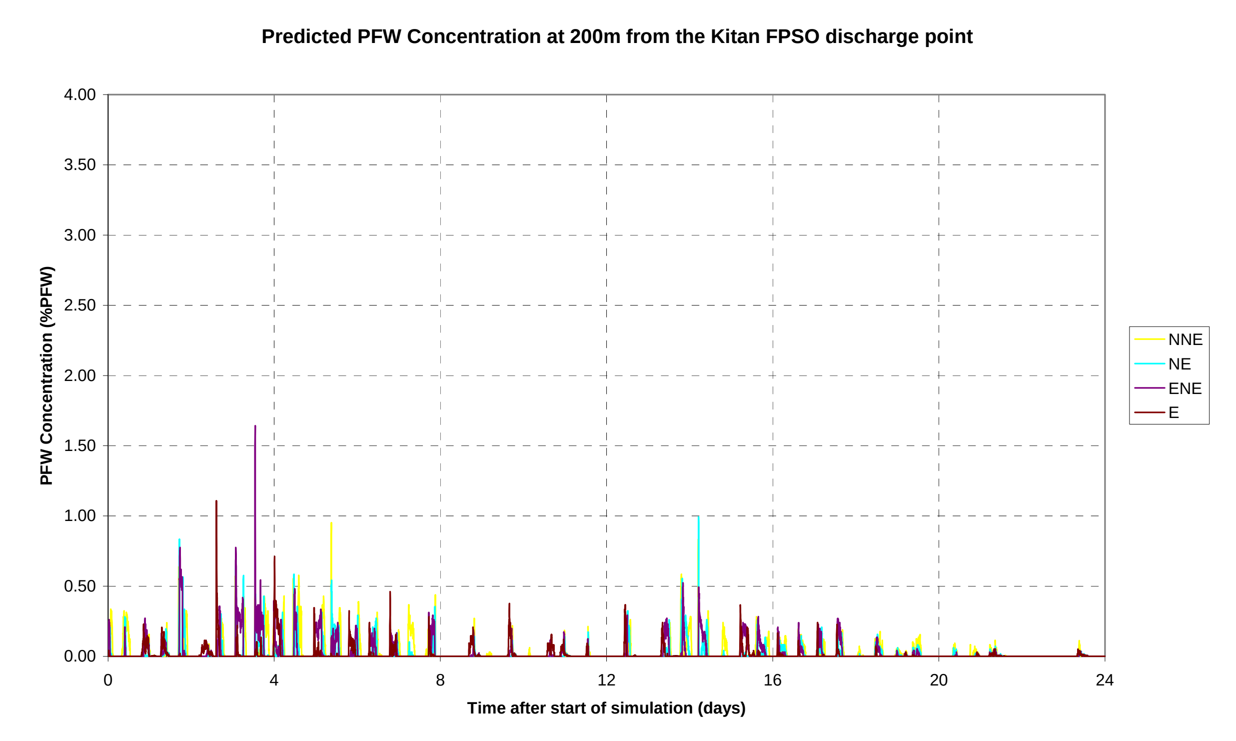




**Figure 5.10 (cont.) Predicted PFW concentrations for maximum design discharge rates ($5,600m^3$/day).**



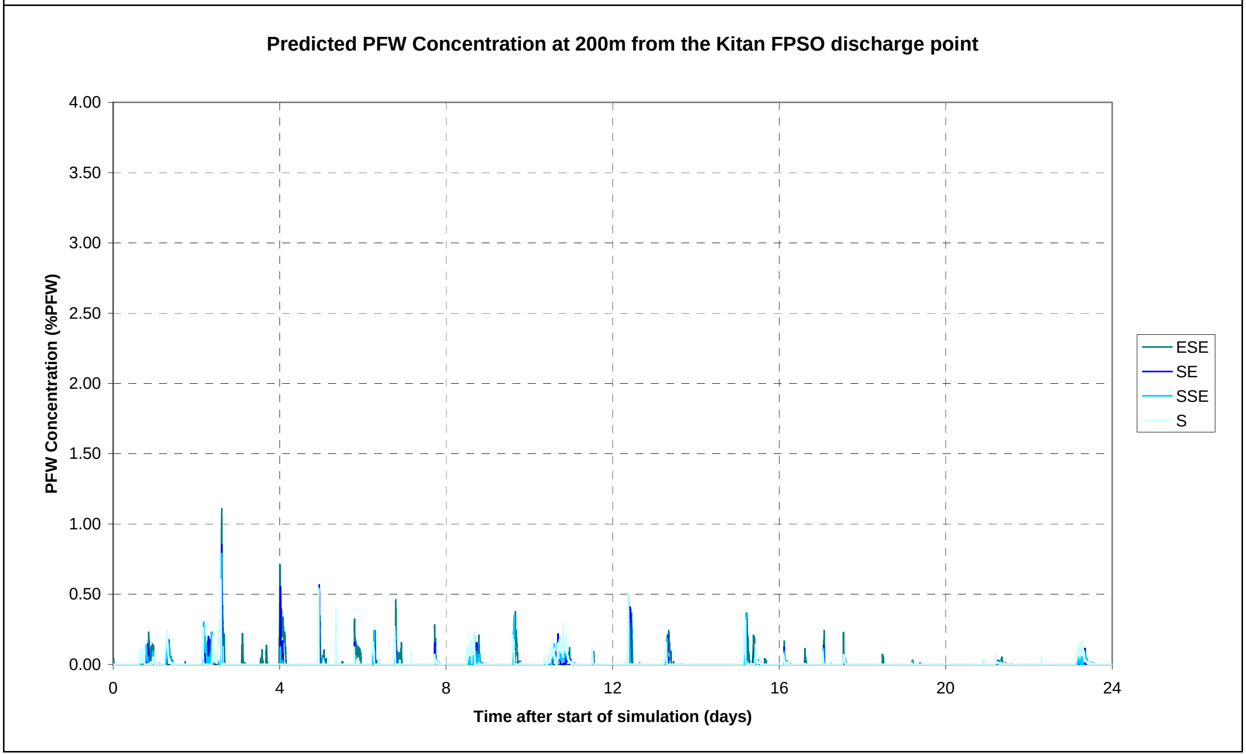
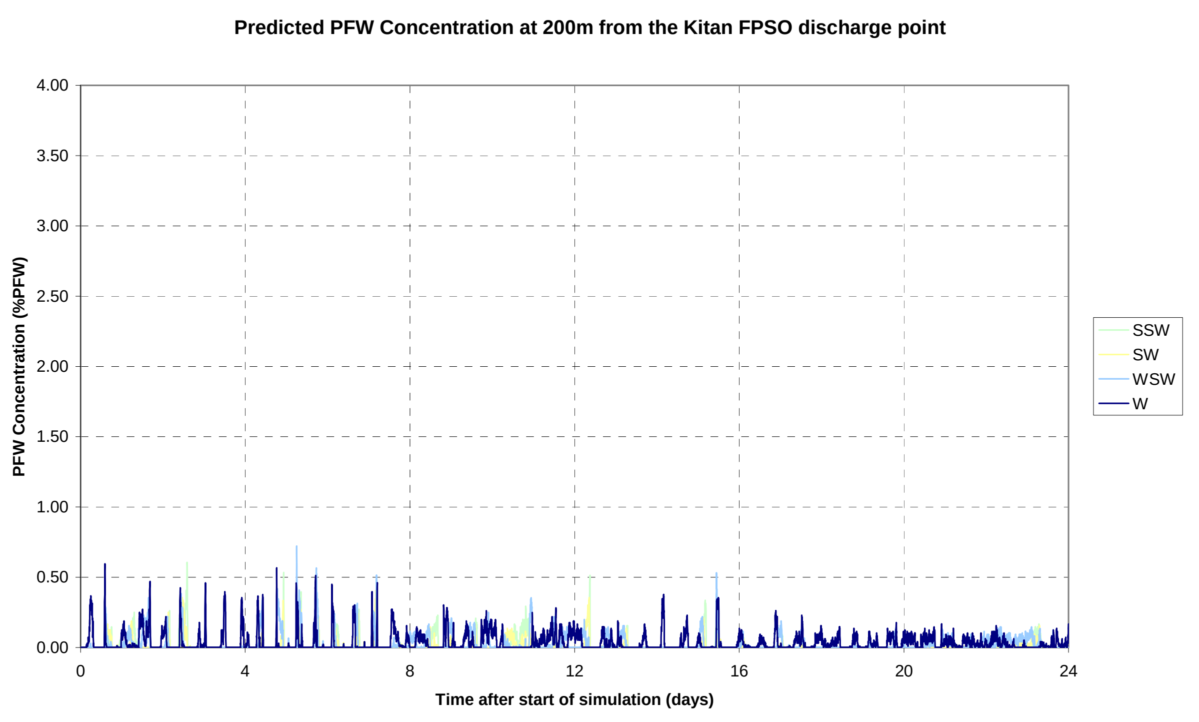




**Figure 5.11: Predicted PFW concentrations at 200m from the discharge point for maximum discharge rate (5,600m$^3$/day).**



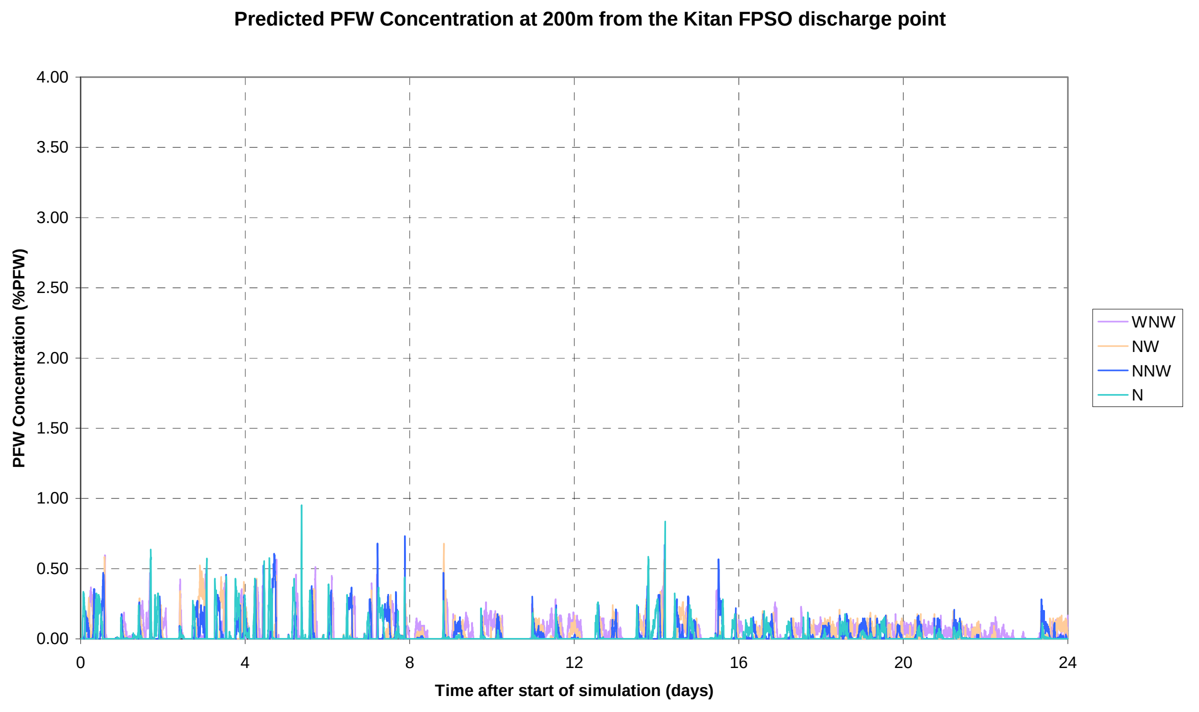




**Figure 5.11 (cont.) Predicted PFW concentrations at 200m from the discharge point for maximum discharge rate (5,600m$^3$/day).**

### 5.5.3 Potential Environmental Effects of PFW

**Ecotoxicity**

Ecotoxicity depends on the chemical compounds present, the exposure duration (acute or chronic) and the organisms impacted. The toxicity of hydrocarbons in mixtures is additive, so the toxicities of a complex mixture depends on the total concentration of bio-available hydrocarbons and degradation products in the water to which aquatic organisms are exposed.

Acutely toxic responses have a sudden onset after or during relatively high exposure, usually for short durations: within four days for fish and macro invertebrates and shorter times (two days) for organisms with shorter life spans. The response may be lethal or sub-lethal. Examples of sublethal effects include: impairment of feeding mechanisms, growth rates, development rates, energetics, reproductive output, recruitment rates and increased susceptibility to disease and other histopathological disorders. Early development stages can be especially vulnerable to hydrocarbon exposure, and recruitment failure in chronically contaminated habitats may be related to direct toxic effects of hydrocarbon contaminated sediment.

In contrast, chronic responses involve endpoints that are realised over a relatively long period of time, often one-tenth of the life span of an organism or more. A chronic toxic response is usually characterised by slow toxic progress and long continuance and may be measured in terms of reduced growth, reproduction or fertilisation at different life stages, in addition to lethality.

Toxic concentrations are standardised as median lethal concentration (LC50s) for lethal responses or median effect concentration (EC50s) and median inhibition concentration (IC50s) for sub-lethal response. Definitions for these terms are as follows:

| | | |
|---|---|---|
| Lethal response | LC50 | The toxicant concentration killing 50% of exposed organisms at a specific time of observation. |
| Sub-lethal response | EC50 | The toxicant concentration estimated to cause a specified effect in 50% of exposed organisms at a specific time of observation. |
| | IC50 | The toxicant concentration estimated to cause a specified inhibition (eg. growth) in 50% of exposed organisms at a specific time of observation. |

The PFW ecotoxicities that have been reported for various oil fields in different locations around the world have been subject to a number of detailed reviews (Patin 1999; Swan *et al* 1994; Somerville *et al* 1987; Neff 2002). The lowest reported LC50 / EC50 acute ecotoxicity (ie. the most toxic response) is approximately 1%PFW, the highest (least toxic) is more than 90%PFW and the mean reported measure of acute ecotoxicity is 23%PFW. The modelling results (Section 5.5.2) indicate that discharged PFW at the Kitan field would be diluted to concentrations less than the mean concentration likely to cause acute ecotoxicity within a very short distance, probably less than 10-20 m from the point of discharge.

The most commonly used formula for determining the theoretical chronic ecotoxicity threshold is to apply a safety factor of 1,000/n, where n is the number of acute ecotoxicity measures (Frost *et al* 1998). Using this approach the theoretical threshold concentration for chronic ecotoxicity, based on reported literature values, would be approximately 0.1%PFW. Modelling shows that this value would be achieved within about 5km from the discharge point, however, this would be an instantaneous value whereas chronic effects occur over much longer time scales.

**Aromatic hydrocarbons**

Aromatic hydrocarbons encompass a diverse group of unsaturated cyclic hydrocarbon compounds, usually separated into three categories:

BTEX – benzene, toluene, ethylbenzene and xylene (moncyclic aromatic compounds);
NPD – naphthalene, phenanthrene and dibenzothiophene (2-3 ring aromatic compounds); and
PAH – polycyclic aromatic hydrocarbons (3-6 ring aromatic compounds).

The range of concentration of aromatic substances in PFW depends on the nature of the reservoir (oil, gas or condensate), with the highest concentrations of individual substances in the BTEX and NPD groups, these being more soluble in water than other hydrocarbons. The bulk composition of aromatic compounds in PFW does not vary significantly over field life and there appears to be little relationship between total oil content and the concentration of aromatics (OGP 2002).

