Statoil

Environmental Impact Study for the Block 39 Exploratory Drilling Project

FINAL REPORT

August 2013

ERM

HOLÍSTICOS
CONSULTORIA AMBIENTAL

Technical Sheet

Title:

Environmental Impact Study for the Block 39 Exploratory Drilling Project.

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Date:

August 2013

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CHAPTER 1

INTRODUCTION

1. Introduction

This chapter introduces the Environmental Impact Study (EIS) for Statoil's Block 39 Exploratory Drilling Project. This chapter explains how the project fits into the wider context of the oil and gas sector in Angola (Executive Decree 92/12). It also discusses the objectives and scope of the study, documents the baseline, sets the areas of influence of the project, describes the EIS team and lays out the structure and contents of the report. Information on the assessment methodology, including monitoring and managing impacts, and an illustration of the regulatory-driven EIS process is also provided herein.

1.1. Background

Angola is a sub-Saharan West African country with an area of 1,246,700 km^2 and has an estimated population of approximately 20 million inhabitants (INE – *Instituto Nacional de Estatística*, 2012). It is bound by Namibia to the south, Zambia to the east, Democratic Republic of the Congo to the north and northeast, and the Atlantic Ocean to the west.

The Angolan economy is dominated by the oil and gas sector, which accounted for approximately 47.06% of Angola's Gross Domestic Product (GDP) in 2011[1]. Angola is the second largest producer of oil in sub-Saharan Africa (after Nigeria) and the lifetime of its oil reserves, previously estimated at 20 years (approximately 5.4 billion barrels), was increased to 50 years with the discovery of the pre-salt layer (approximately 13.5 billion barrels).

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[1] *Banco Nacional de Angola*, 2012 accessed from http://www.bna.ao

Since January 2011, Sonangol has promoted bids and has executed agreements with several international oil companies to award exploration rights in 11 blocks, paving the way for major exploration efforts in the West Africa subsalt region. According to the Ministry of Petroleum, Angola forecasts an increase to 2 million bbl/d due the new fields coming online by 2014[2].

Statoil is a Norwegian company present in Angola for more than 20 years, with established partnerships with other operators in Blocks 4/05, 15, 15/06, 17 and 31 (Figure 1.1). Statoil contributes approximately 10% of the total oil production in Angola. Angola is a very important country of operations for Statoil (around 200,000 bbl/d), and responsible development of resources in the country is considered a top priority for the company.

In December 2011, Statoil was awarded by Sonangol 55% operatorship for pre-salt Blocks 38 (China Sonangol is a partner with 15% interest) and 39 (Total as partner with 15% interest), and partner position with 20% interest in Blocks 22 (Repsol as the operator with 30% interest), 25 (Total as operator with 35% interest and BP as partner with 15% interest) and 40 (Total as operator with 50% interest). Sonangol carries interest of 30% in all blocks during the operation phase. Statoil's technical and subsurface competence, experience in international deep water exploration and established track record in planning and executing large complex offshore projects will be beneficial in unlocking the exploration potential of this pre-salt play.

[2] *http://www.ogl.com/articles/2012/01/angola-sees-oil-production-rise-to-million-bd-in-2014.html*

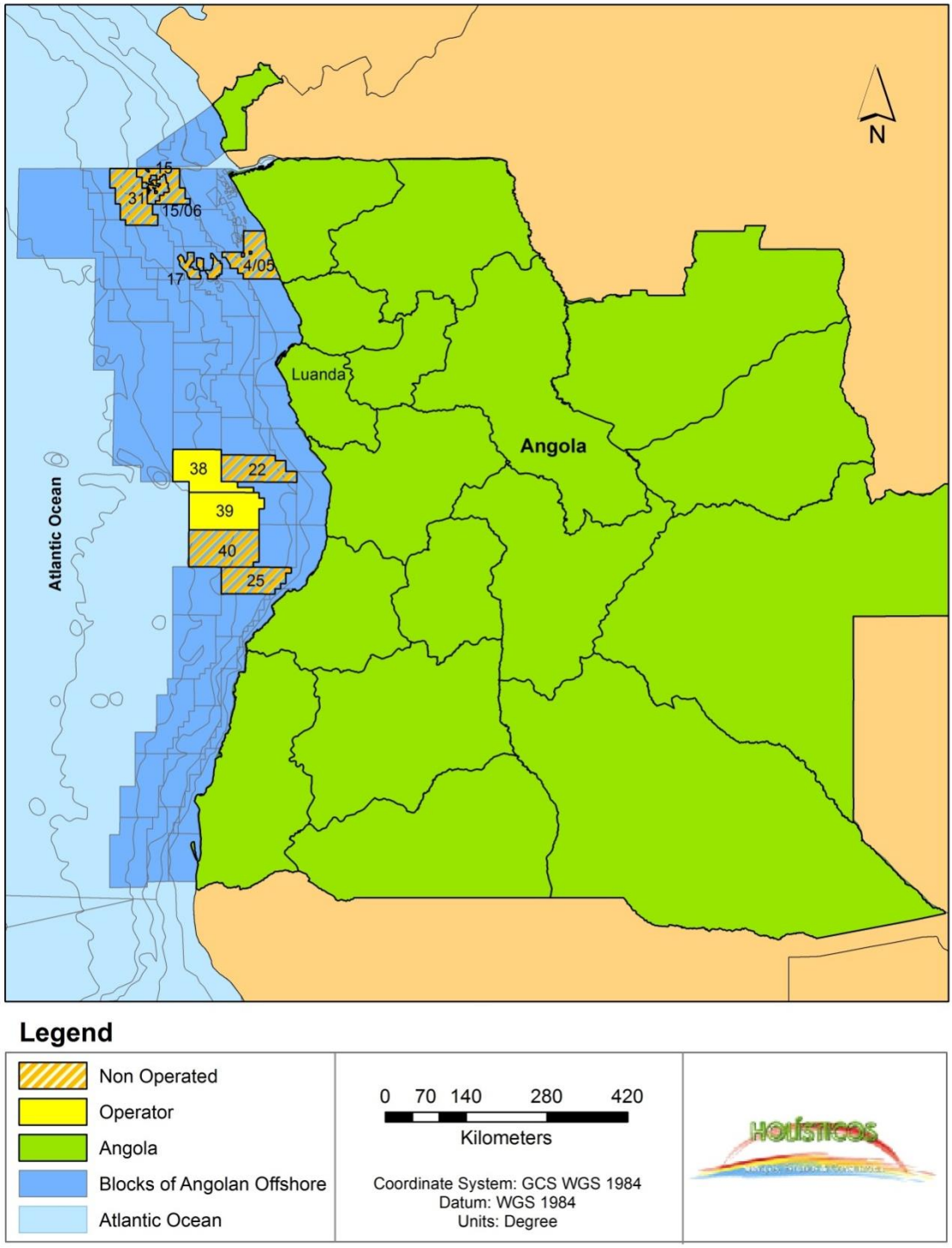

Figure 1.1. Statoil presence in Angolan offshore.

Statoil Angola 39 AS, hereafter referred as Statoil Angola or simply Statoil, plans to begin an exploratory drilling campaign in Block 39 in Q1 2014. The Block 39 Exploratory Drilling Project (hereafter referred to as the "Project") comprises the drilling program consists of up

to five (5) exploratory wells and addition appraisal wells intended to confirm the presence of hydrocarbons. Project description details are captured in *Chapter 3*.

1.2. **Project Site**

Block 39 is located in Benguela Basin, approximately 300 km southwest off Luanda's coastline and about 110 km west off Sumbe's coastline. The block covers an area of 7,809 km^2 and has water depths ranging from 1,500 m to 2,500 m. The location of Block 39 in relation to the coast of Angola and other offshore exploration blocks is shown in Figure 1.2.

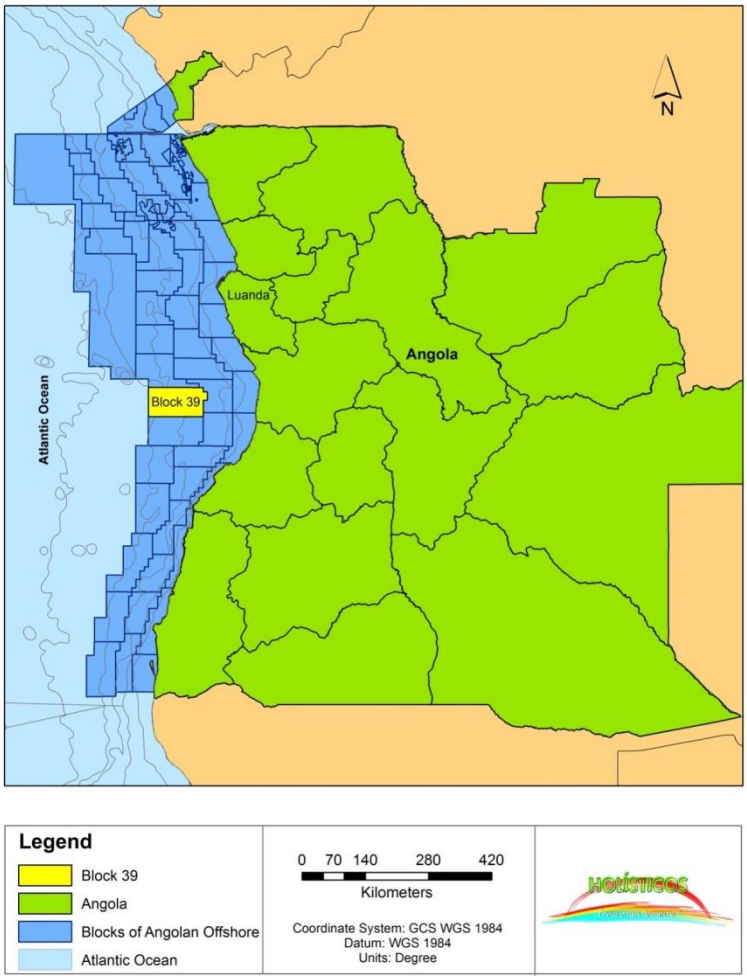

Figure 1.2. Block 39 and others Angola's offshore blocks

1.3. Purpose and Scope of the EIS

In order to conduct the EIA process and to develop the EIS report required for securing a Block 39 environmental license, Statoil retained the services of **Holísticos – Serviços, Estudos e Consultoria, Lda.** (Holísticos), an Angolan firm with the required license to undertake the EIS (see Section 1.5) and **Environmental Resources Management (ERM)**.

This EIS is developed per Angolan legislation. Its content accounts for recommendations from multilateral environmental agreements ratified by Angola and it is aligned with Statoil Health, Safety and Environment (HSE) policy.

The compilation of this study was based on Decree no. 51/04 (Article 9), which regulates the process for undertaking environmental impact assessments. We also accounted for Decree no. 39/00, on Impact Assessments for the Petroleum Industry and Decree no. 59/07 on Environmental Licensing Procedures when completing this study. We also considered the Terms of Reference developed by the Ministry of Environment for the oil and gas sector, particularly the ones related to offshore drilling activities. *Chapter 2* further describes the regulatory framework and supporting legislation related to impact assessment.

This EIS follows a systematic process to characterize the Project and evaluate potential impacts the proposed Project may have on aspects of the physical, biological and socio-economic environment.

This document identifies measures that Statoil will take to avoid, reduce, remedy, offset or compensate for potentially adverse impacts, and to enhance potential benefits, as practicable. The Scope of this EIS includes the following:

- To document baseline conditions of the physical, biological and socio-economic components of the Study Area;

- To characterize activities of the Project in order to identify the potential environmental and social aspects and impacts;
- To evaluate potential adverse impacts of the proposed limited geophysical and geotechnical surveys;
- To propose mitigating, management and monitoring measures to address the identified potential impacts; and
- To satisfy the EIS requirements of Angola.

Aspects and studies related to geophysical and geotechnical surveys, third parties onshore bases and any activity conducted outside of Angola are not included in this scope of work.

The consultants (Holísticos and ERM) have developed this report based on readily available and credible desktop data. No primary data collection was carried out; however, commitments for environmental baseline surveys before drilling operations have been included in this EIS report.

1.4. **Areas of Influence**

Defining the areas of influence of the proposed project is one of the initial stages of the Environmental Impact Study, since it establishes the geographical limits among the areas that can be positively or negatively affected, therefore providing the guidelines for the Environmental Impacts Study. For the drilling project in Block 39, areas that are susceptible to impacts as a result of the project´s activities have been defined based on the physical and biological environment and the social aspect within and around the project´s area. For the physical and biological environment were considered the oceanographic and coastal aspects such as the biological resources and water parameters , concerning the social aspects was considered the eventual changes in the quality of human life that are found in the directly and indirectly affected areas. The following areas are applicable to the Project:

- ✓ Directly Affected Area (DAA);

- ✓ Area of Direct Influence (ADI);
- ✓ Area of Indirect Influence (AII).

1.4.1. **Directly Affected area**

This Directly Affected Area (DAA) of the project was defined as the area within Block 39 that will be affected by the direct footprint of the project. This includes the area where the drilling units, the subsea operations and the wells will be implanted. That is approximately 110 to 250 km west of the Angolan coast, and about 240 km to 390 Km south-southwest of Luanda, Angola as illustrated in Figure 1.2.

1.4.2. **Area of direct influence**

The Area of Direct Influence (ADI) was defined as the areas subject to the direct impacts, both negative and positive likely to be caused by the project's activities. For the referred Block 39 the ADI was considered to be those within a radius of 10 km from the project's area, these include points where cuttings, mud and sand will be discharged, the physical presence of supporting vessels and helicopters in the vicinity of the project and possibly nearby oil and gas operation structures. Existing offshore activities around ADI that may have some interaction with the proposed exploratory drilling program in Block 39 include oil and gas activities (e.g. seismic campaigns in the adjacent blocks), commercial shipping and navigation.

1.4.3. **Area of Indirect influence**

The Area of Indirect Influence (AII) was defined by the broader regional context with respect to the project such as adjacent blocks, general maritime traffic and relevant coastal areas that are potentially vulnerable to any accidental oil spill from the project. Within the AII were identified physical and biological components known to be vulnerable to oiling impacts, these are mostly sensitive coastal habitats (estuaries and river mouths). It also

includes the human populations that live around these sensitive areas along the coastal towns of Kwanza Sul, Benguela, Luanda, Bengo and Zaire) that likely to be affected by impacts (see Tables in chapter 4.6.1). In addition to that, onshore activities regarding drilling materials supply and supporting services, and offshore activities namely fishing and navigation may be subject to the indirect impacts since they can be found within the Area of Indirect Influence (see Chapter 4.6.2 and 4.6.3).

1.5. EIS Team

Holísticos is a Luanda-based environmental consultancy company, registered with the Ministry of Environment and founded in 2006. It consists of a dynamic and multidisciplinary team of specialists with extensive experience working on environmental issues. The contact details for Holísticos are as follows:

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ERM – Environmental Resources Management is a leading global provider of environmental, health and safety, risk, and social consulting services. They deliver innovative solutions for business and government clients, helping them understand and manage their impacts on the world around them. ERM has 140 offices in 39 countries with approximately 4,700 people serving clients globally. The company's 38-year history, extensive industry knowledge and global footprint enable them to deliver world class sustainable solutions globally. ERM is one out of Statoil's 5 prequalified key suppliers for HSE studies world-wide. The contact details for ERM are as follows:

Mr Luiz Guimarães
ERM Southern Africa – Cape Town Office 2nd Floor, The Great Westerford 240 Main Road; Rondebosch, Cape Town
Tel.: +27 21 681 5400
Fax.: +27 21 686 0736
E-mail: luiz.guimaraes@erm.com

The team involved in the development of this EIS is presented in the Table 1.1 and its qualifications are presented in Appendix A.

Table 1.1. Experts involved in the EIS

Name	Training	Role/Responsibility in the EIS
Vladimir Russo	M. Ed. in Environmental Education	Project Director, EIS Reviewer
Luiz Guimarães	MBA in Finance MPA in Environmental Policy	Project Manager, EIS Reviewer
Miguel Morais	M.Sc. on Coastal Zones and Sea	Public Consultation Lead, Biodiversity Expert
Ingeborg McNicoll	B. Sc. in Marine Biology	Technical Advisor, Marine Biology/Offshore Oil & Gas Expert
Paula Roque	Honours in Economy	Financial Manager
Dan Mistler	M.A. in Public Policy	Project Coordinator
Jody Edmunds	M. Sc. in Biological Oceanography	Environmental Lead
Roberto Jiménez	MBA in Finance MPA in Environmental Management	Project Advisor
Isolina Sanchez	M.A. in Sociology M.A. in International Development	Project Advisor
Michael Cobb	M. Sc. in Environmental and Biological Science	Project Consultant
Adjany Costa	Degree in Biology	Project Assistant, Environmental Expert
João Russo	Honors in Environment and Natural Resources	Environmental Expert
Sendi Baptista	Honors in Biology and M.Sc in Conservation Biology	Project Assistant Environmental Expert
Santinho Figueira	Honours in Sociology	Social Expert
Mark Garrison	M. Sc. in Environmental Science	Air Quality Lead
Roberta Macedo	M. Sc. In Environmental Technologies	Report Reviewer
Michael Fichera	M. E. in Environmental Engineering	Drill cuttings & Oil spill Modelling Lead

1.6. Overview of the EIA Process

The EIA is a well-established process in Angola, which aims to examine how a proposed project, in this case the Block 39 Drilling Project, may lead to a change on the environment and what impact this change may bring. Over the past decades, the impact assessment process has evolved into an analysis that goes beyond anticipating possible impacts from a project to suggesting alternatives to avoid, reduce, or mitigate adverse impacts and maximize benefits of a proposed project.

The EIS is also a powerful planning tool that aids the Project Proponent to characterize national legislation and to map and align those requirements with Statoil Health, Safety and Environment (HSE) policy and corporate performance requirements (see Chapter 2). The process we followed for developing this is illustrated in Figure 1.3.

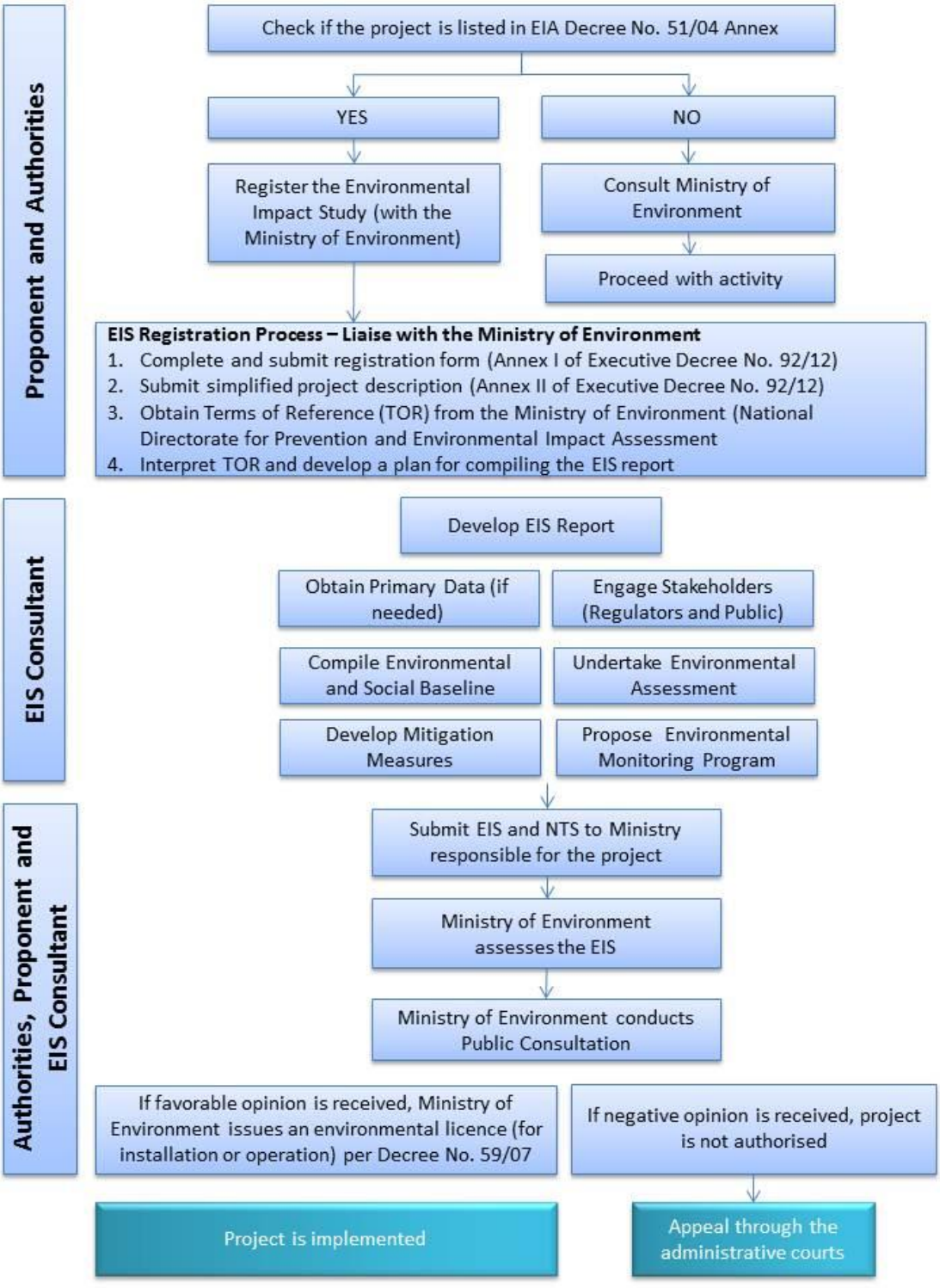


Figure 1.3. Key stages in the EIA process

The subsequent sections provide additional details regarding the approach undertaken for the key stages in the EIA process.

1.6.1. **Scoping Activities**

Scoping activities are a critical part of the EIS process, particularly at the early stages of the development of the EIS report as they provide relevant information for the way forward and enable a better understanding of the data requirements and stakeholders to be involved. Key objectives for scoping are:

- ✓ To focus resources on the important issues for decision making and to avoid or minimize time spent on issues of little or no concern to stakeholders;
- ✓ To drive effective planning, managing and resourcing of the environmental studies;
- ✓ To capture environmental information in the EIS report that is balanced and not burdened with extraneous information;

The outcome of the scoping phase defines the scope of the environmental information to be submitted to the regulator, ensuring that is in line with the legislation and best practices. As per Article 3 of the Executive Decree no. 92/12 on the Terms of Reference for Environmental Impact Studies (see *Chapter 2*), Statoil submitted the appendices I and II to the National Directorate for Prevention and Impact Assessment (DNPAIA).

1.6.2. **Stakeholders Activities**

The key principle of consultation is to ensure that the views of stakeholders are taken into account and reported in the EIS. The objective is to ensure the assessment is robust, transparent and has considered the full range of issues or perceptions to an appropriate level of detail.

Stakeholder activities for the Block 39 Exploratory Drilling Project comprised several meetings. Separate meetings were held with the National Directorate for Prevention and Environmental Impact Assessment (DNPAIA) of the Ministry of Environment and with the National Office for Safety and Environment of the Ministry of Petroleum on the 20th July 2012. The purposes of the meetings were threefold: (1) to reintroduce Statoil and its

intended program of work in Angola; (2) to present the Project to the regulators and the expected activities for the coming years; and (3) to discuss the EIS scope, methodology and timeframe while securing feedback from both Ministries. The outcomes of such meetings are summarised in Table 1.2.

Table 1.2. Outcomes of the meetings with the Ministries of Petroleum and Environment

Item	Description
Ministry of Petroleum (MINPET)	
1	During the exploration phase Statoil needs to investigate the possibility of using other onshore bases rather than Sonils (e.g. in Porto Amboim or Lobito) to provide the logistical support for the project.
2	The revised Executive Decree no. 12/05 (Executive Decree no. 224/12 of 16 July) does not allow discharge of muds into the sea. Only produced waters may be discharged into sea, but accordingly to the new standards (closely related to the Norwegian Legislation) established. Statoil has to adapt their projects to the new requirements.
3	Statoil will have to comply with the taxes for the environmental license for the oil and gas sector, once the related decree has been approved by the ministry of finances.
Ministry of Environment (MINAMB)	
4	Statoil should prepare a more detailed presentation of the project and its EIS for higher education institutions with environment related degrees.
5	Statoil should also consider organising a more detailed presentation for the Petroleum Institute in Sumbe, Kwanza Sul.
6	After all the stakeholder engagement meetings, Statoil shall report the feedback to MINAMB.

Following the recommendations from the Ministry of Environment, a stakeholder engagement meeting was organized for the universities offering environmental courses. The objective was to present the project, share details on the environmental impact assessment process and obtain contributions from the participants. The contributions from lecturers and students from the Agostinho Neto University and Angolan Methodist University are presented in Table 1.3.

Table 1.3. Meeting with universities

Item	Description
1	The EIS report should provide up to date information on the environmental conditions of the project area.
2	Environmental management plans for potential impacts as well as an oil spill response plan should be developed as part of the EIS report.

In order to connect Statoil to a larger Angolan stakeholder group, in terms of sharing insights and sensitivities from data collected through baseline efforts, a wider stakeholder engagement meeting was organized on December 6, 2012. In addition to the Ministries of Petroleum and Environment, representatives from Sonangol, the National Fisheries Research Institute, Artisanal Fisheries Institute, higher education institutions and local NGOs were introduced to the Project and to the EIA process. The comments and questions raised during this meeting are presented in the Table 1.4.

Table 1.4. Meeting with Angolan stakeholders.

Item	Description
1	INIP representatives requested that their staff take part of the environmental baselines field survey planned for Statoil's Blocks so as to take additional samples and undertake their own laboratory analysis. It was also requested that information on tuna, which is a migratory species, is included in the EIS report.
2	Representative from Sonangol requested that different alternatives for handling the drilling muds are discussed in the EIS report.
3	Representative from the Geology Department from the Faculty of Sciences at Agostinho Neto University informed of their availability to cooperate with the Faculty's lab.

1.6.3. Public Consultation and Disclosure

Mandatory stakeholder consultation is carried out as part of the EIS process, it is a requirement under Angolan EIS legislation, and it is required after the EIS report has been lodged with the regulatory authorities (Decree no. 51/04). This is a process managed by the Angolan authorities. The National Directorate for Prevention and Environmental Impact Assessment (DNPAIA) has the responsibility of chairing the consultation, according the Executive Decree no. 87/12, which regulates the public consultation for projects which are subject to the environmental impact assessment process. In order to ensure stakeholder participation, the decree mandates the consultation be disclosed in the *Jornal de Angola* and others relevant media (more details are given in *Chapter 2*).

As a rule, a public meeting starts with the NTS (Non-Technical Summary) disclosure (i.e. the project description and its main significant effects on the environment) and continues with the stakeholder intervention. The questions and opinions presented during the consultation

are expected to be addressed by the Project Proponent and taken into consideration when DNPAIA performs its review of the EIS. Statoil Angola is expected to support the public consultations process.

The end of the EIS process does not signal the end of stakeholder engagement and consultation. Stakeholder consultation at appropriate stages through the delivery of the project will ensure that stakeholders have continuous access to Statoil Angola.

As part of stakeholder engagement process a grievance mechanism will be made available to people that would like to make suggestions, raise issues or ask questions related to the EIS process and the information provided in this report. Statoil will establish a system to log in all communication before and after the public consultation and will keep this system available throughout the duration on its exploratory drilling project.

1.6.4. **EIS Baseline Studies**

The description of the baseline environmental conditions provides information on receptors and resources that have been identified during scoping as having the potential to be significantly affected by the proposed project. The baseline is supposed to provide sufficient detail to meet the following objectives:

- ✓ To document key conditions and sensitivities in areas potentially affected by the Project, thus aiding in the prediction and evaluation of impacts;
- ✓ To provide a basis for extrapolation of the current situation, and development of future scenarios throughout the Project;
- ✓ To illustrate stakeholder concerns, perceptions and expectations regarding the relevant environment and socioeconomic conditions;
- ✓ To provide a benchmark to assess future changes and the ultimate effectiveness of proposed mitigation measures.

The environmental baseline was compiled using existing information both from published literature, from applicable environmental studies previously undertaken in Block 39 and the surrounding area. Where appropriate, comparison with environmental studies carried out in the Angolan offshore region as a whole has been undertaken to inform an understanding of the regional baseline environment.

In compiling available information concerning environmental conditions in the study area, several data sets were leveraged, including the Environmental and Social Characterization to Determine the Coastal Sensitivity of the Areas between Cabinda and Kwanza Sul (Holísticos, 2012).

1.6.5. Interaction with Project Design and Decision-making

The interaction between the EIS team and the project design team is one of the key areas in which an EIS can influence how a project develops. During the development of this EIS, the engineering design and the EIS teams will systematically exchange data, debate options and communicate design changes. The EIS will be part of the documentation Statoil will use before moving the Block 39 Drilling Project from planning to execution.

Other interactions between the Statoil Angola design and EIS team that were established during the development of the EIS included an "*impact assessment workshop"* to discuss the environmental and social impacts and to calibrate mitigation measures.

1.6.6. ENVID Workshop

An Environmental Issues Identification (ENVID) study was developed for Block 39 Exploratory drilling Activities. The objective of this study was to identify and record all environmental issues and impacts associated with the Statoil Exploration Drilling Project. For this purpose an ENVID workshop was organized on November 13 and 14, 2012. In this workshop all of the environmental issues associated with exploration drilling were evaluated as part of the EIS

process and to support the development of an Environmental Risk Assessment (ERA) for oil spill response planning.

The aim of the ENVID Workshop was to identify and preliminarily assess the potential environmental impacts/issues associated with the Project at a high level and in so doing, begin to identify ways in which these can be avoided or mitigated. All Project options and potential impacts / issues associated with the Exploration Drilling were covered in the workshop and the results of the ENVID workshop are summarised in Appendix E.

1.6.7. Identification and Assessment of Impacts

To gain an understanding of the main environmental aspects and impacts associated with the Project and the related mitigation measures required, a number of impact assessment activities were conducted during the early engineering phase. These activities and meetings were undertaken by a multi-disciplinary team, including the EIS team and Statoil staff.

The overall goal of these meetings was to identify aspects and impacts likely to be rated as of “moderate” or “major” significance, to explore mitigation measures that were credible and fit-for-purpose and to drive alignment within Statoil about the management and ownership of such commitments. The EIS impact assessment process is discussed in more detail in Chapter 5.

1.6.8. Environment Management and Monitoring

Key stakeholders for the Project provided their comments during preliminary engagement activities and will be able to provide additional comments during the public consultation phase of this Project, so as to assist the Project Developer in refining and validating the proposed management and monitoring plans measures. Because an EIS is based on predictions made in advance of an activity taking place, it assumes the Project will implement certain controls and mitigation measures.

Once potential impacts have been identified and mitigation measures are developed and captured in the EIS, their integration within the Project is required for effective implementation. Based on this, all commitment/mitigations proposed in the EIS (owned by Statoil and its contractors and Partners) will be monitored and tracked to ensure Implementation of commitments.

The vehicle by which the conclusions of the assessment are turned into specific actions will be the Block 39Exploratory Drilling Project Environmental Monitoring Plan (EMP). This will be initiated in this EIS and developed as the Project proceeds.

The proposed environmental monitoring plan for the Project is explained in more details in Chapter 6.

1.7. Structure of the Report

This report is accompanied by a Non-Technical Summary (NTS) for the purposes of public consultation. The remainder of the report is structured as indicated below:

- ✓ **Chapter 1 – Introduction**: presents the purpose and scope of the EIS report, the EIS team and describes the EIS process;
- ✓ **Chapter 2 – Legislation and Project Standards**: identifies relevant Angolan and international legislation regarding the Project, including environmental laws, decrees and multilateral environmental agreements;
- ✓ **Chapter 3 – Project Description**: describes the drilling program and alternatives considered, including all the proposed activities, facilities and operations; and the drill cuttings and oil spill modelling.
- ✓ **Chapter 4 – Environmental and Social Baseline**: documents the regional offshore and coastal environments of Block 39 and surrounding areas, highlighting the environmental and socioeconomic conditions;

- ✓ **Chapter 5 – Impact Assessment and Mitigation Measures**: identifies and assesses the significance of the Project development on the environment and the population. Mitigation measures adopted to reduce the impacts are described. The health risks to which the offshore-working employees are exposed to are characterised, and mitigation measures are proposed;
- ✓ **Chapter 6 – Environmental Monitoring Plan**: outlines the management system procedures and the monitoring activities to be developed to control and follow-up the impacts of the project;
- ✓ **Part 7 – Final Considerations**: includes the key general conclusion on the Project's environmental and socioeconomic risks and impacts.

A number of appendices are attached to the document including the following:

- ✓ Appendix A: *Curricula Vitae* of the EIS Staff;
- ✓ Appendix B: Waste Management Plan;
- ✓ Appendix C: Operational Discharges Management Plan;
- ✓ Appendix D: Marine Mammals and Turtles Monthly Distributions Maps;
- ✓ Appendix E: ENVID Results;
- ✓ Appendix F: Environmental Risk Assessment.

A full list of references in relation to books, articles, web pages or other published items is provided at the end of the document.

CHAPTER 2

LEGISLATION

AND PROJECT STANDARDS

2. Legislation and Project Standards

This chapter lists Angolan regulatory authorities with jurisdiction over the Block 39 Exploratory Drilling Project. It also outlines the Angolan legislative framework and highlights specific environmental legislation that applies to the Project (this encompasses Angolan administrative organizations and regulations that govern the environment, oil and gas, and fisheries sectors). This Section also includes international organizations and standards, multilateral environmental agreements to which Angola is a signatory (where relevant), as well as Statoil's policy of Health, Safety and Environment.

The Project is committed to complying with the relevant statutory requirements of Angola. In addition, the Project will aim to be consistent with international standards ratified by Angola. These standards include various international treaties, conventions, and protocols related to issues as biodiversity, climate change, and marine pollution, described in this chapter.

Box 2.1 below summarizes applicable national environmental legislation, based on current understanding of the Project. A brief description of the relevant aspects of legislation for each topic is included in the sections following. It is important to note that multilateral environmental agreements, when published in the Government Gazette and ratified by the Angolan Executive, also constitute national legislation (see *Section 2.3*).

- ✓ Environmental Framework Law (Law no. 5/98 of June 19th 1998)
- ✓ Petroleum Law (Law no. 10/04 of November 12th 2004)
- ✓ Decree on Environmental Protection for the Petroleum Industry (Decree no. 39/00 of October 10th 2000)
- ✓ Decree on Environmental Impact Assessment (Decree no. 51/04 of July 23rd 2004)
- ✓ Decree on Environmental Licensing (Decree no. 59/07 of July 13th2007)
- ✓ Joint Executive Decree on Environmental Licensing Fees (Joint Executive Decree no. 96/09 of October 6th2009 and Joint Executive Decree no. 130/09 of 26 November 2009)
- ✓ The Joint Executive Decree on calculation of environmental taxes applicable to projects in the oil industry (No. 140/13 of 13 May)
- ✓ Executive Decree on the Regulation of Public Consultation (Executive Decree no. 87/12 of February 24th2012)
- ✓ Executive Decree which approves the Terms of Reference for Environmental Impact Studies (Executive Decree no. 92/12 of March 1st2012)
- ✓ Decree on Environmental Auditing (Decree no. 1/10 of January 13th2010)
- ✓ Executive Decree on the Regulation of Waste Management, Removal and Deposit (Executive Decree no. 8/05 of January 5th2005)
- ✓ Executive Decree on the Regulation of Notification of Occurrence of Spills (Executive Decree no. 11/05 of January 12th2005)
- ✓ Executive Decree on the Regulation of Operational Discharge Management (Executive Decree no.224/12 of July 16th 2012)
- ✓ Presidential Decree on Control and Prevention of the Pollution of the National Waters (Presidential Decree no. 141/12 of June 21st 2012)
- ✓ Decree which approves the Regulation on Petroleum Operation (Decree no. 1/09 of January 27th 2009)
- ✓ Decree on the Regulation of Safety, Hygiene, and Health in Petroleum Activities (Decree no. 38/09 of August 14th 2009)
- ✓ Presidential Decree on Substances that Deplete the Ozone Layer (Presidential Decree no. 153/11 of June 15th2011)

Box 2.1. Angolan legislation applicable to Block 39 Exploratory Drilling Project.

In addition, Statoil has developed a set of internal corporate policies related to environmental and social performance that will apply to the Block 39 Drilling Project. Those are summarized in *Section 2.6.*

2.1. Angolan Administrative Organizations

The institutional framework relevant to oil and gas projects in Angola includes Government Institutions such as the Ministry of Petroleum (MINPET) and the Sonangol – EP (*Sociedade Nacional de Combustíveis de Angola – Empresa Pública*). In terms of environmental licensing, the institution responsible for issuing these licenses after undertaking the environmental impact assessment and public consultation is the Ministry of Environment (MINAMB).

Taking into consideration that this Project may potentially have an impact on the marine environment, it is important to consider the role of the Ministry of Agriculture, Rural Development, and Fisheries. The roles and responsibilities of these institutions are further described below.