Concentrations of aromatic hydrocarbons in treated PFW are attenuated rapidly in the sea by dilution and also, in the case of BTEX and NPD, by evaporation. For BTEX and NPD, dilution factors of 50,000 to 150,000 have been found within 20 to 50 m of the discharge point (OGP 2002).

For the heavier PAH compounds, dilution rates of 1,000 to 5,000 have been measured. BTEX and the lighter NPD compounds also degrade rapidly in the marine environment. The compounds will pass into marine organisms, but, while they may accumulate at lower trophic levels, vertebrates including fish have detoxification mechanisms that break aromatic compounds down.

Unlike BTEX and NPD compounds, PAH compounds have the ability to bioaccumulate and bioconcentrate in the environment. Bioaccumulation typically refers to the uptake and retention of a contaminant by an organism while bioconcentration refers to the net accumulation of a contaminant resulting from simultaneous uptake and release.

All PAH compounds have a strong tendency to bioaccumulate in the tissues of marine organisms (Neff 2002). Where bioaccumulation has been reported for marine organisms, the PAH profile and tissue concentrations were highly variable. The bioconcentration values for PAH in marine organisms collected near PFW discharge points in the Gulf of Mexico have been found to be variable and generally much less than would be predicted from laboratory-based estimates of bioaccumulation potential.

The environmental effects of aromatic compounds have been extensively researched and a number of toxicity mechanisms have been identified. Evidence of carcinogenicity, mutagenicity or teratogenicity attributable to PAH compounds in the marine environment is scarce. There is limited information on the ability of PAH compounds to act as endocrine disrupters. Combining information on toxicity mechanisms with modelling and monitoring studies has shown that threshold concentrations for toxic effects for aromatic substances are reached, at most, within a few hundred metres of the discharge point.

As a consequence, taking into account the short exposure times experienced by marine organisms, the overall risk posed by aromatic substances is considered to be low.

The potential for bioaccumulation of aromatic compounds in marine organisms to occur at the proposed development as a result of PFW discharge is considered to be low. This reflects the ability of organisms to metabolise and/or purify themselves of low levels of aromatics. The highest levels of bioconcentration, should it occur, would be in the tissues of fouling organisms, such as molluscs and crustaceans. It is unlikely that significant levels of aromatics would bioaccumulate in fish.

**Metals**

The metals associated with PFW are usually present as dissolved mineral salts. Because the reservoir water has been depleted of oxygen (through microbiological activity in the reservoir), the metal ions are typically in lower oxidation states when discharged to the ocean as a component of the PFW. Once discharged to sea the metal ions react with the oxygen in the surrounding seawater to form oxides. The metal oxides then combine with anions such as sulphides, carbonates and chlorides, and form insoluble precipitates. Precipitation as metal hydroxides or sulphides is the principal fate of heavy metals discharged with PFW in the marine environment (Neff 2002). Metals present in marine sediments as hydroxides or sulphides are not generally available for biological uptake and hence would not have any significant environmental effect.

**Production chemicals**

Corrosion inhibitors are intended to limit the rate of corrosion of the inner surfaces of the production process. Corrosion inhibition is based on the formation of a film on the internal surface of the vessel or piping. Although a wide variety of corrosion inhibitors are available, they are mostly carboxylic acids that have had nitrogen-containing chemicals substituted. A number of generic oil or water soluble types of corrosion inhibitor may be used (Swan *et al* 1994). Of these, only imidazoline derivatives, which are water soluble, would be discharged with the PFW. The other generic types are oil soluble and therefore would not be discharged with the PFW.

Imidazoline derivatives are readily biodegradable (Danish Environmental Protection Agency 2001). The maximum expected concentration range of corrosion inhibitor in the discharge would be 7.5–30 mg/L. Scale inhibitor is used to prevent carbonate or sulphate salts of calcium, strontium, barium or radium precipitating from the reservoir water and forming scale on inner surfaces of the production process equipment. The active ingredient of scale inhibitor is usually either a phosphate or a phosphonate ester. These chemicals are strongly water soluble. The expected concentration range of scale inhibitor in the discharge would be 3-10 mg/L.

Forward demulsifiers (also known as emulsion breakers) are essentially detergents that are applied to the water-in oil emulsion to aid separation of the water droplets from the oil (Swan *et al* 1994). The most commonly used demulsifiers include oxyalkalate resins, polyglycol esters; and alkyl aryl sulphonates, which are strongly soluble in oil. Very little of these compounds would be expected to be discharged, with an expected concentration range in the PFW discharge of 1–20 mg/L. Reverse demulsifiers are chemicals that are added late in the production process to aid in the coalescing of oil droplets from PFW. Most reverse demulsifiers contain polyamines or polyamine compounds. These compounds are water soluble. The expected concentration range of reverse demulsifier in the discharge would be 5–15 mg/L.

Biocides are usually used to prevent or control the growth of sulphur reducing bacteria. The metabolic by-products of sulphur reducing bacteria are hydrogen sulphide, which is both corrosive and toxic in high concentrations, and iron sulphide, which can interfere with oil separation. Consequently, biocides are highly toxic. To improve performance and avoid the potential for development of biocide-resistant bacteria, biocides are generally applied in short batches of a relatively high concentration rather than as a continuous dosage. The biocides that are used in the industry typically have either aldehydes or amine salts as the active ingredients. Both of these types of biocide are soluble in water and would be discharged with the PFW.

The expected concentration range of biocide in the PFW discharge would be 10–200 mg/L. Aldehyde-based biocides are unstable and will decay under normal conditions to formaldehydes and orthophosphoric acid over a period of days.

Various acids may be required in maintenance activities associated with wells and process equipment, eg. for removal of solid materials such as calcium carbonate. These activities require different acids for different problems. A weak mixture of acetic acid may be required to remove a build-up of calcium carbonate. Should such a treatment be required, the most likely volume of acid to be used is in the order of ~250 bbls (~40m$^3$) of 15% acid strength. However, the majority of active ingredient reacts with, and dissolves, the solid carbonate material to form a weak, almost neutral solution which would be discharged overboard. It is also possible that more “stubborn” buildups may require treatment with stronger acids including hydrochloric acid. Should such a treatment be required, the most likely volume to be used is in the order of ~125 bbls (~20 m$^3$) of 15% acid strength. It is unlikely that any detectable change in pH of the surrounding waters would occur from discharge of these acids with PFW, primarily because seawater has a strong buffering capacity. The effects on the environment of occasional discharges of acetic and hydrochloric acid are predicted to be slight to non-existent.

Hydrate inhibitors, such as methanol and/or ethylene glycol, are added to the production process to prevent the formation of gas hydrates. Both of these compounds are infinitely miscible in water and would be discharged with the PFW. On entering the marine environment, both methanol and ethylene glycol would be rapidly diluted to low concentrations. At low concentrations, methanol and ethylene glycol can be metabolised as an energy source by micro-organisms.

**Tainting**

When present in foods, petroleum hydrocarbons stimulate an olfactory response that causes a tainting of taste. Studies of threshold concentrations at which tainting occurs for hydrocarbons indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4–300 mg/L of hydrocarbons in the water, with response to phenols and naphthenic acids being the strongest (Connell and Miller 1981). This suggests that PFW discharged to sea is highly unlikely to cause tainting of fish, except for those that remain for long periods within close proximity to the PFW discharge point.

**Sheening**

Sheen associated with PFW discharge occurs when free oil within the discharged water rises to the sea surface and forms a visible micro-layer. The sheen persists until such time as the oil has dispersed. The visibility of the sheen is affected by oceanographic conditions such sea state and surface currents. A calm sea-state leads to increased visibility of the sheen. Strong surface currents move the sheen greater distances and increase the area over which the sheen is visible. The presence of sheens at the scale indicated from modelling of PFW discharge for this Project (Section 5.5.2) would have negligible effects on surface or near surface biota.

The presence of PFW sheen on the ocean surface can cause a negative effect on visual aesthetics of the area. This would only be visible during daylight hours from the air, or from vessels in the immediate vicinity of the FPSO.

### 5.5.4 Environmental Risk of PFW disposal

The environmental effect of PFW has been subject to a large number of separate studies. The majority of studies and reviews carried out to date have focussed on acute ecotoxicity effects. The results drawn from these have generally been to conclude that PFW is not very toxic and that acute ecotoxicity effects to marine organisms are unlikely to occur (Patin 1999; Swan *et al* 1994; Somerville *et al* 1987; Neff 2002).

### 5.5.5 Management of PFW Effects

Safeguards to protect the environment from the potential impacts of PFW would include:

- an approved oil separation system would be used to separate oil from water prior to discharge overboard;
- PFW discharged is passed through the oil discharge monitoring equipment to ensure that the oil concentration does not exceed 15mg/L during each period of 24 hours;
- PFW not meeting the OIW content of 15mg/L will be diverted to the slops tank for re-processing;
- regular maintenance of OIW separators is undertaken and recorded; and
- maintain records of OIW concentrations and volumes.

Other measures employed to reduce the potential for environmental impact associated with PFW disposal are facilities design, procedures for chemical selection, dosing rates and operational maintenance and control of production equipment. PFW process start up and shutdown systems will be incorporated into the design and monitoring of the PFW stream.

## 5.6 Drilling Discharges

### 5.6.1 Source and Characteristics

**Drill Cuttings**

Drill cuttings are crushed rock generated by the drill bit as it penetrates into the seafloor. The composition of the cuttings is determined by the nature of the formation being drilled. The cuttings retrieved are expected to range in size from very fine to very coarse particles, with a mean size no larger than one centimetre. The cuttings may contain up to 10% by weight of drilling muds. Drill cuttings produced are either:

- discharged directly onto the surface of the seabed during riserless drilling; or
- brought to the FPSO by the drill fluids during closed drilling (with a riser), passed through a set of vibrating screens, hydrocyclones and centrifuges, to separate the muds for recirculation, before being disposed of near the sea surface.

**Drill Fluids**

There are three different broad classes of drilling fluid systems:

- WBMs, where the continuous fluid phase is water;
- SBMs, where the continuous fluid phase is a well characterised synthetic organic compound; and
- oil-based muds (OBMs), where the continuous fluid phase is oil.

Different drill fluids are used during different stages of drilling due to variations in water depth, geological formation and drillhole deviation. Both WBMs and SBMs may be used during the establishment of the Kitan production wells. OBMs will not be used at any time.

**Water Based Muds**

WBMs use fresh or sea water as the continuous phase and the most common systems include bentonite, potassium chloride (KCl), polymers and partially hydrolysed polyacrylamide (PHPA). They may also contain a range of additives such as biocides, weighting agents, alkaline chemicals, various salts, defoamers, corrosion inhibitors, scale inhibitors, drilling lubricants, lost circulation materials and pipe release agents. A typical formulation of a water-based fluid system is shown in Table 5.12. Other drill fluid additives may also be used in very small amounts for bacterial control, corrosion inhibition, or when special fluid properties are required. Additionally, circulation material may be added to the mud to control down-hole losses. WBMs deliver acceptable performance for drilling non-challenging wells (e.g. vertical wells with generally unreactive lithologies). They provide the least environmental impact due to their non-toxic nature and ability to disperse and biodegrade rapidly.

**Table 5.12: Typical Water Based Drilling Fluid System Formulation**

| Component | Function | Concentration |
|---|---|---|
| Drill water | - | As required |
| KOH (Potassium hydroxide) | pH Control | 0.5 lb/bbl |
| $NaCO_3$ (Sodium carbonate) | pH Control | 0.5 lb/bbl |
| KCl (8% Potassium chloride) | Clay stabilisation | 41 lb/bbl |
| PHPA (solid) | Cutting's encapsulation and stabilisation | 1 lb/bbl |
| Polyanionic cellulose | Viscosifier and fluid loss control | 0.5–1 lb/bbl |
| Bentonite (Clay) | Viscosity control | 3 lb/bbl |
| Xanthum gum polymer | Viscosifier | 1 lb/bbl |
| Polyglycol | Shale stabiliser | 3% /bbl |
| Barite | Weighting agent | As required |

**Non-Water Based Muds**

Modern NWBMs have been designed to maintain many of the technical features and benefits available from OBMs, whilst incorporating a significant reduction in toxicity and a significant increase in biodegradability. Currently, international regulatory authorities are still reviewing the environmental performance of ester-based and olefin-based synthetic drilling muds. However, there is general agreement that, if discharged to sea, ester-based and olefin-based synthetic drilling muds are environmentally more acceptable than traditional oil-based or low-toxicity mineral oil-based muds, as they contain no or minimal aromatics and appear to have far more rapid anaerobic biodegradation (Swan *et al* 1994).

There are three main pathways for drilling muds to enter the marine environment during drilling activities:

- discharge of whole drilling muds to the ocean at the end of drilling;
- residual mud coating on drill cuttings that are discharged to the ocean; and
- unintentional spills.

Where WBMs are used, the whole drilling muds are routinely discharged to the ocean at the end of drilling, or when the mud property requirements change. Where NWBMs are used, whole muds are not discharged to the ocean, but instead are retained for onshore reconditioning, re-use or disposal.

The drilling fluids are released to the environment with the drill cuttings, either onto the seabed when drilling riser-less, or at sea surface, after centrifuging, when drilling with a riser. The amount of residual drilling mud that is discharged to the marine environment on cuttings varies depending on the viscosity, mud weight and water repellent nature of the drilling mud.

Drilling mud would be shipped to the drill rig in bulk containers then mixed aboard the MODU. Transfer of drilling mud components between the support vessel and drilling rig has a very low potential for material to be spilled overboard. For a spill to occur there would first have to be an accident involving loss of the container overboard and the container would have to rupture to release the contents. The volume of a spill will be limited by the size of the container being transferred and usually be in the order of 200L drums to 1500L bulk containers.

**Well Completion Fluids**

Well completion fluid is used during drilling of the final stage into the oil-bearing formation. The selection of the correct fluid for drilling operations is especially important because the type of fluid can either benefit the output or damage the well and block the surrounding formation.

Diesel is often used in the well completion fluid, as it is an effective oil based solvent to keep the well surface clean and prevent blocking of the surrounding formation. In addition to diesel, a potassium chloride salt solution (brine) is often used as a weighting agent to maintain pressure on the formation during completion.

### 5.6.2 Potential Environmental Effects

The potential environmental effects associated with the discharge of drill cuttings and muds relate primarily to:

- the toxicity of the drilling fluids;
- increases in turbidity;
- smothering and alteration of sediment characteristics;
- oxygen depletion; and
- leaching of materials from cuttings.

**Toxicity**

Eni plan to use WBMs wherever possible as these have a recognised low toxicity. SBMs may be used but these too are of a relatively low toxicity (Neff *et al* 2000). In either case drilling fluids will be selected on the basis of a low toxicity. Consequently, acute toxic effects are unlikely to be caused by drilling fluid disposal and can only occur where the drilling mud is present in very high concentrations far in excess of that which would occur in field situations.

**Turbidity**

When drill cuttings and adhered muds are discharged into the sea, a turbid patch of water develops and gradually dilutes as it disperses down current, and through the water column. Any increase in water turbidity resulting from the discharge of drill cuttings would be expected to be spatially localised and temporary. This was confirmed during ROV surveys undertaken within days of completion of the exploration drilling of Kitan-1 and Kitan-2 wells (Sustainability 2008a, 2008b, refer to Appendix D). These surveys revealed that the water turbidity was low (i.e. a high water clarity) near the seabed throughout the length of each 50m transect emanating from the well.

Field tests and general observations indicate that discharged drilling fluids settle rapidly and that only a minor proportion remains in suspension (BHPP 1998). This is due to the fact that the thinners added to the muds are rapidly diluted by seawater causing the clays to agglomerate. These larger particles sink rapidly (UNEP 1985).

Although prolonged high levels of turbidity can affect photosynthetic activity, drilling the Kitan wells is not expected to cause major, lasting effects because of the temporary nature of the discharge, the limited area affected, the low biological abundance in the area and the significant water depth and consequently the absence of benthic organisms directly reliant on photosynthesis for survival.

**Smothering and Alteration of Sediment Characteristics**

There is a high likelihood that there will be some localised smothering of the benthic invertebrate communities, particularly during the drilling of the top-hole section when cuttings are discharged directly to the seabed in the immediate vicinity of the drill hole. Smothering of benthos is likely to occur close to the discharge point for drilling of the wells, mainly along the axis of the predominant current. Some habitat disturbance is likely to occur due to the difference in particle characteristics, such as size and abrasiveness, to the existing sediment. However, the severity of this impact will be slight, due to the low toxicity of the seawater and bentonite mud, the short time period, small area potentially affected and the action of water currents in dispersing this material.

To predict the fate of drill cuttings in the environment at the Kitan Oilfield, Eni modelled a $78m^3$ discharge of drill cuttings released at the sea surface from Kitan-1 (Sustainability 2007). The modelling indicated that the majority of cuttings would settle on the seabed within 300m of the well at a low average concentration of $5kg/m^2$ – $10kg/m^2$ and an average thickness of 4mm (Figure 5.12). Additionally, ROV surveys undertaken at the conclusion of the Kitan-1 and Kitan-2 drilling campaigns (Sustainability 2008a, 2008b) observed isolated drill cuttings mounds of between two and 10m high within 50m of the well parallel to the predominant water current direction. Elsewhere, cuttings were not detected. The findings of the ROV survey support the view that impacts on benthic organisms from drilling the Kitan-4 well such as smothering would be localised. The results also support the prediction that drilling the Kitan-4 well would not result in the smothering of fauna inhabiting the Big Bank Shoals located several kilometres to the southwest.

**Oxygen Depletion**

Field studies have demonstrated that where changes in the composition and/or abundance of benthic biota have been observed in, or adjacent to, cuttings piles, these changes have been associated with oxygen depletion in the surface sediments (Neff *et al* 2000). The observed effects usually include a decrease in the number of taxa and biological diversity. However, the total number of individuals and biomass may actually remain constant, or even increase, in some instances.

Oxygen depletion of the sediments is associated with the use of oil-based muds, where the resulting cuttings form agglomerations on the seabed due to the hydrophobic properties of the muds. The use of WBMs and modern SBMs reduces the likelihood of oxygen depletion in the sediments because of their greater hydrophilic properties, ability to disperse in the water column and lower toxicity to benthic fauna that re-work the sediments.

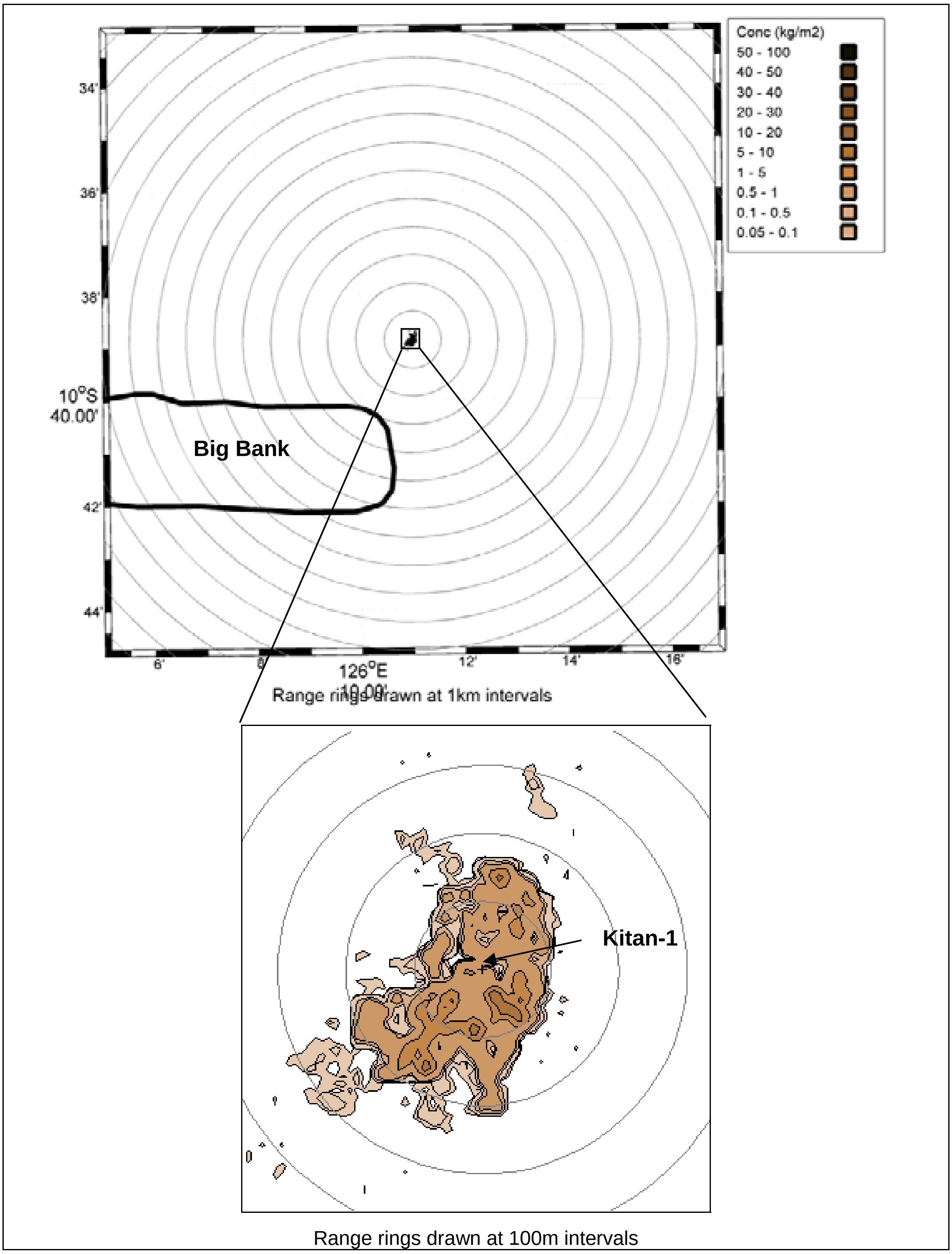



**Figure 5.12 Predicted distribution of drill cuttings during the Kitan-1 drilling campaign (Sustainability 2007)**

**<u>Leaching of Materials from Cuttings</u>**

The heavy metal content of cuttings from individual wells varies considerably based on the characteristics of the host rock and it is therefore difficult to make generalised predictions of metal leaching and its effects (Swan *et al* 1994). The analysis of drill cuttings in other fields (ESSO 1993) has shown that the concentration of metals contained within cuttings is generally within the range of concentrations of typical marine sediments, and it is not anticipated that any significant leachable compounds will be found at Kitan.

Metals in residual drilling mud on cuttings would be transported to the seabed. However, the potential leachate in these muds (i.e. metals) are biologically unavailable or are not in soluble form (with the exception of very minor quantities of formation fluids which may be circulated), and therefore do not constitute a pollution threat (Neff *et al* 2000). Barite and bentonite may contain some heavy metal concentrations, but not in a readily bio-available form. Hydrocarbons may also be present in the cuttings but the volumes of hydrocarbons that may be transported to the seabed via drill cuttings is relatively minor and unlikely to cause any significant environmental effects (Swan et al 1994).

### 5.6.3 Management of Drilling Discharges

Safeguards to protect the environment from the potential impacts of the drilling discharges entail:

- Eni preparing an Environmental Management Plan for the drilling phase of the Kitan Field Development. Eni would consult with regulatory authorities during the development of the EMP and seek acceptance of the EMP by authorities prior to conducting drilling.
- The EMP would include a detailed risk assessment and development of risk registers specific to the Kitan Field Development project.
- Use of low toxicity drilling fluids, comprising seawater and prehydrated gel sweeps for the riserless section of the hole and a PHPA water based gel with KCl for the riser section of the hole.
- Selection of drilling muds based on technical suitability and by having a minimum overall effect on environment (including ecotoxicity and dosing requirement characteristics) where the use of NWBMs is required for technical reasons.
- Whole NWBMs would not be discharged to the marine environment.
- Onboard recovery of muds to minimise discharge of residues on cuttings. Eni would set targets for and measure total surface losses where a NWBM is discharged to ensure cuttings to be discharged have less than 10% by weight associated mud content.
- NWBMs would be shipped back to shore where they would be either returned to the manufacturer for recycling or disposed of in an approved disposal facility.
- Transfer and handling procedures would be in place to ensure that the potential for concentrated mud components being spilled on the rig or during transfer to enter the sea is low.
- Transfer and drainage systems on board the drilling rig. In the event of a spill on board the rig, liquid material would be diverted to drainage sump or slops tank. Dry material would be contained on deck until it can be cleaned up.
- The turbid plume will be minimised by maintaining the cuttings shakers equipment aboard the rig at optimum efficiency.
- Routine checks will be made of the cuttings shakers and other solids control equipment, to ensure that cuttings are not contaminated with oil prior to discharge.
- Well completion fluids will only be used, as required.
- Well completion fluid will be recovered, separated and the diesel component burnt off.
- Only the low toxicity brine component will be discharged.
- Drill rig procedures will ensure that any overboard discharges meet the legislative standards for OIW.

## 5.7 Atmospheric Emissions

### 5.7.1 Source and Characteristics

There are four identified sources of atmospheric emissions, which are:

- flared gas;
- exhaust gas;
- vented gas and fugitive emissions; and
- ozone depleting substances (ODS).

The flaring of production gases releases combustion gases into the atmosphere. Most of these gaseous emissions are in the form of $CO_2$, although smaller quantities of other gases, such as nitrogen oxides (NOx) and carbon monoxide (CO) are generated, with only minimal quantities of sulphur dioxide ($SO_2$), generated owing to the low sulphur content of the oil. The total volume of gas to be flared is reduced by reinjection into the formation to provide gas-lift and through the use of produced gas as a fuel source for machinery aboard the FPSO.

Exhaust gases are produced from running the power plant and machinery on board the FPSO and are ultimately released into the atmosphere. The composition of exhaust gases is similar to those produced from flaring. Eni incorporates exhaust gases into the inert gas system wherever possible.

The processing and storing of crude oil results in the evolution of vapours and gases because low molecular weight compounds are volatised. The principal component of vent gas is volatile organic compounds (VOCs). These volatilised gases may be released to the atmosphere at various stages during processing, on the release of vapours collected in the head space of cargo tanks. Venting from storage tanks is unavoidable and is undertaken as a safety measure. Potentially explosive vapours are displaced from the head-space of storage tanks through the injection of inert gas. The rate of venting to the atmosphere is highest during the filling of the tanks when gases and vapours in the head-space are displaced by crude oil.

ODSs may be present on support vessels required for drilling, installation and decommissioning. There will be no planned discharge of ODS. However halon is used in fire suppression systems and a small volume would be released in the event of a fire.

Table 5.13 summarises the potential air emission types and sources and their significance in terms of greenhouse gas emissions, pollution or ozone depletion.

**Table 5.13 Potential Air Emissions and Sources**

| Gas | Sources | | | | Significance | | |
|---|---|---|---|---|---|---|---|
| | Flaring | Exhaust Gases | Venting and Fugitive Emissions | Refrigerants, Air Conditioning, Fire Suppression | Greenhouse Gas | Air Pollutant / Toxicant | Ozone Depleting Substance |
| Methane | ✓ | ✓ | ✓ | | ✓ (21x $CO_2$-e) | | |
| VOCs | ✓ | ✓ | ✓ | | | ✓ | |
| $H_2S$ | | | ✓ | | | ✓ | |
| $CO_2$ | ✓ | ✓ | ✓ | | ✓ (1x $CO_2$-e) | | |
| NOx (NO, $NO_2$) | ✓ | ✓ | | | | | |
| $N_2O$ | ✓ | ✓ | | | ✓ (310x $CO_2$-e) | | |
| SOx ($SO_2$, $SO_3$) | ✓ | ✓ | | | | ✓ | |
| CO | ✓ | ✓ | | | | ✓ | |
| Particulates/ smoke | ✓ | ✓ | | | | ✓ | |
| Fluorocarbons (CFCs, HFCs, HCFCs, SF, CF) | | | | ✓ | ✓ (560x – 23,900x $CO_2$-e) | | ✓ |

### 5.7.2 Potential Environmental Effects

Air emissions from the Kitan Field Development are considered unlikely to have a significant impact on air quality at the local and regional scales as they are expected to be quickly dissipated into the surrounding atmosphere. Furthermore, the project area is remote from any land mass and far from sensitive receptors.

Therefore, air emissions are not expected to contribute significantly to pollution and the deterioration in air quality.

The most significant aspect relating to air emissions is the project's contribution to greenhouse gases. Greenhouse gases are a natural part of the atmosphere. The earth's atmosphere allows most sunlight (solar short-wave radiation) to enter and warm the earth. As the surface of the earth cools, it emits infra-red radiation (heat) some of which is absorbed by gases in the atmosphere and radiated back to Earth. The main gases responsible for this effect are water vapour, $CO_2$, methane ($CH_4$) and nitrous oxide ($N_2O$) and certain halogenated hydrocarbons.

In recent times, a great deal of effort has been directed at defining the change in atmospheric greenhouse gas concentrations and mean global temperature. The results indicate that since pre-industrial times the concentrations of greenhouse gases in the atmosphere have increased by 30% ($CO_2$), 145% ($CH_4$) and 15% ($N_2O$). Concurrently, since the late 19th century, there has been an increase in the mean global temperature of between about 0.3 and 0.6°C (IPCC 2001).

The global warming potential of different gases varies depending on their particular physico-chemical structure and the time span over which the effect is being considered. In order to be able to compare the effect of different gases the global warming potential (GWP) of a gas is expressed relative to $CO_2$ typically over a 100-year time horizon (referred to as $CO_2$ equivalents or $CO_2$-e). $CH_4$ has 21 times the GWP of $CO_2$, $N_2O$ has 310 and ODSs have between 560 and 23,900 times depending on the particular ODS in question.

The Kitan Field Development is estimated to produce 1.51Mt of GHG from flaring and exhaust emissions during operations over its projected seven year production life (Eni, 2009c and d). Of this, 0.913Mt (60%) are predicted to be produced from exhaust emissions and 0.597Mt (40%) from flaring. Figure 5.13 shows that the contribution to GHG from flaring occurs primarily in the first year and declines sharply in years 2 and 3 (Eni 2009c and d). Negligible quantities of GHG are produced from flaring from years 4 through to 7.