2.1.1. Ministry of Petroleum

The Ministry of Petroleum (MINPET) is the ministerial department responsible for the oil and gas sector, including the execution and coordination of the national policies regarding the petroleum activity in Angola. MINPET has overall responsibility for oil and gas exploration and production projects in Angola. It is also responsible for providing technical comments on the Environmental Impact Studies (EIS) relevant to the oil and gas sector.

MINPET's responsibilities include the administration of the Decree on Environmental Protection for the Petroleum Industry (Decree no. 39/00 of October 10th 2000). Based on its new structure, the Environment and Safety Office (*Gabinete de Ambiente e Segurança*) is responsible for nature conservation and environmental protection related to oil and gas exploration and production activities. Its main objective is to develop mechanisms and instruments to control the oil industry activities. Project proponents are required to consult with MINPET (*Gabinete de Ambiente e Segurança*) before the implementation of any oil and gas project.

2.1.2. Ministry of Environment

The Ministry of Environment (MINAMB) is responsible for the development and coordination of the Angolan environmental policy and the Environmental Management National Program (*Programa Nacional de Gestão do Ambiente – PNGA)*. MINAMB is required to review and assess the Environmental Impact Studies submitted through MINPET. MINAMB is also responsible for the administration and enforcement of many aspects of the Environmental Framework Law (Law no. 5/98) and its enabling legislation. Its responsibilities also include issuing environmental licenses (for both installation and operation project activities) after undertaking the environmental impact assessment and public consultation.

The Ministry of Environment was restructured by Presidential Decree no. 201/10 of September 13th 2010 and is composed of four national directorates, the Directorate most relevant for this project is the National Directorate for Prevention and Environmental Impact Assessment (DNPAIA). This Directorate is responsible for the implementation of the Decree no. 51/04 of July 23rd 2004 on Environmental Impact Assessment, the Decree no. 59/07 of July 13th 2007 on Environmental Licensing and other relevant EIS-related legislation. The Ministry of Environment is also responsible for registering companies entitled to undertake environmental impact studies.

2.1.3. Ministry of Fisheries

The Ministry of Fisheries was established in 2012 through the Presidential Decree n.º 228/12 of December 3rd. This Ministry is responsible, among other activities, for promoting fisheries cooperation through negotiation of international agreements as well as the management of fisheries through licensing and royalty fee agreements. This Ministry must be consulted for projects that may significantly impact the natural marine resources within inland waters, the Angolan territorial sea, and the Angolan Economic Exclusive Zone (EEZ). It is also responsible for the administration and enforcement of the Biological Aquatic Resources (Law no. 6-A/04

of October 8th 2004). Statoil has engaged with this Ministry as part of the Project consultation.

2.1.4. Sociedade Nacional de Combustíveis de Angola – Empresa Pública (SONANGOL – E.P.)

Sonangol[3] – E.P. is the national oil and gas concessionaire of the Angolan offshore and onshore, and a state national oil company established in June 1976 (Decree-Law no. 52/76) that oversees petroleum and natural gas production in Angola.

The regulatory law addressing petroleum activities approved by the National Assembly in November 12th 2004 (Law no. 10/04) retains the principles defined in the previous Law no. 13/78 on oil, which defined the role of Sonangol. Sonangol is the concessionaire for every offshore and onshore Angolan oil field and it has the exclusive rights for the prospection, exploration, and production. However, Sonangol can transfer the implementation of oil and gas activities to other companies, as well as hire third-parties to implement all or part of the activities inherent in the rights that are granted. This is usually done by signing a Production Sharing Contract (PSC[4]) with a block operator. In December 2011, Statoil signed a PSC to operate Blocks 38and 39, and its operating interest became effective in January 2012. Statoil Angola is the operator of Block 39 with 55% interest (see *Chapter 1*). The PSC defines the operator's commitments with the Angolan Government and includes financial clauses, use of local content, as well as Health, Safety and Environment (HSE) recommendations.

Although not part of the Angolan regulatory system, Sonangol exercises its influence through an Operating Committee, which reviews and advises during the exploration phase as appropriate, and supervises the development and production after a commercial discovery has been made by an operator.

[3] Sonangol was later transformed into a public company through the Decree no. 20/99 of August 20th 1999.

[4] The PSC defines the operator's commitments with the Angolan Government and includes financial clauses, use of local content, as well as Health, Safety and Environment (HSE) recommendations.

2.1.5. Angolan Association of the Oil Exploration and Production Companies

The Angolan Association of the Oil Exploration and Production Companies[5] (*Associação das Companhias de Exploração e Produção de Angola – ACEPA*), established in 2006, is a dedicated association formed to represent interests of the exploration and production sector in Angola through its various subcommittees, including the environment, health, and safety committee. The organization also promotes the cooperation amongst its members around issues related to the oil and gas industry. Although not part of the Angolan regulatory system, ACEPA interacts with the Angolan Government by providing feedback on proposed environmental legislation, such as development of a regional environmental monitoring program. Its other activities include:

- ✓ Development of a mutual oil spill response agreement ANG212[6];
- ✓ Assistance with the National Oil Spill Contingency Plan approved in November 2008 by the Council of Ministers;
- ✓ Production of guidelines for voluntary environmental reporting on behalf of Sonangol; and
- ✓ Technical analysis of drill cuttings disposal options.

2.2. Environmental Legislation Regulating Petroleum Operations in Angola

Environmental issues associated with oil and gas activities in Angola are regulated by the following legal statutes.

[5] The original members in 2006 were BP, Chevron, and Esso. Since then, a number of oil and gas companies, including Statoil, have joined ACEPA.

[6] ANG212 is a document signed between Sonangol as the Angolan national oil company and other oil companies operating in Angola. The agreement also deals with other incidents not related to oil spills, for example emergency response on safety issues.

2.2.1. **Environmental Framework Law**

The Environmental Framework Law (Law no. 5/98 of June 19th 1998) addresses the requirements of an Environmental Impact Assessment in general terms and applies to all projects that are likely to have a potential impact on the environment and/or society. It indicates that an Environmental Impact Study (EIS) is a tool for preventive environmental management, which consists of identifying and analyzing in advance, both qualitatively and quantitatively, potential positive and negative effects of a proposed undertaking. Under this law, an EIS report must include the following:

- ✓ A brief non-technical description of the project;
- ✓ A description of the activities to be undertaken;
- ✓ A general description of the environment at the site;
- ✓ A summary of public responses from the consultation process;
- ✓ A description of the possible environmental and social changes which a project may cause; and
- ✓ A description of the systems planned for controlling and monitoring the proposed activity.

2.2.2. **Petroleum Activities Law**

This Law (Law no. 10/04 of November 12th 2004) was developed to address new economic policies, particularly those related to the protection of national interests, promotion of the work force, monetization of petroleum resources, and environmental protection. The Law established the exclusivity principle for the national petroleum concessionary Sonangol.

Article 7 (Paragraph 2) states that all petroleum operations must be conducted with care considering safety of people and infrastructure as well as protection of the environment and conservation of nature.

Article 24 on Environmental Protection requires that all companies involved in petroleum operations, including Sonangol, implement appropriate measures to ensure protection of the environment and guarantee its preservation. The environmental components include water, soil and subsoil, air, biodiversity preservation, flora and fauna, ecosystems, landscapes, atmosphere, and cultural, archaeological, and aesthetic values. As a component of the environment, health at work is also included.

To achieve environmental protection, Article 24 (Paragraph 2) requires that environmental impact assessment plans for environmental preservation and rehabilitation, and the findings of environmental audits, be submitted to the competent authorities within the established time-frames.

2.2.3. Decree on Environmental Protection for the Petroleum Industry

This Decree (Decree no. 39/00 of October 10th 2000) complements the Environmental Framework Law and aims at encouraging petroleum companies to continuously improve their environmental protection practices. It states that priority is to be given to the prevention and control of pollution, including protection of waters, land, and air from spills and operational discharges. Priority must also be given to reduction, recycling, transportation, disposal, and adequate deposit of wastes generated by the oil industry.

The Decree also states that the EIS must be submitted by the Concessionaire, Sonangol, and its Associates (through the operator) to MINPET, which must seek the opinion of MINAMB. If MINAMB approves the EIS, then an Environmental License will be issued.

2.2.4. Decree on Environmental Impact Assessment

Under this Decree (Decree no. 51/04 of July 23rd 2004), project proponents are required to consider potential social impacts of new investments. Article 7 (Paragraph 1, c) of this decree states that the EIS must take account for *"…the socio-economic environment, land use and*

occupation, the use of water and socio-cultural features…relations of dependency between local society, environmental resources and the future potential use of these resources."

This Decree dictates that one of the principal instruments of environmental management is the EIS, which should gauge the effects that projects may have on the environment. It also establishes a set of procedures to be followed when carrying out an EIS. In addition to the requirements of the Decree and its associated regulations (see *Sections 2.2.5, 2.2.6, 2.2.7 and 2.2.8*) Article 10 requires a public consultation be undertaken as part of the assessment. It should be noted that MINAMB has responsibility for promoting the public consultation process. *Section 2.2.7* further discusses the topic of public consultation.

This Decree states under Article 4 that any activity, which may have a substantial impact on the natural or social environment, or those described in its Annex, requires an EIS be submitted prior to granting of any environmental license. The Block 39 Exploratory Drilling Project falls under the extractive industry category established in the Annex 1 of the Decree, and therefore requires an EIS.

2.2.5. **Environmental License Decree**

This Decree (Decree no. 59/07 of July 13th 2007) defines regulations proclaimed under Article 17 of the Environmental Framework Law, including the introduction of administrative procedures for environmental licensing and the requirements for environmental licenses for installations and operation of projects. It provides guidance on which projects are subject to an EIS, what elements are to be included in an EIS, the nature and extent of public participation, the entity responsible for compliance with legal requirements, and the EIS monitoring process. Figure 1.3 *in Chapter 1* describes the EIS process.

There are two types of environmental licenses required for any activity listed under Article 4, namely:

i) **An environmental installation license** that authorizes the layout of works or undertaking installation activities (such as construction, laying out of pipelines, and implementing physical structures); and

ii) **An environmental operational license** that authorizes the operation of a particular project. This environmental operational license is issued after all the requirements contained in the EIS have been complied with. Note: Both LI and LO are conditional on EIS completion.

The Decree also indicates that only Angolan-registered environmental consultancy companies can submit an EIS for approval.[7] Failure to comply with the Environmental Licensing Decree requirements may trigger the imposition of fines and other significant penalties, including closure of facilities and termination of activities.

2.2.6. Executive Decrees on Environmental Fees

The Joint Executive Decree no. 96/09 of October 6th 2009, from the Ministry of Finance and Ministry of Environment, approves the fees to be paid for the environmental license issuing. It also provides a table with indicative fees to be paid for the installation and operational licenses, values that are associated with a percentage of the investment. This Decree states that the renewal of licenses (both for installation and operational purposes) is also subject to a payment of 50% of the initial fee (for the installation license) and 45% (for the operational license).

The Joint Executive Decree no. 130/09 of November 26th 2009 replaced the Kwanza amounts (formerly set out in the Joint Executive Decree no. 96/09) with UCF. The Ministerial Order no. 174/11 of November 3rd 2011, sets the fees to be paid in UCF (*Fiscal Correction Units*), and currently states that each UCF corresponds to 88 Kwanzas.[8]

[7] Holísticos is an Angola-registered environmental consulting company with a valid license.

[8] An Executive Decree is currently being prepared to set environmental licensing fees specific to the oil and gas industry.

2.2.7. Joint Executive Decree that Approves the Basis of Environmental Fees applicable to projects in the oil industry

The Joint Executive Decree of the Ministry of Finance and the Environment (No. 140/13 of 13 May) approves the basis of calculations of environmental taxes applicable to projects in the oil industry, in the granting of the environmental license, differing from existing regulation for other economic activities. This document defines the Scope (A), the Severity (S) and Duration (D) of the impact caused by the proposed project.

The quantification of the amount to be paid through environmental taxes is calculated in terms of the Total Environmental Impact (TEI or IAT in Portuguese), and the basis of calculation is madeaccording to the following formulas:

- TI = 3 x IAT x 220,000 Kz – Calculation of Environmental Installation License.
- TO = 5 x IAT X 220,000T Kz – Calculation of Environmental Operating License.
- TA = n x IAT x 220,000 Kz – Calculation of the Environmental License for expansion or changes to existing facilities.

The quantitative value of the Total Environmental Impacts (IAT) of the Project is obtained by adding the negative impacts of A + S + D, whose score cannot be less than nine (9) nor more than eighty-one (81). The classification is defined as follows:

Description	Classification	Ranking
Scope (A)	Local	3
	Regional	9
	National	27
Severity (S)	Low	3
	Medium	9
	High	27
Duration (D)	Short	3
	Medium	9

Description	Classification	Ranking
	Long	27
IAT = A + S + D		

For the renewal of environmental permits for installation and operation fee payable corresponds to a value not exceeding 20% of the initial rate of each of the respective licenses.

2.2.8. Executive Decree on the Regulation on Public Consultation

The Decree on Regulation on Public Consultation for projects which are subject to the Environmental Impact Assessment (EIA) process (Decree no. 87/12 of February 24th 2012) was established in terms of Article 10 of Decree no. 51/04 (Decree on Environmental Impact Assessment). It defines public consultation as *"the procedure understood in the public participation context that aims to collect relevant opinions and suggestions of the stakeholders on projects subject to the EIA process".*

The National Directorate for Prevention and Environmental Impact Assessment (DNPAIA) in MINAMB has the responsibility of chairing the consultation (Article 4, Paragraph 3) and, in order to ensure stakeholder participation, the Decree stipulates the consultation be disclosed in the "*Jornal de Angola"* and other relevant media (Article 7). As a rule, the public consultation starts with the Non-Technical Summary (NTS) disclosure (i.e. the project description and its main significant effects on the environment) and continues with the stakeholder participation. The questions and opinions presented during the public consultation are answered and taken into consideration in the decision-making process to be performed by DNPAIA.

2.2.9. Executive Decree – Terms of Reference for Environmental Impact Studies

The Executive Decree no. 92/12 of 1st March 2012 establishes the guidelines and procedures to the Environmental Impact Studies (EIS) elaboration. Article 3 sets that the Application Form (*Modelo de Requerimento)* be requested to the MINAMB by the project proponent and completed in accordance with Annex I, accompanied by a simplified description of the project (Annex II)[9]. The content and structure of the Terms of Reference for EIS are defined in Annex III and followed in this report.

2.2.10. Decree on Environmental Auditing

The Decree on Environmental Auditing (Decree no. 1/10 of January 13th 2010) was established in terms of Article 18 of the Environmental Framework Law. It defines the procedures required for an environmental audit to be taken for projects in operation. The environmental audit serves as a tool for post-EIS monitoring. The Environmental Audit permits an organization or institution to understand the current environmental performance of any activity, and to introduce corrective actions and measures to avoid any non-compliance.

This Decree will provide Statoil with the framework for undertaking regular environmental audits during the drilling activities of the Project. Further, to obtain the Project environmental operation license, Statoil will have to conduct an environmental audit to verify progress in meeting proposed mitigation measures.

2.2.11. Executive Decree on Regulation on Waste Management, Removal and Deposit

This Decree (Executive Decree no. 8/05 of January 5th 2005) encourages petroleum companies to prepare and keep an updated Waste Management, Removal, and Deposit Plan in order to ensure the prevention or minimization of harm to the health of people and the

[9] These documents and forms were submitted to the National Directorate for Prevention and Environmental Impact Assessment (DNPAIA) on July 11, 2012.

environment. It applies to all waste generated in the course of petroleum-related activities, as described in Decree no. 39/00 above.

In addition to this Executive Decree, the legislative framework regarding waste disposal relating to exploration and production activities is provided by the Petroleum Environmental Decree No. 39/00 (dated October 10, 2000), Petroleum Law No 13/73 (dated August 26, 1978), Regulation on Waste Management, Presidential Decree No. 190/12 (dated August 24, 2012) and Operational Discharge Management, Ministry of Petroleum Executive Decree No. 244/12 (ED 24412). More details based on Waste Management regulation for the drilling activities in Angola are provided the Presidential Decree No. 190/12, the Decree applies primarily to waste treatment disposal sites, and includes waste generator and transports as well, it basically provides more details on segregation, storage and packaging requirement for individual's waste streams. The key requirements of Presidential Decree No. 190/12 include:

- ✓ Transportation of wastes from the drilling rig to the onshore supply base and from the base to the Treatment and Disposal site will be performed by specific designated service providers permitted in accordance with Presidential Decree No. 190/12 using vessels that are adequately adapted to ensure the safe transportation of wastes. This includes the requirement for the vehicle to be kept in good working conditions and have the necessary licenses approved by regulatory authorities;
- ✓ The onshore supply base will have a storage area for the temporary storage of wastes prior to transport to the management facility. The storage area will be placarded and secured to prevent workers entrance without permission, containers will be labeled and containerized to prevent spills from moving off site;
- ✓ Hazardous wastes arising from the drilling operations will be disposed at a licensed approved TDS. Copies of hazardous waste manifests shall be submitted to the Ministry of Environment in accordance with Presidential Decree 190/12. The Angolan legislation mandates that the Waste Management Disposal and Deposit Plan

(WMDDP) shall be developed based on a process of risk analysis to ensure that the management is proportional to the risks and hazards identified;

- ✓ The operator shall use a Waste Transport Manifest for all shipments of wastes, to record the types and amount of hazardous and non-hazardous wastes shipped off-site approved by a third party waste management facilities. This includes: The Waste Generator, Waste Transporter and the Waste Receiver;
- ✓ A Waste Tracking Log shall be maintained by all generating facilities. It is the basis for reviewing waste inventory and waste identification for waste reduction efforts. These will include the location name, quantity of waste, carrier name, disposal location, manifest number and the initials of the person filling out the log;
- ✓ Operators shall be diligent in the update of the WMDDP in accordance with the changes to Angolan Laws and Regulations, changes in the operator´s policies and reporting procedures, changes in operations, and/or changes as a result of identified deficiencies from incidents or audits;
- ✓ Regulate the quantities of wastes (in accordance with Decree No. 08/05, Article 5) giving reference to the following methods: Re-usage of materials/or products; Recycling of materials and products; use of waste as raw materials for other industries; and return to the suppliers;
- ✓ All waste storage facilities, as stated in Executive Decree No. 8/05 (dated January 5, 2005), will be labeled in accordance with national and international standard; and the storage areas will comply with Angolan regulations related to the storage of wastes.

2.2.12. Executive Decree on the Regulation on Notification of Occurrence of Spills

The Executive Decree no. 11/05 of January 12th2005 approves the regulation on notification of occurrence of an oil spill. It also provides instructions on notifications (*e.g.* deadlines and

notification contents). The regulation defines and standardizes procedures for operators and contractors to notify MINPET on the occurrence of spills.

Additionally, the Resolution on the National Oil Spill Contingency Plan (Resolution no. 87-A/08 of December 12th 2008) creates the National Preparedness and Response System to marine oil spills in Angola, and defines the coastal sensitive areas, as well as the procedures to the notification and response methodology to oil spills. It also defines available resources, i.e., equipment from several oil and gas Angolan operators that can be used in response to oil spills.

2.2.13. Executive Decree on the Regulation on Operational Discharge Management

The Executive Decree no.224/12 of July 16th 2012 revokes the Executive Decree no. 12/05 of January 12th 2005 and set forth new regulation on operational discharge management implemented by oil and gas industry companies. Instructions for the Operational Discharge Management Plan are provided with requirements for main and collateral effluents (Article 5).

The Decree established the rules and procedures regarding the management of operational discharges generated from petroleum operations, both onshore and offshore, except for facilities in transit. Article 4 states that operational discharges to the ground or to internal water bodies, resulting from activities onshore, shall be prohibited, except when properly justified for safety reasons and collateral effluents, either liquid or solid, shall be treated as waste. It also states that discharges resulting from offshore operations are prohibited, and shall be treated as hazardous waste. These discharges include: a) drill cuttings contaminated with non-water based drilling muds; b) non-water based drilling fluids; and c) produced sand.

Implementation of the provisions of this Executive Decree commences on the publication date (July 16th 2012) for all new facilities, and within a maximum period of eighteen months from publication date for all existing facilities (Article 25, Paragraph 1).The differences between the revoked and new regulation are summarized in Table 2.1 below.

Table 2.1. Summary of revoked and new legislations on operational discharges.

Aspect	Executive Decree n.° 12/05 (12th Jan 2005) REVOKED	Executive Decree n.° 224/12 (16th Jul 2012) NEW
Water-based drilling fluids discharge	Allowed if: - discharge rate<1,000 barrels/hour, - fluid's 96-hr LC50 toxicity, assessed for an organism from a similar habitat in a volumetric dispersal of 9:1 (sea water: suspended phase) is over 30,000 ppm (Chapter II, Article 4, Paragraph 1)	**Allowed if:** **- discharge rate<1,000 barrels/hour** **- components used in their preparation comply with the provisions of Article 6 on the use of chemical products (prohibited discharge)** **(Chapter II, Article 7, Paragraph 1)** **Discharge flow shall be measured every hour, during the discharge period** **(Chapter II, Article 7, Paragraph 2)**
Non water-based drilling fluids discharge	Mineral based drilling mud is to be less than 1% aromatic content (Chapter II, Article 5, Paragraph 1); Prohibited, except when personal or facilities safety is at risk; Re-use must be optimized. (Chapter II, Article 5, Paragraph 2)	**Prohibited** **(Chapter I, Article 4, Paragraph 3)**
Water-based drill cuttings discharge	Allowed if discharge rate<1,000 barrels/hour; (Chapter II, Article 6, Paragraph 1)	**Allowed if:** **- discharge rate<1,000 barrels/hour** **(Chapter II, Article 7, Paragraph 1)**
Non water-based drill cuttings discharge	Allowed if: - oil retention<5%; - no visible oil sheen on the sea surface; (Chapter II, Article 6, Paragraph 2)	**Prohibited** **(Chapter I, Article 4, Paragraph 3)**
Produced sand discharge	Allowed if oil percentage <15% of total wet weight of discharged sand (Chapter II, Article 8)	**Prohibited** **(Chapter I, Article 4, Paragraph 3)**

Aspect	Executive Decree n.° 12/05 (12th Jan 2005) REVOKED	Executive Decree n.° 224/12 (16th Jul 2012) NEW
Produced water discharge	Monthly average oil content must be less than 40ppm (Chapter II, Article 7, Paragraph 1); For a daily average over 60ppm, the operator is to make a report to the MINPET (Chapter II, Article 7, Paragraph 2); Oil content shall be measured daily and visual observation made and recorded to detect visual sheen on the sea surface (Chapter II, Article 7, Paragraph 3).	**The monthly average of the oil content in the discharge of produced water shall not exceed 30 ppm, being allowed daily peaks of up to 45 ppm (Chapter II, Article 9, Paragraph 1);** **If a daily average over 45 ppm is observed in the concentration of oil in the discharge, the Operator shall notify the occurrence and submit a report to the MINPET (Chapter II, Article 9, Paragraph 2);** **Oil and fat content shall be measured daily, and visual observation made and recorded to detect visual sheen on the sea surface during the discharge period (Chapter II, Article 9, Paragraph 3).**
Chemicals discharge	Direct discharge of chemical products into the ocean is prohibited. A Chemical Product Management Plan shall be prepared; (Chapter III, Article 14, Paragraphs 1 and 2)	**Direct discharge of chemical products into the ocean is prohibited (Chapter I, Article 6, Paragraph 1).** **Spill of chemical products shall be treated in accordance with procedures established for control and emergency response (Chapter I, Article 6, Paragraph 2).** **Chemical products (organic and inorganic) must comply with several specifications related to biodegradation rate, bioaccumulation rate, and toxicity (Chapter I, Article 6, Paragraph 3a-b).**
Gases Emissions	**N/A**	**Operator shall record the emissions of the following gases in the facilities, vehicles and sites under its responsibility, recording greenhouse gases in CO_2e (per terms set by the UN Convention on Climate Change); ozone-destroying gases (per the Vienna Convention) and organic and inorganic gases (per definitions set by the World Health Organization).** **(Chapter IV, Article 15, Paragraph 1a-c).** **A report shall be sent to the Ministry of Petroleum on an annual basis (Article 24).**

2.2.14. Presidential Decree on Waste Management

Presidential Decree 190/12 was adopted on August 12, 2012, and impacts all waste generators, transporters, treatment and disposal companies. The regulation lays out

Angola's cradle-to-grave system, with primary focus on TSDs and transporters. It also includes waste generator storage and handling requirements.

2.2.15. Presidential Decree on Control and Prevention of Pollution of the National Waters

The Presidential Decree no. 141/12 of June 21st 2012 establishes the regime of prevention, control, and monitoring of pollution of the waters under national jurisdiction from ships, vessels, oil platforms, and industrial establishments. The Decree states that these structures should have an emergency plan to combat the pollution of waters, in accordance with the rules of the MARPOL 73/78 and the national legislation in force (Article 9). Key requirements of this Decree include:

- ✓ Chapter II provides the rules on prevention of oil pollution in accordance with Annex I of MARPOL 73/78, highlighting the ban on discharges of oil in Angolan waters, except cases referred in the Executive Decree no.224/12 of July 16th 2012 (Section III, Article 23º). The Decree also states that the produced water resulting from oil activities can only be discharged to the sea if the oil content < 40 ppm (Article 23º, Paragraph 3).
- ✓ Chapter III establishes the rules on prevention of pollution by noxious liquid substances carried in bulk (e.g. oil, gas and chemical products) in accordance with Annex II of MARPOL 73/78. Article 61 states that the discharge of harmful products and contaminants in Angolan waters is forbidden.
- ✓ Chapter IV lays the rules on prevention of pollution by sewage, in accordance with Annex IV of MARPOL 73/78. Article 68 states that the sewage discharge is allowed only if made at more than 4 nm of the coast (for crushed and disinfected sewage) or more than 12 nm of the coast (for not crushed and infected sewage). Any sewage discharges into Angolan inland waters are strictly prohibited (Article 70).
- ✓ Chapter V, in accordance with Annex V of MARPOL 73/78, provides the rules on prevention of pollution by garbage and prohibits the discharge into the Angolan

waters of plastic materials (Article 75, Paragraph 1), as well as the discharge of any type of garbage in coastal waters (Article 75, Paragraph 2).

- ✓ Chapter VI establishes the standards on prevention of residue discharges from ships and vessels, except when engaged in petroleum operations, since they are governed by Executive Decree no.224/12 of July 16th 2012.
- ✓ Chapter VII (Preventive Measures and Pollution Control during Oil Loading, Unloading and Handling) and Chapter VIII (Preventive Measures and Pollution Control during the Fuel Supplies to the Vessels) sets that the companies involved in these operations must have adequate facilities and prepared personnel to intervene in cases of oil spills, in order to minimize damage to the environment (Articles 92, 93 and 99).
- ✓ Chapter IX sets out the rules on prevention of air pollution from ships, vessels, and oil platforms, in accordance with Annex VI of MARPOL 73/78. Article 103 states that any emission of substances that depletes the ozone layer is forbidden. The Decree also establishes the No_x and SO_x emissions standards (Articles 104 and 105, respectively), as well as the procedures for the use of incinerators on board of ships, vessels, and oil platforms.

2.2.16. Decree which approves the Regulation on Petroleum Operations

The Regulation on Petroleum Operations is approved by Decree no. 1/09 of January 27th 2009 and establishes the conditions and forms to be complied with while performing petroleum operations under the Petroleum Activities Act. It applies to all oil-related activities carried out onshore and offshore.

The Regulation explains the procedures to issue an exploration license and sets out the elements to be provided in the agreements signed between the National Concessionaire, Angolan and foreign entities. It also states that petroleum operations are divided into two separate stages: 1) survey, prospection, and exploration (seismic studies being part of this first stage) and 2) development and production. The activities related to crude oil refining,

storage, transportation, distribution, and commercialization are excluded from the scope of this Regulation.

2.2.17. Decree on the Regulation on Safety, Hygiene and Health in Petroleum Activities

This Decree (Decree no. 38/09 of August 14th 2009) approves the Regulation on Safety, Hygiene, and Health in Petroleum Activities. It defines the responsibilities of workers and operators; health, hygiene, and safety management system; occupational health and safety; safety of operations, facilities, and equipment; and offenses and sanctions. It also establishes a set of technical and non-technical obligations for operators, including training and certification, development of risk assessments, emergency plans, health and safety plans and procedures, notification and recording procedures, and development and implementation of corrective actions.

2.2.18. Decree on Substances that Deplete the Ozone Layer

The Vienna Convention for the Protection of the Ozone Layer (March 22nd 1985) and its Montreal Protocol on Substances that Deplete the Ozone Layer (ratified by the Resolution no. 72 on September 16th 1987), as well as the four amendments of the Protocol (London, Copenhagen, Montreal and Beijing), to which Angola is a party signatory since May 17th 2000, consolidated as one of the most effective multilateral agreements established by the United Nations.

This Decree is enforced through Presidential Decree no. 153/11 of June 15th 2011, which regulates the production, export and import of substances, equipment, and devices containing substances that deplete the ozone layer. The Decree is accompanied by a list (Decree´s Annex 1) of controlled substances and their respective ozone-depleting potential. For import of such substances, it is necessary to request an import permit issued by the Ministry of Commerce, after the assent of the Ministry of Environment.

2.2.19. Presidential Decree on Liability for Environmental Damage

The rules on liability for environmental damage (Presidential Decree no. 194/11 of July 7th 2011) provide a framework for assigning responsibility for risk and environmental degradation based on the principle "polluter pays." This scheme applies to all activities likely to cause environmental damage or imminent threat thereof, caused by pollution derived from planned activities (i.e., drilling) or unplanned events (i.e., oil spills).

2.2.20. Law on Biological Aquatic Resources

The Law on Biological Aquatic Resources (Law no. 6-A/04 of October 8th 2004) sets out the principles for use of biological aquatic resources. It provides regulations governing fishing, grants fishing rights, and develops special rules for protection of aquatic resources and ecosystems. The law regulates fishing vessels and ports, provides guidance on scientific research, describes protocols for monitoring of resources, and lists a process for licensing of fish processing and marketing establishments. In addition, the law provides a framework for controlling and managing activities harmful to resources and ecosystems and sets forth procedures for dealing with breaches of the law.

2.3. Relevant International Guidance

In addition to being in compliance with Angolan statutory requirements, the Project aims to be consistent with relevant international guidance to which Angola is a signatory. According to Article 13 of the new Angolan Constitution of February 5th 2010, international treaties and agreements approved or ratified shall be in force in the Angolan legal system after their official publication.

✓

2.3.1. Multilateral Environmental Agreements

Angola is party to a number of multilateral environmental agreements (conventions, treaties, and protocols) that are relevant to environmental aspects of offshore and onshore oil and gas activities. These agreements are described in Table 2.2 and have been accounted for in developing the Block 39 Drilling Project.

Table 2.2.Multilateral environmental agreements relevant to the Project.

Multilateral Environmental Agreement	Description / Project Standards
United Nations Convention on Law of the Sea (UNCLOS) ratified by Resolution no. 18/90 on October 6th1990; it entered into force in Angola on October 6th1990 (Resolution no. 18/90).	Defines the rights and responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. *The Block 39 Project will be aligned with Angolan legislation and relevant international guidelines that set the limit for internal, territorial and international waters, contiguous and exclusive economic zones and continental shelf.*
United Nations Framework Convention on Climate Change (UNFCCC) ratified by Resolution no. 13/98 on August 28th 1998; it entered into force in Angola on August 28th1998 (Resolution no. 13/98).	Its objective is to stabilize greenhouse gas concentrations in the atmosphere. *The Project will be aligned with Angolan legislation (Resolution no. 13/98) and aim to minimize greenhouse gas emissions.*
United Nations Convention on Biological Diversity (UNCBD) ratified by Resolution no. 23/97 on July 4th 1997; it entered into force in Angola on July 23th 1997 (Resolution no.23/97).	Its objectives are to conserve biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. *Statoil will introduce mitigation measures to ensure that the Project avoids significant impacts to sensitive marine species.*

Multilateral Environmental Agreement	Description / Project Standards
International Convention on Maritime Search and Rescue (SAR) ratified by Resolution no. 34/01 on November 30th 2001; it entered into force in Angola on November 23rd 2001 (Resolution no. 34/01).	Aims at the development of an international Search and Rescue plan and establishes the coordinating mechanism for such plans. *The Project will be aligned with Angolan legislation and relevant international guidelines and will provide support if requested.*
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION) ratified by Resolution no. 23/97 on July 4th 1997; it entered into force in Angola on October 5th 2001 (Resolution no. 29-A/01).	Affirms the right of a coastal State to take measures on the high seas as may be necessary to prevent, mitigate or eliminate danger to its coastline or related interests from pollution by oil or the threat thereof, following upon a maritime casualty. *The Project will be aligned with Angolan legislation and relevant international guidelines and Statoil will establish the appropriate oil spill plan.*
International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC 90) ratified by Resolution no. 33/01 on November 9th 2001; it entered into force in Angola on November 9th 2001 (Resolution no. 33/01).	Establishes measures for dealing with pollution incidents, either nationally or in co-operation with other countries. Parties are required to provide assistance to others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided. *The Project will be aligned with Angolan legislation and relevant international guidelines and Statoil will establish the appropriate oil spill plan.*
International Convention for the Prevention of Pollution (MARPOL 73/78) ratified by Resolution no. 41/01 on December 21st 2001. Angola has also ratified Annexes I (Prevention of pollution by oil), II (Control of pollution by noxious liquid substances), III (Prevention of pollution by harmful substances in packaged form), IV (Prevention of pollution by sewage from ships), V (Prevention of pollution by garbage from ships) and VI (Prevention of Air Pollution from Ships Enforcement); it entered into force in Angola on December 21st 2001 (Resolution no.41/01).	Covers prevention of pollution of the marine environment by ships from operational or accidental causes. *The Project will be aligned with Angolan legislation (Presidential Decree no.141/12) and in compliance with MARPOL requirements.*
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC) ratified by Resolution no. 22/01 on May 19th 2001; Angola has only ratified Protocol 96 (through Resolution no. 22/01 of May 19th 2001).	Contributes to the international control and prevention of marine pollution and prohibits the dumping of certain hazardous materials, requires a prior special permit for the dumping of a number of other identified materials and a prior general permit for other wastes or matter. *The Project will be aligned with Angolan legislation and in compliance with LDC requirements.*

2.3.2. International Organizations and Standards

A) International Finance Corporation

The International Finance Corporation (IFC), established in 1956, is part of the World Bank Group and promotes sustainable private sector investment in developing countries. IFC membership comprises all country members of the United Nations (Angola has been a member since December 1st 1976).

The World Bank Group's Safeguard Policies have defined international best practice for EIA for the last 20 years. In April 2006, after three years of effort including extensive stakeholder consultation, the IFC released a set of Performance Standards (PSs) which were based on the Safeguard Policies but recognized the specific issues associated with private sector projects (see Box 2.2). These Performance Standards were updated in January 2012.

IFC Performance Standards
PS1: Social and Environmental Assessment and Management System;
PS2: Labor and Working Conditions;
PS3: Pollution Prevention and Abatement;
PS4: Community, Health, Safety and Security;
PS5: Land Acquisition and Involuntary Resettlement;
PS6: Biodiversity Conservation and Sustainable Natural Resource Management;
PS7: Indigenous People;
PS8: Cultural Heritage.

Box 2.2.The IFC Performance Standards (PS).

The IFC Performance Standards have been broadened to include issues such as greenhouse gases, human rights, community health, and safety and security. There is a much greater emphasis on community engagement and requirements for "free, prior and informed consultation" where there are significant environmental or social effects on communities. Further there is now an increased focus on social and environmental performance of projects that need to be

managed, and monitored through an action plan and/or management system on an ongoing basis.

The IFC published the Environmental, Health and Safety (HSE) Guidelines in 1998 and published the HSE Guidelines for Oil and Gas Developments in 2007. The HSE Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)[10]. These guidelines contain the performance levels and measures that are generally considered to be achievable by new facilities by existing technology at reasonable costs. The applicability of the EHS Guidelines are tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. Statoil's requirements and guidelines within Environmental Impact Assessment are based on the IFC Guidelines.

B) Equator Principles

The Equator Principles (EPs) established voluntary principles, including adherence to IFC Performance Standards, for addressing environmental and social risks and issues in global project finance transactions. The Equator Principles Finance Institutions (EPFIs) collectively control more than 80% of the global project finance market. The EPs were designed to serve as a benchmark for the financial industry to manage social and environmental issues in project financing. The Principles are:

1. Review and Categorization;
2. Social and Environmental Assessment;

[10]Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

3. Applicable Social and Environmental Standards;
4. Action Plan and Management System;
5. Consultation and Disclosure;
6. Grievance Mechanism;
7. Independent Review;
8. Covenants (conditions of disbursement);
9. Independent Monitoring and Reporting; and
10. EPFI Reporting.

The functional effect of the EPs was to align the major project appraisal policies of private sector finance with those of the IFIs. This was a major step in promoting compliance with international best practice with respect to reducing or eliminating project environmental and social impacts.