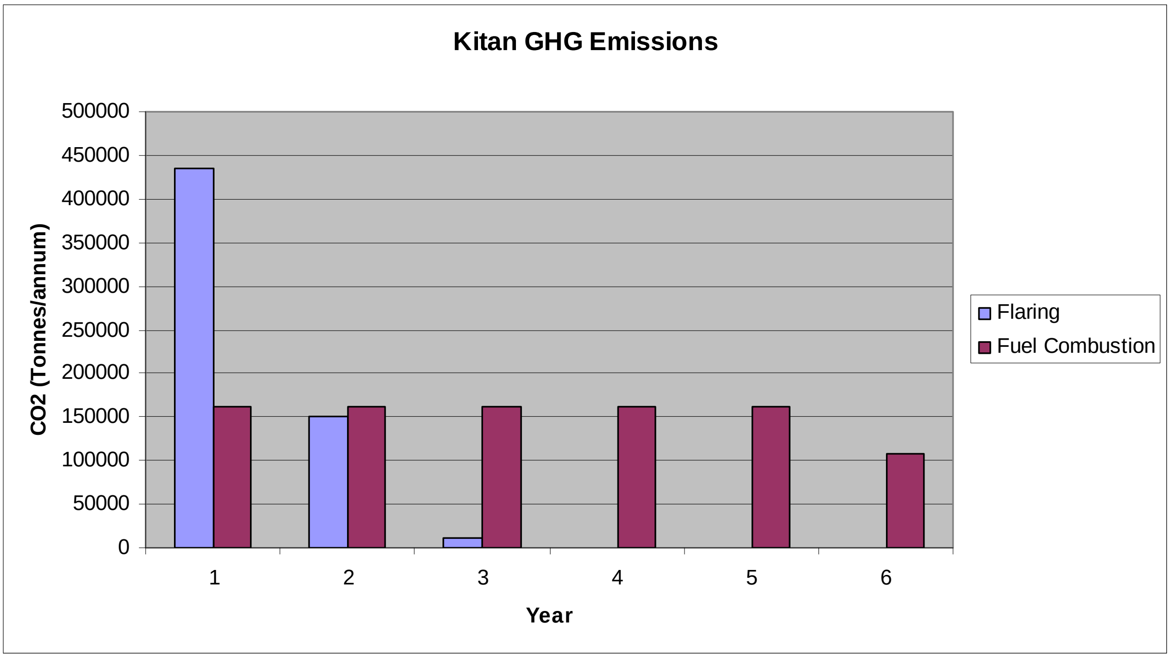



**Figure 5.13 Kitan annual $CO_2$ emission from flaring and fuel gas combustion**

Eni (2009c) investigated produced gas disposal options to compare the flaring base-case with options to re-inject or to pipe to ConocoPhillips' Bayu Undan facility for transport to the mainland. This study indicated that the re-injection option reduced GHG emissions from flaring by 21% and the gas export option reduced GHG emissions by 27%. However, the re-injection option was estimated to increase project capital expenditure by 100% and the gas export option by 160% (Eni 2009c). Based on economic and technical factors, Eni has adopted the flaring option.

Eni (2009d) benchmarked the greenhouse gas production intensity of the Kitan Field Development with other Australian oil production developments, expressed as a greenhouse gas performance indicator (GPI). GPI is expressed as the ratio of GHG emissions to oil production. Figure 5.14 shows that the Kitan Field Development involving flaring is 0.39, which is higher than other Australian developments. However, this should be considered in context with the life of the field. Figure 5.15 shows that the total GHG production of Kitan is lower than that of other fields (where data is available) due to its shorter production life.

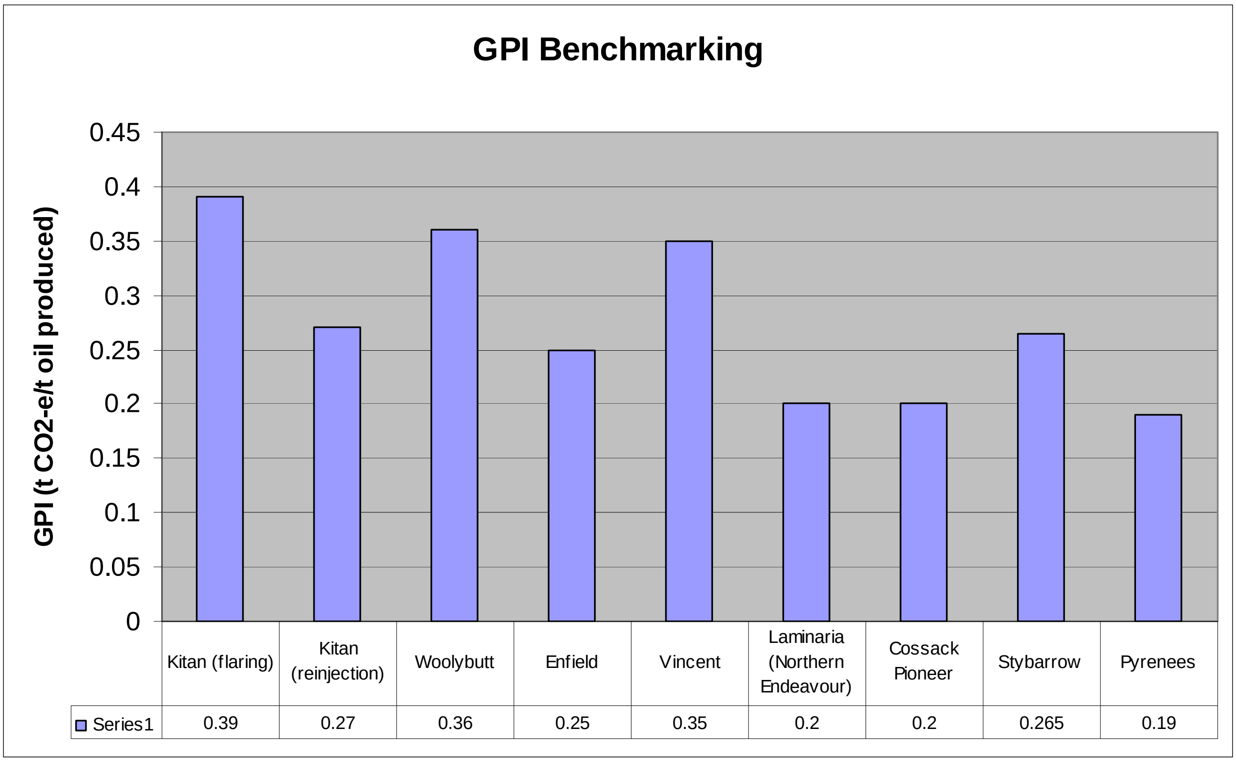



**Figure 5.14: GPI benchmarking for Kitan**

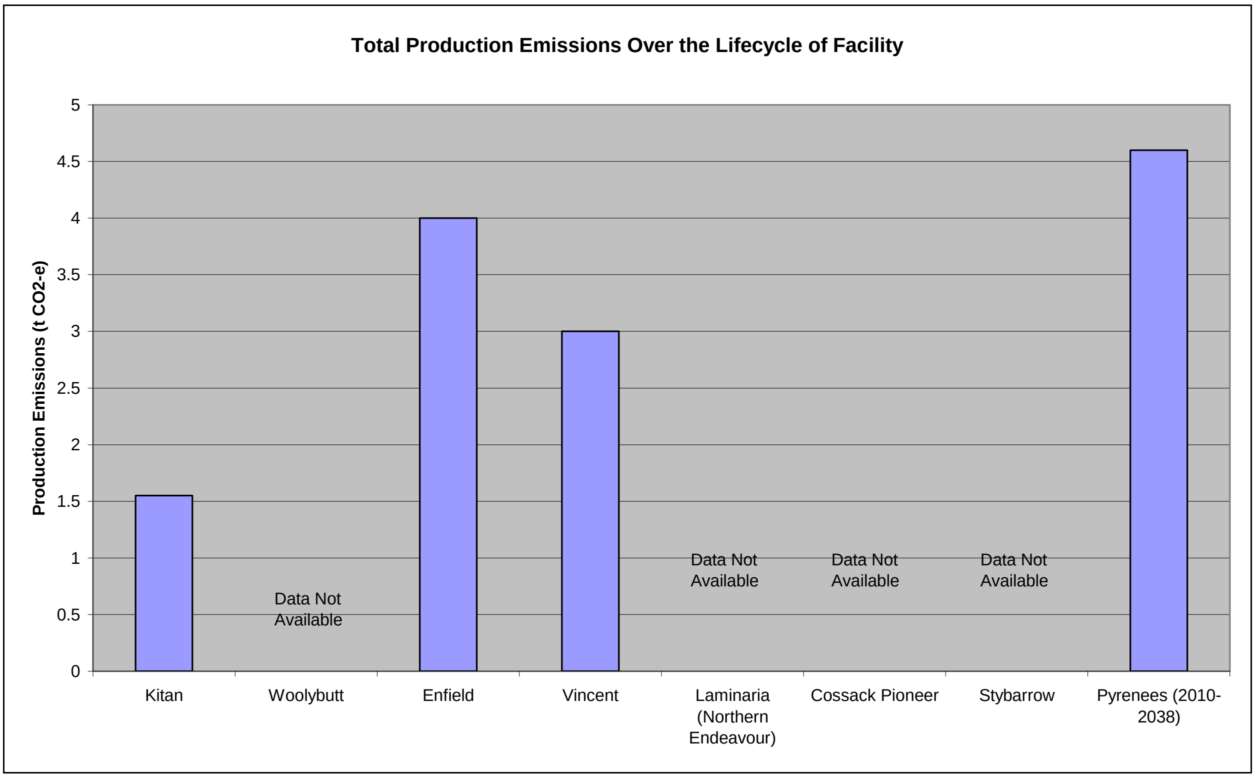



**Figure 5.15: Benchmarking against total production emissions**

### 5.7.3 Management of Atmospheric Emissions Effects

Safeguards that will be adopted to protect the environment from the potential impacts of the atmospheric emissions entail:

- Gas will be used as fuel to run engines, where possible.
- Equipment and machinery will undergo planned maintained to manufacturer's specifications to ensure that it is operating at its optimal efficiency.
- Green burners will be used on flare, ie small droplets that promote complete combustion and consequently low NOx emissions;
- Flare burner characteristics will be optimised to ensure maximum burning of all hydrocarbons.
- Exhaust gas will be rerouted into the inert system (where possible) to maximise the use of gases prior to venting.
- Vent gas from flow lines will be rerouted back to the separation process.
- Fire and gas detection, and shutdown systems will be installed to ensure any unexpected significant leaks of fugitive emissions are quickly detected and rectified.
- There will be no discharge of ozone-depleting substances, except in the case of an emergency.
- Records of flared gas will be maintained.

## 5.8 Solid and Hazardous Wastes

### 5.8.1 Source and Characteristics

Solid and hazardous wastes generated during the development and operation of the Kitan Field Development will include:

- general non-hazardous wastes;
- hazardous wastes;
- production sands;
- separator sludge; and

- maintenance wastes.

General non-hazardous wastes include scrap materials, packaging, wood and paper and empty containers. These non-hazardous waste materials will be stored on board the drilling rig, installation vessels and the FPSO in suitable containers (segregated from hazardous waste materials) ahead of transport back to shore for disposal/recycling in accordance with local regulations.

Hazardous wastes are defined as being waste materials that are harmful to health or the environment. Hazardous wastes generated include recovered solvents, excess or spent chemicals, oil contaminated materials (e.g. sorbents, filters and rags) and batteries. All hazardous waste materials generated will be documented and tracked, segregated from other waste streams and stored in suitable containers. Recyclable hazardous wastes, such as oils and batteries, will be stored separately from non-recyclable materials. All hazardous waste materials will be transported to shore for disposal or recycled at an approved facility in accordance with JPDA requirements.

Production sands are not anticipate. However, provision has been made on the FPSO for sand management if required. Sludges will be stored in suitable containers until the materials are transported onshore for recycling or disposal at approved facilities.

Maintenance wastes include used chemicals, lubricating oils, paint, solvents, rags and other cleaning items. Maintenance wastes will not be discharged to the marine environment but will be stored in appropriate containers until the materials are transported onshore for recycling or disposal at approved and licensed facilities. Waste lubricating oils will either be decanted into the crude oil cargo or be transferred to shore for disposal.

### 5.8.2 Potential Environmental Effects

The effects of discharges of solid or hazardous wastes to the marine environment would vary depending on the nature of the material involved. For example, solid wastes such as plastics are persistent in the environment and have been implicated in the deaths of a number of marine species including marine mammals and turtles. This is due to ingestion, inhalation or physical entanglement.

With the exception of pipe dope, solid and hazardous wastes would be transferred onshore for recycling or disposal. Any release of solid and hazardous wastes into the marine environment would be recorded as an environmental incident and treated accordingly by Eni's incident investigation and corrective and preventative action processes.

Pipe dope is expected to be released to the environment. Pipe dope is considered potentially toxic as it contains toxic heavy metals. However, its impact is considered insignificant based on the very small volumes discharged, and the fact that the metals are usually present as insoluble sulphides or metal granules that have limited bioavailability. The effects of these discharges are expected to be localised and temporary.

With the effective implementation of Eni's policy to transfer solid and hazardous wastes onshore for recycling or disposal, these wastes are not expected to have any impact on the marine environment.

### 5.8.3 Management of Solid and Hazardous Wastes Effects

Safeguards to protect the environment from the potential impacts of solid and hazardous wastes entail:

- A Waste Management Plan will be prepared by the respective contractors for each phase of the project.
- All personnel will be trained in the correct waste management procedures through the induction process.
- Solid and hazardous wastes will not be discharged from any vessels during any phase of the project.
- All hazardous wastes will be segregated into clearly marked containers and stored in a bunded area capable of containing leakage or spillage, prior to onshore disposal.
- Solid and hazardous wastes will be segregated and stored in enclosed areas prior to transfer onshore for recycling or disposal at approved facilities.
- Used sump oil from diesel engines and compressors to be recycled back into the crude oil process.
- Equipment and procedures will be in place to respond to any releases of hazardous wastes.

- The selection of offtake tankers and vessels will include a procedure to ensure compliance to the requirements of MARPOL 73/78 with respect to the handling and disposal of wastes.
- Records will be maintained of solid and hazardous waste volumes generated and transferred for onshore recycling or disposal.

## 5.9 Hydrotesting

### 5.9.1 Source and Characteristics

Following installation, the flowlines would be filled with filtered, chemically-treated seawater and hydrostatically tested for leaks, ensuring the lines are clean and capable of carrying the well product at high pressure to the FPSO. To ensure that the entire lengths of all flowlines and risers are treated with hydrotest water, a slightly greater volume of hydrotest water to the capacity of all lines will be injected. A small volume would be allowed to escape from the downstream end at the wells

On completion of hydrotesting, the flowlines would be dewatered by pumping the hydrotest water to the FPSO slops tank. The hydrotest water would ultimately be discharged to the marine environment along with the general slops water. Consequently, immediately after hydrotesting, the slops tank discharge from the FPSO would be of a different composition from that of normal FPSO operations. The quantities of hydrotest chemicals are likely to be small and would be diluted in seawater in the staged discharges from the FPSO slops tank. This water is gravity separated from oil slops before discharge.

Although the hydrotest water would be flushed to the FPSO, a very small portion of treated test water may be released to the marine environment upon completion of hydrostatic testing in order to reduce the internal pressure to slightly above ambient pressure.

### 5.9.2 Potential Environmental Effects

Hydrotest water is generally treated with additives such as biocide, scale inhibitor and oxygen scavenger to prevent internal corrosion of the flowlines. Environmental issues associated with the discharge of hydrotest water are biocide toxicity (if one is used) and oxygen depletion. The potential impacts of biocide may be minimised by adding only sufficient quantities to kill the bacteria in the filtered seawater without overdosing. Furthermore, the selective use of biocides that biodegrade rapidly and have a low bioaccumulation potential would minimise the impacts of any residual biocide that is released into the environment in the hydrotest water.

The hydrotest water discharge would be partially re-oxygenated using standard industry practices as it falls from the FPSO to the sea surface thereby reducing the potential for seawater deoxygenation from the oxygen scavenger. Dilution, both in the slops tank and upon discharge to the marine environment, would further reduce the potential toxicity of residual biocides and oxygen scavenger.

The impacts of the discharge of hydrotest water are expected to be localised and minor. Hydrotest water would be rapidly dispersed at the sea surface and is only expected to have an impact on planktonic organisms in the immediate vicinity of the discharge plume. Fish and other larger marine fauna are mobile and are expected to remain away from the path of the plume and are therefore highly unlikely to be impacted. The environmental effects of the hydrotest water are expected to be minimal due to the open ocean, rapid dilution in the area and the relatively small quantity of hydrotest water to be discharged.

### 5.9.3 Management of Hydrotesting Effects

Safeguards to protect the environment from the potential impacts of hydrotest water discharge would entail:

- Testing and pre-commissioning systems offsite wherever practicable (e.g. in shipyards where recycling or treatment of appropriate drainage facilities are available).
- Hydrotest chemicals will be reviewed and selected based on having a minimum overall effect on environment (including toxicity, biodegradation and bioaccumulation characteristics).
- Test water would be discharged to the FPSO prior to being discharged to the marine environment in controlled stages to ensure maximum dilution.

- Hydrotest water would be discharged in accordance with an approved Hydrotest Water Management Plan. The Hydrotest Water Management Plan will describe the actual chemicals and quantities to be used, and will address impact minimisation options, including selecting the discharge point and discharge rate to increase the rate of dispersion. The plan will be developed in accordance with World Bank Guidelines on hydrotest water management (IFC 2007) and will be submitted to regulatory authorities for review and approval prior to the commencement of construction.

## 5.10 Deck Drainage

### 5.10.1 Source and Characteristics

Deck drainage consists primarily of rainwater and deck wash-down water. It may include small amounts of detergents, oil and grease, spilt chemicals, used machinery chemicals and dirt from the decks. The volume of drainage likely to be generated is difficult to determine with accuracy as it depends on the rainfall and frequency of deck washing.

Spills on the drill rig deck will be contained and diverted to the slops tank, sump or mopped up to prevent overboard discharge. To achieve this, the drill rig will have scupper plugs available to block overboard drains, as well as absorbent booms and clean-up materials at the ready so that any spill on deck can be rapidly contained. Deck drainage water on the drill rig will be directed to a sump (or similar) which is connected to an oil-water separator. Once separated, the oil and grease will be stored in suitable containers ahead of transfer ashore for recycling, and the treated water will be discharged to sea. This discharge will be monitored for OIW content.

Deck drainage on the FPSO will be separated by bunds from machinery drip pans, oil process areas and chemical storage areas. Deck drainage will be passed through the oil-water separator system and monitored for OIW content before discharge to the ocean. No wastes will be routinely discharged via deck drainage (apart from water-based drilling mud discussed in Section 5.6.1).

### 5.10.2 Potential Environmental Effects

The volume of deck drainage water that is likely to be discharged at any given time is expected to be low. Furthermore, the concentrations of oil, grease and trace metals and other contaminants that could potentially enter the marine environment as a result of deck wash activities are expected to be low. There is unlikely to be a detectable environmental effect due to the expected low volumes of deck drainage in relation to the high dilution rates afforded by the open ocean environment of the Kitan Oilfield.

### 5.10.3 Management of Deck Drainage Effects

The primary mitigation measure is the avoidance of spills through the initial design integrity built into process and utility equipment, materials handling and dropped object studies, and operating and maintenance procedures. Safeguards to protect the environment from the potential impacts of deck drainage include:

- Process areas will be segregated for drainage collection and to restrict contamination of stormwater run-off.
- Routine maintenance and visual monitoring will allow for early detection of leaks, ensuring a quick response to repair leaks on clean up spills.
- Absorbents and containers would be available on the drill rig, installation vessel, FPSO and all support vessels to clean up small accumulations of oil and grease around work areas and decks.
- Deck drains on all vessels will be routed to an oil-water separator and monitored for OIW content prior to discharge. Oily water from FPSO machinery space bilges would be captured and directed to a sludge tank, which in turn drains into a slops tank.
- Process and utility equipment will also be connected to a closed drainage system to allow draining and appropriate treatment of fluids prior to appropriate disposal or re-use. No wastes will be routinely discharged via deck wash-down;
- The discharge of oily water from machinery spaces in the FPSO is regulated by MARPOL 73/78 that requires the OIW content to be less than 15ppm. In this case, the small quantity of machinery space drainage is diluted into a large quantity of formation water (at a normal mixing ratio of 1:99 or greater) prior to discharge, and is therefore regulated as a formation water discharge.

- Deck drainage on trading tankers will be managed to the OCIMF and the International Safety Guide for Oil Tankers and Terminals (ISGOTT) Guidelines to prevent any discharge of oily water.

## 5.11 Laboratory Wastes

### 5.11.1 Source and Characteristics

Laboratory facilities on the FPSO enable operating personnel to carry out analytical checks on samples taken from the various process and utility systems.

### 5.11.2 Potential Environmental Effects

The procedures and design of the facility will be such that the risk of discharge of laboratory wastes is very low. The concentrations of chemicals likely to enter the marine environment, as a result of laboratory activities, are unlikely to cause any detectable environmental effect because of the minor quantities involved. No significant environmental effects are anticipated from this source.

### 5.11.3 Management of Laboratory Wastes

The procedures and design of the facility will be such that the risk of discharge of laboratory wastes is very low. No further management is likely to be required.

## 5.12 Cooling Water and Reject Water

### 5.12.1 Source and Characteristics

Cooling water is usually once-through seawater that does not come in direct contact with production streams. It is used as a heat exchange medium for the purpose of cooling machinery and may contain biocides to control biofouling on the inside of conduction pipelines. The cooling water is then discharged at a temperature higher than that of the ambient seawater (Swan *et al* 1994).

Reject water is seawater that is similarly extracted from the ocean, and is then passed through a reverse osmosis or steam system to obtain freshwater. The residual water is then discharged to the ocean. Reject water is anticipated to be discharged with about 50% higher salinity than ambient seawater.

### 5.12.2 Potential Environmental Effects

Once discharged into the ocean, the cooling water will initially be subject to mixing due to ocean turbulence and some heat will be transferred to the surrounding waters. The plume would then disperse and rise to the ocean surface, where further loss of heat and dilution would occur.

The volume of discharge from the Kitan facility will be small compared to the receiving waters and so the environmental effects of the elevated temperature of discharged waters is therefore predicted to be insignificant due to the large buffering capacity of the ocean. The plume will quickly lose heat and water in only a small area around the outfall will have a substantially elevated temperature (Swan *et al* 1994).

Upon discharge of brine to the sea, the brine is of greater density than seawater and would be expected to sink and disperse in the currents. It is expected that most pelagic species that would occur at the proposed development area would be able to tolerate short-term exposure to the slight increase in salinity caused by discharge of the brine. Both potassium and chloride are common in seawater and so the effect on the marine environment is considered slight.

### 5.12.3 Management of Cooling Water and Reject Water

The discharge of cooling water and reject water is not likely to have a deleterious effect on the surrounding marine environment due to the small volumes involved compared to the open oceanic environment in which the Kitan Field Development is situated. Nevertheless, the waters will be tested at intervals to confirm that there is no contamination with oils or fuels. No other management measures are expected to be necessary.

## 5.13 Sewage, Grey Water and Putrescible Wastes

### 5.13.1 Source and Characteristics

Sewage, grey water and putrescible wastes (those wastes that are liable to decay, i.e. kitchen wastes) will only be released to the sea after the material has passed through a comminuter or grinder such that the material to be released is capable of passing through a screen with openings no greater than 25mm, as per the Interim Regulations (2003). Discharges from the drilling rig and installation vessel will occur during the installation phase only. FPSO sewerage and putrescible discharge will occur on a more or less continual basis throughout the life of the project.

### 5.13.2 Potential Environmental Effects

The primary concerns relating to sewage discharge are increases in nutrient availability and biological oxygen demand (BOD). In the open oceanic environment of the Kitan Oilfield, the effect of the BOD of the effluent on seawater oxygen concentrations around the Kitan facility is predicted to be undetectable (Swan *et al* 1994).

Increased nutrient availability may result in the biostimulation of marine organisms and a slight increase in algal growth in a small area near the outlet. The mass of nutrients to be discharged in sewage on a daily basis is likely to be small and, given the Kitan Oilfield's open ocean environment, rapid dilution of the effluent is expect to result in a highly localised influence. This is not considered to lead to any adverse impacts. The discharge of sewage, grey water and putrescible wastes is not considered to have any potential adverse effects on the marine environment.

### 5.13.3 Management of Sewage, Grey Water and Putrescible Waste Effects

Safeguards to protect the environment from the potential impacts of sewage, grey water and putrescible wastes entail:

- Sewage, grey water and other putrescible wastes such as food scraps from the FPSO and all support vessels would be disposed of in accordance with MARPOL 73/78 Annex IV.
- Sewage effluent on the FPSO will be treated in an extended aeration system and comminuted to pass through a screen of less than 25mm diameter prior to discharge, in accordance with the Interim Regulations (2003).
- All drilling, construction and support vessels would be required to have either a certified sewage treatment plant or sewage treatment facilities. As a minimum, sewage will be macerated to a diameter of less than 25mm and disinfected prior to disposal in accordance with the Interim Regulations (2003).
- Sewage, food scraps or putrescible wastes would not be discharged within 12 nautical miles of land.

## 5.14 Anti-Fouling Biocides

### 5.14.1 Source and Characteristics

Anti-fouling paints are used to coat the bottom of ships to prevent biofouling organisms such as algae and molluscs attaching to the hull and thereby slowing down the ship and increasing fuel consumption. Anti-fouling paints contain the organotin tri-butyl tin (TBT), which is a substance that is designed to be toxic to marine organisms that settle on the hull of a vessel painted with such paints. In 2008, The International Convention on the Control of Harmful Anti-fouling Systems on Ships prohibited the use of such harmful organotins in anti-fouling paints used on ships.

### 5.14.2 Potential Environmental Effects

Given the open ocean location and water depth of the Kitan Field Development, the potential impact of antifouling on the marine ecology of the area is considered to be localised and slight. An impact from antifouling is unlikely to occur and the environmental risk associated with anti-fouling paints is considered to be low.

### 5.14.3 Management of Antifouling Biocides

Anti-fouling methods will be selected according to those with least environmental harm whilst still meeting operational requirements. TBT anti-fouling paints will not be used on any of the subsea structures, drill rig, installation vessel or the FPSO.

## 5.15 Marine Pests

### 5.15.1 Source and Characteristics

Marine pest species may potentially be transported to the proposed development area as a component of ballast water (and associated sediments) or as marine fouling on vessels, the FPSO and subsea facilities. Ballast water would be periodically discharged from the FPSO to the surrounding ocean and from the tankers loading oil from the Kitan FPSO. Ballast water inevitably will contain organisms such as fish, invertebrate larvae and phytoplankton from the location from which the ballast was taken onboard. Similarly, despite the use of antifouling systems, there will inevitably be some degree of hull fouling on drilling and construction vessels, the FPSO and off-take tankers. At greatest risk of hull fouling will be the heavy lift vessel which will be moored off Dili during idle periods of the installation and commissioning phase.

### 5.15.2 Potential Environmental Effects

The successful establishment of an exotic species transported via either ballast or hull-fouling depends primarily on three factors:

- Colonisation and establishment of the marine pest on a vector (vessel, equipment or structure) in a donor region (e.g. a home port, harbour or coastal project site where a marine pest is established);
- Survival of the marine pests on the vector during the voyage from the donor to the recipient region; and
- Colonisation (for example, by reproduction or dislodgement) of the recipient region by the marine pest, followed by successful establishment of a viable new local population.

In terms of the potential introduction of marine pests from ballast water, the Kitan Field Development would not pose any such risk because the Development is located in oceanic waters with a water depth of over 200m. Indeed, the exchange of ballast water in open ocean conditions in water depths greater than 200m is a recommended management measure to minimise the port-to-port transfer of marine pests via ballast water. On the rare occasions when the FPSO is required to move to another location, the ballast waters will be exchanged at sea in open waters. Similarly the shuttle tankers will be deballasting in open waters and not in coastal waters. Thus, the risk of introducing marine pests to the oceanic environment of the Kitan Field Development is negligible.

In relation to hull biofouling, should organisms be dislodged from a vessel at the project site, there is a slight possibility that the organisms may settle on the new substrate provided by the FPSO. Organisms may then transfer from the FPSO to other support vessels. However, the Kitan Field Development is located in deep oceanic water distant from any coastline and environmental conditions at the site are unlikely to be suitable for coastal species. Furthermore, due to the long journey that organisms would have to survive from any given port to the Kitan Field Development site, and the surface currents around the FPSO, the likelihood that any marine organisms could transfer from the FPSO to other vessels and then survive on those vessel long enough to reach coastal waters is remote.

### 5.15.3 Management of Marine Pests

Safeguards to protect the environment from the potential impacts of marine pests would entail:

- Application of Eni's HSE Management Standard for Marine Pests and Quarantine Management (Document No.: ENI-HSE-ST-034) to all vessels used throughout each phase of the project.
- Requirements for each vessel to maintain a ballast water management plan specific for the vessel.
- Requirements for each vessel where ballast discharge is required, to exchange ballast water at sea and in water depths greater than 200m prior to arriving at the Kitan Field Development site.
- There will also be a requirement for the shipping companies to demonstrate to that the vessel hulls have been adequately maintained and are free of biofouling organisms and to maintain a Biofouling Record Book.
- Eni shall vet each vessel, examining the vessel's previous ports of call, patterns of operation and dry-docking/hull inspection and cleaning activities, to determine the risks of introducing marine pests to the Kitan Field Development site.

## 5.16 Physical Disturbance

### 5.16.1 Source and Characteristics

Disturbance to the seabed will occur during the installation as a result of the laying of anchors, pipelines and other subsea structures. The drilling rig will most likely be a semi-submersible MODU, and in order to maintain the MODU in position while drilling, between eight and twelve anchors are dropped and strategically spread out around the rig to a radius of approximately 1km around the MODU. Disturbance of the seabed mainly results during laying and retrieval of these anchors. During laying, the anchor can be dragged along the sea floor by the support vessel as it is transferred to its correct position. However, once the anchor reaches this position it will thereafter only move minimally with the prevailing sea-state.

The flowlines and umbilicals would be laid directly on the seabed and are inherently stable so that trenching or rock-armouring would not be required. Pipe laying and installation of subsea connectors, Christmas trees will impact the sediment substrate directly beneath the structures as they are installed on the sea floor. Due to the soft nature of the sediment, the flowlines and umbilicals are expected to sink into the surface and become partially covered within a short period. Infauna inhabiting the seabed would be expected to re-establish rapidly and any impact is expected to be localised and slight. It is also possible that the installation vessel may be dynamically positioned, avoiding the potential for impacts associated with anchoring.

The presence of the facility and associated subsea structures would cause minor changes to the character of the seabed. These changes would arise from the presence of permanent anchor moorings for the FPSO, subsea structures and flowlines connecting the wells to the central riser location. The presence of these structures may have effects on fish and other biota in the region.

### 5.16.2 Potential Environmental Effects

The effect of anchoring on the soft sediment in the proposal area is considered to be slight as the anchor and anchor chain scars are expected to fill in relatively quickly. Similarly the biological communities associated with deep water, soft sediments are expected to recover quickly from the physical disturbance. There are no known rocky outcrops or areas of hard bottom habitat in the vicinity of the project.