C) United Nations Environment Program

An example of the international guidelines on environmental regulation for petroleum activities is the United Nations Environmental Program (UNEP) environmental law guidelines and principles on offshore mining and drilling issued in 1982. Key provisions are summarized below:

- ✓ States should take preventive measures to mitigate, limit, and reduce pollution and other adverse effects on the environment resulting from offshore exploration and production of hydrocarbons and other minerals by adopting regulations and implementing international co-operations. National laws and regulations should not be less effective than international rules and standards;
- ✓ The granting of an authorization should be preceded by an environmental assessment. Authorizations should be refused if there are clear indications that significant adverse effects caused by such operations could not be avoided;

- ✓ States have the responsibility to ensure that activities within their jurisdiction do not cause damage to the environment of other states or areas beyond the limits of national jurisdiction;
- ✓ States should ensure that safety measures, contingency planning, and implementation measures are undertaken for offshore operations and that appropriate measures are adopted for determining environmental liability and compensation for damages resulting from offshore operations.

D) International Petroleum Industry Environmental Conservation Association

The International Petroleum Industry Environmental Conservation Association (IPIECA), established in 1974, is a voluntary non-profit organization whose membership includes both petroleum companies and associations at the national, regional, or international levels. It addresses global environmental and social issues related to the oil industry, such as oil spill preparedness and response, global climate change, biodiversity, social responsibility, fuel quality and vehicle emissions, and human health. IPIECA also helps members to identify new global issues and assesses their potential impacts on the oil industry.

The Association represents the views of its members[11] (in public forums and provides an interface between the petroleum industry and the United Nations Agencies. IPIECA's goals are to promote good practices and industry consensus through arranging international workshops, publishing authoritative reports, providing a channel of communication with the United Nations, providing a forum for open dialogue, facilitating stakeholder engagement, and promoting partnerships.

[11] Statoil is an active and contributing member of IPIECA

E) International Maritime Organization

The purposes of the International Maritime Organization (IMO) is "*to provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships*". IMO developed and introduced international conventions dealing with safety at sea and prevention of marine pollution.

Angola is a member state of IMO and has ratified the Marine Pollution Conventions, including the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), which is one of the few global conventions prescribing quantitative environmental standards for operational aspects of offshore E&P activities. MARPOL makes specific reference to the requirements applicable to the oil industry. This convention entered into force in Angola on December 21st2001 (Resolution no. 41/01 of December 21st 2001). Angola has also passed Presidential Decree no.141/12, which codifies many of the regulations within MARPOL 73/78 as national legislation.

2.4. Relevant Applicable Legislation for THE Project

As presented in previous sections, Block 39 Exploratory Drilling Project needs to be in compliance with Angolan statutory requirements and relevant international guidance to which Angola is a signatory.

Table 2.3 summarizes the relevant applicable Angolan and international standards that will be applicable for the Block 39 Exploratory Drilling Project.

Table 2.3. Key Angolan and international standards relevant to the Project.

Item/Aspect	Angolan Legislation	Relevant International Standards and Guidelines
Non-hazardous solid waste from offshore activities	Executive Decree no. 8/05 requires that operators produce a Waste Management Plan (WMP). Presidential Decree no. 141/12 requires compliance with MARPOL 73/78 Annex V.	International Convention for the Prevention of Pollution from Ships, 1973 as amended by the Protocol of 1978 relating thereto (MARPOL 73/78) Annex V. The IFC HSE Guidelines (2007) Oil and Gas Developments (Offshore) recommend compliance with MARPOL 73/78.
Food and domestic waste from offshore activities	Executive Decree no. 224/12 requires that the food waste may only be discharged to the sea if crushed <25mm, for facilities distances >12 nm from coast; and requires that operator produce an Operational Discharge Management Plan (ODMP). Presidential Decree no. 141/12 requires compliance with MARPOL 73/78 Annex IV.	MARPOL 73/78 Annex IV. The IFC HSE Guidelines (2007) for Oil and Gas Developments (Offshore) recommend compliance with MARPOL 73/78.
Sewage from offshore activities	Executive Decree no. 224/12 establishes the rules and procedures for operational discharges from the oil industry; and requires that operator produce an Operational Discharge Management Plan (ODMP). Presidential Decree no. 141/12 requires compliance with MARPOL 73/78 Annex IV.	MARPOL 73/78 Annex IV. The IFC HSE Guidelines (2007) Oil and Gas Developments (Offshore) recommend compliance with MARPOL 73/78.
Solid / liquid hazardous waste	Executive Decree no. 224/12 prohibits the discharge to the sea of all hazardous waste; and requires that operators produce a Operational Discharge Management Plan (ODMP). Presidential Decree no. 141/12 requires compliance with MARPOL 73/78 Annexes I, II and III.	MARPOL 73/78 Annexes I, II and III. The IFC HSE Guidelines (2007) Oil and Gas Developments (Offshore) recommend compliance with MARPOL 73/78.
Ballast water discharges	Executive Decree no. 224/12 – Vessels must have management plan for ballast water, must keep a register of discharges, appropriate treatment of ballast water, such exchange must take place at more than 200 nautical miles off the Angola coast. Presidential Decree no. 141/12 requires compliance with MARPOL 73/78 and IMO.	2004 International Convention for the Control and Management of Ship´s Ballast Waste and Sediments (BWM Convention). MARPOL 73/78 and IMO recommends: ✓ discharges shall be at more than 200 km from the intake point and at less than 22 km offshore and 25 m depth (limiting the risk of foreign invasive species intrusion); ✓ vessels shall be equipped with isolated ballast water systems (avoiding risk of oil content).

Item/Aspect	Angolan Legislation	Relevant International Standards and Guidelines
Unintended releases (e.g. accidental oil spills)	Decree no. 39/00 (Articles 7 and 8) requires operators to prepare a Spill Prevention Plan and a Spill Response Plan. Resolution no. 33/01 approves accession to the 1990 Convention on Oil Pollution Preparedness, Response and Cooperation. Executive Decree no. 11/05 sets definition and standardization procedures for the notification of an occurrence of a spill to be provided to MINPET by the Operator.	1990 Convention on Oil Pollution Preparedness, Response and Co-operation. The IFC HSE Guidelines (2007) Oil and Gas Developments (Offshore) make recommendations in regards to oil spill preparedness although it should be noted these are aimed mainly at producing facilities.
Gases emissions by diesel consumption from drill rigs, marine vessels, supply boats, helicopters and facilities operation	Presidential Decree no. 153/11 of June 15th 2011 regulates the substances that deplete the ozone layer. Executive Decree no. 224/12 established that the operator must record emissions of the GHG, gases that deplete the ozone layer, and organic and inorganic pollutants. Presidential Decree no. 141/12 requires compliance with MARPOL 73/78 Annex VI.	United Nations Framework Convention on Climate Change (1992) and the Kyoto Protocol to the UNFCCC (1997). MARPOL 73/78 Annex VI. The IFC HSE Guidelines (2007) *Oil and Gas Developments (Offshore) a*ssess greenhouse gas emissions from all equipment annually using IFC's IMAGE model or an alternative model acceptable to IFC or provide an annual GHG emissions inventory.
Impacts on offshore flora and fauna (e.g. marine resources stocks in Block 39 and adjacent areas)	Law no. 6-A/04 of October 8th 2004 (Law on Biological Aquatic Resources) sets out the principles and objectives of the use of biological aquatic resources, as control and management of activities harmful to resources and ecosystems. Decree no. 317/11 of December 30th 2011 regulates the policies for conservation and sustainable renewal of biological resources with the adoption of appropriate measures for protection and conservation of endangered species and their habitats.	United Nations Convention on Biological Diversity (1992) states that measures should be taken to implement the biodiversity management and conservation requirements, especially in what concerns endemic species and vulnerable ecosystems.
Noise and Vibration	Decree no. 39/00 recommends minimizing noise soured and use of personal protective equipment.	The IFC HSE Guidelines (2007) *Oil and Gas Developments* (Offshore) recommend limits on noise levels allowed offshore: ✓ inside of buildings: 45 to 75 dB; ✓ outside of industrial unit (less than 15 m from a work place or regular maintenance area) < 85 dB.

Note: This table does not present an exclusive list of all legislation used as guidelines for oil and gas projects. Regular regulatory reviews will be required to ensure that the Block 39 Drilling Project is compliant with the current national legislation.

2.5. National Biodiversity Strategy and Action Plan

To implement the recommendations from the United Nations Convention on Biological Diversity (UNCBD, ratified by the Resolution no. 23/97), the Government of Angola approved through the Resolution no. 42/06 of July 26th 2006 the National Biodiversity Strategy and Action Plan (NBSAP). This strategy incorporates measures for the conservation and sustainable use of biological diversity/resources in development policies and programs.

The Strategy and Action Plan are interconnected through Eight Strategic Areas that were defined through a process of public consultation that involved representatives of government institutions, local and traditional authorities, environmental protection institutions, the education sector, the private sector, and the press. These areas, listed below, are meant to be integrated into broad programs that drive the conservation and sustainable use of biodiversity:

- ✓ Strategic Area A: Research and Information Dissemination;
- ✓ Strategic Area B: Education for Sustainable Development;
- ✓ Strategic Area C: Biodiversity Management in Protected Areas;
- ✓ Strategic Area D: Sustainable Use of Biodiversity Components;
- ✓ Strategic Area E: The Role of Communities in Biodiversity Management;
- ✓ Strategic Area F: Institutional Strengthening;
- ✓ Strategic Area G: Legislation and Its Implementation; and
- ✓ Strategic Area H: Management, Coordination and Monitoring.

As described in the next chapters, this EIS documents the current Block 39 baseline, assesses the potential impacts on the marine environment and biodiversity, and describes the management practices to be implemented.

2.6. **Regional Programs**

The Project location (Block 39– Angolan EEZ) includes some regions enclosed for regional programs of environmental conservation. These regions are considered as areas of direct or indirect influence of the Project (see *Chapter 4*). The measures established for these programs, e.g. harmonization of national environmental policies and legislations for offshore petroleum, must be taken in consideration for development and implementation of projects in Angolan offshore. The relevant regional programs are described below.

2.6.1. **Benguela Current Large Marine Ecosystem**

The Program was funded by the Global Environment Fund (GEF). The Benguela Current Large Marine Ecosystem (BCLME) Program is designed to improve the structures and capacities of Namibia, Angola, and South Africa to deal with the environmental problems that occur across their respective national boundaries, so the Benguela Current Large Marine Ecosystem can be managed as a whole.

One of the most important actions of the BCLME Program with respect to environmental impact assessments is the harmonization of national environmental policies and legislations for offshore petroleum exploration and production, dredging and mining-related activities in the BCLME region. At the moment, the Program is implemented by the Benguela Current Committee headquartered in Windhoek, Namibia.

2.6.2. **Guinea Current Large Marine Ecosystem**

The Guinea Current Large Marine Ecosystem (GCLME) Program is an ecosystem–based effort to assist countries adjacent to the Guinea Current Ecosystem to achieve environmental and resource sustainability. This is to be accomplished by shifting from short-term sector-by-sector driven management objectives to a longer-term perspective and from managing commodities to sustaining the production potential for

ecosystem-wide goods and services. The GEF pilot phase included a Gulf of Guinea Large Marine Ecosystem Program integrating six countries (Angola included) and ended in November 1999.

A new phase of this Program has now extended the Gulf of Guinea Program from six to sixteen countries, all of which are influenced by the Guinea Current. This new Program assists the sixteen countries in making changes in the way human activities are conducted in the different sectors of national life to ensure that the GCLME and its multi-country drainage basins can support a sustainable socioeconomic development of the region.

One of the Program goals is to build capacity of Guinea Current countries to work jointly and in concert with other nations, regions, and GEF projects in West Africa to define and address priority trans-boundary environmental issues within the framework of their existing responsibilities under the Abidjan Convention and its Regional Seas Program. This Program is being managed by the GCLME Interim Commission headquartered in Accra, Ghana.

2.7. **Statoil ANGOLA – Block 39 Exploratory Drilling Project Standards**

The Block 39 Exploratory Drilling Project will follow the Statoil Health, Safety and Environment Policy (HSE Policy) and HSE goal. Statoil's HSE goal is "Zero harm". The strategy to reach this goal is to:

- ✓ Understand and manage the risks;
- ✓ Prevent all accidents;
- ✓ Stop unsafe acts and operations;
- ✓ Minimize the impact on the environment and climate;
- ✓ Care about each other;
- ✓ Create a safe and healthy working environment;
- ✓ Work together with its partners to improve HSE results; and
- ✓ Have an open dialog with society.

As part of its HSE Policy, Statoil is committed to:

- ✓ Integrating HSE in how they do business;
- ✓ Improving HSE performance in all its activities;
- ✓ Contributing to the development of sustainable energy systems and technology;
- ✓ Demonstrating the importance of HSE through hands-on leadership and behavior; and
- ✓ Openness in all HSE issues and active engagement with stakeholders.

Statoil's management system and central operational units are certified in accordance with ISO 9001 "Quality management systems" and ISO 14001 "Environmental Management Systems".

CHAPTER 3

PROJECT DESCRIPTION

3. Project Description

This section describes Project components at a level of detail sufficient to estimate and characterize environmental and social impacts potentially related to Project activities. The section begins with an overview of the Project location, schedule and alternatives. *Section 3.2* describes the main Project components. *Section 3.3* outlines proposed activities that support the implementation of the exploratory drilling program. *Section 3.4* estimates Project-generated emissions and discharges. Section 3.5 outlines the proposed decommissioning process.

3.1. Project Overview

Statoil proposes to undertake an exploratory drilling campaign in Block 39, which is located in the in Benguela Basin, approximately 260 km southwest off Luanda's coastline and about 110 km west off Sumbe's coastline.

The block covers an area of 7,809 sq. km, in water depths ranging from 1,500 to 2,500 meters. Figure 3.1 shows the location of Block 39 in relation to the Angolan coast and other offshore concession blocks.

The proposed exploratory drilling program consists of up to five (5) exploratory wells and addition appraisal wells intended to confirm the presence of hydrocarbons. The wells will target reservoir objectives in the pre-salt and are expected to be drilling to a target a final depth of 5,000 m – 6,200 m. Depending on the final well locations, the wells will be drilled in water depths of approximately 1,500 – 2,500 m.

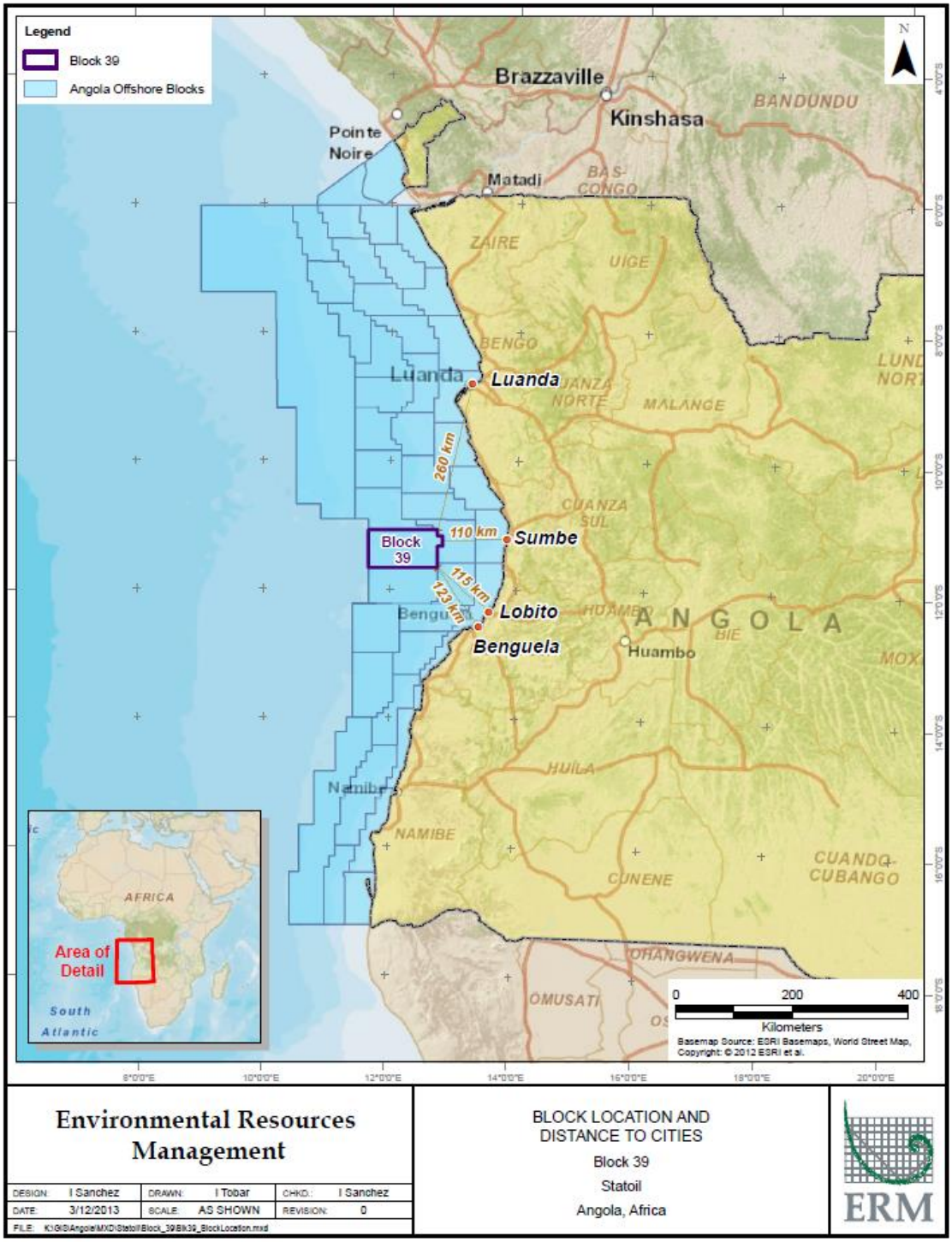


Figure 3.1: Location of Block 39 in Offshore Angola.

The coordinates for the proposed one (Dilolo-1) of the three exploratory wells is shown in Table 3.1. The coordinates of Dilolo-2 and Dilolo-3 will be provided once information is made available.

Table 3.1: Proposed Block 39 exploration well coordinates.

Well Names	Proposed Coordinates	
	Latitude	Longitude
Dilolo-1[12]	11°16'39,71''S	12°26'45,00''E
Dilolo-2	Not Available	Not Available
Dilolo-3	Not Available	Not Available

Notes: Datum: Camacupa – EPSG: 4220; Projected CRS: Camacupa / UTM; ZONE 33S – EPSG: 22033

Source: Statoil, 2013.

If the exploratory wells confirm the presence of hydrocarbons, several appraisal wells might be drilled to address remaining geologic uncertainties and to characterize the reservoir conditions. The appraisal drilling program will be addressed in a separate EIS Addendum, following the outcome of the exploratory drilling program.

3.1.1. Project Schedule

The first exploratory well is expected to spud Q1 2014. Drilling of this first well is expected to last around 128 days or 4.5 months (please see Table 3.2 below). Drilling of the second well is expected Q4 2014 and it will also last around 4.5 months. As shown in Table 3.2 below, well completion is expected to take approximately 128 days.

Table 3.2: Project schedule.

[12] Dilolo-1 being is an exploration well and Dilolo-2 and Dilolo-3 are appraisal wells.

Well	Type	Start	End	Time (days)	Notes
Dilolo-1	Exploratory	01.03.2014	04.08.2014	128	Days for dry well only. Can be DST[13] as well
Well 2, AB 39	Appraisal/Exploratory	14.12.2014	20.04.2015	128	Days for dry well only. Can be DST as well
Well 3	Appraisal	24.02.2016	12.07.2016	128	Optional[14]
Well 4	Appraisal	12.07.2016	30.11.2016	128	Optional

Note: The number of days depend on scope of well (coring, with or without DST among other factors)

3.1.2. Alternatives Analysis

Project alternatives were evaluated based on geologic, environmental, economic and social factors. These considerations were also made taking into account the obligations of Statoil relative to its agreement signed with Sonangol. Various alternatives were considered with the aim that every environmental practice decision should be made on a transparent and cost effective basis. The following Project alternatives were considered:

- **Location:** The main objective for the chosen well location is to optimize sub-surface success, which is placement of a well such that it will safely penetrate a well-developed sag phase reservoir section while not leaving potential commercial volumes up-dip. The location was determined to avoid drilling through volcanic formations and anomalies in the salt, which could have caused drilling problems. The surface spud location was placed in a position where there is clean seabed, without pockmarks.

[13] DST are Drill Stem Tests used to provide a more definitive idea of the production capacity of the well, drill stem tests identify the types of fluids within the well, as well as the flow rate of these fluids, formation permeability and reservoir pressure

[14] These wells are designated as optional because it is uncertain if they will be drilled (only if one of the exploratory wells yields a discovery).

- **Drilling equipment (criteria used to select the MODU):** The main criteria for selecting drilling equipment for deepwater Block 39 is the ability to safely operate at such depth. At these depths, only a few drillships and newer generation Semi-submersible rigs can be used. A drillship also can accommodate higher payload volumes and personnel, which in turn reduce the number of shipments between the rig and onshore base.

- **Well design and safety considerations:** A robust well design is planned for this project. The casings through the salt will be thick walled to counter for collapse forces in the salt. A design is selected to withstand the loads created during the Drill Stem Test. Well design also contemplates the installation of a casing as close as possible above the reservoir. By doing so, the formation left open above the reservoir is minimized, thus reducing the probability of hole problems.

- **Shore base location:** Sonils Base is chosen as the only offshore supply base for drilling operations in the Kwanza basin today.

- **Mud selection:** Drilling salt with Synthetic Oil Based drilling fluid is regarded as best practice, since the salt will not be washed out when using a Synthetic Oil Based drilling fluid.

- **Waste management options (transportation, storage and disposal):** To comply with Executive Decree 224/12, and in accordance with options raised and evaluated in its Implementation Plan, Statoil plans to skip and ship the non-water based cuttings to shore for treatment and disposal. Skips will be used for transportation.

The chosen Project Design, after consideration of various engineering options against an environmental, social and regulatory backdrop, is expected to yield environmental and/or

socio-economic impacts that will be limited in scope, significance and timescale (see Chapter 5 for a description of predicted impacts).

3.2. **Description of the Drilling Process**

For the purpose of this assessment, the Project will be described by the following main components:

- Drilling Unit;
- Drilling Technique;
- Well Information;
- Drilling Fluids;
- Blowout Prevention;
- Well testing;
- Well abandonment; and
- Workforce.

An existing shore-based facility will be utilized to support the drilling program and therefore does not represent an additional project activity.

3.2.1. **Drilling Unit**

A dynamically positioned mobile offshore drilling unit (MODU) rated for operations in water depths sufficient for operation in Block 39 will be used to drill the two wells. The DP system is designed to DNV DP Class 3[15] such that loss of position should not occur from any single failure. The vessel has installed a Kongsberg Simrad Dynamic Positioning (SDP) system[16]

[15] Typical examples of standards used for DP ships are DNV DYNPOS-AUTR and DYNPOS-AUTROnotations, and IMO MSC/Circ. 645 "Guidelines for vessels with dynamic positioning systems" equipment class 2 and equipment class 3.

[16] www.kongsberg-simrad.com. Retrieved on March 14th, 2013.

complying with Class Notation DNV DYNPOS AUTRO (NMD Class 3) and this system controls the vessel position and heading by using the vessel's azimuth thrusters.

Dynamically positioned units improve drilling safety, optimize efficiency, and reduce environmental impacts by avoiding subsea disturbance. The advantages of a dynamically positioned drillship include: self-propulsion, capability for storing equipment, and minimal impacts to the seabed.

Statoil is planning to use a drillship specifically designed for ultra deep-water operations and to meet latest internal regulatory requirements (Figure 3.2, Table 3.3). The selected vessel, *Stena Carron*, will be a drillship capable of drilling to 10,700 m in water depths of 300 - 2,743 m. It has a capacity of 2,000,000 lbs. The DP of this ship is design to prevent loss of position even in case of a single failure, through a system that controls the vessel's position and heading by using the vessel's azimuth thrusters. It has also a comprehensive drilling mud treatment facility, as well as facilities for building stands of casing, DP & DC in parallel with normal drilling, tripping and casing running operation.

Figure 3.2: Deep-water drillship to be used.

Table 3.3: General Specification of the drillship involved in the well-drilling program.

Size			
Main deck Width	42 m	Pipedeck area	758 m^2
Main deck Length	228 m	Riserdeck area	940 m^2
Main deck Depth	19 m	Area for safe storage of containers	720 m^2
Storage/Accommodation Capacity			
Water Capacity (drilling)	2.600 m^3	Total mud capacity	More than 240 m^3
Water capacity (potable)	2,000 m^3	Accommodation Capacity (berths)	210
Fuel Capacity (diesel)	2,600 m^3	Tubular handling capacity	20”

Oil Capacity (fuel)	10,700 m^3	Maximum tubular length	15 m
Barite / Bentonite storage capacity	420 m^3 (4 tanks)	Sack storage capacity	7,500 units
Cement storage capacity	420 m^3 (4 tanks)		
Technical specifications			
Maximum speed	Self-propelled 12 Knots	Fuel usage during drilling	85 m^3/day
Power generation	6 x 7,400 kW diesel generators	Fuel usage during transit	40 m^3/day
Relevant Drilling Properties			
Maximum water depth	2,743 m	Maximum Drilling depth	10,700 m
Minimum water depth	200 m		

Source: http://www.stena-drilling.com/uploads/vessels/Stena-Carron-Brochure.pdf

In the drilling unit, a number of pre-screeened third party companies will be responsible for different operations, as described in table 3.4. These companies are yet to be selected. Nevertheless, all contractors working for Statoil on this Project will be required to comply with Angolan legislation and relevant Statoil requirements, thus supporting the implementation of the mitigation measures proposed herein. Compliance with national regulations and adherence to corporate risk management procedures by 3rd parties is standard contractual requirements within Statoil.

Service Companies working for Statoil will be prequalified on the merits of their health, safety and environmental record to be included in the bidders list and ultimately invited to tender. This prequalification is done to ensure that the companies are able to comply with HSE requirements in the contract. Regular HSE follow-up towards the companies are conducted throughout the contract period.

Table 3.4: Main operations to be undertaken by third party companies

Operation
ROV
Mud logging
Cement equipment
Drilling fluids
Directional drilling
MWD

Before drilling, a geo-hazard study, including seabed surveying with a ROV system, will be conducted to confirm the suitability of the chosen locations (2 x for the main well – i.e. primary + backup – 1 x pilot hole and 2 x relief wells). Upon positioning at the drilling location, the drillship will first conduct a short seabed survey using a Remotely Operated Vehicle (ROV) to obtain seabed images and confirm lack of obstacles or structures that may affect operations. The selected unit is designed for operations in harsh environments and actual water depths and equipped with DP class 3. It is equipped with a complete set of rescue and safety equipment, including but not limited to:

- 5 lifeboats capable of evacuating 180 people;
- 1 fast rescue craft
- Life jackets with 100 & equivalency to the maximum number of people on-board, plus 50% stores at the lifeboat stations;
- H_2S-protection system and equipment are installed at the drill ship. , including breathing system stored all around the ship (including in all cabins) and 25 H_2S detectors;
- A complete fire and gas detection/combat system, with alarms, affected area panels, separated water pump system, fire water rings, water deluges systems, and others;
- 35 HC gas detectors;

- Emergency Shutdown System (EDS), including the automatic shutdown of the ventilation in the generators rooms and safe areas when detecting low gas levels in the ventilation intake.

3.2.2. **Drilling Technique**

A conventional drilling method will be used and this will include a drill bit attached to a bottom hole assembly consisting of downhole motors and/or rotary steerable system along with measurements while drilling tools will be connected to a surface top drive system via drill pipes. Drilling cuttings will in general be displaced by mud and return to sea bed for water based drilling fluids and to surface for non-water based fluid system.

3.2.3. **Wells Information**

Statoil's first exploration well will represent a well-recognized and proven well design. The current plan (preliminary design) for hole sections and casings are described in Table 3.4, and illustrated in Figure 3.4. The expected exploration wells coordinates are given in Table 3.1 (and approximate locations in Figure 3.3), with Dilolo-1 being an exploratory well and Dilolo-2 and Dilolo-3 being appraisal wells. In addition there are various contingency options available if required.

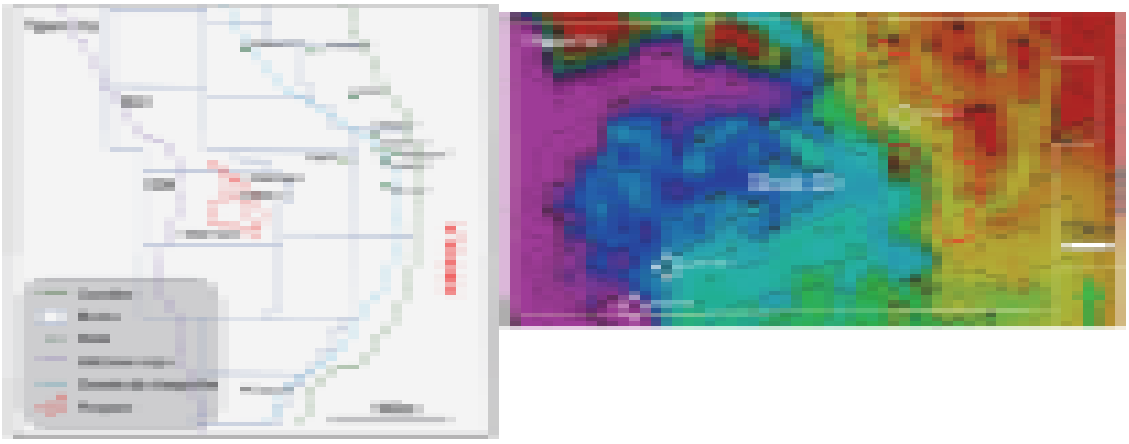


Figure 3.3: Preliminary location of Block 39's wells. Source: Statoil, 2013.

The proposed well location (see Figure 3.3) is evaluated as being the most promising, based on analysis of seismic survey results undertaken between December 2011 and December 2012. No other location is considered although minor adjustments of location may be needed if the ROV-survey (prior to spudding) identifies any obstacles. There will be two locations for the main well (one primary and a contingency) in case ROV observations prior to spud identifies any other hazard not encountered during the shallow hazard study. The contingency location will also be used if drilling problems that could potentially affect the integrity of the well.

The selected well design, drilling procedures and well locations are meant to minimize risks. Table 3.5 presents the preliminary design for the exploratory well.

Table 3.5: Preliminary design for proposed deep-water exploratory well.

Casing Size (in)	Depth of Shoe (m below RKB)	Section Length (m)
36	1,867	53
28	2,226	359
22	2,597	371 or 580
18	3,332	735
16	3,849	517 or 1,252
14	5,221	1,372
11 ¾	5,301	80
9 7/8	5,607	306 or 386
7 5/8	6,097	490

Some of the minimum required rig specifications associated to the related wellheads are presented in Table 3.6 and the schematic representation of the well in Figure 3.4.

Table 3.6: Minimum required rig specifications for wellheads.

Property	Rig Required compliance
EWT (Expected Wellhead Temperature)	145 ^{o}C

MSWP (Maximum Shut in Wellhead Pressure)	900 Bar
DRWCP (Design Rig Well Control Pressure)	1,035 Bar

HOLE			CASING			Top / bottom of salt	TOL	TOC	CSG. SHOE	
SIZE	Section TD TVD RKB MD RKB	SIZE	TYPE / RAD. MARKERS	CENTRALIZERS	Est FG [SG]	MD RKB	MD RKB	MD RKB	TVD RKB	MD RKB
Seabed, 1782m										
9 7/8" Pilot hole	2570 2570	N/A								
Jetted	1867 1867	36"	Type:726, 552,5 lbs/ft Material: X-80 (or X-56) Connection: HC100 - D60 w/ anti rotation device			Sea bed 1814			1867	1867
30" x 32"	2226 2226	28"	Type: 218,2 lbs/ft Material: X-56 Connection: S60 MT w/ anti rotation device	Bow centr.	1,04			Seabed	2226	2226
26"	2597 2597	22"	Type: 226 lbs/ft Material: P-110 Connection: S90 MT, S60 MT Drift: 19.75"	Bow centr.	1,08 1,11	Top Salt 2447	16" 2467 2547 18" 2497	Seabed	2597	2597
18 1/8"x 21"	3332 3332	18"	Type: 119 lbs/ft Material: Q-125 HC Connection: Hydril 511 **Drift: 16.532"**		1,11 1,32			2932	3332	3332
16 1/2" x 19"	3849 3849	16"	Type: 96lbs/ft Material: Q-125 HC Connection: Hydril 511 **Drift: 14.75"**	Bow spring centr	1,32 1,58			3549	3849	3849
14 3/4" x 17 1/2"	5221 5221	14"	Type: 112,6 lbs/ft Material: SM125S Connection: Vam SLIJ-II **Drift: 12.25"**	Bow spring centr	1,6 1,68		11 3/4" 5171	4901	5221	5221
12 1/4" x 14"	5301 5301	11 3/4"	Type: 65 lbs/ft Material: SM125S Connection: Vam SLIJ-II **Drift: 10 5/8"**	Bow spring centr	1,73 1,58	Base Salt 5251	9 7/8" 5251 5171	5201	5301	5301
12 1/4"	5607 5607	9 7/8"	Type: 62,8 lbs/ft Material: SM125S Connection: Vam SLIJ-II **Drift: 8 1/2"**	Bow spring centr	1,56 1,56		7 5/8" 5557	5307	5607	5607
8 1/2"	6097 6097	7 5/8"	Type: 39 lbs/ft Material: Q-125 Connection: Vam SLIJ-II **Drift: 6 1/2"**					5607	6097	6097

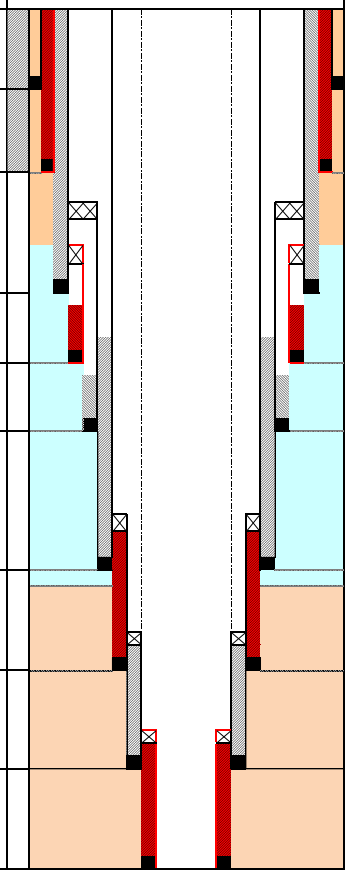


Figure 3.4: Simplified well schematic for Block 39.

3.2.4. **Drilling Fluids and Cuttings**

Drilling fluids are a fundamental part of the drilling process. The main functions of the drilling fluid are to control well bore pressure, keep the bit and bottom hole assembly cool, lubricate the bit, reduce friction between the drill pipe and the hole, inhibit reactive clays (prevent clay selling and hole degradation) and transport cuttings out of the wellbore. Drilling fluids include various mixtures, and are also known as drill mud. Bentonite and other

clays and/or polymers are the basic constituents of drill mud; they are mixed with fluids to the desired viscosity.

The compositions of the drilling fluids are determined at an early stage of the well planning. Various kinds of additives and chemicals are required and need verification. The most commonly used drilling fluids are Water Based Mud (WBM), Oil Based Mud (OBM), and Synthetic-Oil Based Mud (SOBM). The type of drilling fluid used is dependent on the geological properties in the area of the drill site.

Two drilling fluid systems will be used for this project: WBM and SOBM. WBM will be used for drilling the upper, riser-less portion of the well (approximately 735 m) and SOBM will be used after the Blow out preventer (BOP) and Riser has been installed. An overview for the hole sections, type of mud and predicted mud volumes is provided in Table 3.7.

Table 3.7: Overview of the hole sections and types of muds to be used.

Section	Bore Diameter (Open holes)	Well Interval between Sections (m)	Mud Type	Fluid Volumes (m^3)
Post salt sediments	42'', 32'', 26''	1,800 – 2,597	WBM	1,138
Salt sediments	21'', 19'', 17 1/2''	2,597 – 5,221	SOBM	3,486
Pre salt sediments	14'', 12 1/4'', 9 1/2''	5,221 – 6,200	SOBM	1,365

An illustrative list of the chemicals usually used for each mud is presented in Table 3.8.

Table 3.8: Estimates of principle drilling chemicals for WBM and SOBM.

Function	Total Usage (MT)	Discharge (MT)]
pH control	2,43	2,43

Function	Total Usage (MT)	Discharge (MT)]
Viscosity	219,00	219,00
Weight	485,00	485,00
Alkalinity	2,43	2,43
Viscosity/ Filterloss	8,66	8,66
pH puffer/ Ca++ treatment	7,98	7,98
Filterloss	33,80	33,80
O2 remover	5,77	5,77
Biocid	5,17	5,17
SUM	**770,24**	**770,24**
Base Oil	1.275,01	0
Emulgator	88,00	0
Emulgator	29,07	0
Alkalinity	42,40	0
Viscosity	96,20	0
Salt (Inhibition)	106,40	0
Filterloss	86,50	0
Weight	538,90	0
LCM	155,70	0

The proposed drillship is equipped with a mud management system that includes mixing, circulating, solid control and storage systems. There are mud pumps, storage tanks, cuttings dryer, centrifuges, rotary hoses, mud conditioner, mud shear, mud hopper, degassers and shale shakers available on-board. The densities of the muds and cuttings are presented in Table 3.9 while Table 3.10 provides information on the volumes.

Table 3.9: Drilling muds and cuttings densities.

Product	Density (kg/m^3)

Cuttings	2.38
WBM	1.28
SOBM	1.58

Table 3.10: Drilling muds and cuttings volumes.

Casing Depth (mud Line at 1,780m) m	Estimated Interval Drilling Time Days	Cuttings Volume m³	Discharge Depth	Mud Type	Mud Weigh t S.G	Cutting Particle Size M m	Total Volume Cuttings + SOBM m³	Total Discharge Mass Load MT/hr
2,538	20	425	Seabed	WBM	1.03	2.5	N/A	13,5
5,048	30	574	'Zero' discharge	SOBM	1.58	1.9	631	0
5,500[17]	60	46	'Zero' discharge	SOBM	1.3	2.1	50	0

The drillship is designed as a contained drillship, with a zero spillage system with appropriate sloped bottom tanks for the muds storage, with drain and suction at the lowest point. It will be possible to run all mud pumps simultaneously and continuously while drilling. There will also be a surface mud circulation system, which will include two surface mud tanks.

SOBM cuttings will be treated and disposed onshore, in accordance with Operational Discharge Management Regulation, Ministry of Petroleum Executive Decree No. 224/12 (ED 224/12). Statoil is planning to acquire 320 skips for SOBM transfer. A project supply vessel will be used to transfer SOBM cuttings skips to SONILS base. Angola Environmental Services (AES) will transfer the SOBM cuttings from the base by truck to its waste management facility, where AES is currently treating cuttings by thermal desorption followed by landfill disposal.

[17] Dry well case will have the casing depth at 5,500 m. If a discovery well, it will be at 6,200 m.

3.2.5. **Blow-out Prevention (BOP)**

The Stena Carron has two (2) BOPs, with main properties as listed in Table 3.11.

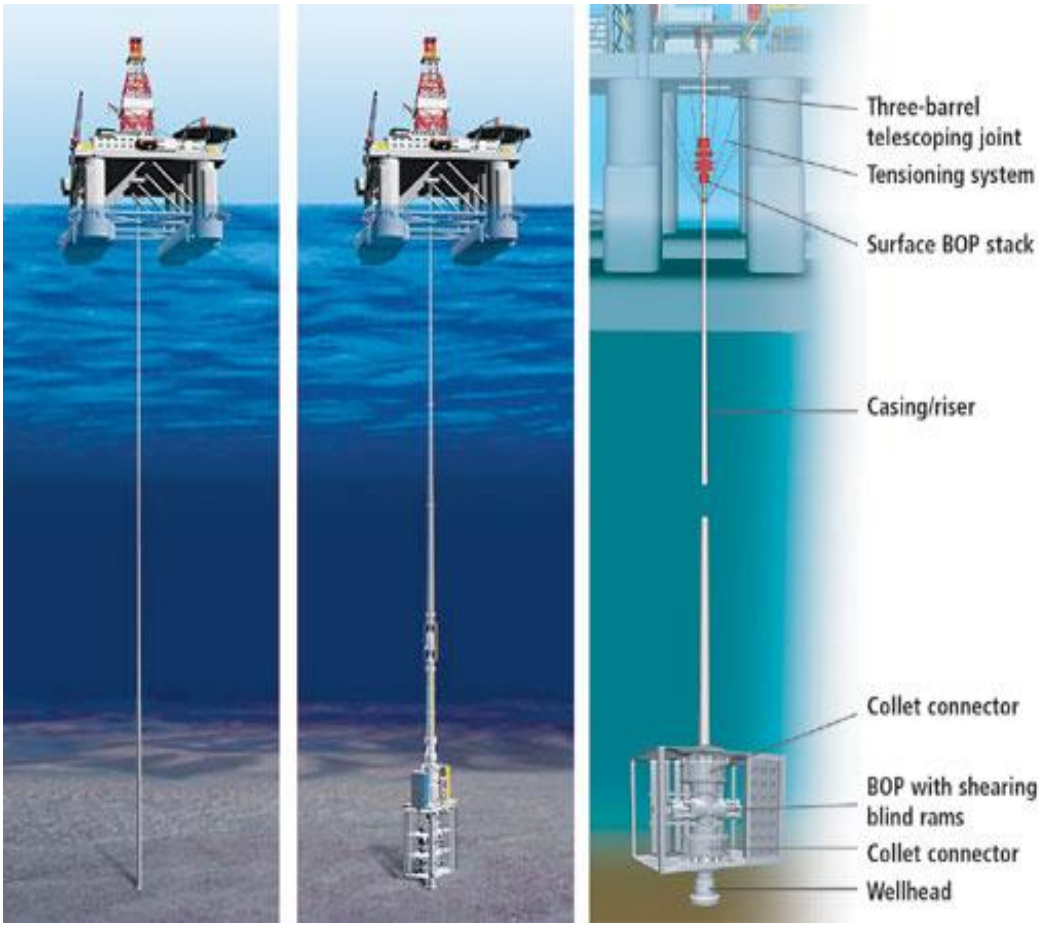


Figure 3.5: Schematic of Subsea Blowout Preventer Stack.

Although the Project wells are not expected to encounter any zones of abnormal pressure, the BOP will be rated for well pressures in excess of those expected to be encountered in the wells. In an emergency, the BOP can be controlled from the drilling rig. Testing of the BOP is conducted during drilling operations.

The project will use a Cameron BOP that is built according to current editions of requirements from the American Petroleum Institute (API) particularly API specification 16A. The properties of the BOP are provided in Table 3.11 below.

Table 3.11: Main properties of BOP to be used for the Project

Property	Description*
Bore size	18 ¾"
Working Pressure	1,035 bar
Total weight	App. 340 tons
Maximum working T during drilling	104 °C (83 °C for the 2nd BOP)
Nº of rams	6 (80/90 open/close volume)
Nº of annulars	2 (variable open/close volume)
Nº of surface accumulators	32
Accumulators working pressure	344 bar
Control fluid tank capacity	6 m^3
Antifreeze fluid tank capacity	2,6 m^3
Temperature rating of all Gaskets of the BOP Body (Stem Seals, Bonnet Seal etc.)	104 Celsius (220 Fahrenheit)
Nº of pumps	6 (electrically operated)

*common for both BOP, unless detailed otherwise.

In order to avoid personnel working over open sea in moon pool, the following equipment is present in the BOP:

- Hydraulic operation of slip joint locking device.
- Support ring with integrated choke-/kill-/booster-/mux- connections.
- "Cherry picker's" used in the moon pool area.

The BOP storage area will have sufficient access platforms or other means to access the BOP and its parts where maintenance may be required without climbing on the BOP stack.

3.2.6. **Well Testing**

The purpose of the testing is to evaluate the potential production capacity of the well. Testing may be conducted in more than one zone as drilling progresses and hydrocarbon intervals are encountered. The detailed design of any well-test and the number of tests to be carried out will be dependent upon the results of well logging.

A generic plan for well test operations, should it be required, has been developed for the proposed exploration program. This involves a complete suite of surface testing equipment, including Test Separator, test manifold, flow lines, Surface Flow Tree, Burners just to name a few of the components of a surface testing package. The surface test package allows for the hydrocarbons to be handled at surface in a controlled manner during the flow test (well test). If necessary, a coil tubing lifting frame would be rigged up prior to running in hole the testing string.

As far as in the well bore, a DST (Drill Stem Testing) string including a production test packer (to protect the string and provide sealing), a tester valve (downhole shut in valve), a circulating valve, memory gauges and samplers would be run in hole. Then, the desired target would be perforated (depending on perforation strategy and desired flow out rates calculated by Statoil's reservoir engineering department). Depending on the reservoir characteristics, a stimulation job could be performed after seeing the reaction from the perforated zones.

For the well testing, Burner booms with the specifications detailed in Table 3.12 will be installed. These booms will also be equipped with the following lines: High Pressure (HP) gas line, Low Pressure gas line, HP oil line, Compressed air vent line, cooling water line, return flash line, overboard line, and others. The production standpipe will be installed in the derrick. The line will terminate approximately 12 m above drill floor.

Table 3.12: Typical **s**pecifications of the Burner booms for well testing.

Property	Description*

Length	18.8 m
Slewing angle	180 ^{o}
Design temperature	-20 ^{o}C
Cooling water supply	
Capacity of burner water sprinkler shield	780 m^3/h
Sprinkler shield (ring) distance from burner head	App. 0.5 m
Rig cooling	780 m^3/h

3.2.7. **Wells Abandonment**

When all drilling, coring and logging activities are finalized the well will be permanently abandoned according to regulations. After a hole section has been drilled, a casing is run and cemented in place. Materials used for the cementing operations[18] include cement and chemical additives.

The majority of the chemicals to be used will be left in the hole, between the casing and the formation. The materials are presented in Table 3.13.

Table 3.13: Functions of Cement materials

Function
Cement
Cement
Defoamer
Foamer
Dispersant
Accelerator
Strength Retrogression

[18] Cementing volumes plans for the base case (dry well) are estimated to be 341 m^3 in total

Function
Dispersant
Retarder
Retarder
Anti-Settling
Fluid Loss
Spacer
Fluid Loss
Retarder
GAS control
GAS control
Spacer
Lost Circulation
Tracer
Dispersant

When the Target Depth (TD) is reached and pipe casings installed and cemented, drilling will cease. The well will be logged and possible coring undertaken. Irrespective of whether any hydrocarbon sources are discovered, the well will be plugged and permanently abandoned, a process that involves cement plugs set across all reservoir sections identified and an abandonment cap placed on top. Wellhead assemblies and associated equipment constructed entirely of high-grade steel will remain on the sea floor, with the wellhead assembly extending approximately 3 m above the seabed, with a diameter of 1 m.

3.2.8. **Workforce**

The drilling team includes 5-10 staff. The drillship will operate 24 hours-per-day and be staffed by about 180 personnel, plus 30 personnel for the supply vessels and 6-8 associated with the helicopters. The full contingent of personnel engaged by Statoil, including shore staff, will be more than 200 people during the drilling activities. These include expatriate

specialists (mainly ship's crews and some resident staff) plus local/regional/national laborers. All workers, and those of contractors, will be provided with health and safety training and personal protective equipment (PPE) suitable for the types of activities in which they participate.

3.3. Support Operations

This section describes the logistics needs of the Project.

3.3.1. Logistic Base

Support operations to Project will be conducted from the onshore base SONILS located at Rua da Boavista in Luanda (see Figure 3.6).

Figure 3.6: Sonils base in Angola.
Source: http://www.sonils.co.ao/overview.asp

SONILS base will act as a shore base for offshore operations and provide the following services and/or facilities:

- Laydown area for pipes and equipment;
- Mud Plant to provide drilling muds;

- Water supply;
- Customs clearance;
- Covered storage space (e.g. for bulk goods);
- Wash down area for equipment and machines;
- Stevedoring services;
- Handling and storage services for chemicals and hazardous materials;
- Waste management service; and
- Offices (with communications and emergency procedures/facilities[19]).

Drill pipes, steel casings and drilling chemicals (above) will be imported into Angola from well-established global suppliers. SONILS base will receive these materials with transportation conducted to international standards. Chemicals will be purchased through licensed contractor and stored in Statoil's facilities. The cement and bulk dry goods (barite and bentonite for the drilling mud) might be stored in SONILS base before transportation to the drillship.

3.3.2. **Supply Vessels and Helicopters**

The drillship will be supported by three supply vessels, two of these with Oil Recovery (OR) class (Figure 3.7 and Table 3.13). These will be manned by 12-18 crew each, supply vessels are capable of between 10-13 knots cruising speed.

[19] Part of the company area in Sonils Base will be shared with the drilling contractor.

Figure 3.7: Possible supply vessels to be used.

The supply vessels will load most materials at SONILS base and transport them to the well location. There are likely to be four to five sailings each week during drilling. Marine operations will comply with MARPOL and other applicable international, regional and national maritime legislation.

The selected route to and from SONILS base to the drill locations is chosen because it is direct, without obstacles or within the existing navigational routes. It also minimizes fuel consumption and travel time. Alternative courses would require greater investment and disturbance to the natural environment. This base has been selected to support the deep-water drilling operations for Statoil basically because it is closer to its offices in town. In addition, this base is currently the only one in Angola that has the contractors needed to support oil operations, especially when it comes to cuttings treatment and discharge.

SonAir will provide helicopter services for Block 39. One dedicated Eurocopter EC225 – 19 seater - will be the helicopter used for the services. The helicopter will be operated from the Domestic Terminal in Luanda. Based on the assumption that the drillship's POB will be up to maximum – 180 persons – with a further assumption that the rotation for the personnel will be a 50/50 mix of 3 and 4 weeks on the ship, the estimated number of passengers travelling out to the ship will be around 60-70 each week. This means that the helicopter schedule should consist of 5 weekly helicopter departures to the ship.

3.3.3. **Water supply**

Drilling a single well will require about 4,000 tons of freshwater, while some 20 tonnes per day (Statoil's well is estimated to 128 days) will be needed by the Mud Plant facility at SONILS base. Drinking/potable water is needed for the total workforce of about –180 - 210 people engaged in drillship plus crew of the supply vessels/security vessels. Some of the water distribution properties of the drillship are detailed in Table 3.13.

Table 3.14: Typical Water distribution systems on a drillship.

Seawater system (deck)					
Nº of pumps	6	Pump capacity (each)	250 Sm^3/h	Design pressure	2.5 barg
Drill water system					
Nº of pumps	3	Pump capacity (each)	180 m^3/h	Design pressure	6.8 barg
Potable water					
Nº of Tanks	4	Tanks volume (each)	50 m^3	Total storage capacity	2,000 m^3

Source: Statoil, 2013.

The drill unit possesses pH meters, conductivity meters and chlorine meters to control the potable water quality.

The drillship has three potable water tanks of 50 m^3 each one, thus it is capable of producing 2,000 m^3 tonnes of potable water a day. The average support vessel potable water consumption is estimated at two tonnes a day each. At the Mud Plant (SONILS Base), the water will be supplied by the municipality public system.

3.3.4. **Fuel supply**

The daily consumption of marine gasoil (MGO) estimated for the campaign is approximately 32 tonnes/day for each of the two supply boats, 12 tonnes/day for each of the three guard vessels and around 35 tonnes/day from drilling rig (depending on the operation stage and weather). The average usage, for a 128-day well, is therefore approximately 11,600 tonnes of MGO fuel. Up to 90% of the MGO will be used by the drillship. Fuel will be purchased locally and supplied to the drillship by the supply vessels.

3.3.5. **Other services**

The operators of the respective vessels, including the drillship, will determine their own food selection, quantities, and sources with support from the shore base (coordinate local purchases, etc.). Fresh produce will most likely be purchased locally.

A Medivac plan will be established for personnel on rig and in the base. An emergency response plan will be established and appropriate personnel will be contracted to supply these services, following agreed emergency response procedures.

3.4. **Discharges and Emissions**

This section describes the operational discharge streams and air emissions generated by the Project and the treatment and/or disposal procedures that will be followed in compliance with Angolan regulatory requirements.

Non-routine discharges (such as oil spills or releases of oil and/or chemicals) are possible, but unlikely. In the event of a non-routine discharge, actions in Emergency plan will be carried out.

3.4.1. **Drilling Fluids and Rock Cuttings**

The synthetic oil based drilling muds and cuttings will be sent to SONILS base, and stored in landfills after heat treatment, as discussed in Section 3.2.4. The water based muds will be discharged directly up on the sea bed. Around 1,596 m^3 of WBM will be used and thus the same amount will be discharged into sea, plus approximately 500 m^3 of cuttings, including a pilot hole. These will be discharged during 20 days horizontally on the seabed (1,800 m of depth) with a 36” discharge pipe.

There will be on-board mud treatment equipment, with two degassers of 5 m^3 of capacity each, as well as 5 shakers. The mud cleaner and the degasser capacity will be able to handle expected mud flow during planned operations. The drilling fluid system will be enclosed with active ventilation in fluid tanks. There will be 4 x 1,641 kW mud pumps, operating at 517 bar pressure, with an output total/maximum capacity of 587 m^3/hr.

Because oil-based mud is considered hazardous, all areas for treatment, transportation and storage of cuttings will have appropriate "hazardous area" classification. There will be a mud laboratory with proper ventilation.

There will be a non-hazardous drain system for clean areas, a non-hazardous drain system for polluted areas and a hazardous drain system for polluted areas. It will be possible to connect all drain buffer tanks to the oil separation system, which will be able to clean the solution to below 15 ppm of oil content. This will consist of decanter settling tanks, centrifuges and fitters. The oil separation system will be able to handle a minimum of 10 m^3/day with 2,000 ppm oil in and less than 15 ppm out.

3.4.2. Sanitary and Domestic Wastes

3.4.2.1. Liquid Wastes

The amount of wastewater generated and discharged from the drilling rig depends on the number of persons on board (POB). It is assumed that one person generates 100 L/day of sanitary wastewater (from toilet facilities) and 220 L/day of domestic wastewater ("gray water" from showers, sinks, laundries, and galleys, as well as from safety shower and eye-wash stations). The rig owner will describe all liquid waste from all areas of the deck, and all run off from the drill floor, mud tanks and mud mixing and handling area, and all bilges and machinery spaces shall be contained and treated as required (i.e. oil/water separator).

There will be a bilge water separator, and at least one ballast pump in each pump room that will be connected to the bilge system. The bilge water cleaning system will be designed to clean emulsified oil in water.

There will be a non-hazardous drain system for clean areas, a non-hazardous drain system for polluted areas and a hazardous drain system for polluted areas.

It will be possible to connect all drain buffer tanks to the oil separation system, which will be able to clean the solution to below 15 ppm of oil content. This will consist of decanter settling tanks, centrifuges and filters. This oil separation system will be able to handle a minimum of 10 m^3/day with 2,000 ppm oil in and less than 15 ppm out.

All areas where spills can occur directly to sea will be fitted with a closed boundary. The height of the boundary will be sufficient to prevent the fluid from spilling over the edge due to rig movement.

All discharges to the sea will be in accordance with the MARPOL discharge requirements and the Angolan legislation. Any waste that cannot be discharged to sea (with or without treatment) will be contained and shipped onshore for further treatment and/or appropriate disposal.

3.4.2.2. Solid Wastes

Activities aboard the drillship will generate various wastes streams that include maintenance products (e.g., lube oil and other greases), packaging waste (e.g., paper, card, wood, sacks, drums and grease/paint cans), scrap metal, and empty chemical drums. These will be sorted, transported to shore and disposed according to the Statoil's drilling campaign-specific Waste Management Plan. Any spilled materials will be collected and disposed of through appropriate channels. Quantities of waste generated by the drillship will vary depending on depth, geology and drilling duration.

The domestic waste produced by the drillship and other vessels will include the usual organic and kitchen waste, plus solid wastes (e.g., scrap wood, paper, packaging. etc.). For each well, about 30 tonnes of such waste is generated. As above, all will be sorted and removed to shore for disposal, in accordance with the drillship's and Statoil's Waste Management Plan, Angolan legislation and international best practices. Expected non-hazardous solid waste produced is approximately 82 tonnes, 0.5 tonne per day. Table 3.15 below lists the main sources of waste.

Table 3.15: Examples of typical waste types estimated from the Waste Management Plan (in kg unless indicated).

Class	Waste	One well	Waste per day
I	Bilge (Slop) kg	201,170	1,117
II	Metal Waste (kg)	20,394	1,133
III	Treated wood / Wood / Glass (kg)	25,842	143
IV	Used Lubricants, Waste oil (liter)	5,620	31
V	Cardboard / Paper / Aluminum (kg)	16,687	92
VI	General Waste (kg)	5,891	32
VII	Plastic (kg)	14,011	77
VIII	Sludge (kg)	18,750	104
IX	Medical Waste (kg)	2	-
X	Hazardous Waste (kg)	7,000	38
XI	Cuttings (ton)	1.604	8,9

All waste products are covered in a comprehensive Statoil *Waste Management Plan* to which Statoil is committed (Appendix B) and aligned with the Waste Management Plan (WMP) developed by the drill ship. Statoil will carry out verification on the drill ship to ensure that all wastes generated are correctly identified, and stored pending collection/transfer for re-use, recovery, recycling, treatment and/or disposal in an environmentally sound manner. All reasonable steps are to be taken to minimize both

quantities and hazards of waste generated. In addition, proper waste segregation will be maintained at all times.

3.4.2.3. Chemical Waste

All chemicals are registered with data sheets and HSE classifications. Material Safety Data Sheets (MDSD) datasheets are available for all chemicals both in English and Portuguese. Any hazardous chemical wastes are to be accompanied by their corresponding MSDS. Chemicals are stored separately in tightly sealed containers/drums, which are labeled clearly with the type of hazard. Waste is then collected by the Waste Management Contractor, analyzed, and transported to final disposal.

All chemicals will be handled, stored and used in strict accordance with laws and regulations (such as Angolan and Statoil requirements/guidelines) and the MSDS of each product. Relevant hazardous materials/waste will be included in the Waste Management Plan.

Drilling also requires the handling and storage of very small quantities of radioactive materials that will be stored on the drillship, as per recommended best practice, and carefully sited to ensure safety of workers. Similarly, small amounts of explosive will be available and stored either aboard the drillship or in a safe storage elsewhere.

Chemicals involved in operating the ship and its activities will be under chemical management. In-house products (e.g., catering, engine oils, chemicals for maintenance, etc.) will be handled by the rig owner. The chemical substances used for the drilling operation is defined as those used for drilling and cementing, dope for drillpipe and casing, BOP-fluids and rig wash.

The chemicals involved in the drilling operation will be assessed environmentally according to specific regulation, OSPAR-recommendations and Statoil's governing documents. Based on documentation provided by the suppliers, environmental hazard and risk will be assessed

individually for each product where inherent properties together with application area are considered. For chemicals known to cause environmental harm, substitution shall be investigated. Statoil is cooperating closely with suppliers and contractors and will aim for the best solution where both HSE and technical performance is considered. Statoil will always consider chemical usage from a holistic perspective where key elements are green chemistry, low discharge, reduced waste and re-cycling.

The products involved in the drilling operation will be assessed for occupational and safety risk. Hazard and risk assessment are based on safety data sheets provided by the suppliers. If chemicals known to represent any potential risk, Statoil will together with suppliers look for replacements or take mitigating efforts to ensure acceptable risk.

3.4.3. **Air Emissions**

The Project will generate atmospheric air emissions throughout the drilling program. This section discusses air emissions related to propulsion and power generation onboard the drillship and fuel combustion from support vessels and aircraft.

Drilling operations are expected to last approximately 128 days for each proposed well. During drilling activities, emissions will result from internal combustion engines used in the propulsion and power generation systems. It is assumed that an emergency engine is also onboard. High pressure pumps and compressors on most drilling units are electrically driven. Thus, during normal operations, the primary source of air emissions will be from diesel-fueled generators and engines onboard the MODU drillship.

For purposes of air emissions calculation, it is assumed the main engines and generators will operate continuously, 24 hours per day. It is also assumed the emergency generator will

operate approximately 16 hours per week for maintenance purposes. Manufacturer specifications were utilized to calculate air emissions[20].

In addition to the MODU, one helicopter and three supply vessels with internal combustion engines will contribute to air emissions. It was assumed that for each trip, the supply vessels' engines will operate continuously, 20 hour per day at sea and 4 hours per day maneuvering. It is also assumed the helicopters will undertake 5 roundtrips per week. Table 3.16 lists air emissions sources, estimated hours of operation, and type of fuel to be used.

Table 3.16: . Air Emission Sources and Operating Data for the Exploratory Drilling Program

Unit Type	Source	Fuel Type	Assumed Operating Time
MODU	Six (6) 7,400 kW Generators	Diesel	24 hours / day
MODU	One (1) 400 kW Emergency Generator	Diesel	16 hours /week
MODU	Six (6) 5,500 kW Engines	Diesel	24 hours / day
Vessel –Type 1	One (1) 6,780 kW Engine	Diesel	24 hrs / trip, 5 trips per week
Vessel – Type 2	Two (2) 2,730 kW Engines	Diesel	24 hrs / day, 5 trips per week
Helicopter	Three (3) turbo shaft 6,000 shp-class Engines	Jet A1	4 hrs/ trips, 6 trips per week

Operating times listed above reflect conservative assumptions based on input from Statoil and general knowledge of offshore operations. An equipment load factor of 0.75 was used as a model input for estimating MODU emissions[21]. For estimating supply vessels emissions, a load factor of 0.80 was applied when the vessel was at sea while a load factor of 0.10 was

[20] For propulsion system and power system of the drilling rig -per manufacturer specs: http://www.stena-drilling.com/uploads/vessels/Stena-Carron-Brochure.pdf

[21] Table 6-3 of the Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE) Draft Report: Year 2008 Gulf Wide Emissions Inventory Study (September 2010)

used when the vessel was maneuvering. Emission factors from the AP-42 database published by the U.S. Environmental Protection Agency were employed for diesel engines[22].

Table 3.16 presents the air pollutant emissions calculated for the exploratory campaign, which is assumed to last for 128 days.

Table 3.17: Estimated Air Emissions for the Duration of the Exploratory Campaign[23].

Types of Pollutants	Drilling Rig Combustion Sources (tpy)	Support Vessels (tpy)	Helicopter (tpy)	Total Estimated Emissions (tpy)
NO_X	2,685	590	0.62	3,276
CO	578	54	2.34	635
VOC	219	10	1.11	230
PM_{10}	189	10	0.00	199
SO_2	177	10	0.15	187
CO_2	99,843	32,064	831	132,738

[22] Source for emission factors for uncontrolled diesel industrial engines is the US-EPA's AP-42 database Chapter 3.3 (10/1996)

[23] Emissions are based on data from the Environmental Impact Study for the Block 39 Exploratory Drilling Project; therefore, emissions from flaring are excluded. The emissions depicted in the table are for two wells and for a period of 256 days.

CHAPTER 4

ENVIRONMENTAL AND SOCIAL BASELINE

4. Environmental and Social Baseline

4.1. Project Study Area

This chapter documents the environmental and social characteristics of Block 39 and its surroundings, including onshore, near-shore and off-shore areas. For the purposes of assessing impacts, the onshore study area is limited to the area of indirect influence (see *Section 1.4*). This includes the coastal area of Kwanza Sul, Luanda, Bengo, Benguela, Zaire and a small portion of Cabinda province, which could be affected during an unplanned event.

The transport of supplies and personnel is expected to occur between the onshore Sonils Base in Luanda and the Mobile Offshore Drilling Unit (MODU). Due to the industrialization of those coastal waters (including the port area) and the fact that these areas are outside the directly affected area of influence, the baseline does not include such areas.

Block 39 is located in Benguela Basin, approximately 260 km southwest of Luanda's coastline and about 110 km west of Sumbe's coastline. The block covers an area of 7.809km^2 and its water depth ranges from 1,500 m to 2,500 m.

The location of Block 39 (in relation to the coast of Angola and other offshore exploration blocks) is shown in Figure 4.1.

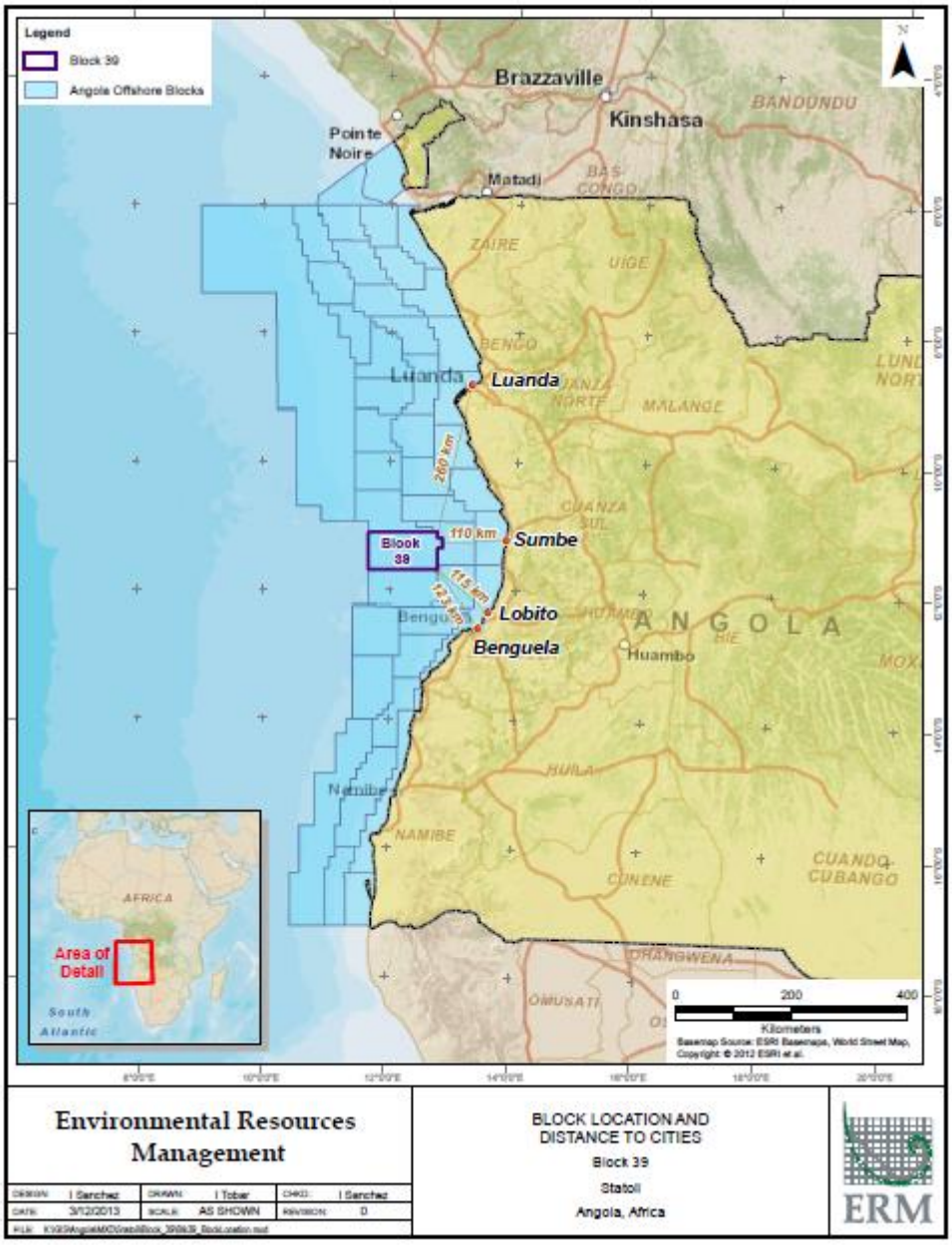


Figure 4.1. Location of Block 39 and distance to main cities.

The information presented in this chapter describes and illustrates the current environmental and social conditions of the areas that will b subject to the impacts resulting from the drilling activities. The chapter has been divided into the following sections:

- ✓ Physical environment;
- ✓ Chemical environment;

- ✓ Biological marine environment; and
- ✓ Human and socioeconomic activities (Onshore and Offshore).

This chapter does not include baseline environmental or social conditions at third party fabrication yards, or of any activity conducted outside Angola.

4.1.1. Sources of Information

This section leverages information accessed from: public and available sources; Marine Mammal Observation (MMO) data from previous seismic campaigns[24]; and physical, chemical, biological and social-economic data acquired from the National Institute of Fisheries Research (INIP) in 2012. Data collected by Statoil, its partners, or contractors as part of engineering studies conducted in 2011 and in 2012 (*e.g.,* seabed mapping and geophysical data) was also leveraged in documenting the baseline.

In compiling available information regarding existing environmental conditions in the study area, the following documents were used as sources:

- ✓ Environmental Impact Study for Seismic Operation in Blocks 35, 36, 37 and 38 – WesternGeco Seismic Holdings Ltd. Angola. Holísticos Ltd. & ERM Southwest Inc., April 2011;
- ✓ Environmental Impact Study for CGGVeritas Seismic Operations in Blocks 35, 36, 37, 38, 39 and 40. Angola. Holísticos Ltd., November 2011;
- ✓ Artisanal Fisheries between the province of Cabinda and Namibe, Angola. Artisanal Fisheries and Aquaculture Institute (IDPAA), February 2012; and
- ✓ Marine Mammals Observation Report during the 3D Seismic Survey along the Kwanza Basin, Offshore Angola, Blocks 38 and 39. Report to TGS NOPEC and WesternGeco Angola. Geomotive, January 2013.

[24] Such as the one conducted by WesternGeco in the third quarter of 2011 in Blocks 35, 36, 37 and 38.

4.2. **Environmental Baseline Survey and Analysis**

Statoil plans to conduct an environmental baseline field survey and a sampling plan for Block 39 during the second quarter of 2013 as part of their participation in the Joint Industry Project. The main focus of these sampling activities will be the characterization of water and sediment, including hydrologic profiling, seawater sampling, sediment characterization and chemical analysis and benthic infauna[25] sampling. When that survey is completed and its results tabulated, Statoil will supplement the Block 39 baseline and will circulate such results to local authorities. As this information is not available during the development of the EIS, other sources of information where used to capture applicable environmental and social data for this report.

4.3. **Physical Environment**

This section describes the physical environment of the area, including an overview of climate and meteorology, temperature, precipitation and winds.

4.3.1. **Climate and Meteorology**

Offshore, the weather in the tropical and Southeast Atlantic is controlled by the relative positions and intensities of the northern and southern subtropical high-pressure systems located over the Atlantic Ocean and the near equatorial belt of low pressure (Hirst & Hastenrath, 1983).

Offshore winds to the south of Luanda lead to coastal upwelling that reduces evaporation and promotes arid conditions. In contrast, the area to the north of Angola and in the Cabinda province is part of the Inter Tropical Convergence Zone (ITCZ), which results in tropical, rainy

[25] Benthic organisms that dig into the sea-bed or construct tubes or burrows. They are most common in the subtidal and deeper zones.

conditions. Annual fluctuations in the position of the ITCZ influence Angola's wet and dry seasons.

4.3.2. Temperature and Precipitation

The climate in the study area is divided into two main seasons:

- ✓ October to April (summer), a warm season with an average temperature of 26° C and frequent showers and thunderstorms; and
- ✓ May to September (winter or *cacimbo*), a dry season with cooler temperatures averaging 21° C.

The relative humidity is generally high, exceeding 80% throughout the year and 85% in the summer. Like the temperature, rainfall fluctuates throughout the area and it is strongly associated with variations in coastal winds and ocean currents, generally with precipitation in the order of 600 mm.yr^{-1}.

The dry season is experienced during the winter months, with precipitation frequency below 1% from June to August. The rainy season occurs during the summer months, with the highest precipitation in November-April. Over most of the interior of Angola the mean annual rainfall is between 1,000 mm and 1,500 mm. On the coast, the Benguela Current reduces temperature and rainfall resulting in a near total absence of rain in the south near the Namibian border. However, there is a gradual increase in rainfall northwards until, in the far north, it is over 600 mm per year. Table 4.1 provides an indication of mean daily temperatures in Angolan coastal towns.

Table 4.1.Mean daily temperatures in Angolan coastal towns (1995 – 2011)[26].

Towns	Distance from B39 (km)	Winter Mean	Coldest Month	Summer Mean	Warmest Month

[26]Source: Remote Sensing Systems - www.remss.com.

Cabinda	655	21.0	July	27.0	March
Soyo	590	21.2	July	28.2	April
Luanda	312	20.8	July	27.0	March
Porto Amboim	145	21.2	July	26.7	April
Lobito	179	21.0	August	26.8	March

4.3.3. **Winds**

Regional wind patterns are dominated by tropical winds blowing south-east to south-west. These are moderate and relatively constant, with an average daily speed of less than 5 m/s. In general, the wind shifts to the east in the morning (offshore wind) and to the west in the evening (onshore wind). Occasionally, extreme wind conditions such as squalls (intense low-level winds associated with cumulonimbus storms) occur. These occur mainly during the rainy season and are therefore particularly strong from February to April. Along the Angolan coastline, wind speeds change from low to moderate, a phenomenon that is primarily associated with the decrease in winds coming from the east direction between September and October and the increase in winds coming from the south and southwest directions (ERM, 2004; MINUA, 2006).

Figure 4.2 presents the wind speed and direction data for April and September (2003-2011) in the southern Atlantic off the West African coast, and illustrates the seasonal changes in wind direction and speed (April corresponds with the peak of the rainy season and September represents the transition between the dry and rainy seasons). The approximate location of Block 39 is also shown (please note red box).