The area disturbed by the FPSO moorings is a very small fraction of the total habitat area and would result in medium to long-term displacement of the benthic community directly beneath the mooring anchors. However, the loss of this small area would not cause any significant impacts to the surrounding environment and the environmental consequences are predicted to be slight.

The presence the subsea structures would provide a hard substrate for the colonisation of fouling organisms. Due to the depth at the site, it is most likely that the subsea facilities providing artificial substrate will only be colonised by local organisms which are able to survive in the surrounding area. This is likely to include attached filter-feeding organisms such as sponges, soft corals, fan corals and whip corals as well as a variety of mobile invertebrates. The presence of structures, and the fouling community, also provides for predator or prey refuges and visual cues for aggregation. The colonised communities are likely to attract a variety of fish that may utilise the newly formed habitat as a source of food and refuge.

The impact of physical disturbance would be restricted to a small area of soft sediment habitat that is widespread in the region inhabited by communities that are likely to have a low sensitivity to physical disturbance. Only localised, temporary effects on benthic communities close to construction areas would be expected to occur.

### 5.16.3 Management of Physical Disturbance

Safeguards to protect the environment from the potential impacts of physical disturbance would entail:

- Use of a semi-submersible rig during drilling activities which minimises the area of direct seabed disturbance to the proposed well, anchor points and chains to the 'touchdown' point.
- Procedures would be implemented for anchor deployment, securing the rig to avoid unnecessary disturbance and to ensure proper chain tension to minimise chain drag along the seafloor.
- The flowlines and umbilicals would be laid directly on the seabed rather than trenched and as such, only a small localised effect on benthic communities is anticipated.
- Selection of an FPSO as opposed to a platform which greatly reduces the footprint of potential seabed disturbance.
- Decommissioning of the FPSO and subsea facilities will be undertaken as per a Decommissioning Plan approved by the relevant authorities.

## 5.17 Noise and Light Disturbance

### 5.17.1 Source and Characteristics

**Noise**

During drilling, installation and commissioning there will be noise emissions from the drilling rig, support vessels, installation vessels, flaring and helicopters. During operations, the FPSO, support vessels, off take tankers and helicopters will continue to generate noise, but to a lesser extent. Noise will be generated above and below the water surface.

At the drilling rig, noise will be emitted from the drill pipes and onboard machinery. McCauley (1998) measured the underwater noise emitted from a drilling rig in the Timor Sea and found the broadband noise level to be approximately 146dB re 1μPa when not actively drilling and 169dB re 1μPa during drilling operations.

The FPSO will emit noise from the machinery onboard, production equipment, flaring and associated subsea equipment. The noise characteristics likely to occur from production are expected to be comparable to that of a similar FPSO (Northern Endeavour). Generally, it is estimated that underwater noise from an FPSO of this design would be audible above background noise at a distance of approximately 10km to 15km in calm conditions, and approximately 2km to 4km in moderately windy conditions. Aside from flaring, the main source of underwater noise from such an FPSO comes from tonal machinery noise in engine spaces, and this is also expected to be the case for the proposed development.

Under normal operating conditions, when idle or moving between sites, the support vessel noise would be detectable only over a short distance. Working support vessels usually maintain position during loading and unloading supplies or during installation activities which means strong forward and reverse thrusts from the engines and bow thrusters for short periods of time. McCauley (1998) measured underwater broadband noise of approximately 182dB re 1μPa from a rig support vessel holding station in the Timor Sea.

Noise emissions can affect marine fauna in the following ways:

- Attraction;
- Increased stress levels;
- Disruption to underwater acoustic cues;
- Behavioural avoidance;
- Hearing impairment and pathological damage; and
- Secondary ecological effect may occur as a result of one or more species influencing another species, e.g. by alteration of a predator/prey relationship.

The frequency of whale, other marine mammals and turtle visitations to the project area is perceived to be low although whales, turtles and dolphins are known to occur within the wider region. Cetaceans are sensitive to sounds below the water surface. For some offshore developments, there is the potential that severe sound waves created from drilling activities could induce stress, and any pulsating or modulating effects may cause abandonment of important habitats, such as calving and nursery sites (McCauley 1994). However, the nearest known whale calving ground to the project, is that of the Humpback Whale over 300km away from Kitan. Therefore any effect on important habitats, such as calving and nursery sites, is highly unlikely. Similarly, turtles would be expected to avoid areas where sound was at such levels long before it caused them any physical harm.

Disturbance to fish is likely to be minimal as fish will be expected to avoid acoustical emissions which attain levels that may cause pathological effects. The levels of noise generated during the proposed development may cause behavioural changes or a masking of other acoustic cues necessary for normal biological or ecological functioning.

The degree of observed effect weakens with depth, with fish below about 200m depth being only mildly affected and the effect is temporary with normal schooling patterns resuming shortly after the noise source has passed. Surface and mid-water dwelling fishes may theoretically be adversely affected by noise generated during vessel movements. However, the clear and abundant presence of fish that accumulate adjacent to operating facilities indicates that they are able to habituate to these noises to no apparent detriment.

**Light**

Lighting would be used by the drilling rig, the FPSO, support and service vessels for safe illumination during all phases of the proposed development. Light would also occur from flaring activity during well testing, commissioning and predominantly over the first two years of oil production. However, as the nearest coastline is approximately 160km from the proposed surface facilities, FPSO lighting and flaring will not be visible at sea level from any mainland or island beaches. Lights on the drilling rig and FPSO are likely to attract marine life and seabirds in the immediate vicinity but the impacts are expected to be slight. It is highly unlikely that there will be any impact on breeding turtles, nesting areas or hatchlings.

Turtles may forage on the reef flats of the Sahul Shelf and have been observed on Big Bank Shoals. However, disturbance to turtles on the Big Bank Shoals may be expected to be negligible because the Kitan FPSO is approximately 6km away, and there are no islands with nesting beaches and no known ‘key’ habitat for turtles in the area. Additionally, turtles are very mobile and although they may pass through the area on their way between feeding grounds, they will only be in close proximity to the proposed development area for a short period and can easily avoid the facilities. The impacts on turtles are thus expected to be slight.

### 5.17.2 Potential Environmental Effects

Noise and light emissions from the proposed development would be localised and so the effects on marine mammals, turtles and fish is expected to be minimal. Further to this, it is important to note that whales, turtles and fish are highly mobile and will temporarily avoid the project area, if disturbed, as a result of drilling operations.

It is also unlikely that seabirds will be affected in any way from light or noise generated by the proposed development. Due to the distance of the proposed development from seabird rookeries, the potential for impacts due to airborne noises from the proposed development is extremely remote.

### 5.17.3 Management of Noise and Light Disturbance

Safeguards to protect the environment from the potential impacts of noise and light disturbance would entail:

- Helicopter flights would be carried out during daylight hours only, except if required during emergencies and training purposes.
- Flight paths would be routed to avoid any sensitive areas, such as shoals or known nesting sites.
- The facility design would consider minimising light spill from the drilling rig, installation vessels and FPSO as much as practical whilst maintaining safety requirements.

# 6.0 SOCIO-ECONOMIC ENVIRONMENT, IMPACTS AND MANAGEMENT

## 6.1 Introduction

Undertaking a Social Impact Assessment (SIA) is not a legal or contractual requirement of the PSC but is part of the standard best practice approach taken by Eni to assess the potential social impacts of a proposed project, in order to mitigate any negative ones and enhance positive impacts.

Eni collected existing socio-economic data for Timor-Leste into a Social Baseline Assessment (SBA) (ERM 2009), which will provide a useful set of baseline socio-economic indicators, from which Eni and others can draw guidance in the implementation of Eni's local content commitments.

It is reasonable to suggest that the impact of the Kitan Field Development will be largely economic, given Kitan's remote offshore location. The project's economic impacts will primarily be:

- macro-economic: through the contributions to Timor-Leste through production share and taxes; and
- micro-economic: through maximising the economic participation of Timor-Leste suppliers and the Timor-Leste labour market in the petroleum operations and associated multiplier effects in the local economy.

This chapter provides an overview of the potential socio-economic influences of the proposed Kitan Field Development on both Timor-Leste and the Northern Territory (Australia). The socio-economic overview describes the context within which the proposed Kitan Field Development will be implemented. The subsequent sections identify positive or negative impacts the development will have on the relevant socio-economic aspect e.g. fishing, shipping, employment, local industry and tourism. Safeguards and management measures are described where applicable. Although the impacts and consequences are described as for all other impacts, where positive impacts are identified, risks are not applicable.

## 6.2 Socio-Economic Profile

### 6.2.1 Timor- Leste

Timor-Leste became independent in May 2002 following nearly two years under United Nations Transitional Administration in East Timor. In mid 2008, the population of Timor-Leste was estimated to be 1.1 million. The current annual GDP in 2008 was estimated to be US$2.526 billion with an annual growth rate of 12.8%. Per capita GDP adjusted for purchasing power parity is estimated at US$2,300. Unemployment in 2006 was estimated to be 20% in rural areas and 40% in urban areas (CIA 2009).

The capital, Dili, on the north coast of Timor-Leste, is serviced by a harbour capable of taking medium sized cargo ships. The airport at Dili is capable of taking medium to large passenger and cargo aircraft (e.g. Boeing 737). The only other airstrip capable of taking similar sized aircraft is that near the town of Baucau, some 100km to the east of Dili. Baucau airport is capable of taking large passenger and cargo aircraft and has been used for military purposes.

Timor-Leste has an agricultural based economy, primarily focused on subsistence farming. In 2008, 90% of the population was dependent on agriculture as a livelihood (CIA 2009). Traditionally, the East Timorese are not fishing people. Most fishing is from canoes or small boats with outboard motors that remain close to shore. Fishing is likely to be seasonal and is frequently undertaken at night or early in the morning. The Government sees great potential to increase income from fishing in the future aiming to increase fishing grounds to about 33 times that of the past. This could increase fishing activities and sea traffic both in deepwater and near coastal areas. Government plans are to increase investment in national fishing capacity and licence foreign vessels. The Government's strategy identified several key fishing areas:

- the inshore reef;
- coastal and Timor-Leste shelf fisheries for demersal and small pelagic species;
- the pelagic fishery for tunas including Yellow Fin and Big Eye;
- reef fish species of the Sahul Bank in the southern region;
- deepwater trawl resources well off the south coast; and
- aquaculture including hatchery and pond production.

Although 90% of the workforce is employed in agriculture, it contributes only 32% to GDP, whereas industry and services account for 13% and 55% of GDP respectively (CIA 2009). The construction industry, and the sector which provides its supplies, is the largest employer in the private wage paying sector. The large contractors are expatriate firms and local contractors are currently only able to pre-qualify for work under US$50,000. The only sector of potential and major significance to Timor-Leste is the oil and gas industry.

Oil and gas revenues underpin the government's routine and development programmes in the absence of any other substantial source of revenue. The oil and gas industry may be expected to provide the following benefits to Timor-Leste:

- expansion of the economy over time due to increased service and supply requirements of the oil and gas industry;
- potential support towards the development of social development initiatives aimed at improving the quality of life of local communities; and
- vocational education and training opportunities to develop a skilled workforce.

The underlying economic policy challenge the country faces remains how best to use oil-and-gas wealth to lift the non-oil economy onto a higher growth path and to reduce poverty. In June 2005, the National Parliament approved the creation of a Petroleum Fund to serve as a repository for all petroleum revenues and preserve the value of Timor-Leste's petroleum wealth for future generations.

### 6.2.2 Northern Territory

Darwin is the capital city of the NT and its proximity to major economic growth areas in the Asia Pacific region means the NT can play a major role in the future of the Region. Darwin is the economic focus for Northern Australia and as a result Darwin's economy closely reflects the economic prosperity of the NT.

NT gross state product (GSP), at about AU$13.4 billion, accounts for about 1.3% of national gross domestic product (GDP). International exports of goods and services from the Territory are an important source of demand, averaging around 40% of Territory GSP for most of the past decade (Northern Territory Government 2009). Key activities in the NT economy include mining, defence, alumina production, liquefied natural gas production and government services. In terms of output, mining is the most significant industry in the Territory, accounting for 26% of GSP in 2006-07.

The significant energy resources in the Territory are oil, uranium, natural gas, LPG and condensate (a light hydrocarbon liquid used to manufacture petrol and petrochemicals often found mixed with deposits of natural gas). The nominal value of energy production is estimated to increase by 2.4% to AU$3.1 billion in 2007-08.

## 6.3 Potential Impacts

### 6.3.1 Socio-Economic Development

Timor-Leste faces considerable challenges in rebuilding its infrastructure and creating employment opportunities for young people entering the workforce. The development of oil and gas resources in offshore waters has begun to supplement government revenues resulting in the creation of jobs.

The PSC for the JPDA-05-106 includes clear obligations for Eni to provide a real opportunity to suppliers based in Timor-Leste and give preference in employment to Timor-Leste nationals and permanent residents. In order to fulfil these obligations, Eni has developed a Local Content Plan for the Kitan Field Development (Eni 2009a). The purpose of this plan is to set out Eni's approach to maximising the use of goods, services and labour from Timor-Leste, associated with the Kitan Field Development and other exploration activities within the contract area JPDA-06-105, in accordance with the provisions of the Production Sharing Contract (PSC).

Eni's commitments towards incorporating local content into the Kitan Field Development include:

- requiring, as a part of the tendering process, for Eni's major contractors to develop local content plans for the training and employment of Timor-Leste nationals and the procurement of goods and services;
- implementing initiatives to develop the capacity of local suppliers;
- providing professional and vocational training of Timor-Leste nationals; and

- preferentially employing suitably skilled and qualified Timor-Leste nationals.

Eni's SBA will be used to review and refine the Local Content Plan. Given the dynamic nature of exploration and production services and labour markets, the SBA and the Local Content Plan would be reviewed on a periodic basis, throughout the project development and execution phase to ensure their currency and relevance. Through the implementation of its Local Content Plant, the impacts of Eni's Kitan Field Development can be expected to be substantial and positive.

### 6.3.2 Traditional and Subsistence Fisheries

Along the north-western coastline of Australia, traditional and subsistence fishing is generally limited to shorelines, creeks and nearshore reefs (Le Provost, Dames and Moore 1997). Traditional Indonesian fishing for shark occurs along the edge of the continental shelf, with fishing usually conducted between April and December. Traditional fishing also occurs along the emergent reefs of the Timor Sea (including Hibernia and Ashmore Reefs and Cartier Island).

Indonesian traditional fishing rights are maintained under the provisions of the 1974 Memorandum of Understanding between Australia and Indonesia. Activities include fin fishing and the collection of trochus shell and sea cucumbers (Heyward *et al* 1997). Regular observations of Indonesian and East Timorese line fishing vessels are made in the region, suggesting that the area may be more heavily exploited than initially considered.

Traditional fishing boats are often observed fishing on Big Bank Shoals around the well head platform of the Buffalo Field. Regular observations of Indonesian and Timor-Leste line fishing vessels are made from the Northern Endeavour. However, there are no known fishing activities in the deep waters of the Kitan Field Development area. An impact on traditional fishing activities is highly unlikely and the risk may be considered to be low.

### 6.3.3 Commercial Fishing

The Kitan Field Development area and shoals immediately to the south lie in a 'zone of overlapping jurisdiction' between Australia and Timor-Leste. The area lies outside the Australian fishing zone and as such there are no Australian commercial fishing activities in the region. Whilst Timor-Leste may exercise EEZ rights for the water column (i.e. fishery resources), Australia may exercise Continental Shelf sovereign rights for the seabed (i.e. resources such as Trochus, Trepang and seabed mineral resources). As a result, any commercial fishing operations in the vicinity of the Big Bank area will be licensed under Timor-Leste law.