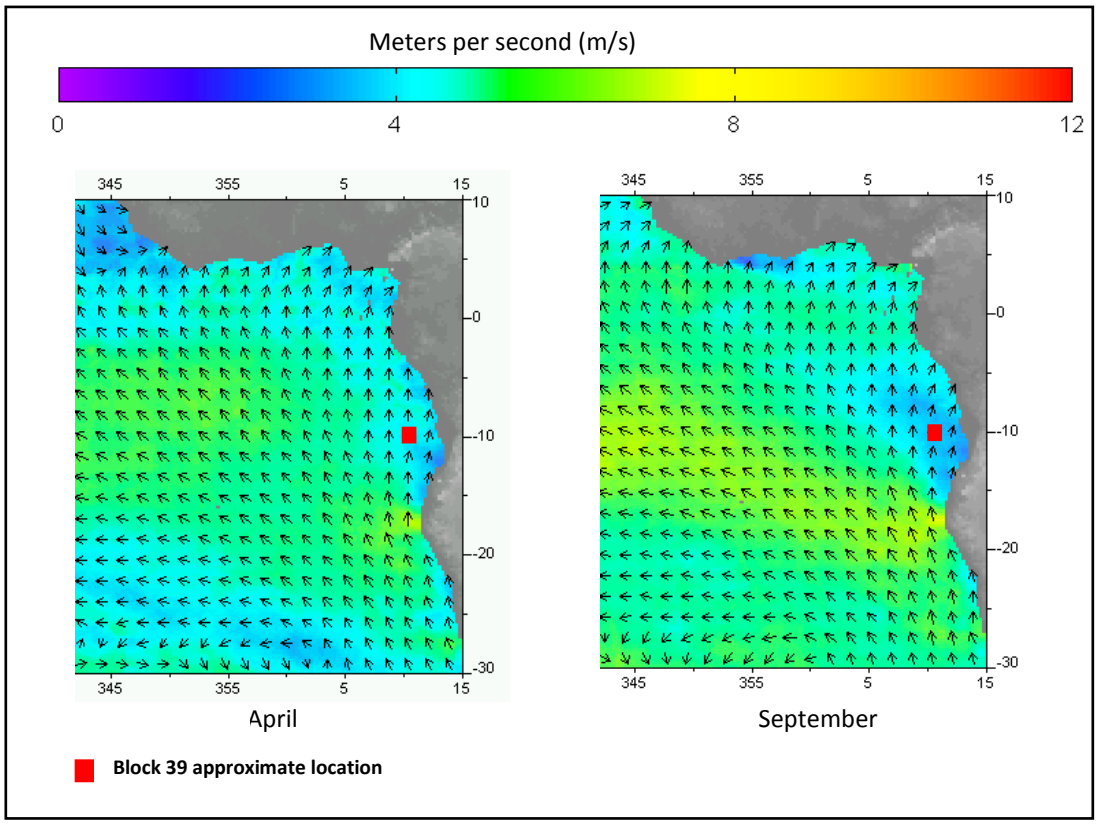


Figure 4.2. Variation in wind direction and speed (m/s) on the west coast of Africa[27]

4.3.4. Cloud Cover

Cloud cover off the coast of Angola is generally high throughout the year, although it increases during September to December, with the mean monthly cloud cover reaching 75%. The region with the highest cloud cover is over the ocean, from the Equator to 30° South, and from the coast to 20°West. In this region, within which Block 39 is located, the cloud cover is higher from September to November, with the hot air flow over the cold water causing a very high percentage of low clouds. Average cloud cover in this period varies from 6.5 to 7oktas (out of 8 oktas).

4.3.5. Bathymetry and Sediments

[27] Monthly averages 2003-2011. Source: Remote Sensing Systems - www.remss.com.

The wider bathymetry offshore Angola is dominated by the continental shelf break that occurs at a depth of approximately 100-200 meters between 30-40 km offshore (Pioh&S, 2001). Past the continental shelf break the seabed slopes down gradually to reach an eventual depth of approximately 5 km in the south Atlantic ocean, more than 2,000 km offshore. In the general Block 39 area, the water depths range from 1,500 m to 2,500 m.

Block 39 is known to have different formations, from Albian and late Aptian carbonates to Tertiary sands, sag sediments and syn-rift sequences.

According to the nautical charts, the continental shelf is regular in shape with a gentle slope and its sediments range from mud at the coastline to fine sandy mud in the remaining area. Research studies carried out in other blocks of similar water depth show that the sea bottom in these areas is characterised by soft and very fine-grained clays where there are virtually no coarse sediments.

Figure 4.3 shows the bathymetry (water depth) associated with the area and location of the Project area in relation to the Angolan coastline.

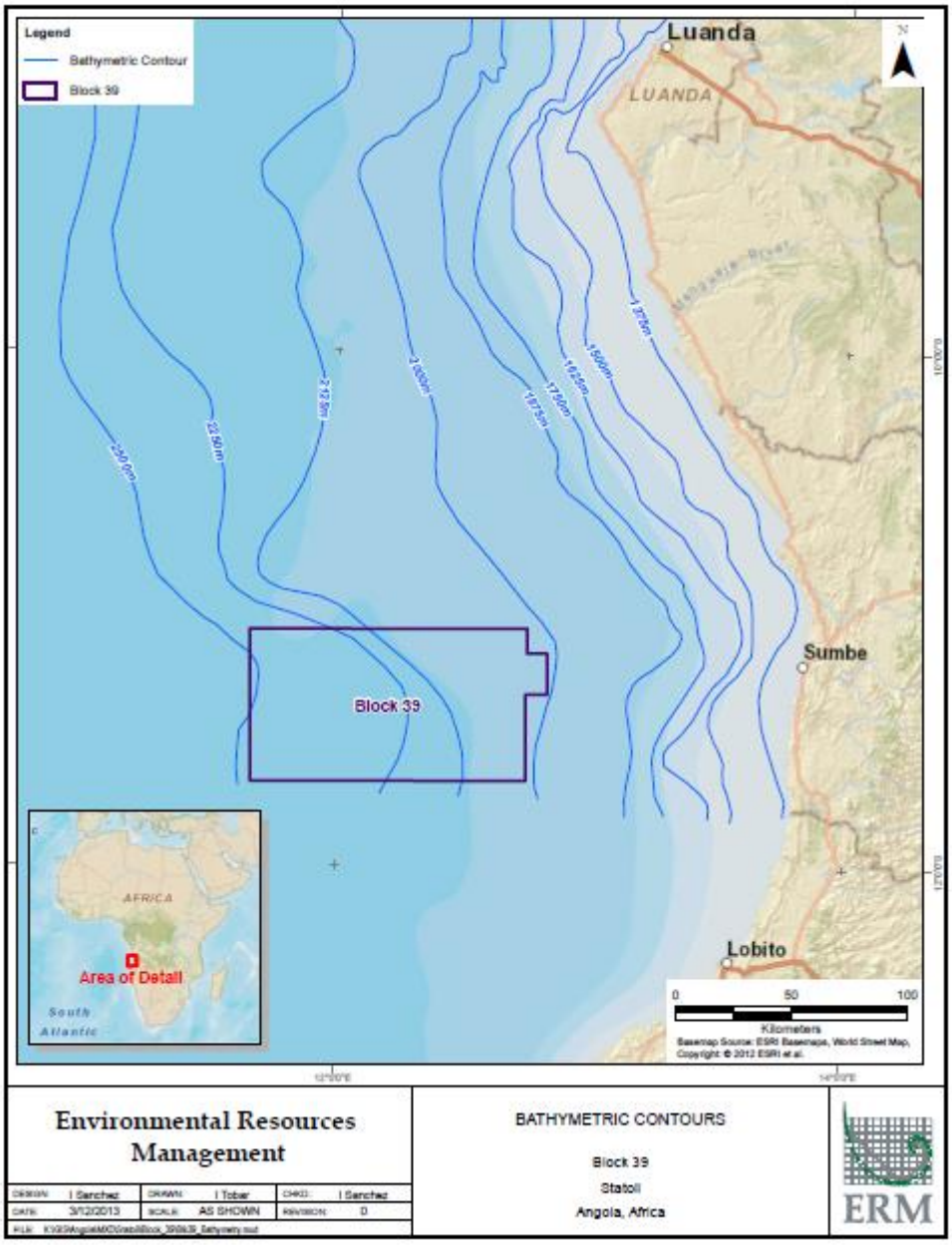


Figure 4.3. Bathymetry in the study area, Offshore Angola.

The physiographic characteristics of the study area show that the seafloor slopes, while the central and western parts of the Block (39) are characterized by mini-basin development which are areas that normally result from salt withdraw or movement; most likely as due to the increase in tension.

4.3.6. **Oceanography**

Water masses, Temperature and Salinity

Along the West African coast, three water masses are recognized. The South Atlantic Central Water overlays the Atlantic Intermediate Water which in turn overlays the Antarctic Intermediate Water. The Antarctic Intermediate Water is formed by surface water sinking at the Antarctic Convergence (50^{o} S) and it extends as far as 10-20^{o} N. These three water masses have profiles reaching 1,300 m in depth. A well-developed thermocline is formed at 10-20 m. The surface water temperature varies according to the latitude and the season, with temperatures lower in the south of the country (20-26^{o} C) and higher in the north (27-30^{o} C). At the surface, the water salinity is approximately 36.4 psu, reaching figures close to 35.4 psu within the thermocline.

Figure 4.4 shows the temperature gradient of the surface water in 2011 (data obtained from Remote Sensing Systems). March (peak of the rainy season and atmospheric temperatures), June (beginning of the dry season), September (transition between the dry and rainy season) and December (period during which rainfall and atmospheric temperature begin to rise considerably) were the months selected to best illustrate the seasonal climatic variations. Figure 4.4 also demonstrates that in the study area (please note red box) the temperature ranges from approximately 23 to 28^{o} C throughout the year.

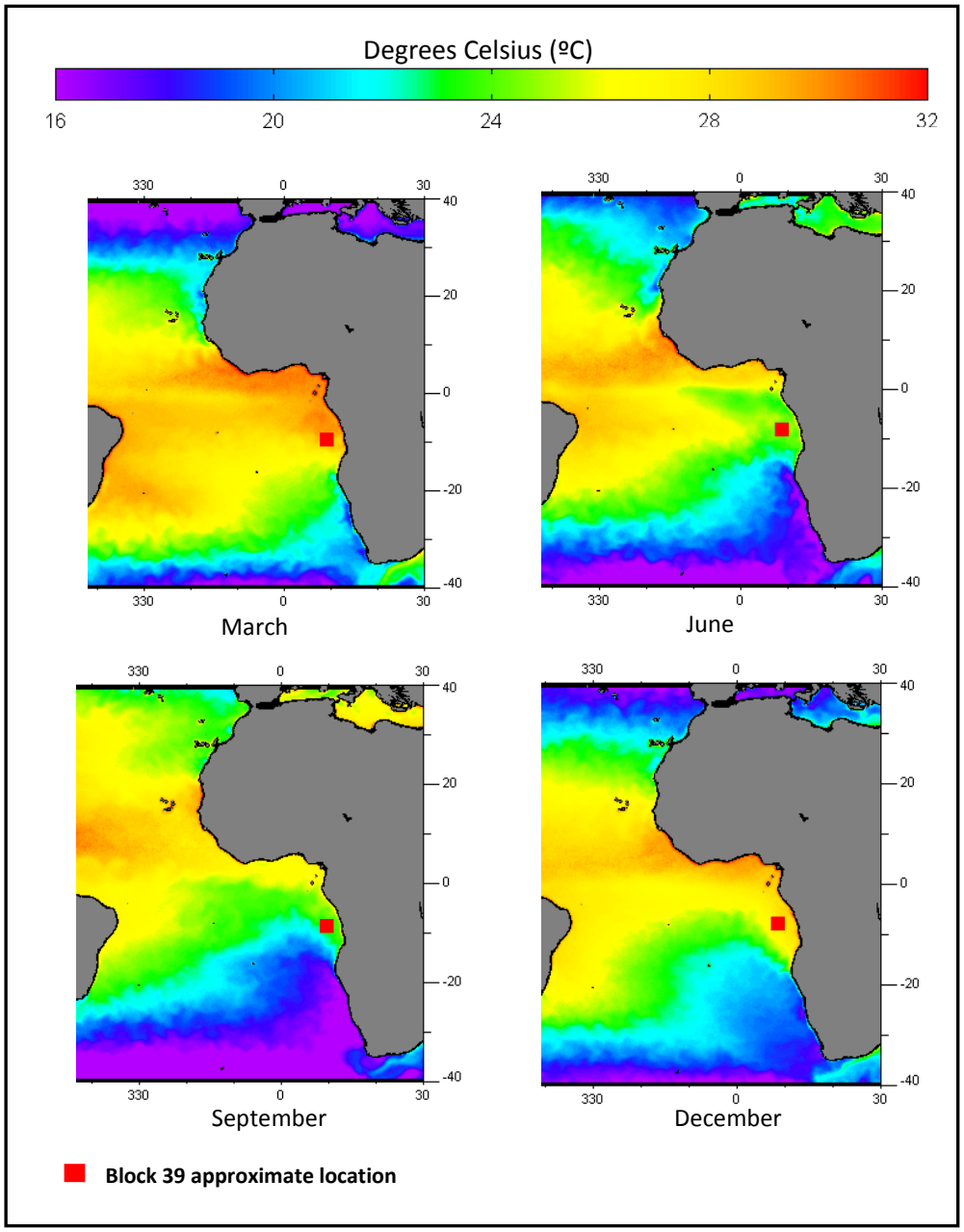


Figure 4.4. Variation in the surface water temperature on the west coast of Africa[28]

Currents

The regional ocean circulation off the Angolan coast is part of the eastern boundary current system of the South Atlantic. The following currents form this system and are represented in Figure 4.5.

- ✓ Benguela Current (BC) from the south;

[28] Monthly averages illustrated. Source: Remote Sensing Systems (www.remss.com).

- ✓ Branches of the South Equatorial Current (SEC);
- ✓ Eastward flowing equatorial currents comprising South Equatorial Counter Current (SECC) and the South Equatorial Under Current (SEUC) which are deflected southward at the coast; and
- ✓ Angola Current (AC) flowing south.

Water current patterns in the Block 39 area are largely influenced by two main current systems (Box 4.1): the Benguela Current (BC) and the Angola Current (AC).

Angola Current (AC): the surface AC carries warm equatorial waters southward down the coast of Angola. The Angola Current is formed by the southeast branch of the South Equatorial Counter-Current (SECC), which extends to a depth of 250-300 m, covering the shelf region and a part of the continental slope. In Block 39, the southerly moving AC meets the northerly moving Benguela Current in the Angola-Benguela Frontal Zone (ABFZ), commonly known as a pole ward undercurrent. The ABFZ essentially demarcates the warm, nutrient-poor AC water and the cold, nutrient-rich, Benguela Current water, creating a transition zone between the tropical ecosystem in the north and the upwelling-driven ecosystem in the south.

Benguela Current (BC): flows northward off the coast of south western Africa along the western coasts of South Africa, Namibia, and southern Angola. The BC, along with the South Equatorial Current, and the northern part of the Antarctic Circumpolar Current, make up the South Atlantic subtropical gyre. It draws icy-cold waters from the Southern Ocean and carries them northward along the coast of Africa. Because of these cold waters, rain clouds do not develop over the southwest coast of Africa. The BC is one of the regions off the west coasts of the continent where there is an upwelling of cool, nutrient-rich water due to the coastal edge of the continental shelf, the prevailing winds, and the Earth's rotation. Because of these nutrient-rich waters, there is an abundance of marine life. The BC tends to be stronger in December and January, when the southeast trade winds are well established.

Box 4.1. Ocean current system in the study area.

The Angolan coast extends some 800 nautical miles along the south-eastern Atlantic, from 5^{o} to 16^{o}S, to the Cunene river mouth. The coastal area is characterized by a typical tropical regime in the northern part and a more temperate one in the south, where the southward warm AC and the northward cold BC meet and form the Angola-Benguela front, with an

average position at 17°S. As characterized by Shannon *et al.*, 1987, this front extends to at least 150 km offshore and shifts about 2°S during the first quarter of the year, and north during the third quarter. Although the front is strongest in the near surface layers, it may extend to a depth of several hundred meters and its dynamics are thought to be influenced by a large cyclonic eddy, the Angolan Dome (Figure 4.5).

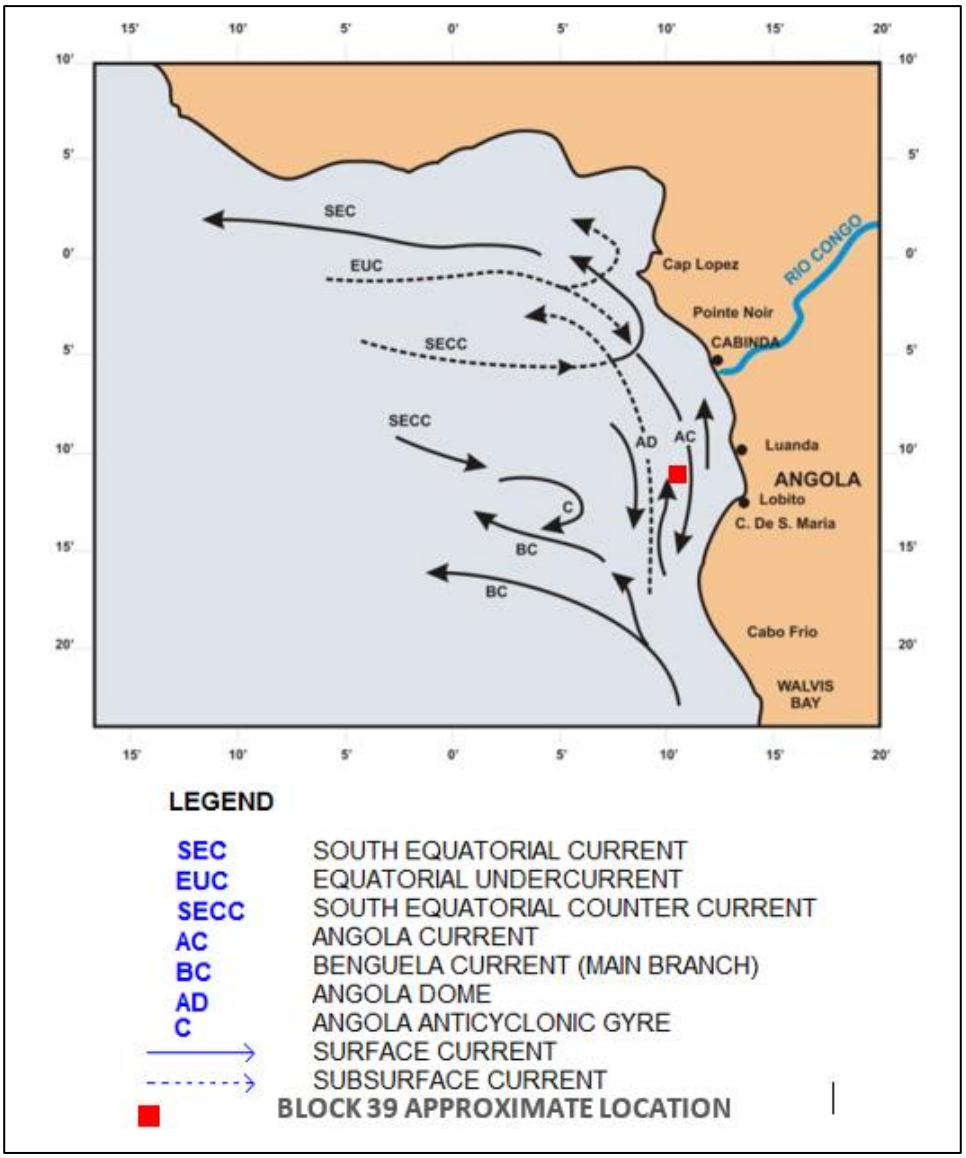


Figure 4.5.Ocean current system in the study area.

The pattern of interaction between these various surface currents is complex and fluctuates seasonally. However, in general the currents off the coast of Angola form a clockwise

circulation known as the Angola Gyre, which extends to a depth of approximately 300 m (Mohrholz *et al.*, 2001).

Tides and Waves

Tides in the wider study area are semi-diurnal and have a relatively small range compared to other parts of the world. The tidal range is between 1.0 and 1.2 m, with spring tides reaching 1.7 m (Fugro, 2012).

Waves are predominantly from a south-southwesterly direction, with swell heights averaging 1.0 to 1.5 m between November-April and 3.0 to 4.0 m between June and August (Pioeh&S, 2001). Occasionally, swell heights are greater than 3.0 m (CSIR, 2002). Swell waves are notably larger in the southern hemisphere winter between June and September, due to the increased intensity of storms in the South Atlantic.

4.3.7. Seabed Sediment Characteristics

Hydrocarbon Seeps

The physical characteristics of the natural hydrocarbon seeps in the waters off the coast of Angola are not well understood. Evidence of the presence of shallow gas hydrates in marine sediments is provided by various seabed surface features, such as pockmarks, seabed domes, and mud diapirs as well as by seepages and associated phenomena such as methane-derived carbonates and anomalous biological communities (Judd & Hovland, 1992). The pockmarks that appear to be related to shallow gas and oil reservoirs (buried channels or micro faulted intervals) are produced by the dewatering of over-pressured interstitial fluids above a less permeable layer. These pockmarks are observed along the Congo-Angola margin.

4.4. Chemical Environment

This section describes the chemical environment of the area, including an overview of the water and sediment quality.

4.4.1. **Water Quality**

Nutrients and Dissolved Oxygen

Nutrients are present in a dissolved form in seawater, and are essential to the survival of plant and marine life. These nutrients comprise many different types from gases, minerals, and other substances that are either derived from terrestrial inputs (from river sand seeps from the sea floor) or from biological activity, including waste and decaying plant and animal matter.

On the Angolan continental shelf, the surface waters present low concentrations of inorganic nutrients, with nitrate/nitrogen and orthophosphate concentrations of 0.2-0.5 µM/l (van Bennekom *et al.*, 1978). In sub-thermocline waters and waters from the South Atlantic, higher nutrient concentrations are recorded and concentrations of 10-18 µM/l, 0.8-1.5 µM/l and 6-15 µM/l have been recorded for nitrates, phosphates and silicates, respectively (Jones, 1971). These concentrations may change through removal and addition processes within the continental shelf (Chapman and Shannon, 1985) but will remain high when compared to the ones recorded in usually oligotrophic surface waters.

Therefore, due to strong and relatively shallow thermoclines with high nutrient concentrations in sub thermocline water columns any coastal or river induced upwelling can lead to large increases in nutrients at the surface (van Bennekom *et al.*, 1978).

In the open ocean, dissolved oxygen decreases with depth due to reduced photosynthesis from values near saturation at the surface to relatively low values at mid-depth (300-600 m) where an oxygen minimum is recorded. In coastal upwelling systems such as the Benguela Current the oxygen minimum rises toward the coast.

Bubnov (1972) showed three distinct classes of vertical oxygen distribution off Angola and in the northern Benguela region:

- ✓ The continental shelf, where the oxygen content decreases with depth to a minimum in the bottom layer;
- ✓ The open ocean, where the oxygen minimum (typically 1 mg/l) is found at mid-depth (300-600 m); and
- ✓ A dual minimum situation where a second (subsurface) minimum (1-2 mg/l) occurs at a 100-200 m depth overlying the main minimum.

The vertical gradients of the oxygen concentration found in the waters of the continental shelf of the central and southern parts of Angola have been highlighted by Lass *et al.* (2000). They presented vertical cross-sections of the platform where the oxygen concentrations at the surface layer reached 5.0 m/l, overlaying the bottom layers where concentrations were under 2 mg/l. Low levels of oxygen (dissolved oxygen concentrations between 2.0 mg/l and 0.1 mg/l) are a chronic feature of the sub-thermocline waters of the continental shelf of both southern Angola and northern Namibia.

Hydrocarbon and Metal Concentration in the Water Column

Discharges from previous offshore oil and gas installations and operations may have some influence on water quality but this is expected to be temporary and localized around those installations, and will not significantly elevate levels of pollutants in the wider area.

Analyses of hydrocarbons and trace metals in adjacent blocks did not indicate the presence of contamination in the water column. Most trace contaminants become incorporated into the particulate bound phase and would not therefore be anticipated to be present in aqueous form.

4.4.2. Seabed Sediment Chemistry

Some natural variation in sediment chemistry is common and entirely natural. For instance, the chemical characteristics of sediments change naturally with variables such as depth.

Nitrogen Content

The total nitrogen ranges in Angolan offshore areas are from 0.33% to 0.43%, while the ratio of organic carbon and total nitrogen (the C:N ratio) ranges from 6.1 to 7.5. It is possible to use the C:N ratio of sediments as a 'proxy' to determine the origin of the material that composes the sediments; i.e. whether it is derived from a marine or terrestrial source. This is illustrated by the fact that the C:N ratio for marine phytoplankton is 6.6, for fresh marine sediments it is 7 to 10, and for terrestrial plants it is over 20 (Deevy, 1973; Rullkötter, 2000).

Organic Content

Organic matter is generally considered a coarse indication of organic concentrations. Organic matter is primarily made up of detrital matter and napthenic materials (carboxylic acids, humic acids).

There is a general depth-related decrease in organic carbon fluxes from coasts to the open ocean (Smith & Hinga, 1983). Organic carbon availability is the primary limiting resource in most deep-sea benthic ecosystems and it exerts a major influence on the abundance and distribution of deep-sea benthic organisms (Thiel, 1983). In the open ocean, the benthic biota are generally dependent on the flux of organic matter from surface waters, while along the continental margins terrigenous inputs may also be important. Off the coast of Angola riverine inputs from the Congo may be important. Although organic material derived from chemosynthesis sustains large faunal communities in reducing environments (e.g., hydrothermal vents, cold seeps), it is unlikely to be of importance for the majority of deep-sea organisms (Tyler, 1995).

Total organic carbon (TOC) is measured as a percentage of the total sample weight, and represents the organic carbon constituent of the total organic matter discussed above. Defined as a measure of the concentration of organic carbon in water, it is determined by oxidation of the organic matter into carbon dioxide (CO_2). TOC has a major influence on both the chemical and biological processes that take place in sediments. The amount of organic

carbon has a direct role in determining the redox potential in sediment, thus regulating the behavior of other chemical species such as metals.

Heavy and Trace Metal Concentrations in Sediment

Heavy metals are generally persistent in the environment and most are toxic to varying degrees. Many, including mercury (Hg), cadmium (Cd) and lead (Pb) readily bio-accumulate, meaning that even low levels may potentially cause lethal and sub-lethal toxic effects in higher level consumers and ecosystems.

During drilling operations, mud is used to stabilize the well and remove the fragments of drilled rock (i.e. carbonate, shale and sandstone). This mud contains several minerals such as barite and carbonates which are used to manage its density, viscosity and other properties. As a consequence it may also contains quantities of trace metals such as Ag, As, Cd, Cr, Cu, V, Zn, Hg, Ni and Pb (Philips *et al*., 1998) at insignificant concentrations. Of particular relevance to oil and gas development areas is the level of barium (Ba) in sediments, as high concentrations of barium can be indicative of contamination by drilling muds, since barite is a major constituent used to control the specific gravity of drilling muds.

Many metals are leached naturally from soils and sediments and occur at relatively low levels in the environment. Natural metal concentrations in marine sediments generally exceed those found in overlying seawater by 3 to 5 orders of magnitude (Bryan & Langston, 1992) since the buffering effects of saline water cause many metals to be rapidly precipitated.

Anthropogenic sources of metal contamination in the marine environment can result from ‘point-source’ emissions such as the release of chemicals containing elevated levels of metals or the more widespread deposit of sediments from river plumes that may contain elevated levels of metals due to contaminated run-off from terrestrial activities.

4.5. **Biological Marine Environment**

The seasonal variation in the location of the frontal zone of the Guinea-tropical and Benguela currents is an important control on the distribution of fish species offshore. Da Franca (1968) characterized two different faunal complexes along the Angolan coast, the "Guinea-tropical fauna" in the northern and central region and the "Benguela fauna" predominant off southern Angola, reflecting the locations of the two currents.

The Benguela current is one of the world's major eastern-boundary current systems, and is rich in pelagic and demersal fish populations supported by the plankton production driven by the intense coastal upwelling (see Box 4.1). According to Hampton *et al.,* 1999, these fish stocks have been heavily exploited, particularly since the Second World War. The Angolan current influences the tropical regime in the north. The current flows parallel to the coast toward the south and transports warm lower saline water.

4.5.1. **Plankton**

Plankton collectively refers to the three categories of organisms that passively drift in the marine environment: phytoplankton, zooplankton and ichthyoplankton. The ichthoplankton refers to the phase of the fish lifecycle in which it cannot drift against water currents, namely: fish larvae, eggs and at early juvenile stage. The abundance of plankton is dependent on a variety of factors, including: ocean currents, temperature, nutrient availability, amount of sunlight, and ocean depth (Terry, 1997). Plankton and algal blooms can provide indications of nutrient and potential pollution levels from sources such as terrestrial run-off and diffuse pollution.

Plankton distribution and relationships between seasonal variation and density off the coast of Angola are not well understood (Longhurst, 1998). The information that is available suggests that the general index of primary production in the southern Atlantic Ocean is approximately 0.19 gC m^{-2} day^{-1} (CSIR, 2002). Measurements of ocean reflectance from

satellite images show that surface phytoplankton biomass (as chlorophyll) is relatively low in the oceanic areas offshore from Angola but that there is a characteristic increase in biomass in the vicinity of the coastal waters.

Phytoplankton

The study of phytoplankton biomass (Neto *et al.* 1999) across and along the Angola-Benguela Frontal Zone shows that the distribution of nutrients in the upwelling zone was more uniformly distributed in the water column, which probably supports a high primary productivity through the water column. The distribution of *Chlorophyll a* concentrations suggest that phytoplankton biomass is higher in the Angola Dome region and upwelling zone, supporting a linkage between nutrient levels and high biomass production. The distribution of phytoplankton also correlates to levels of solar irradiance and the nutricline during the night in the water column. This is illustrated by the maximum of the fluorescence curve corresponding closely to the higher concentration of phytoplankton biomass in the water column (at 20-50 m).

Phytoplankton biomass distributions for the region are shown in the four satellite images of *Chlorophyll a* in Figure 4.6. Each image is a composite of three daily images centered on a specified date: (a) 20/3/2006, b) 20/6/2006, c) 20/9/2006, and d) 20/12/2006. The images were obtained from the Remote Sensing Server for Marine Sciences, a South Africa website. The temporal base for each of the images (composite images over 3 days) is insufficient to show seasonal variations; however, it is evident that variability between the seasons is high. This extends from the almost complete absence of any phytoplankton biomass in the region in the September and December images to fairly well developed distributions in March to extensive high concentrations in June. It is notable that phytoplankton blooms do not seem to be as well developed in the central Angolan continental shelf area as in the northern areas.

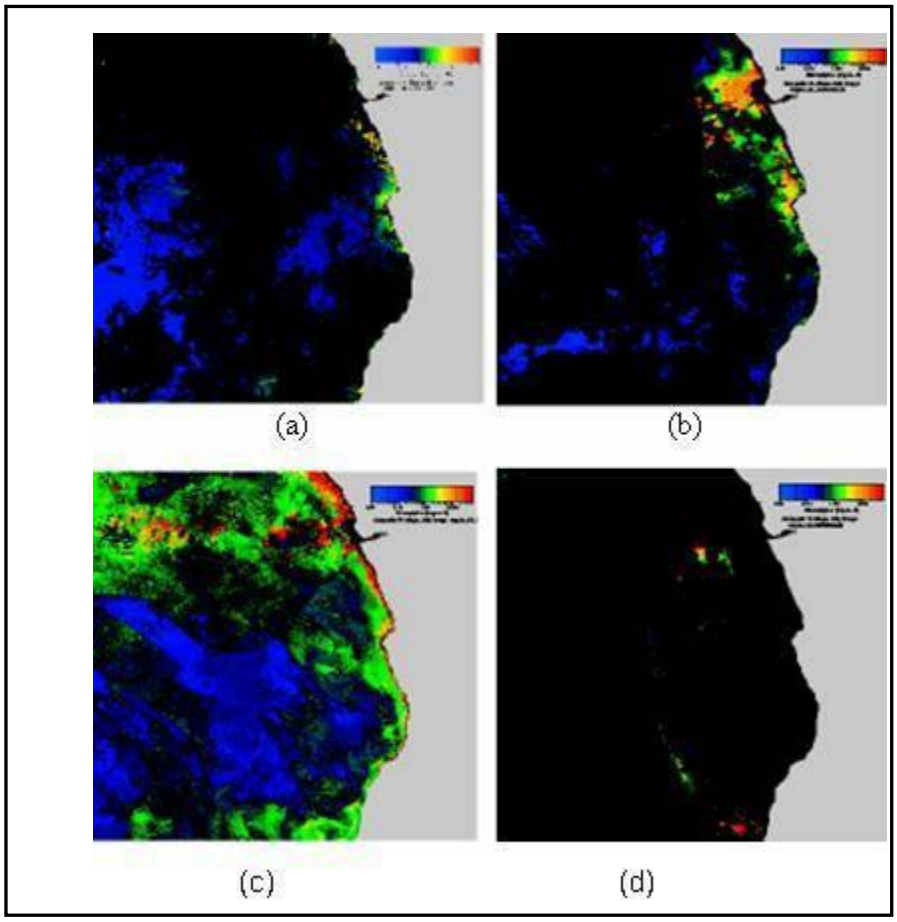


Figure 4.6. MODIS satellite images of ocean *Chlorophyll a* off Angola.

According to The National Fisheries Research Institute - INIP (2012), and illustrated by Figure 4.7, diatoms and dinoflagellates are abundant in the area and respectively represent 44% and 43% of the total groups found. Flagellates (cyanophytes and chlorophytes) constitute 13% of the phytoplankton community in the area.

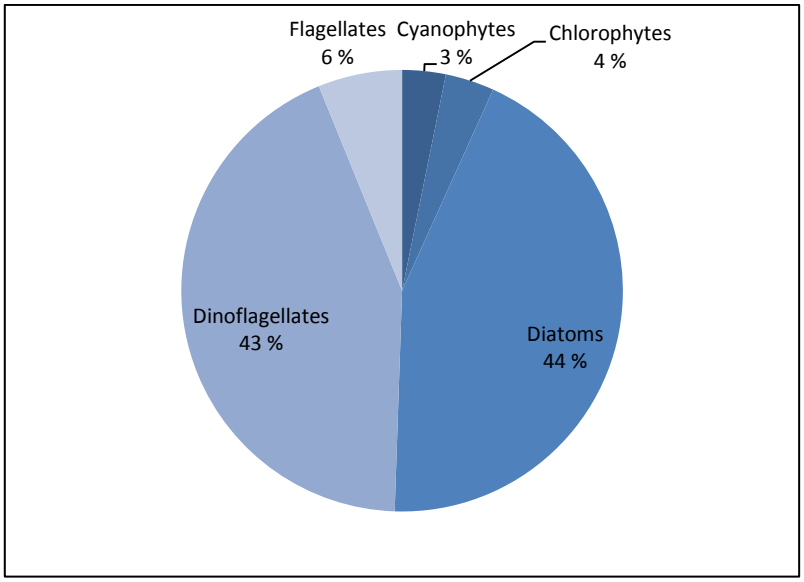


Figure 4.7. Percentage of the main phytoplankton groups in study area[29]

Zooplankton

Zooplankton in the Benguela ecosystem is mostly comprised of small crustaceans (tiny shrimp-like animals), the most important groups being copepods and euphausiids. Of these, copepods are numerically the most abundant and diverse group. Species diversity is highest near the warm water boundaries of the ecosystem, i.e. in the vicinity of the confluence between the Angola and Benguela Currents, west of the oceanic front and shelf break.

Despite the distribution of zooplankton in the study area is poorly understood, CSIR (2002) suggests that zooplankton biomass attains reasonable levels and that species structure is diverse.

Postel *et al.* (2007) investigated the variability in horizontal and vertical zooplankton biomass distribution down to a maximum depth of 1,250 m off Angola/Namibia, using a combination of net samples and backscatter profiles. Results show that the biomass-rich zone extends deeper into the regions south of the Angola Benguela Frontal Zone (ABFZ) than north of it as a response to coastal upwelling. The diurnal vertical migration (DVM) caused “centers of the populations” (weighted mean depths) at 122 m (night), 303 m (day), 135 m (dawn), and 154

[29]Source: National Institute of Fisheries Research - INIP, 2012

m (dusk). The phenomenon was more pronounced north and seaward of the ABFZ (i.e. north of Benguela, corresponding with the Block 39 location) than south and shoreward of it.

Da Silva (2004) analyzed the data collected during a research survey aboard the R/V Meteor from August 30th to September 13th 2000. In that study, the zooplankton net sample was taken only up to 500 meter depths and additionally the Lowered Acoustic Doppler Current Profiler (L- ADCP) system was run down to maximum depths of 1,250m to determine the biomass at different depth layers. The results showed that in the 9°S transect (along the coast of Luanda), organisms larger than 500 µm were predominant, comprising mainly of crustaceans and a smaller proportion of gelatinous organisms, chaetognaths and protozoans (Figure 4.8).

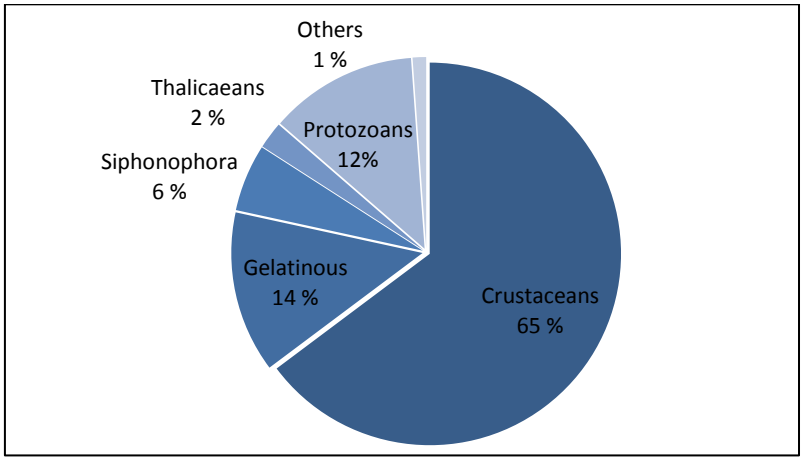


Figure 4.8. Main taxonomic categories - R/V Meteor survey in 2000[30]

Associations of planktonic forms in the sediments of the East Angolan Basin consist of both tropical-subtropical and transitional sub-Antarctic species (Zachariasse *et al.*, 1984). The latter are "southern intruders" transported to the area by the Benguela Current, and most likely include two copepod species, *Centropages brachiatus* and *Metridia lucens*, to which the Benguela Current ecosystem is host. These organisms are present off the far southern coast of Angola.

Ichthyoplankton

[30]Source: National Institute of Fisheries Research- INIP, 2012

This is the phase of the fish lifecycle in which it cannot drift against water currents, namely: fish eggs, larvae and fish at early juvenile stage. Although there is no literature on the ichthyoplankton diversity and distribution in the study area, numerous and recent research studies carried out in adjacent areas have collected ichthyoplankton specimens (*such as* R.V. Poseidon, April 1999), which adds to the knowledge of the biogeography of the ichthyoplankton in this region. Some studies carried out along the Angola-Benguela Front Zone (ABFZ) showed the presence of eggs and larvae of the South American pilchard (*Sardinops sagax*), round sardinella (*Sardinella aurita*), anchovy (*Engraulis encrasicolus*), Cape horse mackerel *T. trachurus capensis* and hake (*Merluccis* sp.). The eggs of these species hatch in the region in addition to other species that live in mid-waters of the pelagic zones. known as mesopelagic species.

These results are consistent with fishing results obtained in the general region, which list horse mackerel and sardine as common catch. Based on that, species like *Sardinella maderensis*, *S. eba* and *Trachurus trecae* are probably part of the ichthyoplankton of the region, since many of these juveniles are found in the area.

Algal Blooms

An algal bloom is a rapid increase or accumulation in the population of algae (typically microscopic) in an aquatic system. Algal blooms may occur in freshwater as well as in marine environments. Only one or a small number of phytoplankton species are involved, and some blooms may be recognized by discoloration of the water resulting from the high density of pigmented cells. Although there is no officially recognized threshold level, algae can be considered to be blooming at concentrations of hundreds to thousands of cells per milliliter, depending on the severity. Algal bloom concentrations may reach millions of cells per milliliter. Algal blooms are often green, but they can also be other colors such as yellow-brown or red, depending on the species of algae.

In Angola, algal blooms occur both in the northern and southern Benguela regions. They tend to be observed most frequently close to shore, where their visual and, at times, harmful effects (due to oxygen depletion in the water column) are most apparent.

Red tides are most frequent during quiescent conditions which follow upwelling, or during periods of light onshore winds and down-welling which commonly occur in the southern Benguela during times of Pacific *El Niño* events. A major algal bloom occurred between Namibe and Luanda in August-September 1951, and was associated with high fish mortality (Silva, 1953).

Although algal blooms are known to occur in coastal waters of Angola, they are not thought to be frequent or occur on a regular basis nor occurring in deeper waters such as those found in Block 39.

4.5.2. **Benthos**

Organisms living on the seabed contribute significantly to deep-sea benthic biomass; therefore, assessing the distribution and abundance of the seabed fauna is essential to understanding the ecology of deep water benthic environments. Benthic organisms can be sensitive to impacts such as smothering from high sediment deposition.

Investigations into benthic community structure have been carried out by oil and gas operators in the region focused on water depths greater than 500m (CSIR, 2003). These have revealed that the fauna is dominated by annelids (approximately 55% of total species) followed by arthropods (crustaceans, approximately 23%), mollusks (approximately 14%) and echinoderms (approximately 3%). Other groups such as sipunculids and nemerteans comprise minor proportions of the benthos in terms of species numbers. In deep water (>400m) the benthos appears to be sparse and patchy but reaches higher abundance and a more uniform distribution in the shallower depths of the continental shelf.

A program on the deep sea ecology (benthic ecosystems found between 400 and 4,000 meters deep) of the continental margin in the Gulf of Guinea was developed by the French Institute Ifremer (in French, *Institut Français de Recherche pour L'Exploitation de la Mer)*, between 2001 and 2004. Results have shown that associations of organisms living around hydrothermal vents at the oceanic ridge axes and around cold-seeps on the continental margins have drastic ecological characteristics. Few animal species are adapted to thrive in a toxic habitat, likely due to important biological and biogeochemical interactions (especially competition for space and resources). This promotes a highly dynamic symbiosis between prokaryotic producers and eukaryotic consumers.

4.5.3. **Crustaceans and Cephalopods**

The southern pink shrimp *Penaeus notialis* is the most important shallow water shrimp species off the coast of Angola. It can be found predominantly at river mouths and sandy areas at depths of about 50 to 100 meters. It is distributed between 7^{o}S and 11^{o}S (National Institute of Fisheries Research – INIP, 2008). The depth distribution of the two deep-sea shrimp species found in the area is different. *P. longirostris* (rose shrimp) is found at depths between 50 and 400 meters on the continental shelf and upper slope and it is related to sandy bottoms. *A. varidens* (striped shrimp) is mainly distributed on the slope at 400 to 800 meter deep, with a strong relation to muddy bottoms. However, neither of these is anticipated to occur in the Block 39 area due to the depth range.

Data from the National Institute of Fisheries Research (2012) indicates that the *Nematocarcinus africanus* is the main deep water shrimp in the study area, representing 30.28% of the total biomass weight (data from 2011). Although this species does not have any economic value, it provides an important ecosystem service because it constitutes the main food resource for fish, particularly for hakes (Kilongo 2001).The species catch rates show declining trends in the last two years (2010 and 2011) (Figure 4.9), but this may not be interpreted as a decline in the stock. Rather, this finding is likely related to survey

methodology, taking into consideration that fewer trawls have been allocated to this depth stratum (National Institute of Fisheries Research – INIP, 2012).

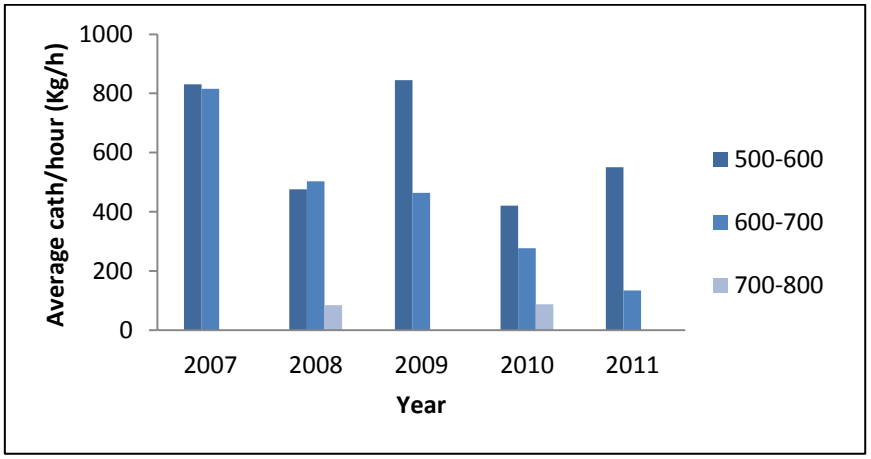


Figure 4.9. Average catch rate (kg/h) 2007-2011 – *Nematocarcinus africanus*[31]

Red crabs (*Chaceon maritae*) are deep-sea crabs found on the slope of the continental shelf from about 27°S off Namibia, northwards to Angola, Congo and the Ivory Coast. Off Namibia they are found on soft mud substrata at depths of between about 300- 900 m, and are fished commercially using traps. Off Angola they are found within a similar depth range, particularly in the southern most area, and are taken in traps and (occasionally) bottom trawls. Males mature to a carapace width of 80 mm, and females to 62 mm. It is a slow growing species, with females having a faster growth rate than males. According to the National Institute of Fisheries Research – INIP (2012), *Chaceon maritae* is caught in the study area only as by-catch in the shrimp fishery.

Cephalopod species (cuttlefish *Sepia officinalis* and *S. orbignyana* and squid *Loligo vulgaris reynaudi*) are often taken as by-catch in the demersal trawl fleets and by artisanal fishermen. However, their catches are not always recorded and so the extent to which they are exploited is unknown.

[31]National Institute of Fisheries Research- INIP, 2012

Sepia officinalis is a demersal, shallow coastal water species occurring predominantly on sandy to muddy bottoms from the coastline to a depth of about 200 m, but most abundant at a 100 m depth. Larger individuals are encountered in the deeper part of the range. Seasonal migrations (mainly vertical) have been shown to occur in all stocks.

The pink cuttlefish (*S. orbignyana*) is a free swimming species occurring over the muddy and detritus-rich continental shelf and slope areas at 50 to 450 m depths, but it is most abundant at depths of between 80 and 150 m throughout the year. No onshore spawning migrations have been reported. Spawning occurs at temperatures of 13 to 16^{o}C from early summer to autumn. Mature males aged 6 or 7 months carry about 100 spermatophores; females of 9 or 10 months, some 400 eggs.

4.5.4. **Fishes**

Species composition of fish in Angolan waters constitutes a typical tropical regime in its northern part as well as a temperate one in the south, separated by the Angola-Benguela Frontal Zone – ABFZ (Bianchi, 19 92). The ABFZ creates a strong upwelling that supports high primary production and in turn supports an area of high production of marine resources. Upwelling is a wind-driven motion of dense, cooler, and usually nutrient-rich water towards the ocean surface, replacing the warmer, usually nutrient-depleted surface water. National data is relatively sparse with respect to life history characteristics (breeding and migration routes) of fish located in Angolan waters. Data are largely restricted to the commercially-exploited species.

The sections below derive from data compiled by the National Institute of Fisheries Research (INIP) for the Block 39 fishery resources and existing information on fish populations off the Angolan coast, mainly by FAO (1998)[32] and Ketos Ecology[33], who report relatively broad scale

[32] Food and Agriculture Organization. Source :*http://www.fao.org*

[33]Ketos Ecology, 2011 accessed from *www.ketosecology.co.uk/Angola*

distribution patterns for fish, mammals and other fauna sampled in research cruises conducted in the region.

Pelagic Species

Pelagic fish are those that live in the upper layer of the water column, usually near the surface, are distributed along the Angolan coast and make up about 80% of the total fish landed in Angola. Four species represent the most important proportion of small pelagic fish in Angola: Flat sardine (*Sardinella maderensis*), Round sardine (*Sardinella aurita*), Cunene horse mackerel (*Trachurus trecae*) and Cape horse mackerel (*Trachurus capensis*). These groups of species have a widely coastal distribution and therefore are not found in the ultra-deep waters of Block 39.

The yellowfin tuna (*Thunnus albacares*) and the bigeye tuna (*Thunnus obesus*) are the most important large pelagic fish species taken off the Angolan coast (Photo 4.1). Both are highly migratory species that have transoceanic distributions and are seldom resident in any area for long periods. These species are expected to be located in and around Block 39. The bigeye tuna is part of an Eastern Atlantic population whose core distribution extends from north-west Africa to southern Angola.

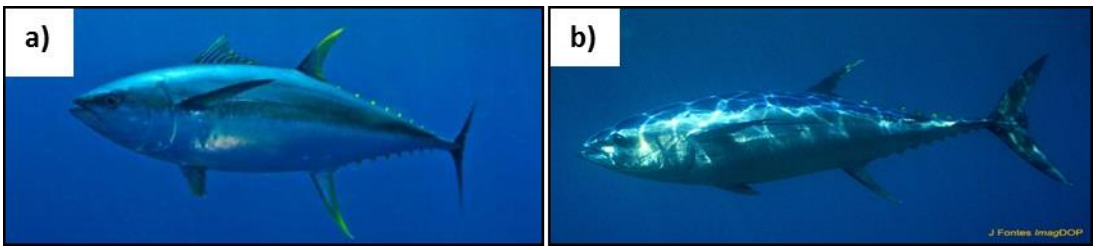


Photo 4.1. Tuna species - main large pelagic fish off the Angolan coast[34].a) *Thunnus albacares;* b)*Thunnus obesus.*

Yellowfin tuna feed near the surface, they are known to be epipelagic fish since they live near the surface, down to 200 meters, whereas bigeye tuna forage over a greater vertical range, and feed on a wide range of fish and cephalopod species. Yellowfin are found in open waters of tropical and subtropical seas worldwide and are essentially confined to the upper

[34]Food and Agriculture Organization. Source: *http://www.fao.org*

100 m of the water column in areas with marked oxyclines (areas of water separated by differences in oxygen concentrations). Yellowfin tuna require water with a minimum oxygen concentration of 2 mg/l or more in order to maintain the supply of oxygen to their demanding muscles. They are rarely encountered below thermoclines, and strong thermocline gradients tend to exclude their presence in deeper water. Their vertical distribution appears to be influenced by the thermal structure of the water column, the depth of the mixed layer, and the strength of the temperature gradient within the thermocline. Their thermal boundaries of occurrence are between 18 and 31^{o}C.

The yellowfin tuna caught in Angola forms part of an Atlantic population which spawns off Brazil and in the Gulf of Guinea and migrates to the Equatorial East Atlantic in the austral summer (Payne & Crawford, 1989). Larval distribution in equatorial waters is transoceanic all year round, but there are seasonal changes in larval density in subtropical waters. It is believed that the larvae occur exclusively above the thermocline. Adults and juveniles can be found in large schools in near-surface waters grouped primarily by size, either in monospecific or multispecies groups often associated with floating debris.

Bigeye tuna forms part of an Eastern Atlantic population whose core distribution extends from northwest Africa to southern Angola. Generally, this species is epipelagic (occurring on surface down to 200 meters) and mesopelagic in oceanic waters from the surface down to about 1000 meters where light continue to fade until there is none. Temperature and thermocline depth seem to be the main environmental factors governing the vertical and horizontal distribution of bigeye tuna, although to a very different extent than yellowfin tuna. This species has been found in water temperatures between 13 and 29^{o}C, but the optimum range lies between 17 and 22^{o}C. This coincides with the temperature range of the permanent thermocline. They spawn in a more or less permanent manner throughout this zone (Cayré & Marsac, 1993).

The management of the tuna fisheries in Angola is carried out in line with the regulations of ICCAT (International Convention for the Conservation of Atlantic Tunas), of which Angola

became a member in 1979. Currently 100 vessels are permitted to fish in national jurisdiction waters, and about 45 vessels are actually operating. These consist of 19 purseiners and 26 long liners (Angola does not have any vessels specifically for tuna fishing). In Angola only *Thunnus albacore* catches are included on the ICCAT database (Table 4.2).

Table 4.2. Tuna fish catches (tons) in Angolan waters reported to ICCAT[35].

Species	2007	2008	2009	2010	2011
Thunnus albacore	405	98	98	98	98

*Data from *"Report of the Standing Committee on Research and Statistics"*, ICCAT 2011.

The ICCAT has listed the big eye tuna (*Thunnus obesus*) as the species of greatest concern (after the bluefin tuna, which does not occur in Angolan waters) in terms of sustainable fishing levels. There is an advisory minimum weight limit of 3.2 kg on bigeye tuna. It is believed that smaller fish are also often netted along with skipjack and *bonitos*.

In addition to published data on the occurrence and distribution of tuna species, ongoing observations during the marine mammal observation (MMO) and research surveys off the Angolan coast have recorded data on the occurrence and distribution of other pelagic fish species. Hammerhead sharks were the most commonly seen; large numbers of dolphin fish and ocean sunfish were also recorded[36].

Many of these species are also taken as by catch by vessels targeting tuna, and represent other major commercial fisheries interests. Swordfish in particular have been recorded as being caught in Angolan waters. Hammerhead sharks were only identified to genus and not to the species level, since at least three species of hammerhead (the great hammerhead *S. mokarran*, scallop hammerhead *S. lewini* and the smooth hammerhead *S. zygaena*) are known to occur regularly within the Angola region (Nel, 2004). Table 4.3 lists some of the large fish species that occur in Angolan coast (INIP, 2012).

Table 4.3.Summary of large fish species occurring off the Angolan coast.

[35]Source: INIP, 2012.
[36] Ketos Ecology, 2011 accessed from *www.ketosecology.co.uk/Angola*

Species	Seasonality (peak)
Shark sp.	All year (Jul-Aug)
Hammerhead shark	All year (Jul-Sep)
Blue shark	All year (Jul-Aug)
Dusky shark	Oct
Great white shark	Jul
Mako shark	Jul
Thresher shark	Jul
Whale shark	Oct
Ocean sunfish	Jul-Sep
Ray sp.	Jul, Dec
Manta ray	Jan, Aug, Sep, Nov (Aug-Sep)
Billfish sp.	All year (Aug-Oct)
Swordfish	May, Oct, Nov
Sailfish	Feb, Aug
Marlin sp.	All year
Dolphinfish	All year (Jan, Nov)

Demersal Species

Demersal fish are widely distributed along the Angolan coast, from Cabinda (5^{o}S) to the Cunene river (17^{o}S). Most of the species of higher commercial interest in Angola belong to this group. The demersal fish include around 79 species of commercial interest, distributed into 13 families of which the most important are: Sparidae (seabreams), Scianidae (croakers), Serranidae (groupers), Pomadasydae (grunts) and Merluccidae (hakes).

Seabreams are found along the entire Angolan coast at depths of between 0-400 m, and the highest concentrations are found at depths between 100-300 m. The most important species are *Dentex macrophthalmus* (large–eye dentex), *Dentex angolensis* (Angola dentex), *Pagellus bellottii* (red pandora), and *Dentex barnardi* (barnard dentex). Of these, *D. macrophtalmus* is most abundant in southern Angola, *while D. angolensis* is common to the northern area of the coast, and *P. bellottii* is mainly concentrated at depths of between 0 and 200 m along most of the coast (INIP, 2012).Figure 4.10 represents the distribution of the group in Angola, as well as images of the most important species.

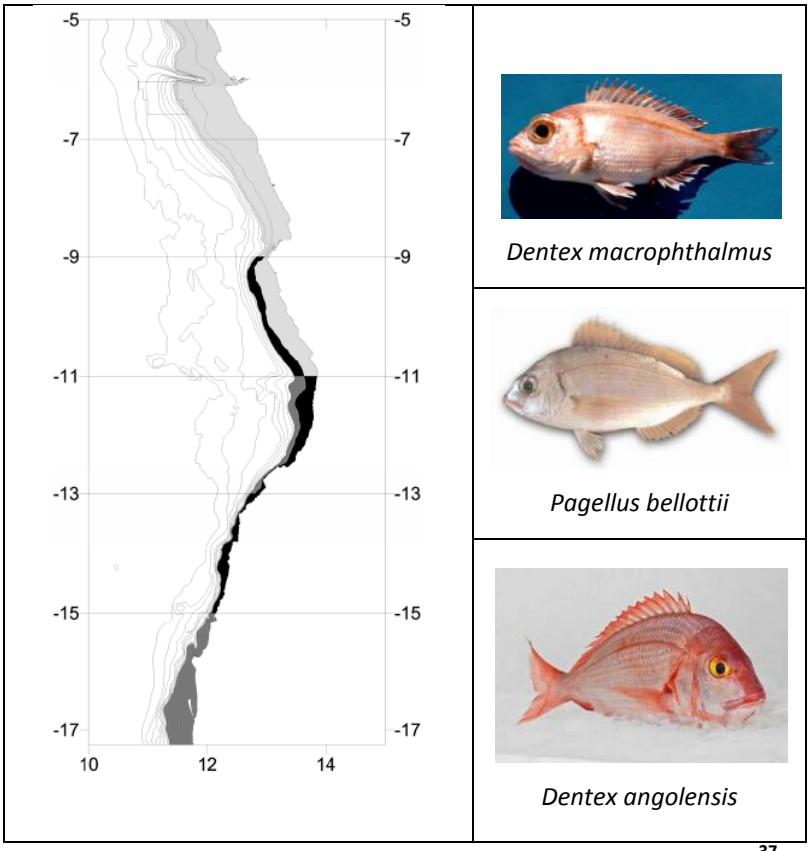
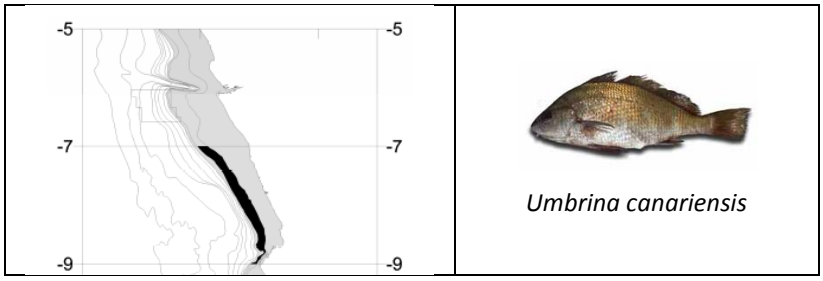


Figure 4.10.Distribution map and illustration of seabreams species[37].

Croakers are found along the entire Angolan coast at depths of between 0 and 300 m, and with the highest concentrations occurring at depths of between 0 and 200 m. The most important species of this group are: *Umbrina canariensis*, *Atractoscion aequidens*, *Argyrosomus hololepidothus* and *Pseudotolithus typus* (Figure 4.11).



[37]Source: INIP, 2012 and *http://www.fao.org*

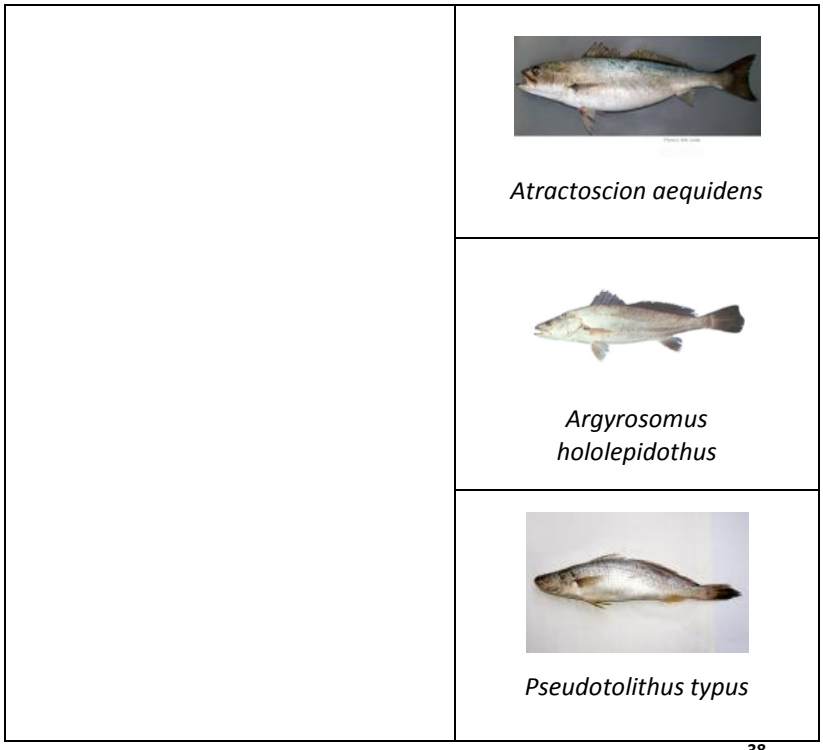


Figure 4.11.Distribution map and illustration of croaker species[38].

Groupers are mainly found in the northern area of the coast (5° S to 12° S), at depths of 0 and 200 m, mainly between 0 and 100 m. The most commercially important species of this group are *Epinephelus aenus* and *Epinephelus gorrensis* (Figure 4.12).

[38]Source: INIP, 2012 and *http://www.fao.org*

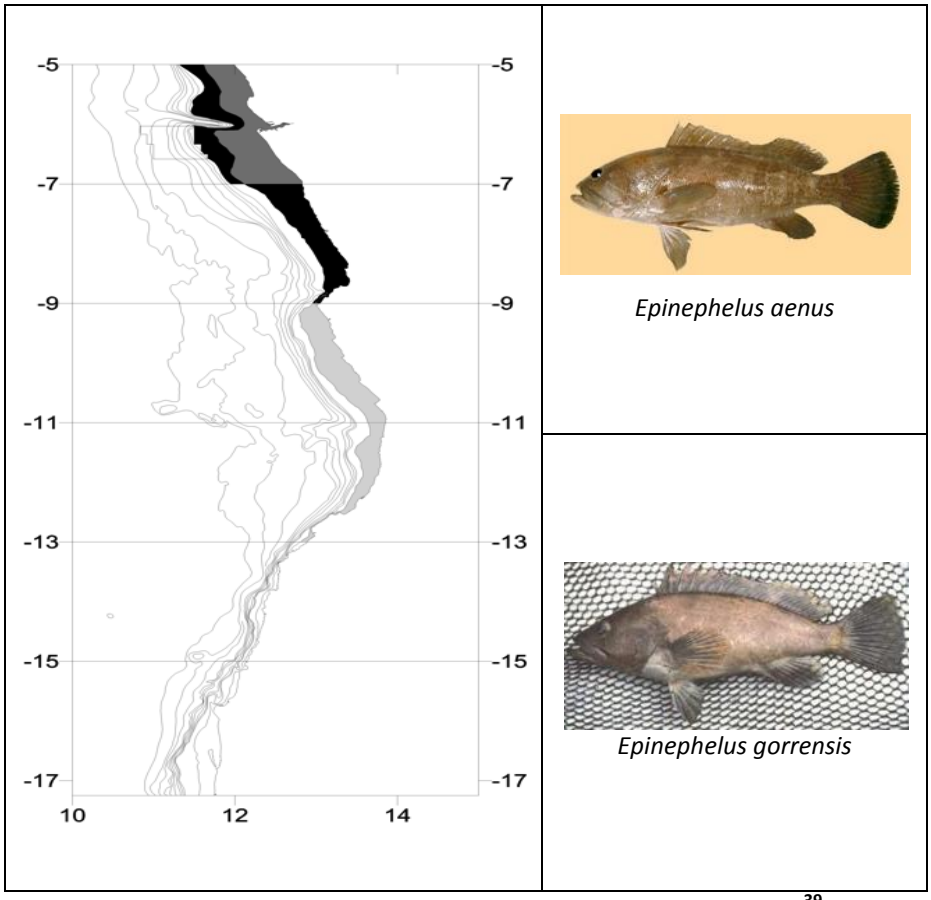


Figure 4.12.Distribution map and illustration of grouper species[39].

Grunts are distributed along the Angolan coast (5° S to 17° S), at depths of between 0 and 100 m. The most commercially important species of this group are *Pomadasys jubelini*, *Pomadasys incisus* and *Pomadasys rogeri* (Figure 4.13).

[39]Source: INIP, 2012 and *http://www.fao.org*

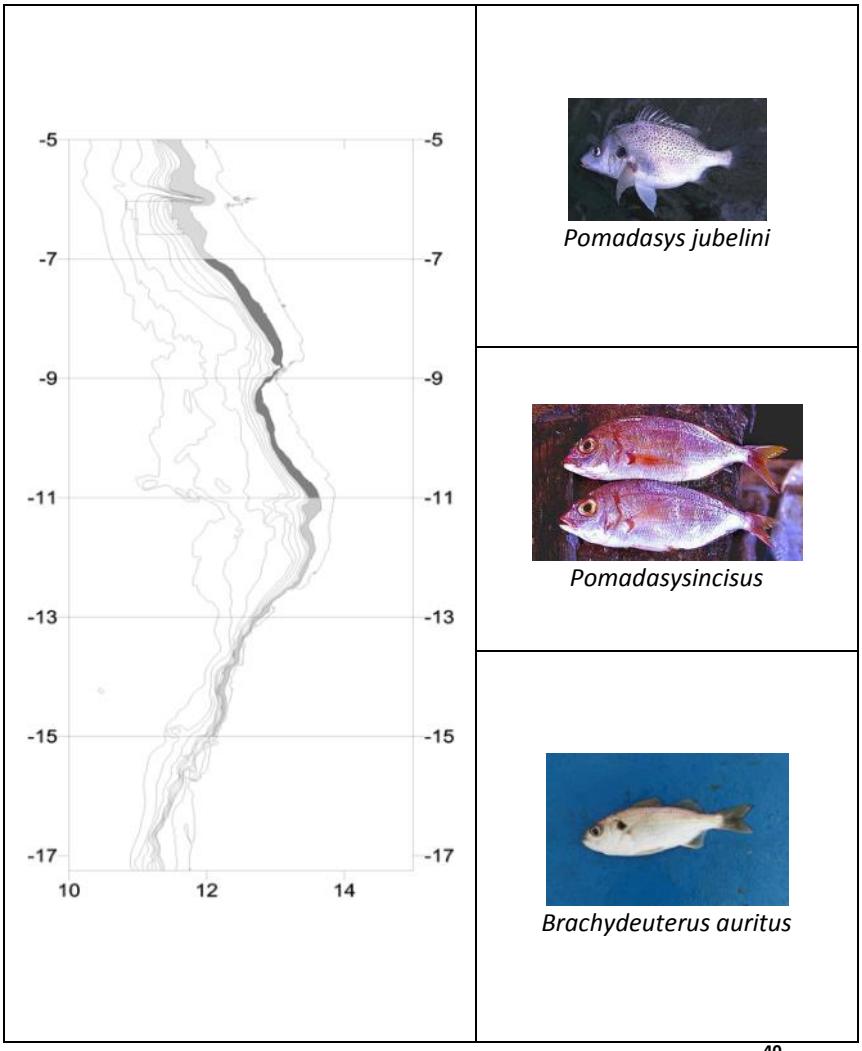


Figure 4.13. Distribution map and illustration of grunts species[40].

Two species of hake are found along the Angolan coast, *Merluccius polli* (Benguela hake) and *Merluccius capensis* (Cape hake). Benguela hake is distributed along the Angolan coast from 5°S to 17°S, at depths of between 0 and 800m, but it is most abundant at depths of 300 and 400m along the coast. *M. polli* migrate southward in the spring and northward in autumn (Cohen *et al.*, 1990) and breed throughout the year. Peaks of reproductive activity occur in August and September. Small hakes are typically found at depths of between 0 and 100m during the cold season. Figure 4.14 illustrates the distribution of the group in Angola, as well as an image of the most important species.

[40]Source: INIP, 2012 and *http://www.fao.org*

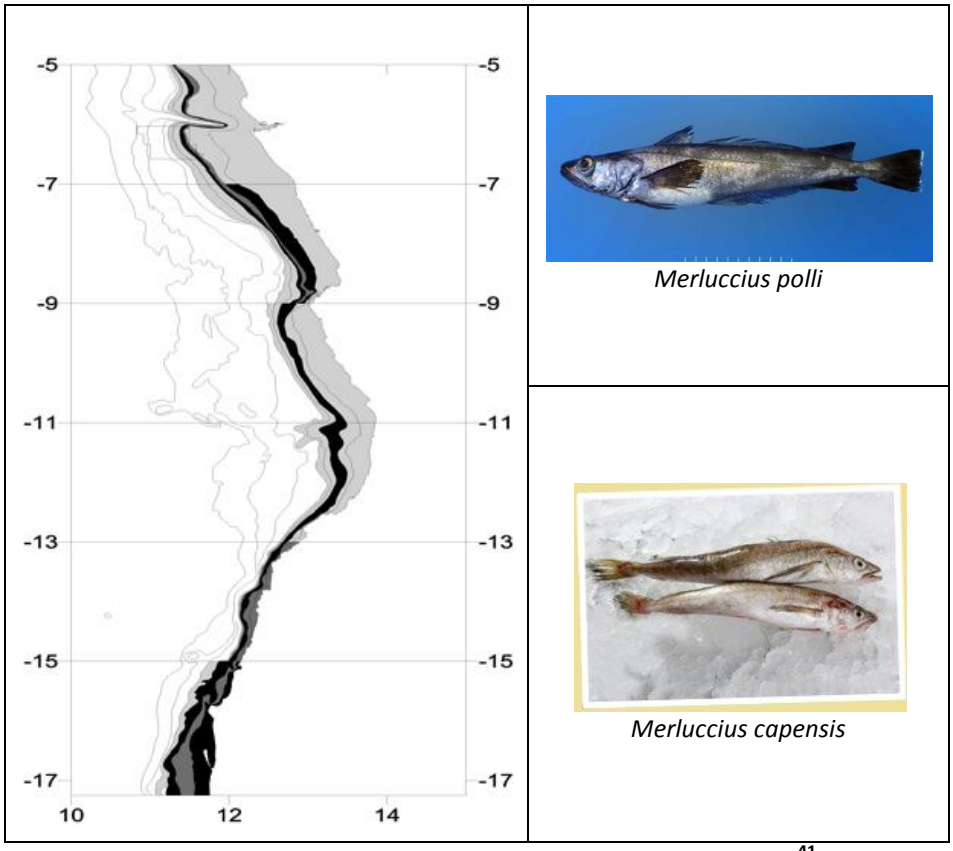


Figure 4.14.Distribution map and illustration of hake species[41].

Cape hake are reported to aggregate to spawn, predominantly in early summer with a second spawning period in autumn. Hake eggs, after fertilization at depth, float to the surface and the larvae quickly develop and become free swimming. After a short pelagic period, juvenile hake migrate to the bottom of the sea (Powers *et al*., 2003). Diurnal (daily) vertical migrations are also a distinct part of their biology. Hake remain close to the bottom and aggregate during daylight hours. At night hake disperse, moving higher in the water column where they feed.

Trawl surveys from the Norwegian Research Vessel Dr. Fr Norwegian Research Vessel Dr. Fridtjof Nansen between 1985 and 1995 yielded biomass estimates between 5,000 and 20,000 tonnes (Sætersdal, 1999), and showed that the Benguela hake frequently co-occurs with commercial deep-water prawns such as the rose prawn (*Parapenaeus longirostris*) and the striped prawn (*Aristeus varidens*) (Kilongo, 1998). However, according to INIP (2012), the

[41]Source: INIP, 2012 and *http://www.fao.org*

biomass estimates of Benguela hake have been showing a declining trend. The biomass estimated in 2011 is 25% lower than the 2007 estimate (Table 4.4).

Table 4.4.Biomass estimates of Benguela hake (tons) at depths of200 - 800m[42].

Year	2007	2008	2009	2010	2011
Biomass	4,117	5,925	2,814	3,611	2,433

Deep Sea Species

Few data is available about deep sea fish behavior. Most of the knowledge has been inferred from species caught in the trawl stations covering the mid slope aboard of R/V Dr. Fridtjof Nansen. The dominant fish species were *Hoplostethus cadenati* and *Yarella blackfordi* (INIP, 2012).These groups are classified as batydemersal species and are distributed throughout the Angolan coast from depths of 500 to 1,500m.

In general, data shows declining trends in catch rates of both species (Figure 4.15). However, since 2009 these trends showed higher catch rates at depths of 800m. This could be an indication that these species are distributed beyond this depth.

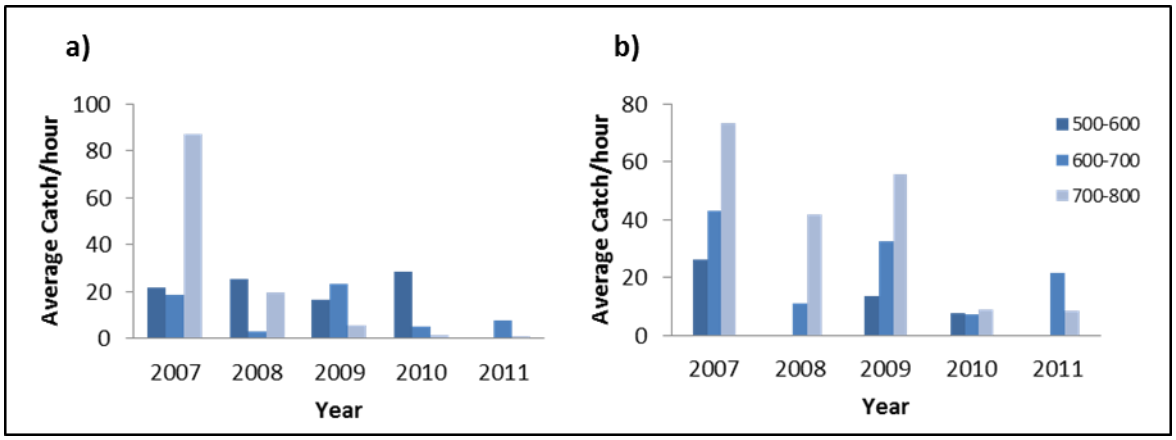


Figure 4.15. Average catch rate (kg/h) from 2007 to 2011.a) *Hoplostethus cadenati* and b) *Yarella blackfordi*)[43].