In terms of the open sea commercial fisheries, the region is only lightly exploited by longline fishermen, although the level of exploitation is increasing. Shark is the main target species. The shark fin fishery is increasing, with *Charedon spp.* and *Carcharhinus spp.* being the most valued species. The shark fishing grounds are extensive and it is possible the vessels will pass through the region during the April–December period. Other species likely to be targeted by Indonesian fishermen (and Taiwanese with Indonesian endorsement) are tuna and mackerel.

Trawl fishing is commonly undertaken in shallower and inshore areas with the target species being Scarlet and Saddletail Perch, Snapper (*Lutjanidae*) and Emperor Fish (*Lethrinidae*). Trawl fishing is also concentrated in the vicinity of Sahul Bank and Echo Shoals and boats may pass through the area to reach these fishing grounds. However, there are no known trawling activities within the vicinity of the project area.

No Australian commercial fishing zones overlap the Kitan Field Development location. The nearest Australian commercial fishing activities to the JPDA occur in Australian territorial waters to the east and south-east. Commercial fishing in that locality primarily comprises the Shark Fishery, Demersal Fishery (Sea Perch), and Northern Prawn Fishery (Banana, Tiger and Endeavour Prawns).

As the area is not extensively used by fisheries, only minor effects on fisheries are likely to occur, resulting from restricted access to fishing grounds during the life of the project. However, the impact is considered unlikely and the risk low.

#### 6.3.4 Recreational Fishing

The project is located in a very remote area and the deep waters and flat bottom of the project area are unlikely to be of interest to recreational fishing. No known tourist or recreational fishing occurs in the area. Apart from the possibility of occasional passing private motor vessels or yachts, there are no known tourism interests in the area. Impacts on recreational fishing or tourism as a result of the Kitan Field Development are considered unlikely and the risk low.

#### 6.3.5 Shipping

Shipping in the area is light, and there are no designated shipping lanes near the Kitan Field Development area. The major commercial shipping routes through the Timor Sea pass well to the north and south of the permit area. Vessels utilising these routes include bauxite carriers servicing terminals at Gove (Northern Territory) and Weipa (Cape York Peninsula), and coal carriers and container vessels departing Queensland ports for destinations in the Middle East, Europe and South Africa (Le Provost, Dames and Moore 1997).

Vessel movements in closer proximity to the permit areas include those servicing the Challis/Jabiru, Corallina/Laminaria oilfields and Bayu Undan gas field. Other vessels include smaller refined product carriers and coastal ships servicing Western Australian and Northern Territory ports.

Communication will be established with these vessels prior to installation activities and during the life of the project with the intention of planning vessel routes to avoid any potential interference. Strict adherence to marine navigation, communication and safety procedures will be maintained to ensure no risk is presented during all activities.

As shipping in the area is not significant, it is not expected that the development will cause any disruption to shipping activity in the region. Marine safety notices will be issued through AMSA prior to the installation activities commencing and radio contact will be maintained with any vessels in the area. Measures taken to minimise the risk of collisions from shipping will include the designation of a safety zone. This will be in place for the whole of the proposed development and will consist of a 500m radius around any subsurface and surface equipment. The safety zone will appear on Australian navigation charts. Notices will be issued to shipping and appropriate navigation lights and markers will be displayed. Standard marine communications systems will be provided on all facilities.

The impact to shipping from the loss of access to the safety exclusion zone around the proposed development is mitigated by the relatively small size of the exclusion zone. Impacts on commercial shipping are therefore considered unlikely and the risk low.

#### 6.3.6 Amenity, National Parks and Conservation Reserves

There are no national parks (Ramsar) listed areas or other special conservation areas near the development area. Similarly, there are no marine protected areas, areas listed on the Register of the National Estate, shipwrecks or heritage sites.

The distance of the proposed development from shore will avoid any potential impacts to visual amenity and aesthetics from the proposed Kitan Field Development. The choice of an FPSO as the production facility will mitigate the visual impact to any observers, as it will look similar to commercial shipping that already routinely uses the area. Impacts to amenity and conservation reserves may be considered unlikely and the risk low.

#### 6.3.7 Heritage Conservation and Aboriginal Sites

Due to its remote offshore location, there are no known heritage or archaeological sites of significance, shipwrecks or heritage sites in the vicinity of permit area JPDA 06-105. Impacts on heritage sites may be considered unlikely and the risk low.

### 6.4 Summary of Impacts and Management

Table 6.1 presents a summary of the potential impacts of the Kitan Field Development (both positive and negative) and their management.

**Table 6.1: Summary of Socio-Economic Impacts and their Management**

| Aspect | Source | Potential Impact | Predicted Impact and Mitigation |
|---|---|---|---|
| Socio-economic development | Economic flow-on from proposed development | Job creation through demand for labour, services and materials and infrastructure<br>Business opportunities<br>Enhanced community development | Majority of economic impacts are positive. Potential to contribute several million AU$ over the life of the project.<br>***Predicted Impact***: Positive, Medium Term<br>***Consequence***: Substantial<br>***Likelihood:*** Likely |
| Access and Use | Presence of Safety Exclusion zone | Restricted access to:<br>• Traditional Fishers;<br>• Recreational Fishing;<br>• Tourism; and<br>• Shipping and Navigation. | Small localised exclusion area relative to the remainder of the JPDA available for use. Proposed development offshore in deep water, away from areas commonly used. Relatively low use area for shipping.<br>No commercial fisheries currently operate in the area. Low level or no traditional fishing in development area. No known tourism interests in the area.<br>Consultation with relevant Indigenous interest groups (any local Timorese fishers). Marine safety notices issued through ANP and AMSA prior to start of installation activities. Designated safety zone of 500m radius around any subsurface and surface equipment.<br>***Predicted Impact***: Negative, Medium term<br>***Consequence:*** Slight<br>***Likelihood:*** Highly unlikely<br>***Risk:*** Low |
| Amenity, National Parks and Conservation Reserves | Presence of wells and subsea installation | Disturbance of visual amenity<br>Disturbance to conservation values | The area is remote and accessed by few people. The FPSO would resemble a typical bulk carrier. Thus, disturbance of the visual amenity of the area is not a credible scenario.<br>No national parks (Ramsar), listed areas or other special conservation areas occur nearby. Therefore, disruption of the conservation values of the nearest conservation reserves is not a credible scenario.<br>***Predicted Impact***: Neutral, Medium term<br>***Consequence:*** Nil<br>***Likelihood:*** Remote<br>***Risk:*** Low |
| Heritage Conservation, Aboriginal Sites | Presence of wells and sub- sea installation | Disturbance of sites with ethnographic or archaeological significance to the populations of Timor-Leste, Indonesia and Australia. | The area is remote and accessed by few people. No significant wrecks are known in the area. Therefore, disturbance of heritage values is not a credible scenario.<br>***Predicted Impact***: Neutral, Medium term<br>***Consequence:*** Nil<br>***Likelihood:*** Remote<br>***Risk:*** Low |

# 7.0 MANAGEMENT MEASURES AND COMMITMENTS

## 7.1 Environmental Management Framework

### 7.1.1 Guiding Principles

Environmental management of the Kitan Field Development will be conducted within a framework comprising:

- currently accepted best practice approaches to environmental impact assessment;
- a systematic hazard management process, with defined procedures for identifying, assessing, controlling and mitigating hazards and effects; and
- EMPs to be developed and implemented for defined aspects of the Project at appropriate stages and in compliance with applicable legislation.

These guiding principles will drive improvements in environmental performance during the design phase of the Project. The Project will meet minimum environmental standards in line with the above listed documents. Opportunities for improving environmental performance will be pursued at appropriate stages during the Project schedule and in accordance with business requirements.

### 7.1.2 HSE Integrated Management System

The environmental management framework is underpinned by Eni's HSE Integrated Management System (IMS), which incorporates systematic environmental management and controls as part of its standard business processes. Eni's HSE IMS is certified to the ISO 14001 standard and is applied throughout all Eni operations and projects. Eni's management of the Kitan Field Development would be modelled on its successful implementation of management measures and procedures at its Woollybutt development, located on the North West Shelf, Western Australia.

### 7.1.3 HSE Policy

Eni's HSE Policy (Appendix A) has the following general objectives:

- setting health, safety and environmental objectives as an integral part of business activities and decision making;
- promoting best HSE practice throughout Eni's activities;
- setting objectives and targets, implemented through appropriate programmes, thus ensuring the continual improvement in overall HSE performance;
- implementing safe working and fitness to work programmes to pursue the goals of zero harm to the health of, or injury to, people and protects the environment and business assets;
- complying with relevant legislation and other requirements to which Eni subscribes or applies company standards where laws and regulations do not exist;
- assessing and managing HSE risks across each life cycle for all business activities;
- maintaining a documented HSE IMS certified to ISO14001, which enables comprehensive reporting and review of performance;
- including HSE performance in appraisal of staff and contractors;
- preventing pollution and minimising greenhouse gas emissions, effluents, discharges and other impacts on the environment while safeguarding our resources; and
- fulfilling Eni's commitment to sustainable development and the welfare of its host communities.

## 7.2 Environmental Management Plans

Environmental aspects of the Kitan Field Development will be managed primarily through the development and implementation of EMPs for the four phases of the project:

- Drilling;
- Installation and Commissioning;
- Operation; and

- Decommissioning.

An EMP shall be developed for each phase of the project once the detailed design phase has been completed. Each EMP will:

- define Eni's environmental and social performance objectives for that phase of project;
- describe the standards that Eni will adopt to meet its objectives and the criteria by which Eni will measure its performance;
- present Eni's management measures and commitments by which it will fulfil its stated environmental and social performance objectives;
- describe Eni systems and procedures for implementing its management measures and commitments;
- describe the roles and responsibilities of Eni personnel and its contractors in management of the Kitan Project and related operations;
- detail Eni's emergency management and contingency planning in place in the event of an unplanned incident or activity;
- describe Eni's training and competency standards and procedures that ensure that Eni personnel and its contractors are qualified and competent to fulfil their roles and responsibilities;
- detail Eni monitoring and auditing procedures that are intended to reduce environmental risk to ALARP and to ensure that environmental performance objectives are met; and
- describe Eni reporting obligations to both internal and external stakeholders.

## 7.3 Monitoring Programs

### 7.3.1 Environmental Baseline Study

Prior to the implementation of the project, a marine environmental baseline study would be carried out to characterise existing biophysical conditions. The baseline study would measure water and sediment quality characteristics and biota at the FPSO and wellhead locations. Parameters to be measured would comprise:

- water column physico-chemical characteristics such as salinity, temperature, dissolved oxygen and nutrients;
- sediment physico-chemical characteristics such as grain size and total organic carbon;
- potential water column and sediment pollutants such as hydrocarbons and trace metals; and
- water column biological parameters such as phytoplankton abundance and species diversity.

The marine environmental baseline study would be developed in consultation with ANP prior to its implementation.

### 7.3.2 Environmental Monitoring Program

A detailed long-term marine environmental monitoring programme (MEMP) will be developed and implemented in accordance with the *Interim Administrative Guidelines* for the JPDA. The MEMP will be designed to detect any environmental effects of development activities and to provide a feedback system for responding to impacts of concern. In this way, impact may be identified, mitigated and minimised.

Once detailed design information is available for the Kitan Field Development, the monitoring programme will be developed in consultation with ANP and submitted for approval with the EMPs.

### 7.3.3 Operational Monitoring Program

In addition to its environmental monitoring program, Eni would monitor key aspects of its operational processes and activities that could interact with the environment. The operational monitoring program would be developed based on Eni's experience in operating the Woollybutt FPSO on the North West Shelf of Western Australia. The operational monitoring program likely to be employed at the Kitan FPSO, based on that conducted at the Woollybutt FPSO, is shown in Table 7.1.

**Table 7.1: Operational monitoring likely to be employed at Eni's Kitan FPSO**

| Environmental Risk | Criteria to be Monitored | Frequency of Monitoring | Review Period |
|---|---|---|---|
| PFW | OIW content | On going | Quarterly (during the audit process) |
| Production Chemicals | Usage, concentration and total loading | On going | Quarterly (during the audit process) |
| Deck and Production Area | All drainage directed to slops tanks ahead of OIW separators. | Quarterly | Quarterly (during the audit process) |
| Laboratory Wastes | Type, usage, toxicity | Quarterly | Quarterly (during the audit process) |
| Waste Oils and Workshop Chemicals | Usage, disposal paths and destination | Quarterly | Quarterly (during the audit process) |
| Sewage discharge | Correct operation of sewage treatment system | Quarterly | Quarterly (during the audit process) |
| General rubbish disposal | Volume | Quarterly | Quarterly (during the audit process) |
| Hazardous waste disposal | Type and volume | Quarterly | Quarterly (during the audit process) |
| Production sand disposal | Volume | Quarterly | Quarterly (during the audit process) |
| Separator Sludge | Disposal path and destination | Quarterly | Quarterly (during the audit process) |
| Flared gas emission | Volume | Quarterly | Quarterly (during the audit process) |
| Fuel gas usage | Volume | Monthly | Quarterly (during the audit process) |
| Diesel usage | Volume | Monthly | Quarterly (during the audit process) |
| Vented gas and fugitive emissions | Volume | Quarterly | Quarterly (during the audit process) |
| Oil spills | Type and volume | Ongoing | Quarterly (during the audit process) |
| Chemical spills | Type and volume | Ongoing | Quarterly (during the audit process) |

## 7.4 Summary of Management Commitments

Eni is committed to undertaking its petroleum exploration and production activities in a manner that is consistent with the principles of sustainable development. Eni aspires to the goals of zero harm to its people, its host communities and the environment. In keeping with these goals and aspirations, Eni is committed to designing, constructing, operating and decommissioning the Kitan Field Development in a manner that minimises impacts on the surrounding biophysical and social environments.

Eni's commitments for the Kitan Field Development are presented in Table 7.2, which are based on Eni's experience of operating the Woollybutt FPSO in Western Australia. Eni's commitments will be reviewed and revised, if required, as the project concept and design details advance.