[42]Source: The national Institute of Fisheries Research – INIP, 2012

[43]Source: National Institute of Fisheries Research- INIP, 2012

4.5.5. **Commercially Important Species**

Angolan waters are particularly rich in commercially relevant species and the fishing activities along the coast are important from a socio-economic standpoint (fish exports, employment and source of food). These species are conventionally grouped into crustaceans, demersal fish and pelagic fish (pelagic fish are distributed along the Angolan coast and make up about 80% of the total fish landed in Angola). According to the INIP data (2012), the species of higher commercial value are mainly captured at water depths between 100 and 300m. Table 4.5 summarizes the commercial species recorded in Angola by fishing vessels and scientific surveys, between 1995 and 2011.

Table 4.5.Commercial species recorded in Angolan waters from 1995 to 2011.

Common name	Scientific name	Highest abundance depth (m)
Large-eye dentex	*Dentex macrophthalmus*	100-300
Angola dentex	*Dentex angolensis*	100-300
Red Pandora	*Pagellus bellottii*	100-300
Striped seabream	*Pagellus mormyrus*	100-300
Sompat grunt	*Pomadasys jubelini*	20-100
Pigsnout grunt	*Pomadasys rogeri*	20-100
Bigeye grunt	*Brachydeuterus auritus*	20-100
White grouper	*Epinephelus aeneus*	100-200
Dusky grouper	*Epinephelus guaza*	100-200
Benguela hake	*Merluccius polli*	300-400
African weakfish	*Atactoscion aequidens*	0-200
Cassava croaker	*Pseudotolithus senegalensis*	0-200
Longneck croaker	*Pseudotolithus typus*	0-200
Canary drum	*Umbrina canariensis*	0-200
Wedge sole	*Dicologoglossa cuneata*	20-100
Chub mackerel	*Scomber japonicas*	0-200
Yellowfin tuna	*Thunnus albacares*	0-100
Bigeye tuna	*Thunnus obesus*	0-250
Little tunny	*Euthynnus alletteratus*	0-200
Cunene horse mackerel	*Trachurus trecae*	20-100
Round sardinella	*Sardinella aurita*	0-200

Common name	Scientific name	Highest abundance depth (m)
Flat sardinella	*Sardinella maderensis*	0-200
Guachanche barracuda	*Sphyraena guachancho*	20-100
European barracuda	*Sphyraena sphyraena*	20-100
Largehead hairtail	*Trichurus lepturus*	20-100
Deep water rose shrimp	*Parapenaeus longirostris*	50-400
Striped red shrimp	*Aristeus varidens*	400-800
Pink shrimp	*Penaeus notialis*	50-100
Royal spiny lobster	*Panulirus regius*	0-50
Deep water crab	*Chaceon maritae*	300-900

Among the several species of commercial interest found along the Angolan coast, those occurring in Block 39 are the yellowfin tuna (*Thunnus albacares*), the bigeye tuna (*Thunnus obesus*), the Benguela hake (*Merluccius polli)* and the striped red shrimp *(Aristeus varidens)* (National Institute of Fisheries Research – INIP, 2012).

4.5.6. **Marine Mammals**

A review of sightings and existing literature suggests that up to 30 species of whales and dolphins either migrate through or visit the waters of Angola. Many of the species found in Angolan waters are listed by the IUCN (International Union for the Conservation of Nature) and therefore should be deemed sensitive to disturbance (Table 4.6). The detailed distribution and seasonality of these species in Angolan waters is not known.

However, data collected during recent fisheries research investigations and current mammal observers during oil & gas activities off the coast of Angola has provided an appreciation of which species occur in this area. These records also include observations of turtles, sharks and other conspicuous marine species.

This local data along with literature searches has enabled an understanding of the regional patterns of cetacean distribution over a large study area. Consideration of movements across the region is important, since most cetaceans travel large distances as part of migration, breeding and feeding activities.

Table 4.6.Marine mammals from Angola to the Gulf of Guinea (IUCN conservation status).

Common name	Scientific name	Confirmed in Angola	*IUCN status[44]
CETACEANS			
Atlantic hump-backed dolphin	*Sousa teuszii*	No	VU
Atlantic spotted dolphin	*Stenella frontalis*	Yes	DD
Blainville's beaked whale	*Mesoplodon densirostris*	No	DD
Blue whale	*Balaenoptera musculus*	No	EN
Bottlenose dolphin	*Tursiops truncatus*	Yes	LC
Bryde's whale	*Balaenoptera edeni*	Yes	DD
Clymene dolphin	*Stenella clymene*	Yes	DD
Cuvier's beaked whale	*Ziphius cavirostris*	Yes	LC
Dusky dolphin	*Lagenorhynchus obscurus*	No	DD
Dwarf sperm whale	*Kogia simus*	Yes	DD

[44] For further detail, please refer to section 4.5.9 *Threatened Species: IUCN Red List*

Common name	Scientific name	Confirmed in Angola	*IUCN status[44]
False killer whale	*Pseudorca crassidens*	Yes	DD
Fin whale	*Balaenoptera physalus*	Yes	EN
Fraser's dolphin	*Lagenodelphis hosei*	Yes	LC
Gervais' beaked whale	*Mesoplodon europaeus*	No	DD
Heaviside's dolphin	*Cephalorhynchus heavisidii*	No	DD
Humpback whale	*Megaptera novaeangliae*	Yes	LC
Killer whale	*Orcinus orca*	Yes	DD
Long-beaked common dolphin	*Delphinus capensis*	No	DD
Melon-headed whale	*Peponocephala electra*	Yes	LC
Minke whale	*Balaenoptera acutorostrata*	No	LC
Pantropical spotted dolphin	*Stenella attenuate*	Yes	LC
Pygmy killer whale	*Feresa attenuate*	No	DD
Pygmy sperm whale	*Kogia breviceps*	No	DD
Risso's dolphin	*Grampus griseus*	Yes	LC
Rough-toothed dolphin	*Steno bredanensis*	Yes	LC
Sei whale	*Balaenoptera borealis*	Yes	EN
Short-beaked common dolphin	*Delphinus delphis*	Yes	LC
Short-finned pilot whale	*Globicephala macrorhynchus*	Yes	DD
Southern right whale	*Eubalaena australis*	No	LC
Sperm whale	*Physeter macrocephalus*	Yes	VU
Spinner dolphin	*Stenella longirostris*	Yes	DD
Striped dolphin	*Stenella coeruleoalba*	Yes	LC
SIRENIANS			
West African manatee	*Trichechus senegalensis*	Yes	VU
PINNIPEDS			
South African fur seal	*Arctocephalus pusillus*	Yes	LC
Southern elephant seal	*Mirounga leonina*	No	LC

Key: DD (Data Deficient),LC (Least Concern), EN (Endangered), VU (Vulnerable)
Source: Ketos Ecology, 2011; *IUCN 2012 Red List of Threatened Species

A seismic survey (3D) was conducted in the Kwanza basin, offshore Angola, within Blocks 24, 25, 38, 39 and 40, situated east and northeast of Lobito. Seismic surveys covered a total area of 26,300 km² and occurred in two periods on two different vessels:

- ✓ Survey vessel Ramform Valiant*:* December 24, 2011 to October 21, 2012 (Paixão, I., Teixeira, X., Poles. S, 2013); and
- ✓ Survey vessel PSG Apollo: February 26, 2012 to January 23, 2013 (May, D., 2013).

Each marine mammal observer (MMO) team provided a report for the campaigns which includes the methods used for marine mammal, turtles, seabirds and other conspicuous species observations, results and recommendations for minimize the risk of disturbance and injury to marine mammals from seismic survey.

Table 4.7 summarizes the results of MMO data featuring the species identified, total sightings and number of marine mammals in the study area during the survey.

Table 4.7. Marine mammals within Blocks 24, 25, 38, 39 and 40 (data collected during the survey from December 2011 to January 2013)

Common name	Scientific name	Total sightings	Total number of animals
CETACEANS			
Humpback whale	*Megaptera novaengliae*	161	293
Bryde's whale/Sei whale	*Balaenoptera sp*	88	138
Blue whale	*Balaenoptera musculus*	5	8
Bryde's whale	*Balaenoptera edeni*	13	18
Minke whale	*Balaenoptera acutorostrata*	2	3
Risso's dolphin	*Grampus griesus*	123	1.837
Sperm whale	*Physeter macrocephalus*	44	196
Dwarf sperm whale	*Kogia sima*	5	10
Pilot whale	*Globicephala sp*	108	2.222
Short-finned pilot whales	*Globicephala macrorhynchus*	5	183
Melon-headed whale	*Peponocephala electra*	6	495
Killer whale	*Orcinus orca*	1	6
False Killer whale	*Pseudorca crassidens*	8	236
Common dolphin	*Delphinus delphis*	27	3.775
Bottlenose dolphin	*Tursiops truncatus*	46	840
Fraser's dolphin	*Lagenodelphis hosei*	3	430
Clymene dolphin	*Stenella clymene*	3	550
Pantropical spotted dolphin	*Stenella attenuata*	1	30
Atlantic spotted dolphin	*Stenella frontalis*	8	401
Rough-toothed dolphin	*Steno bredanensis*	5	155
UnID whales		63	74
UnID dolphins		332	23.955
UnID large cetaceans		32	41

Common name	Scientific name	Total sightings	Total number of animals
UnID "blackfish"		1	150
	PINNIPEDS		
South African fur seal	*Arctocephalus pusillus*	89	185
UnID seal		1	1

UnID: unidentified species.

With a total of **1,090 sightings** comprising **36,046 individuals**, being the common dolphin (*Delphinus delphis*) and the short-finned pilot whale (G*lobicephela macrorhynchus*) the most frequently sighted cetacean species during the seismic survey. Both species are gregarious and, in Angola, pilot whales are often seen in deepwater accompanied by bottlenose dolphins and common dolphins associate with many other cetaceans including Clymene dolphin and humpback whales (Weir, C., 2006). The short-finned pilot whale is also known as the 'Cheetah of the Deep' for its high speed pursuit of squid at depths of hundreds of meters. It is also the most frequently recorded 'blackfish' species[45] off Angola and inhabits the region year-round.

Photographs of some of the most commonly sighted marine mammals during the MMO surveys are shown in Photo 4.2 and photo 4.3. Monthly distribution maps are available in both reports and an example is shown in Appendix D.

[45]The term 'blackfish' is applied to six species of large dolphin, which due to their size and appearance are commonly referred to as whales. All six of these species potentially occur off Angola, and five have been confirmed in the region to date. The blackfish are: short-finned pilot whales (G*lobicephela macrorhynchus*), long-finned pilot whales (*G. melas*), killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*), melon-headed whales (*Peponocephala electra*) and pygmy killer whales (*Feresa attenuata*).

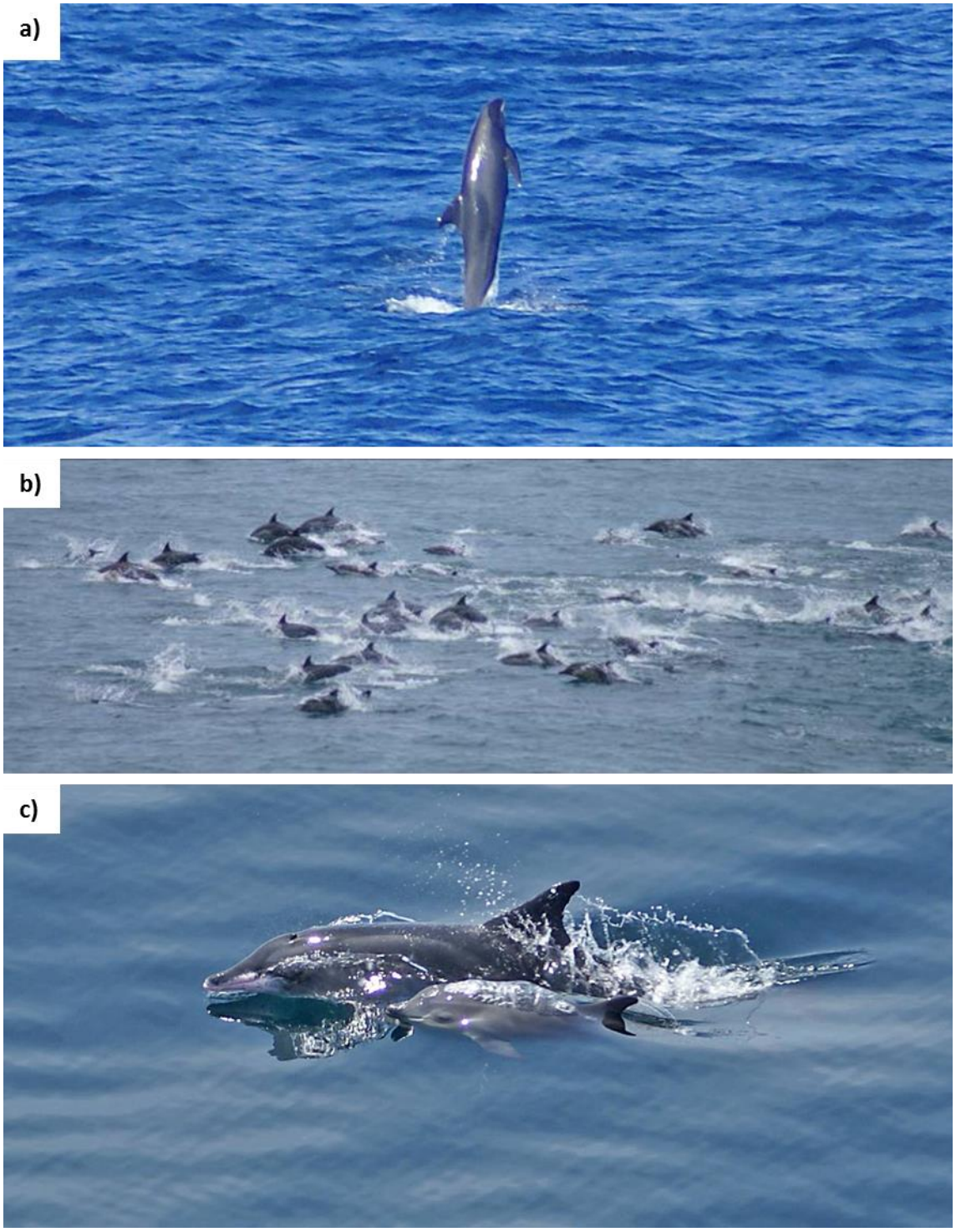


Photo 4.2.Marine mammals recorded during the MMO surveys[46].a) Melon-headed whale; b) Common dolphins; c) Rough-toothed dolphin (mother and calf)

[46]Source: TGS – WesternGeco, 2012.

Photo 4.3. Marine mammals recorded during the MMO surveys. a) Risso's dolphin; b)Humpback whale; c) Pilot whale.

4.5.7. **Marine Turtles**

There are five species of marine turtles known to occur along the coast of Angola: the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*) and hawksbill turtles (*Eretmochelys imbricate*) (Brongersma, 1982; Carr & Carr, 1991; Fretey, 2001; Hughes, 1982; Huntley, 1974). All are considered to be Critically Endangered or Endangered by the IUCN 2012 (The World Conservation of Union), except for the olive ridley turtle which is considered Vulnerable.

Nesting activities occur throughout the area although most of the nests were distributed between 7°S and 10°S. Hatching commences in the middle of this period and extends into May. Turtle migrations are usually quite large and the animals likely move *en masse* out of the area.

Table 4.8 shows species known to occur in Angola waters, their likely distribution and their IUCN classification.

Table 4.8. Species of marine turtles know to occur in Angolan waters.

Turtle species	Likely Distribution	Peak Breeding Time	*IUCN Status[47]
Loggerhead	Northern Angola Coastal waters	November to January	EN
Green Turtle	Coastal waters from south of Cabinda northwards, and from north of Angola south to Benguela	November to January	EN
Olive Ridley	Entire coastal waters of Angola	November to January	VU
Leatherback	Coastal waters around central Angola (distributed between - but not reaching - Luanda and Benguela) Northern Angola Coastal waters (north of River Congo)	November to January	CR
Hawksbill	Entire coastal waters of Angola	November to January	CR

Key: CR (Critically Endangered), EN (Endangered), VU (Vulnerable).
Key: DD (Data Deficient),LC (Least Concern), EN (Endangered), CR (Critically Endangered) VU (Vulnerable)
Source: Ketos Ecology, 2011; *IUCN 2012 Red List of Threatened Species

[47] For further detail, please refer to section 4.5.9 *Threatened Species: IUCN Red List*

According to Angolan legislation[48] hunting for turtles is strictly prohibited. However, there are incidences of fishermen hunting for turtles and their eggs. Angola is signatory to the Nairobi declaration 'Memorandum of Understanding' concerning Conservation Measures for Marine Turtles off the Atlantic Coast of Africa. While turtle hunting is illegal in Angola, it might not be the case in other nations. Exploitation of turtles for their eggs is a local tradition in a number of countries in West Africa, which has an impact on turtles' population structures. A brief overview of the turtle species which may occur in the Project Study Area is provided below.

In general, the data collected on marine turtles indicates a clear seasonal peak in the occurrence of turtles in the offshore area from July to September. This seasonal movement is inferred to be related to the aggregation of turtles prior to their moving towards the nesting beaches on the Angolan coast.

During the MMO surveys (see section 4.5.6 for survey details) marine turtles were also seen and registered by the observers. Table 4.9 summarizes the results of the MMO surveys data featuring the species identified, total number of animals in the study area.

Table 4.9. Marine turtles registered within Blocks 24, 25, 38, 39 and 40 (survey from December 2011 to January 2013)

Common name	Scientific name	Total number of animals
Loggerhead	*Caretta caretta*	53
Green Turtle	*Chelonia mydas*	17
Olive Ridley	*Lepidochelys olivacea*	641
Leatherback	*Dermochelys coriacea*	49
UnID turtle		1,354

UnID: unidentified species.

. Some photographs of turtles sighted during the MMO surveys are shown in Photo 4.4.

[48]Joint Executive Decree No. 37/99 of January 27, 1999. Ministry of Agriculture and Rural Development and Ministry of Finances.

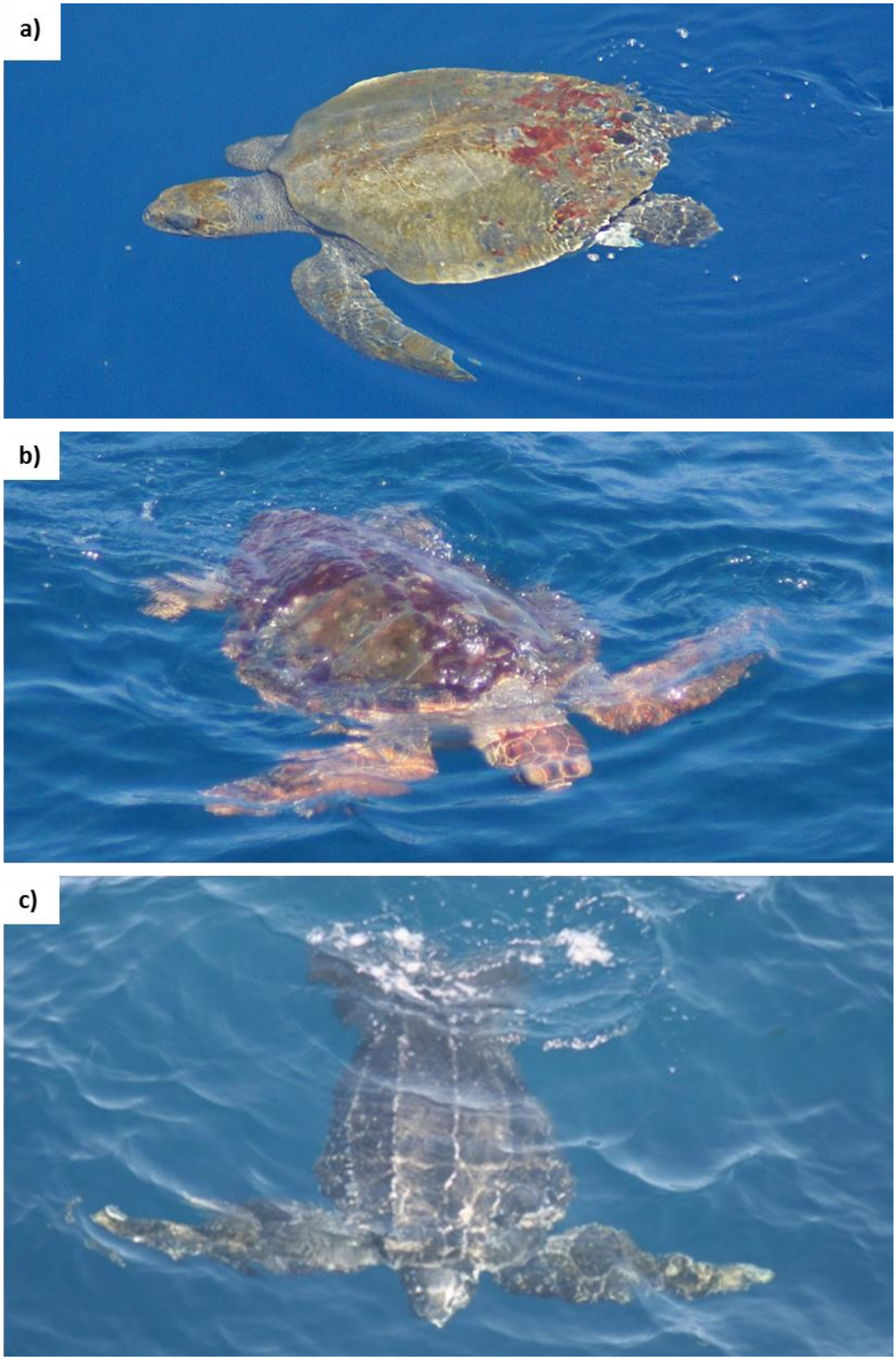


Photo 4.4. Marine turtles recorded during the MMO surveys. a) Olive Ridley turtle; b) Loggerhead turtle; c) Leatherback turtle.

A total of **2,114 marine turtles** were sighted during the seismic survey, being the largest number of identified turtles the olive Ridley's. This data was not surprising and one of the largest olive Ridley's turtle nesting sites in the world is found in Angola. Sea turtles were mostly observed at the surface in very calm sea states or incidentally spotted when surfacing for breathing. However, crew members would also frequently report incidental sightings, particularly of animals feeding close to the seismic equipment (streamers). Animals were often associated with floating objects such as logs, debris or Fish Aggregating Devices.

Green Turtle

The green turtle (*Chelonia mydas*) is a solitary swimming species that occasionally congregates in groups in shallow water in areas where seagrass or algae is abundant. Nesting activity is greatest between November and January, but sometimes occurs as early as September (Carr & Carr, 1991).

This species commonly occurs along the coast of Angola with a large nesting population on beaches south of Luanda. Surveys conducted in 1999 suggest that Mussulo Bay is an important site for growth of juveniles. In addition, nesting sites have been reported on beaches of the Democratic Republic of Congo, Republic of Congo, and of the province of Cabinda.

Olive Ridley

The olive ridley turtle (*Lepidochelys olivacea*) migrates along the continental shelf and feeds in shallow water in fine and medium to coarse grained sand. This species is distributed throughout Angolan water and nests in similar locations to green turtles but they are dominant immediately south of the Congo River and along the coast of Cabinda. Major nesting sites have been reported south of Luanda and a number of sightings have been made in the Bay of Bengo, 21 km north of Luanda (Carr & Carr, 1991).

Leatherback

Leatherback turtles (*Dermochelys coriacea*) have been recorded between Gabon and Angola. Leatherbacks nest from October to February, in particular along a 200 km stretch of beach south of Luanda, encompassing part of the Quiçama National Park. Other nesting sites have been identified along the coast of Gabon and the Congo. Recent research efforts into the distribution patterns and behaviors of leatherbacks have revealed a high concentration of leatherbacks south of Mayumba.

Loggerhead and hawksbill

Relatively little information is available relating to the distribution, seasonality and abundance of loggerhead and hawksbill turtles. Loggerhead turtles are found as far south as the Congo River. Minor nesting sites have also been reported in southern Angola. Unlike the loggerhead, the hawksbill is distributed along the entire Angola coast. The exact location of nesting beaches is unclear and sightings are relatively sparse.

4.5.8. **Seabirds**

An assessment compiled by the Council for Scientific and Industrial Research (CSIR, 2003) identified 22 species of bird expected to occur on the central Angolan coast and continental shelf areas. Actual counts that have been made in the area over the recent past have revealed the presence of 27 species.

A summary of the species likely to occur in the wider study area and their respective IUCN status is presented in Table 4.10.

Table 4.10. Summary of seabirds likely to occur in the wider study area.

Family	Species	English name	*IUCN[49] Status
Diomedeidae	*Thalassarche melanophrys*	Black-browed albatross	**EN**
Diomedeidae	*Thalassarche chlororhynchos*	Atlantic yellow-nosed albatross	**EN**
Diomedeidae	*Thalassarche chrysostoma*	Grey-headed albatross	**VU**
Procellariidae	*Daption capense*	Cape petrel	**LC**
Procellariidae	*Calonectris diomedea*	Cory's Shearwater	**LC**
Procellariidae	*Puffinus gravis*	Great shearwater	**LC**
Procellariidae	*Puffinus griseus*	Sooty shearwater	**NT**
Procellariidae	*Procellaria aequinoctialis*	White-chinned petrel	**VU**
Procellariidae	*Pterodroma mollis*	Great-winged petrel	**LC**
Hydrobatidae	*Oceanodroma leucorhoa*	Leach's storm-petrel	**LC**
Hydrobatidae	*Oceanites oceanicus*	Wilson´s storm-petrel	**LC**
Sulidae	*Morus capensis*	Cape gannet	**VU**
Phalacrocoracidae	*Phalacrocorax capensis*	Cape cormorant	**NT**
Phalacrocoracidae	*Phalacrocorax carbo lucidus*	White-breasted cormorant	**LC**
Stercorariidae	*Stercorarius pomarinus*	Pomarine jaeger	**LC**
Stercorariidae	*Stercorarius parasiticus*	Parasitic jaeger	**LC**
Stercorariidae	*Catharacta antarctica*	Brown skua	**LC**
Laridae	*Larus cirrocephalus*	Grey-headed gull	**LC**
Laridae	*Larus sabini*	Sabine´s gull	**LC**
Sepidae	*Sterna hirundo*	Common tern	**LC**
Sepidae	*Sterna maxima*	Royal tern	**LC**
Sepidae	*Sterna sandvicensis*	Sandwich tern	**LC**
Sepidae	*Chlidonias niger*	Black tern	**LC**
Sepidae	***Larus dominicanus vetula***	**Kelp gull**	**LC**

Key: DD (Data Deficient),LC (Least Concern), EN (Endangered), VU (Vulnerable), NT (Near Threatened)
Source: Ketos Ecology, 2011; *IUCN 2012 Red List of Threatened Species

According the National Institute of Fisheries Research (2012), some of these species were recorded in the study area, such as Wilson´s storm petrel, Grey-headed gull, Kelp gull, Royal and Common terns.

During the MMO surveys in Blocks 38 and 39, sea and terrestrial birds were registered and photographed. There are no quantified data by species but a minimum of 7 families were

[49] For further detail, please refer to section 4.5.9 *Threatened Species: IUCN Red List*

represented. The most abundant were possibly terns (family Sternidae), with 4 species being identified. Arctic and Common terns (*Sterna paradisaea* and *Sterna hirundo)* were the most observed, in higher numbers during the summer months, frequently observed feeding in association with pelagic fish schools. Black terns (*Chlidonias niger*) were seen in relatively small groups, mostly in October. The second most common family of seabirds recorded was Procellariidae, which also included the second most abundant species, the Cory's shearwater (*Calonectris diomedea*) observed from December to May. Another family of seabirds commonly found was Hydrobatidae, with at least 3 species being identified. Leach's storm-petrel (*Oceanodroma leucorhoa*) was possibly the most commonly sighted and the presence of Wilson's storm-petrels (*Oceanites oceanicus*) was noted from July on (Paixão, I., Teixeira, X., Poles. S, 2013).

Photographs of seabirds sighted during the MMO surveys are shown in Photo 4.5.

Photo 4.5. Seabirds recorded during the MMO surveys .a) Pomarine skua; b) Common/Artic tern; c) Roseate tern.

4.5.9. Threatened Species: IUCN Red List

The International Union for Conservation of Nature (IUCN) aims to find pragmatic solutions to the most pressing environmental and development challenges. The IUCN supports scientific research, manages field projects globally, and brings governments, non-government organizations, United Nations agencies, companies and local communities together to develop and implement policy, laws and best practice.

This organization evaluates the conservation status of species and subspecies on a global scale. Each species is evaluated by IUCN according to a specific classification based on biological factors related to extinction risk, which includes: rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation. We briefly define below the nine categories in the IUCN Red List system:

- ✓ **Extinct (EX)**: no individuals remaining.
- ✓ **Extinct in the wild (EW)**: known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
- ✓ **Threatened species**, grouping of three categories:
  - ✓ Critically Endangered (CR): Extremely high risk of extinction in the wild.
  - ✓ Endangered (EN): Very high risk of extinction in the wild.
  - ✓ Vulnerable (VU): High risk of extinction in the wild.
- ✓ **Near Threatened (NT)**: Likely to become endangered in the near future.
- ✓ **Least Concern (LC)**: Lowest risk (widespread and abundant taxa are included in this category).
- ✓ **Data Deficient (DD)**: Not enough data to make an assessment of its risk of extinction.
- ✓ **Not Evaluated (NE)**: Has not yet been evaluated using the above criteria.

Within the Central East Atlantic Ocean (including Cameroon, Guinea, Gabon, Congo and Angola), about 42 threatened animal species have been recorded, including cetaceans, fish,

sea turtles and sea birds. Table 4.11 provides the list of threatened species in Central East Atlantic Ocean (CR, EN, and VU) for the year 2012.

Table 4.11.Threatened species present within the Central East Atlantic Ocean.

Common Name	Scientific Name	*Red List Status[50]
MARINE MAMMALS		
Blue Whale	*Balaenoptera musculus*	**EN**
Sei Whale	*Balaenoptera borealis*	**EN**
Fin Whale	*Balaenoptera physalus*	**EN**
Sperm Whale	*Physeter macrocephalus*	**VU**
Atlantic Humpbacked Dolphin	*Sousa teuszii*	**VU**
African Manatee	*Trichechus senegalensis*	**VU**
Mediterranean Monk Seal	*Monachus monachus*	**CR**
MARINE TURTLES		
Green Turtle	*Chelonia mydas*	**EN**
Leatherback	*Dermochelys imbricate*	**CR**
Hawksbill Turtle	*Eretmochelys imbricate*	**CR**
Olive Ridley	*Lepidochelys olivacea*	**VU**
Loggerhead	*Caretta caretta*	**EN**
FISHES		
Goliath Grouper	*Epinephelus itajara*	**CR**
Dusky Grouper	*Epinephelus marginatus*	**EN**
Island Grouper	*Mycteroperca fusca*	**EN**
Sea Bass	*Mycteroperca olfax*	**VU**
Oceanic Whitetip Shark	*Carcharhinus longimanus*	**VU**
Night Shark	*Carcharhinus signatus*	**VU**
Grey Nurse Shark	*Carcharias Taurus*	**VU**
Great White Shark	*Carcharodon carcharias*	**VU**
Gulper Shark	*Centrophorus granulous*	**VU**
Deepwater Spiny Dogfish	*Centrophorus squamosus*	**VU**
Basking Shark	*Cetorhinus maximus*	**VU**
Flapper Skate	*Dipturus batis*	**CR**
Liver-oil Shark	*Galeorhinus galeus*	**VU**
Longfin Mako	*Isurus paucus*	**VU**

[50] For further detail, please refer to section 4.5.9 *Threatened Species: IUCN Red List*.

Common Name	Scientific Name	*Red List Status[50]
Porbeagle	*Lamna nasus*	**VU**
Giant Devilray	*Mobula mobular*	**EN**
Angular Rough Shark	*Oxynotus centrina*	**VU**
Wide Sawfish	*Pristis pectinata*	**CR**
Largetooth Sawfish	*Pristis perotteti*	**CR**
Common Sawfish	*Pristis pristis*	**CR**
Whale Shark	*Rhincodon typus*	**VU**
Blackchin Guitarfish	*Rhinobatos cemiculus*	**EN**
Common Guitarfish	*Rhinobatos rhinobatos*	**EN**
African Wedgefish	*Rhynchobatus luebberti*	**EN**
Bottlenose Skate	*Rostroraja alba*	**EN**
Great Hammerhead	*Sphyrna mokarran*	**EN**
Cape Shark	*Squalus acanthias*	**VU**
Monkfish	*Squatina aculeata*	**CR**
Smoothback Angel Shark	*Squantina oculata*	**CR**
Angel Shark	*Quantina squatina*	**CR**
SEABIRDS		
Cape Gannet	*Morus capensis*	**VU**
White-chinned Petrel	*Procellaria aequinoctialis*	**VU**

Key: CR (Critically Endangered), EN (Endangered), VU (Vulnerable).
Source: IUCN 2012 Red List of Threatened Species

4.5.10. Protected and Sensitive Areas

The review of sensitive coastal areas has focused on those areas of the coast which are considered to be at risk from a potential large oil spill. This review identified the coastline of Angola (namely provinces of Zaire, Luanda, Benguela and Kwanza Sul) as being a potential receptor of any oil spill arising from an unintended release from the Project. Much of it is only accessible from the sea or air, making response to oil spills from land difficult at many locations.

Most of the 1,650 km Angolan coastline consists of soft marine sediments and supports large areas of mangroves (70,000 ha) at the mouths of several rivers, and extensive salt marshes. The coastal sensitivity summary for the Angolan coastal area that is considered to be at risk

from a potential large oil spill (i.e. Zaire, Luanda and Kwanza Sul) is presented in Table 4.12 and in Figure 4.16. Only the sites with a percentage of impact of oil higher than 50% are further described in this report.

Table 4.12. Summary of the Potential Coastal Sensitive Sites in the Study Area.

Province	Potential Sensitive Sites	Impact of Oiling (%)
Zaire	Matadi River	30
	Quipai River	30
	Sange River	30
	Macamena River	30
	Quintana River	30
	Zangala River	30
	Quinguenge River	30
	N'zeto River	30
	Calungo River	30
Bengo	Quitungo River	30
	Uezo River	30
Luanda	Buraco	40
	Barra do Kwanza	50
	Sobe e Desce	90
	Cabo Ledo	50
	Sete Irmãos	60
	Praia de São Bras	70
	Kitoba	50
Kwanza Sul	Cabo das Três Pontas	100
	Porto Amboim	80
	Keve River Mouth	70
	Ponta da Balela	40
	Ngunza River Mouth	70

Source: Oil Spill Modelling Report, ERM & Holísticos, 2013.

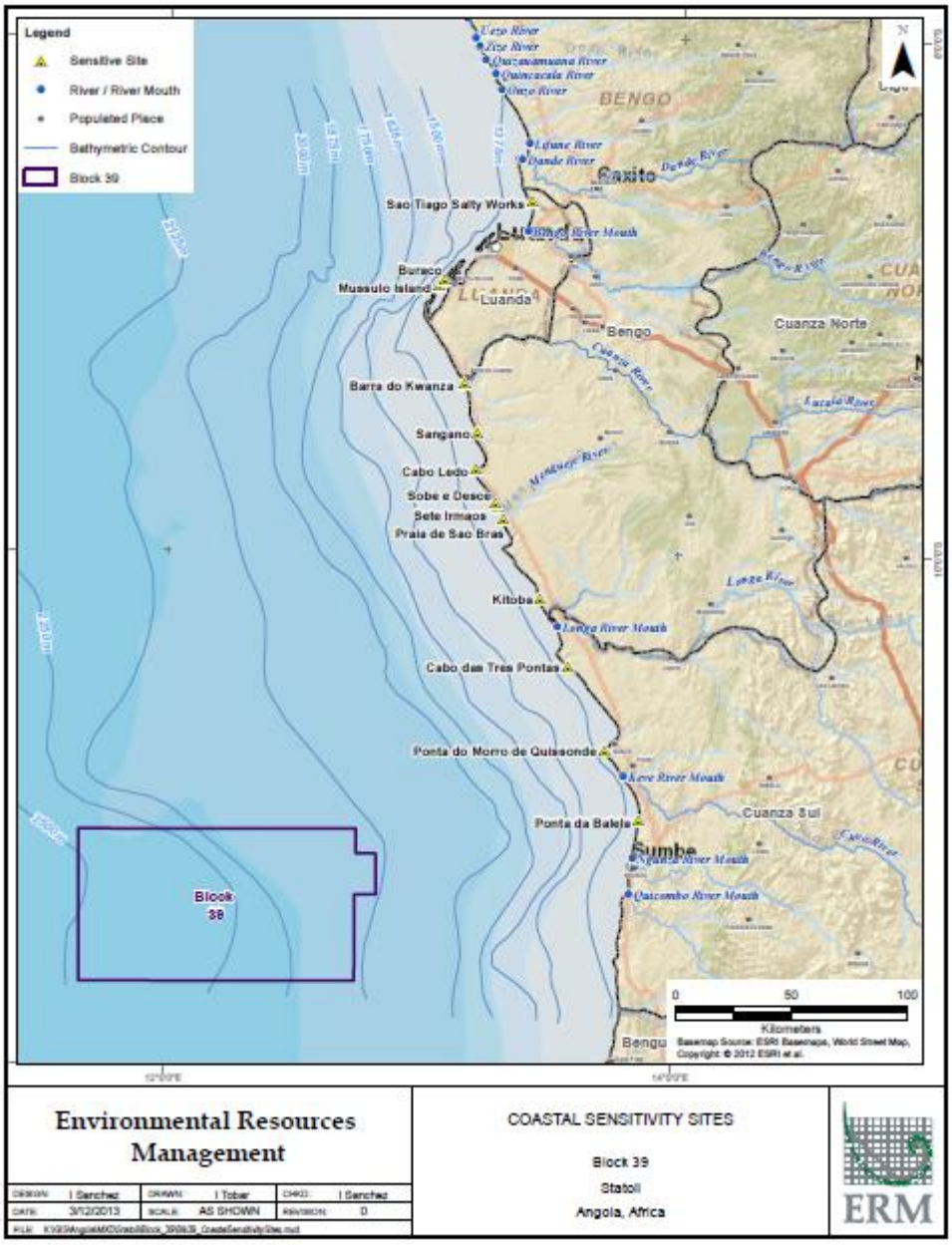


Figure 4.16. Potential Coastal Sensitivity Sites

Additionally, there are a few protected areas on the coast of Angola as well as along the coast of Gabon, Republic of Congo and the Democratic Republic of Congo. The ones listed below are located in the indirect area of the study area.