**Table 7.2: Summary of Commitments for the Kitan Field Development**

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 1. | Integrated Management System | Provide a risk-based management system for the identification and control of impacts. | • Implement Eni's HSE Integrated Management System for the Kitan Field Development that embraces the ISO 14001 standards. | All Phases |
| 2. | Environmental Management Plans | Provide operational control documentation for the management of environmental impacts associated with drilling, installation and commissioning, production and decommissioning. | • Develop and implement a separate EMP for each phase of project, i.e.:<br>◦ Drilling;<br>◦ Installation and commissioning;<br>◦ Production; and<br>◦ Decommissioning.<br>• The EMPs will incorporate the environmental and social management measures detailed in Chapters 5 and 6 of this EIS where relevant.<br>• The EMPs will be developed in consultation with the ANP. | All Phases |
| 3. | Risk assessment | Ensure project risks are fully identified and understood and management measures and controls are implemented accordingly. | • Conduct detailed environmental and social risk assessments for each phase of the project.<br>• Maintain the findings of each risk assessment in a project Risk Register.<br>• Incorporate any additional management measures identified during the detailed risk assessments into the relevant EMPs. | All Phases |

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 4. | Marine Environmental Monitoring Program | Ensure that Eni's management measures for the Kitan Field Development are effective in minimising environmental harm. | • Develop and implement a marine environmental monitoring program for the Kitan Development.<br>• A baseline study will be conducted prior to the implementation of the Kitan Development project to provide a suitable basis for long-term monitoring (note: this was completed in May 2010 [Gardline 2010]).<br>• The baseline study and marine environmental monitoring program will include measurements of water column and sediment physico-chemical parameters.<br>• The baseline study and marine environmental monitoring program will be developed in consultation with the ANP. | Prior to Drilling |
| 5. | Operational Monitoring Program | Ensure that Eni's management measures for the Kitan Field Development are effective in minimising environmental harm.<br>Ensure that the Kitan Field Development complies with applicable legislation and regulations.<br>Enable the implementation of contingency measures, if required. | • Develop and implement an Operational Monitoring Program for the Kitan FPSO.<br>• The Operational Monitoring Program will be developed in consultation with the ANP. | During Production |
| 6. | Decommissioning | Carry out decommissioning at the end of field life in accordance with legislation and industry guidelines, using technology and best practices in place at that time, with the aim to return the site to as near as practicable original conditions. | • Develop and implement a detailed Decommissioning and Abandonment Plan will be prepared and submitted to the relevant authorities prior to commencement of decommissioning activities. | Prior to decommissioning |
| 7. | Socio-economic development | Ensure that opportunities for Timor-Leste businesses and communities are maximised in line with Eni's resource requirements for the Kitan Field Development. | • Implement Eni's *Local Content Plan* (Eni 2009a) for the Kitan Field Development.<br>• Periodically review the Kitan Field Development baseline socio-economic assessment and update the *Local Content Plan* as required.<br>• Conduct ongoing stakeholder consultation to identify opportunities and build capacity to source goods, materials, services and labour from Timor-Leste during the life of the development. | All Phases |

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 8. | Emergency Planning and Response | Ensure that adequate emergency response procedures and resources are in place to minimise the environmental impacts of an incident e.g. oil spill. | • Develop and implement an Incident Management Plan (IMP) and an OSCP for the Kitan Field Development.<br>• The IMP and OSCP will be developed in consultation with the ANP, Eni's contractors, other petroleum operators in the region and appropriate emergency response authorities and resource centres.<br>• The IMP and OSCP will be tested and reviewed at least once during the drilling and installation and commissioning phases of the project.<br>• The IMP and OSCP will be tested and reviewed annually during the production phase of the project. | All Phases |
| 9. | Training and awareness | Ensure that all personnel are aware of their responsibilities towards the management of environmental and social impacts. | • Provide training to all Eni and contractor personnel on the requirements of Eni's Environmental Management Plans, specifically<br>◦ the environmental and social sensitivities of the project;<br>◦ Eni's management objectives and commitments; and<br>◦ obligations of all personnel towards the management of impacts in their areas of responsibility.<br>• Provide training to all Eni and contractor personnel on Eni's OSCP. | All Phases |
| 10. | Auditing | Ensure that Eni's environmental and social performance objectives for the Kitan Field Development are met. | • Conduct environmental compliance audits against the drilling and installation and commissioning EMPs at least once during these project phases.<br>• Conduct environmental compliance audits against the production EMP at least annually during the production phase of the project.<br>• Conduct compliance audits annually against the Local Content Plan. | All Phases |

| No. | Topic | Objective(s) | Management Action | Timing |
|---|---|---|---|---|
| 11. | Stakeholder consultation | To maintain open and transparent communication between Eni and its stakeholders. | • Consult with stakeholders throughout the development of the project EMPs and the Local Content Plan.<br>• Deliver a presentation on the project operations to the key stakeholders at least once a year. | All Phases |

## 8.0 REFERENCES

ADIOS2 (Automated Data Inquiry for Oil Spills). http://response.restoration.noaa.gov

AUSGEO (2003). Issue No. 69 Timor Sea Activity, March 2003.

BHPP (1987). Challis Preliminary Environmental Report. Report by BHP Petroleum.

BHPP (1998). EKKN Development Final Environmental Assessment Report. Report by BHP Petroleum.

BOM (2010). Bureau of Meteorology. Commonwealth of Australia. Website: http://wwww.bom.gov.au

Caton A. and McLoughlin K. (1999). *Resource assessments of Australian commercial fisheries, Fishery Status Reports 1999*. Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry.

CIA (2009). Central Intelligence Agency – The World Factbook. Website: www.cia.gov/library/publications/the-world-factbook

CMPT (1999). A Guide to Quantitative Risk Assessment for Offshore Installations. Centre for Marine and Petroleum Technology (CMPT), 1999.

CONCAWE (1996). Gas Oils (Diesel Fuels and Heating Oils). Product Dossier No. 95/107, CONCAWE, Brussels.

Connell, D W and Miller, G J (1981) Petroleum Hydrocarbons in Aquatic Ecosystems – Behaviour and Effects of Sublethal Concentrations. CRC Report: Critical Reviews in Environmental Controls.

Cresswell G, Frifche A, Peterson J and Quadfafel D (1993). Circulation in the Timor Sea, Journal of Geophysical Research, 98:369-379.

CSIRO (1999a). Survey And Stock Size Estimates Of The Shallow Reef (0-15m Deep) And Shoal Area (15-50m Deep) Marine Resources And Habitat Mapping Within The Timor Sea Mou74 Box Volume 1: Stock Estimates And Stock Status. Commonwealth Scientific and Industrial Research Organisation.

CSIRO (1999b). Survey And Stock Size Estimates Of The Shallow Reef (0-1m Deep) And Shoal Area (15-50m Deep) Marine Resources And Habitat Mapping Within The Timor Sea Mou74 Box Volume 3: Seabirds And Shorebirds Of Ashmore Reef. Commonwealth Scientific and Industrial Research Organisation.

Danish Environmental Protection Agency (2001). Environmental and Health Assessment of Substances in Household Detergents and Cosmetic Products. Danish Environmental Protection Agency Report No. 615-2001.

Department of Environment, Water, the Arts and Heritage (2010). Protected matters search tool. Australian Government. Viewed 11 May 2010 at: <http://www.environment.gov.au/erin/ert/epbc/index.html>.

DEWHA—see Department of Environment, Water, the Arts and Heritage.

Dunlop, N.J., Surman, C.A. and Wooler, R.D. (1995). Distribution and abundance of seabirds in the Eastern Indian Ocean: an analysis of potential interactions with the offshore petroleum industry. A report to the Australian Petroleum Production and Exploration Association.

Edgerley DW (1974). *Fossil Reefs of the Sahul Shelf*. Proceedings of the Second International Coral Reef Symposium, Brisbane.

Eni (2007). *External Relations and Stakeholder Management Plan*. Document reference ENI-000-PG-0014. Eni Australia Limited, Perth, Western Australia.

Eni (2009a). *Kitan Development Local Content Plan.* Document reference 0000177_DV_CS.DPM.0017.0000.01. Eni JPDA 106-05 Pty Ltd, Perth, Western Australia.

Eni (2009b). *Kitan Development Project Stakeholder Management Plan*. Document reference 0000177_DV_CS.DPM.0010.000_01 Eni JPDA 106-05 Pty Ltd, Perth, Western Australia.

Eni (2009c). *Kitan Field Development Gas Disposal Study*. Document reference 007105.00.D.P.RV.00053 Eni JPDA 106-05 Pty Ltd, Perth, Western Australia.

Eni (2009d). *Kitan Project Greenhouse Gas Performance Benchmarking*. Document reference 000177_DV_CD.HSE.0200.000_01 Eni JPDA 106-05 Pty Ltd, Perth, Western Australia.

Eni (2010). *Kitan EnvId Report* (draft). Eni JPDA 106-05 Pty Ltd, Perth, Western Australia.

ERM (2009). *Social Baseline assessment for Eni Timor-Leste (Draft)*. Unpublished report prepared by Environmental Resources Management for Eni JPDA 06-105 Pty Ltd, Perth, Western Australia.

ESSO (1993). *West Tuna Offshore Oil and Gas Development Environmental Plan*. ESSO Australia Pty Ltd and BHP Petroleum Pty Ltd.

Frost, T K, Smith, A T, Johnsen, S and Reed, M (1998). Experiences and challenges in aquatic risk assessment of environmental realistic concentrations of complex wastewater. SPE Paper 46848. SPE Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Venezuela, 1998.

Fugro (2008). *Field Report on the Kitan Field Development Project – Geophysical Surveys 2008*. Unpublished report prepared for Eni-JPDA-06-105 Pty Ltd, Perth, Western Australia. Report No. CS2008-700032.

Gardline Marine Sciences Pty Ltd (2010). *Kitan Field Development Environmental Monitoring Program; Environmental Baseline Report*. Prepared for Eni JPDA 06-105 Limited. Perth, Western Australia. Report No. 00177_DV_CD.HSE.0209.000_01

Heyward, A. J. and Smith, I. D. (1996). *Analysis of Timor Sea Macrobenthos from ROV Video – Bayu-Undan*. Produced at the request of BHP Petroleum Pty. Ltd. By the Australian Institute of Marine Science, Dampier, Western Australia: in Leprovost Dames and Moore (1997), Appendix C.

Heyward, A., Pinceratto, E. and Smith L. (1997). Big Bank Shoals of the Timor Sea: an Environmental Resource Atlas. Brisbane.

Hinwood, J.B., Potts, A.E., Dennis, I.R., Carey, J.M., Houridis, H., Bell, R.J., Thompson, J.R., Boudreau, P. & Ayling, D.M. (1994). *Environmental Implications of Offshore Oil & Gas Development in Australia – Drilling Activities*. In Swan, J.M., Neff, J.M. & Young, P.C. (eds). Environmental Implications of Offshore Oil & Gas Development in Australia – Findings of an independent scientific review. Australian Petroleum Exploration Association, Sydney.

IFC (2007). *Environmental, Health, and Safety Guidelines for Offshore Oil and Gas Development*. International Finance Corporation, World Bank Group.

Intertek (2008). Kitan-1 oil assay. Unpublished report for Eni Australia Limited

IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell and C.A. Johnson (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.

ITOPF (2002). Technical Information Paper. Fate of Marine Oil Spills. www.itopf.com

Kagi, R.I., Fisher, S.J. and Alexander, R. (1988). Behaviour of Petroleum in Northern Australian Waters. In: Purcell, P.G. and R.R. (eds). Proceedings North West Shelf Symposium Perth, WA.

Lavering, I. H. (1993). Quaternary and Modern Environment of the Van Diemen Rise, Timor Sea and the Potential Effects of Additional Petroleum Exploration Activities. Journal of Australian Geology and Geophysics 13: 281-292.

Le Provost, Dames and Moore (1997). *Bayu-Undan Field Development Preliminary Environmental Report.* Prepared for Phillips Petroleum Company and BHP Petroleum.

Marsh, I.M and Marshall, J. I. (1983). Some Aspects of the Zoogeography of North-Western Australian Echinoderms. Bulletin of Marine Science 33(3)671:687.

McCauley. R.D. (1994). *The Environmental Implications of Offshore Oil and Gas Development in Australia - Seismic Surveys*. In: Eni Energy Ltd, Mescal 3D Marine Seismic Survey. Sunrise/Troubadour Environment Plan, April 2000

McCauley, R.D. (1998). Radiated Underwater Noise Measured from the Drilling Rig Ocean General, Rig Tenders Pacific Ariki and Pacific Frontier, Fishing Vessel Reef Venture and Natural Sources in the Timor Sea, Northern Australia. Report prepared for Shell Australia, Melbourne, July 1998.

Metzger, B.H., Salmond, D., and Tilstone, A. (2010). *FPSO Environmental Risk Management*. SPE Economics and Management. Society of Petroleum Engineers.

Neff, J.M., S. McKelvie and R.C. Ayers, Jr. (2000). *Environmental impacts of synthetic based drilling fluids.* Report prepared for MMS by Robert Ayers and Associates, Inc. August 2000. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-064. 118 pp.

Neff, J.M. (2002). Bioaccumulation in Marine Organisms. Effects of contaminants from oil well produced water. Elsevier.

Northern Territory Government (2009). 2008-09 Budget. www.nt.gov.au.

OGP (2002). Aromatics in Produced Water: Occurrence, Fate and Effects, and Treatment. Report No. 1.20/324, International Association of Oil and Gas Producers, London.

OGP (2010). Risk assessment data directory: Blowout frequencies. Report No. 434-2. International Association of Oil and Gas Producers, London.

Patin, S (1999). Environmental Impact of the Oil and Gas Industry. Chapter 7: Ecological and Fisheries Implications of Offshore Oil and Gas Development. Pp 303-359. EcoMonitor Publishing, New York.

Pinceratto, E.J. and Oliver, G. (1996). Cooperative Industry Approach to Environmental Investigations in the Timor Sea. APPEA Journal 36.

Saipem Energy Services (2009). Kitan Field Development Project Metocean Design And Operational Criteria. Doc. A-050-GR-71500 Rev 0. Unpublished report prepared by Saipem Energy Services for Eni JPDA 06-105 Pty Ltd, Perth, Western Australia.

Sinclair, Knight and Merz (1995). *Environmental Baseline: Laminaria Field and Adjacent Reefs of the Sahul Shelf.* Prepared for Eni Offshore Petroleum by Sinclair Knight Merz, July 1995.

Somerville, H J , Bennett, D, Davenport, J N, Holt, M S, Lynes, A, Maheiu, A, McCourt, B, Parker, J G, Stephenson, R R, Watkinson, RJ and Wilkinson, T G (1987). Environmental effect of produced water from North Sea oil operations. Marine Pollution Bulletin 18(10): 549– 558.

Sustainability (2007). Kitan-1 Drilling Cuttings Modelling Report. Unpublished report prepared by Sustainability Pty Ltd for Eni JPDA 06-105 Pty Ltd, Perth, Western Australia.

Sustainability (2008a) Kitan-1 Exploration Drilling ROV Environmental Survey. Unpublished report prepared by Sustainability Pty Ltd for Eni JPDA 06-105 Pty Ltd, Perth, Western Australia.

Sustainability (2008b) Kitan-2 Exploration Drilling ROV Environmental Survey. Unpublished report prepared by Sustainability Pty Ltd for Eni JPDA 06-105 Pty Ltd, Perth, Western Australia.

Sustainability (2010). Kitan Oil Spill Risk Assessment Modelling. Unpublished report prepared by Sustainability Pty Ltd for Eni JPDA 06-105 Pty Ltd, Perth, Western Australia.

Swan, J.M., Neff, J.M. and Young, P.C. (eds.) (1994). *Environmental Implications of Offshore Oil and Gas Development in Australia, the Findings of an Independent Scientific Review*. Australian Petroleum Exploration Association (APEA), Sydney.

Tranter, D. (1962). Zooplankton abundance in Australasian Waters. Australian Journal of Marine and Freshwater Research 13(2):106-142.

UNEP (1985). *The Impact of Water Based Drilling Mud Discharges on the Environment*. United Nations Environmental Programme Report.

Wijffels, S.E., Bray, N., Hautala, S., Meyers, G. and Morawitz, W.M.L. (1996). The WOCE Indonesian Throughflow Repeat Hydrography Sections: I10 and IR6. WOCE, 24.

Wilson, B.R. and Allen, G. (1987). *Major Components and Distribution of Marine Fauna*. In: Fauna of Australia, Vol 1a - General Articles. Australian Government.

World Wildlife Fund (2010). *Coral Triangle*. Viewed online 21 May 2010 at: <http://wwf.panda.org/what_we_do/where_we_work/coraltriangle/coraltrianglefacts/>.

WWF—see World Wildlife Fund.