- ✓ Ilhéu dos Pássaros Integral Nature Reserve (1973)

Located 8 km west of Luanda, Angola, Ilhéu dos Pássaros Integral Nature Reserve was established in 1973 (WCMC, 2002). The nature reserve comprises a tidally inundated island of mudflats and mangroves and represents an important habitat for wading birds and mangroves (including *Rhizophora* and *Aricennia* species).

- ✓ Quiçama National Park (1957)

Quiçama National Park, established in 1957, is located on the coast in Luanda province, 70 km south of Luanda city. The 996,000 ha park has 125 km of coastline consisting of extensive high cliffs and isolated sandy beaches. Green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) turtles nest along the coast of Quiçama National Park. The national park is listed by Stuart *et al* (1990) as a critical site for biodiversity.

Existing and Proposed marine Protected Areas on the West African Coast that are near the Project Area (see Figure 4.17).

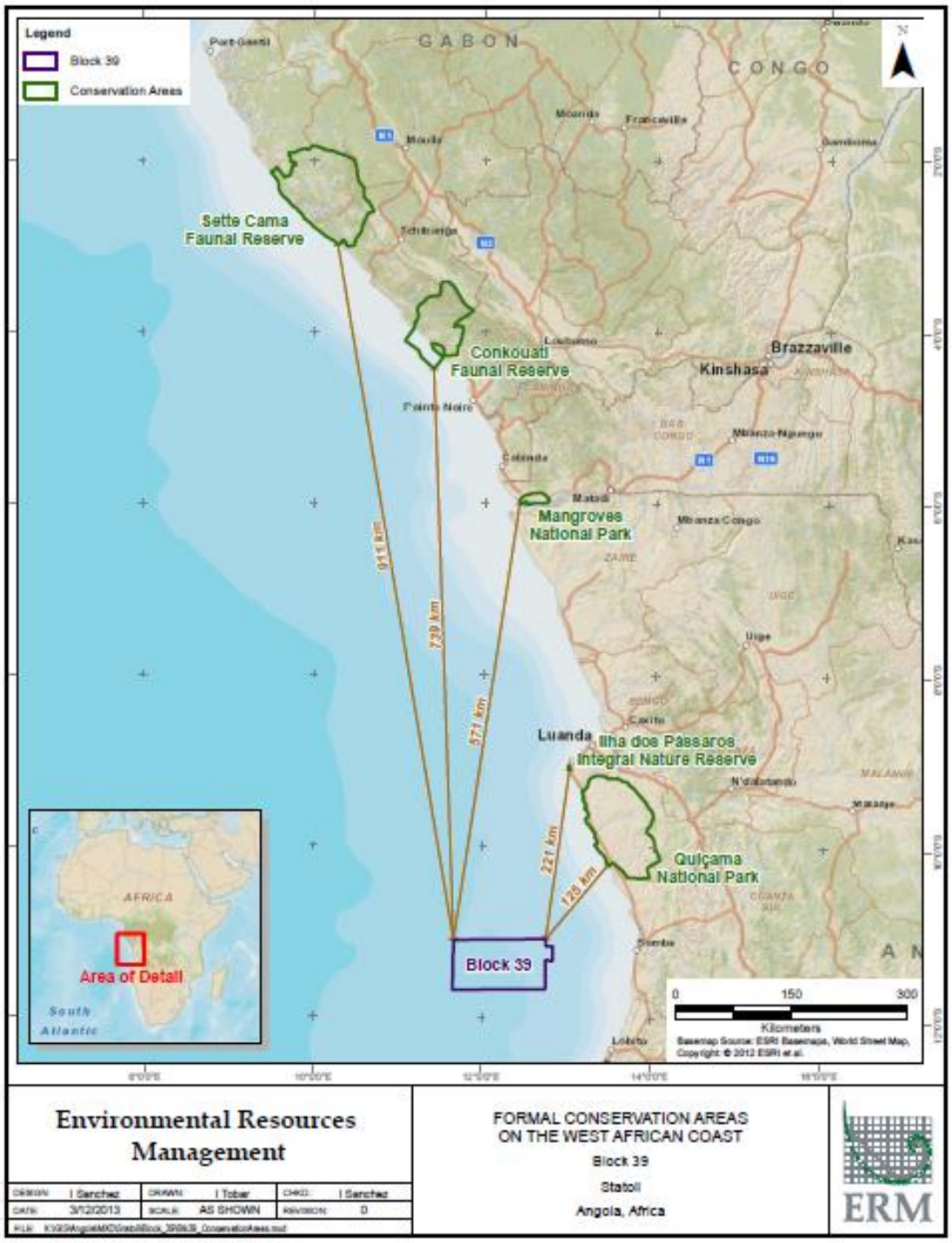


Figure 4.17. Protected areas along the coast of Angola until Gabon and its distances to Block 39.

Gabon

Gabon lies entirely within the Guineo Congolian regional center of endemism, and is the most biologically diverse region in the continent. Tidal mangrove forest occur in all estuaries, bays and lagoons along the 800 km coastline. The total area of tidal forest is probably in excess of 350,000 ha. Numerous shallow lakes, fringed by extensive swamps, occur on the coastal plain. The six protected areas along the coast are, by order of increasing area:

- ✓ Ongua Plain Faunal Reserve;
- ✓ Petit Loango Faunal Reserve;
- ✓ Iguela Hunting Reserve;
- ✓ Settle−Cama Hunting Reserve;
- ✓ Ngove−Ndogo Hunting Reserve; and
- ✓ Wongha−Wonghe Presidential Reserve and Ramsar Wetlands.

The Gabon Sea Turtle Partnership, which is funded by the Marine Turtle Conservation Fund, together with the Wildlife Conservation Society, have proposed to join an d expand the Mayamba and Conkouati-Douli National Park, creating what is the first International Marine Park in this region of the world, all in order to protect the Olive ridley sea turtle that is normally trapped in fishing nets.

The Republic of Congo

The republic of Congo has a coastline of 190 km. coastal lagoons are separated from the sea by thin land masses. Mangroves are not extensive, reaching a maximum width of around 10 m along the coastal estuaries, and forming a single row around coastal lagoons. The existing and proposed protected areas (within mangroves) along the coast are:

- ✓ Existing Conkouati Faunal Reserve which includes littoral habitat with mangroves and manatee;
- ✓ Proposed Koilou Estuary Marine Protected Area, near to Cabinda's northern border; and

- ✓ Proposed projects to protect their globally important beaches, swamps and coastal forests along the coast.

The Democratic Republic of Congo

The Democratic Republic of Congo has the Marine National Park in the Congo River Delta close to the border with Cabinda has substantial sub−littoral as well as coastal mangroves.

4.5.11. Deep Sea Sensitive Habitats

Research undertaken between 2001 and 2004 by the French Institute Ifremer (in French, *Institut Français de Recherche pour L'Exploitation de la Mer*) identified potentially sensitive marine habitats in the deep sea and coastal waters off Angola. This survey covered off the coasts of Gabon and Angola, along the sub-sea channel carved by the Congo River. The aim of the research program was to enhance knowledge and understanding of the benthic ecosystems found in the deep offshore zone (between 400 and 4,000 meters deep). Results showed that associations of organisms living around hydrothermal vents at the oceanic ridge axes and around cold-seeps on the continental margins have extreme ecological characteristics such as: Tolerance of high temperature range (up to 113^{o}c); use chemosynthesis whereby hydrogen sulphide spewed from the vents is converted into energy; able to survive in low ph aquatic environments. The habitats identified included:

- ✓ Cold water corals (*Lophelia*);
- ✓ Carbonate concretions;
- ✓ Giant pockmarks supporting mussel (*Bathymodiolus sp*.) Colonies; and
- ✓ Subsea vents supporting vesicomyid bivalves and vestimentiferan tubeworm.

4.6. Human and Socioeconomic Activities

In this section, detail will be given both to fishing activities and to oil & gas industry activities occurring in the area of influence of the Project, which is defined as the area of direct

influence of the project and subject to the direct impacts of the project (such as the points where cuttings mud and sand will be discharged) about 150 km parallel to the shoreline of Kwanza Sul.

Certain areas along the coast of Luanda, Bengo, Zaire and Benguela might be affected as well, in the event of an accidental oil or diesel spill. Onshore activities related to the Project will be briefly characterized, as well as the baseline socio-economic situation of the areas of the coast that could be affected in case of an oil spill. This is focused on the potential impacts on the fishing industry, although impacts could occur to salt pans, tourism and recreation.

For discussion purposes, we divide the baseline for human activities and socioeconomic issues relevant to the Project into:

- ✓ National and regional socioeconomic context;
- ✓ Onshore activities; and
- ✓ Offshore activities.

4.6.1. Socioeconomic Context

National Data

The Republic of Angola is a country on the western Atlantic coast of Africa, bordered by the Democratic Republic of Congo to the north and east, by Zambia to the east, by Namibia to the south and by the Atlantic Ocean to the west. The territory also includes the enclave of Cabinda, which borders the Republic of Congo to the north. Angola occupies 1,246,700 km^2 and has approximately 20 million inhabitants (National Institute of Statistics – INE, 2012). The currency is the Kwanza (Kz).

The country's capital city of Luanda is located on the Atlantic coast and is the main port and administrative center of Angola with a population of approximately 6.5 million inhabitants.

The country is divided into 18 provinces. The main urban centres, apart from the capital Luanda, are Huambo, Lobito, Benguela and Lubango. Angola has a coastline of 1,650 km, and its main ports are Luanda, Lobito and Namibe.

Although the civil war (1975-2002) severely affected the productivity and performance of the Angolan economy, economic performance has been improving recently as a result of greater stability.

Regional Data

This section provides a brief environmental and socioeconomic summary of the sites sampled in the coastal provinces of Luanda, based on the results of the oil spill modelling report (Figure 4.18).

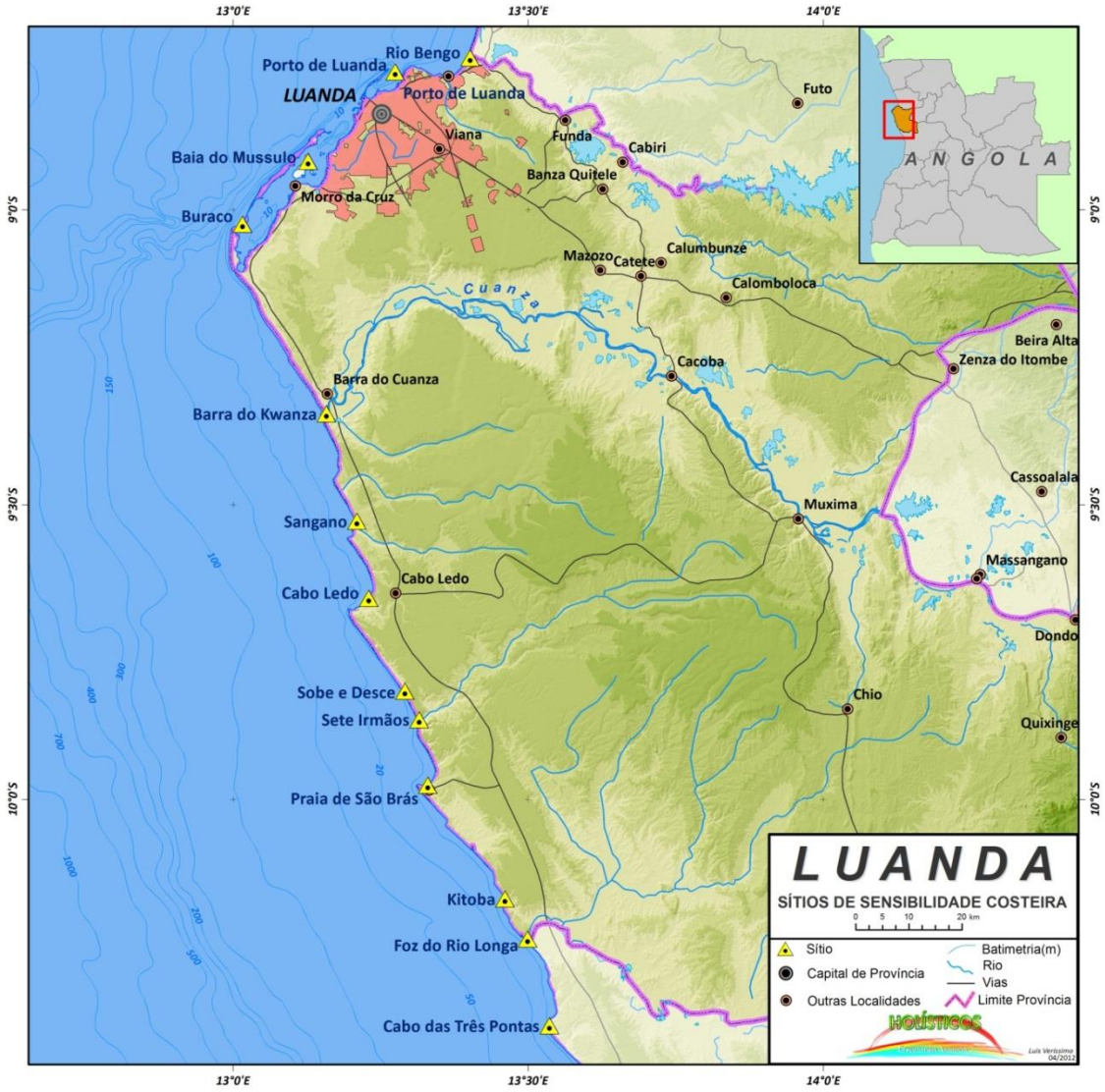


Figure 4.18. Sensitive sites along coastal provinces of Luanda

The province of Luanda is home to the national capital Luanda. Current estimates indicate a population of over 6.5 million inhabitants[51]. The province is home to one of the three most important ports in the country. There are approximately 6,622 artisanal fishermen in the province with approximately 1,737 vessels, accounting for 21,779 tons in 2011 (Artisanal Fisheries and Aquaculture Development Institute – IDPAA, 2012). Sand extraction for the construction sector is practiced south and north of Luanda, with significant impacts especially along the coast between the Kwanza River Mouth and the Mussulo Peninsula.

[51]Data from the Ministry of Territorial Administration – Republic of Angola, 2012 accessed from *http://www.mat.gv.ao*

The environmental and socioeconomic issues of the sites that are likely to be affected along the shoreline of Luanda are summarized on Table 4.13.

Table 4.13. Sites that are likely to be affected along the coast of Luanda.

Site	Luanda Province	
	Environmental Characterization	**Social Characterization**
Barra do Kwanza	▪ Physiographically, presents itself under a flatness in the vicinity of the river mouth, influenced by the sedimentary basin of the Kwanza; ▪ Iit covers an area of approximately 960,000 hectares; ▪ The predominant soils are alluvial river and sandy soils; ▪ the vegetation is dominated by mangroves with tree and shrub type; ▪ The estuarine system houses a huge diversity of fish and birds (feeding and spawning ground); ▪ One can also point out the presence of crocodiles, green turtles, olive ridleys and leatherbacks; manatees; cetaceans, such as the fin whale, the Atlantic humpback and the common dolphin.	▪ The inhabitants of Barra do Kwanza are mostly from the island of Luanda, who settled in that place in the early 50s; ▪ Currently the population is estimated at 213 inhabitants who live mainly from fishing and trade;. ▪ The houses of fishermen, totaling 49, are located about 150 meters from the beach and others along the road linking the diversion to the mouth of the Kwanza river; ▪ There are no land mines in the area.
Sobe e Desce	▪ The Sobe e Desce beach ends in a pronounced cliff that is from gently rolling slopes that characterize the landscape; ▪ Brown calcareous soil type; ▪ The predominant vegetation is savannah with the presence of *Euphorbia conspicua*; grassy layer composed of several species with a predominance of *Eragrotis superb*; ▪ Potential fishing grounds, where the seasonal presence of fish and shellfish should be considered; ▪ Most of the birdlife are casual visitors; ▪ Species like the olive Ridley and leatherback turtle are also found in the area. ▪ Whales can often be observed, with emphasis on different species of	▪ Currently the population is estimated in 360 inhabitants, of which about 93 are artisanal fishermen; ▪ The main activity of the region is artisanal fisheries: pungo, black and white sea bass, grouper, hake, and lobster being the main captured species; ▪ May through December are the biggest for fish catch, while January to April is considered the lowest catch period. ▪ There are no land mines in the region or mined fields.

Site	Luanda Province	
	Environmental Characterization	**Social Characterization**
	dolphins that come remarkably close to the coast.	
Cabo Ledo	▪ The beach of Cabo Ledo is set within a bay that is extended from the southern part of the region; ▪ The soils are brown calcareous; ▪ Vegetation is predominated by savannah with the presence of *Euphorbia conspicuous* and *Sterculia sp*. along the beach exotic vegetation influenced by anthropogenic changes can be found; ▪ Potential fishing grounds, where the seasonal presence of fish and seafood such as pungo, sole and lobster is common; ▪ In terms of birdlife, most are casual visitors who use the beach as feeding and resting grounds, the common tern is very common; ▪ Cetacean can often be observed, with emphasis on different species of dolphins that come remarkably close to the coast.	▪ Currently, the population in the area is estimated at 681 inhabitants; ▪ The main activity of the region is essentially artisanal fisheries; ▪ The monthly biomass capture in this area is estimated at around 122,609 kg/month and the main species are: pungo, tuna, sea bass, snappers mackerel, sardines and lobster; ▪ May to November are the months where the biggest catch are recorded, while December to April are the lowest; ▪ The Lighthouse (old) and the quarry are as important and historical points of this area; ▪ Cabo Ledo was defined by the Angolan Executive as a reserved area to promote tourism.
Sete Irmãos	▪ The beach of Sete Irmãos has an extensive coastline that stretches 22 kilometres to the Cape of Cabo Ledo; ▪ The coastal strip is quite wide, and is almost parallel to the shoreline; ▪ The predominant vegetation on the beach is usually rhizomatous, creeping or prostrate; ▪ The beach has a fishing potential, where the seasonal presence of fish and seafood such as pungos and lobsters should be considered; ▪ Most of the birds are casual visitors who use the beach as feeding and resting ground such as the gulls, common terns and some waders are very common; ▪ One can also highlight the presence of the olive Ridley and leatherback turtle; common cetaceans include the common dolphins.	▪ There is a small village consisting of fishermen and their immediate families. The beach is often visited by tourists and fishing enthusiasts.

Site	Luanda Province	
	Environmental Characterization	**Social Characterization**
Praia de São Bras	▪ The São Brás Cape is evidenced by a steep cliff pending into the ocean in the far North and South; ▪ The soil is mostly brown calcareous type; ▪ The predominant vegetation in the area is savannah with the presence of *Euphorbia conspicua;* grassy layer composed of several species; ▪ Potential fishing grounds for lobsters, shrimps and crabs; ▪ Most birds (especially the common tern) are casual visitors anduse the beaches for feeding and resting; ▪ Presence of turtles leatherbacks, whales, the Atlantic humback and the common dolphin.	▪ Currently the population is estimated at 773 inhabitants, about 203 are residents and 33 occasional fishers; ▪ Fish caught in the area: cod, southern meagre, tuna, cassava croaker, white and black skate, barnard dentex (in the cold months), lobster, white grouper, malesso, among others; ▪ The Bay of São Brás features beaches are frequented by tourists.
Kitoba	▪ The Kitoba beach includes a short stretch of sand bordered by a cliff drop into the interior; ▪ Brown calcareous soil type; ▪ The predominant vegetation in the savannah area is the *Euph, Acacia welwitchi* and *Aloe zebrine*; ▪ The beach has an important fishing potential, featuring seasonal presence of fish and seafood such as the pungo, croakers and lobster; ▪ Casual visiting birds, that use the beaches for feeding and resting; ▪ A large presence of common stern; ▪ Presence of olive turtles and leatherbacks.	▪ There are in total 301 people; ▪ The main activity of the region is essentially artisanal fisheries; ▪ The fish catch of the region is estimated to be at about 36,000 kg/month and the main species are: white croaker, halibut, skate, grouper, and mackerel; ▪ Biggest catch occur in the months of June to December, while the period of January to May is considered the lowest yield for fishing;

Province of Kwanza Sul

The capital of the province of Kwanza Sul is the city of Sumbe.It has an area estimated at about 58,698 km² which constitutes 4.7% of the national territory. According to the report of the Institute for Development of Artisanal Fisheries and Aquaculture (IDPAA) December 2011, there are four (4) infrastructures of artisanal fisheries in this province, two located in the fishing community of Quicombo, one in Carimba and another one in the area of the beach of Frimar.The province is potentially rich in biological resources and hence the existence of a strong commercial fishing. The community of Quicombo and Karimba are the

main fish landing centers in the province and as a result of this, fish and seafood markets are quite strong.

The environmental and socioeconomic issues of the sites that are likely to be affected along the shoreline of Kwanza Sul are summarized on the Table 4.14 and Figure 4.19.

Figure 4.19. Sensitive sites along coastal province of Kwanza Sul.

Table 4.14. Sites that are likely to be affected along the coast of Kwanza Sul.

Site	Kwanza Sul Province	
	Environmental Characterization	**Social Characterization**
Cabo das Três Pontas	▪ The relief between the road and the beach is gently undulating with steep slopes with numerous lines of drainage runoff to the ocean; ▪ The predominat soil types comprise brown and red calcareous and sandy types; ▪ The predominant vegetation is savannah, with the presence of *Acacia welwitchi;* ▪ In terms of fisheries resources, one should note the presence of lobster and white grouper; ▪ Potential area for sea turtles; some coastal and marine birds e.g. waders, terns and seagulls; marine mammals such as the fin whale, the Atlantic humpack and the common dolphin.	▪ One should highlight that there are no communities near the coast in the *Cabo das Três Pontas*, that is because of the farms that surround it. Those living in adjacent areas (Ngola beach) are in total 127 people; ▪ Fishing activities are carried out very near the coast and there is a total of 62 fishermen. Houses are located roughly 100 meters from thecoast, while the mines are more than 10 km; ▪ There are no place of historical or cultural importance; no tourist activities due to difficult access to the beaches, although the beaches are conducive to such.
Porto Amboim Bay	▪ Physiographically the bay is in a flat valley on the east, north and south slope; ▪ Brown limestone soil; ▪ Predominant vegetation is savannah with the predominance of the grass *Setaria welwitschii,*and some matebeiras *Hyphaene gossweileri;* ▪ In terms of fishery resources there is a relative variety in the area, especially the cassava croaker, the senegale tongue sole, the cod, the white grouper, sardines, lobsters and more; ▪ In terms of avifauna, we highlight the presence of some waders, terns, seagulls and cormorants; ▪ Marine mammals presence is noteworthy since cetaceans are present throughout the Angolan coast.	▪ In the area of the bay of Porto Amboim were identified three communities: Gilco, União and Torre do Tombo having a total population estimated at 634 inhabitants; ▪ There are no land mines and no grazing area near the coast; ▪ Artisanal fisheries is the main activity; ▪ Beyond the palace the jetties of the fishing companies of Peskuanza and of Cassongue represent places of cultural importance in the city of Porto Amboim; ▪ Tourism has great influence in this city; ▪ There is the possibility of building a fishing port in the coming years.
Keve River Mouth	▪ The mouth of the Keve river is inserted into a floodplain, with large areas of riverine flooding, ▪ The predominant soils are brown calcareous soils that generally have a yellowish colour and fine textures; ▪ The vegetation along the river mouth consists of grassy savannahs	▪ Near the river mouth are two neighbourhoods: the neighbourhood of the Keve river and the neighbourhood of Chicucula These have 187 and 169 people respectively; ▪ The houses are located roughly 100 meters from the coast;

Site	Kwanza Sul Province	
	Environmental Characterization	**Social Characterization**
	with the presence of *Euphorbia conspicua,* and mangroves; ▪ The most important fishery resources in this area are oysters, lobster, white groupers, swords, croakers, tilapia, among others; ▪ In terms of bird species one observes the heron, terns, herons, raptors among others; ▪ Marine mammals which are found along the entire coast: the fin whale, the Atlantic humbacked dolphin and the common dolphin.	▪ Livestock and crop farming is the second activity after fishing, The beaches near the river mouth are frequented by many tourists especially at weekends and holidays; ▪ It is here where people hold their traditional festivals, called "Kitutas."There are no land mines in the study area or mined fields.
Ponta da Balela	▪ Between the National Road 100 and Ponta da Balela the relief is very expressive and wavy shape, with the presence of numerous valleys. ▪ Brown calcareous type of soils, usually with a yellowish to olive colour and fine textures; ▪ vegetation predominated by savannah with the presence of *Acaciawelwitchi* and *Aloezenbrina,* disseminated in a grassy stratum composed of several species; ▪ occasional visiting birds using the beach as a feeding point or to rest: swallows, seagulls, herons, crows and others; ▪ Marine mammals which are present along the entire coast of Angola: fin whale, the Atlantic humback and the common dolphin.	▪ There are two communities, one in Ponta da Balela and another further south; ▪ The community of Ponta da Balela is dedicated to just fishing; they are in total 60 people of which 20 are fishermen; ▪ The area with its natural beauty is conducive to the practice of tourism, but unfortunately it is not frequented by tourists due to poor access conditions; ▪ There are no places with historical or cultural significance.There are no land mines in the study area or mined fields.
Ngunza River Mouth	▪ The mouth of the Ngunza River has two coastlines that make up the sandy beach from shore, influencing water movement in the extreme north and south of the mouth; ▪ The predominant soils are lithosols; vegetation is predominated by meadows subject to flooding, with the abundant occorrence of *Cyperus papyrus;* ▪ High incidence of anthropogenic cultures, the most obvious being the palm*(Elaeis guineensis),* banana *(Musa* sp.) and sugarcane *(Saccharum* sp.); ▪ The presence of birds associated	▪ Most of the current population is native in the neighbourhood and is estimated at 3,803 people; ▪ Houses are situated 200 meters from shore and less than 100 meters from the river; ▪ Soils are not suitable for the practice of agriculture, which makes the population mostly resorted to fishing and salt works; ▪ Currently, no salt works due to its advanced state of degradation and the neighbourhood has a 40 fishermen; ▪ There are no land mines in the study area or mined fields.

Site	Kwanza Sul Province	
	Environmental Characterization	Social Characterization
	with wet environments: gray heron, little egret, black-headed heron, among others; ▪ Marine mammals that are nearly found along the entire coast of Angola: the fin whale, the Atlantic humpback and the common dolphin.	

Province of Benguela

The province of Benguela is situated in the central west part of Angola covering an area of 39,826.83 km², and it has a population of approximately 2 million inhabitants. Benguela has a very similar age distribution, with about 46 percent of the population under the age of 15 and a very low percentage over 65 years old. Benguela's economy is dominated by the primary sector of fishing and subsistence agriculture. Currently, Benguela region has about 23,395 fishermen and 25 fishing organized cooperatives, fully operational. The fishing fleet of the province consists of 2334 vessels, also including 196 that were provided by the Governmental Program of Recovery of the Artisanal and Maritime Fisheries (*Programa de Relançamento da Pesca Artesanal e Marítima*) (IDPAA, 2012).

There are not ecological sensitivity sites for the Benguela province as the Joint Industry Project implemented by ACEPA only covered in 2012 the coast of Angola from Cabinda do Kwanza Sul. A second phase of this project is ongoing and will map out the ecological sensitivity areas in the provinces of Benguela and Namibe.

4.6.2. Onshore Activities

The Block 39 Exploratory Drilling Project is yet to enter the detailed design phase and, as such, no contracts have been awarded for drilling and support activities. However, it is anticipated that the Project will require onshore support, which will be contracted to third parties.

There are existing marine bases, onshore construction and fabrication yard facilities in Angola. The project will make use of the existing fabrication yards and port facilities; the choice of yards and port facilities will be dependent upon location, and the availability and capacity of Angola-based contractors who are suitably qualified to provide the services required. The onshore activity will take place in the Sonils Base in Luanda.

4.6.3. Offshore Activities

In this section information is provided on the existing offshore activities in the area of influence of the Project that may have some interaction with the proposed Block 39 drilling program. These activities include fishing, oil and gas activities, commercial shipping industries and navigation.

Fishing

The Angolan coastline has approximately 1,650 km in length, with a divergent system resulting from interaction between the coastal wind direction (predominant southerly/south-westerly) and Angola and Benguela currents, creating a strong upwelling that supports high primary productivity. The Angolan continental shelf is very narrow with an average width of about 30 km and a total area of approximately 5,100 km^2. The Exclusive Economic Zone (EEZ) extends beyond the shelf and has an area of approximately 330,000 km^2.

The optimal offshore conditions result in Angola's coastal region being rich in fish, mollusks and crustaceans. Less than 15 years ago, the main commercial marine fish populations available in Angola showed an exploitable potential of 360,000 tons, as follows:

- ✓ 285,000 tons of pelagic species in the coastal waters;
- ✓ 20,000 tons of tuna; and
- ✓ 55,000 tons of demersal species (including around 7,000 tons of shrimp and deep-water crabs).

Historically, Angolan fisheries suffered from overfishing in the 1960s, 1970s and 1980s. In the 1980s, some fish stocks were severely depleted and reduced to an unsustainable level. However, fish stocks have recovered in the last 20 years and are thought to be returning to more sustainable levels.

According to the Artisanal Fisheries and Aquaculture Development Institute - IDPAA (2012) there are 188 fishing communities along the Angolan coast that are engaged in fishing and which are organized into cooperatives, totaling approximately 130,000 people (both artisanal and commercial fishing). Most of these communities are located in northern Angola. In addition fish is the main source of available animal protein consumed in Angola with an average per capita consumption of around 19 kg per annum, increasing to 30 kg in the coastal areas.

The Ministry of Fisheries regulates fishing activity in the country, issues licenses to boats and enforces allocates fishing zones. Zones are primarily delineated within 12 nautical miles (nm) from the shore. Beyond this, internationally-registered commercial fishing fleets are allowed to fish under agreement with Angola. Within the 12 nm distance from shore, Angolan commercial and artisanal fleets can fish in the following officially designated zones:

- ✓ Artisanal fishing boats: up to 4 nm from the coast;
- ✓ Semi-industrial trawlers: 4 to 6 nm from the coast;
- ✓ Bottom and pelagic trawlers: 4 to 8 nm from the coast;
- ✓ Shrimp trawlers: 4 to 12 nm from the coast; and
- ✓ Crabbing: 4 to 5 nm from the coast.

The national fishing fleet land all their catches in Angola (at ports such as Luanda, Lobito, Namibe and Matadi), mainly for national consumption. The majority of demersal fishing activity occurs in the waters off northern Angola, compared to intensive pelagic fishing in the central part of the Angolan coast. Block 39 is far from the main fishing areas, and therefore

the buffer zone forbidding fishing activities within a 1 km radius of oil & gas infrastructure will not require fishers to relocate.

Angola's northern fishing zone extends from Luanda to the mouth of the Congo River. This area is characterized by a wider continental shelf and is influenced by the warm Angola current. There is higher resource diversity in the north and a greater abundance of demersal resources. Inter-annual variation is less and the abundance of small pelagic fish is generally lower (FAO, 2004).

Angola has created regional and intercontinental partnerships and relations that have positioned the country as a producer and exporter. The National Research Fisheries Institute (*Instituto Nacional de Investigação Pesqueira* – INIP) has promoted a number of international cooperation programs with several countries such as Norway (NORAD and the Nansen Project), Spain, Portugal, Mozambique, São Tomé e Príncipe and Cape Verde.

- ***Artisanal Fishing***

After independence, the pressure on near-shore fish resources increased steadily since there were very few alternative livelihood options. Artisanal fishers mainly target commercially valuable demersal species within 4 nm of the shore, and use boats which are up to 14 meters in length with little capacity for processing or freezing the catch.

Along the coast there are currently 188 organized artisanal fishing communities, of which 38 communities are organized into co-operatives and most of which are found in the north. Between 50,000 and 80,000 people are engaged in artisanal fishing and related activities. Fishing takes place with canoes, chatas (planked boats) which may or may not have an engine, and catrongas (whale boat types) which have an inboard engine Artisanal Fisheries and Aquaculture Development – IDPAA, 2012).

According to the Artisanal Fisheries Development Institute (*Instituto de Desenvolvimento da Pesca Artesanal e Aquicultura* – IDPAA, 2012), the total artisanal catch exceeded 100,000 tons per year in the last 10 years, representing about 30% of the total catch of the country. In 2011, the total catch was 102,039 tons and the province of Zaire was the largest contributor, accounting for 29.2% of the total.

Fishing is an important source of income and employment for coastal communities, especially the poorer sector of society, and although the artisanal sector only accounts for around 18% of landings, over 60% of fishermen are employed in this sector (SADC, 2002). It should be noted that in some areas (e.g. in the north of Angola), a significant proportion of the artisanal catch is for subsistence purposes.

Although continental fisheries in Angola have mainly been exploited as a subsistence activity, they have the potential for creating an additional 10,000 to 15,000 artisanal fisherman jobs, though that would require access to means of production and proper training (National Institute of Fisheries Research – INIP, 2012). In view of the sector's potential and the fact that domestic demand for fish has grown in recent years partly attributable to an increase in the population of around 4% a year, fishing is regarded as a state priority and could contribute to the desirable diversification of the national economy. The main goal of fishing policy in Angola is thus rational, long-term exploitation of maritime resources in its economic area. In addition to fishing activity, there are also opportunities in the salt industry and construction of support infrastructures for the sector in general. Artisanal fishing activities are scattered along the coast with the majority of registered artisanal fishermen landing their catches at some 105 controlled landing places, predominantly in the central provinces of Luanda, Benguela, Zaire, Bengo and Kwanza Sul. Benguela and Luanda provinces have the greatest concentration of artisanal fishing areas. Though the project's activities will not directly influence any of the artisanal fisheries, it is important to note that due to the location of Block 39, the areas that may be potentially sensitive to an oil spill are Luanda, Kwanza Sul and Benguela. The photographs below

illustrate artisanal fishing activities and fishing communities located along the study area on the Angolan coast.

Photo 4.6. Artisanal fishing activities and local communities along the coastal area

Information about artisanal fishing in these provinces for the year 2011 is summarized in Table 4.15; this is derived from the IDPAA report on Artisanal Fisheries (2012).

Table 4.15. Artisanal fishing in Luanda, Kwanza Sul and Benguela for 2008 – 2011[52].

Province	No. of Communities (2011)	No. of fishermen (2008-2011)	No. of vessels (2008-2011)	Total capture (tons) (2008-2011)	Future plans
Luanda	24	3,399 6,227 6,327 6,622	1,543 1,728 1,737 1,737	22,691 12,036 21,779 21,779	Fuel pumps for supply vessels, full recovery of infrastructure to support artisanal fisheries in Ilha do Cabo, construction of infrastructure in Sarico, Cacuaco and Ramiro
Kwanza Sul	24	2,037 1,659 1,663 2,986	696 973 973 972	20,224 3,958 5,735 6,443	Construction of infrastructure in Praia de Sousa, Praia Frimar and Carimba
Benguela	25	4,723 5,018 5,018 8,636	1,455 1,494 1,494 2,334	21,637 23,954 22,485 1,508	The rehabilitation of the fishing center in Damba Maria.

- ***Commercial Fishing***

Commercial fishing takes place across portions of the Project area and involves medium to large-scale fishing undertaken with more sophisticated boats and equipment. For 2011, The National institute for Fisheries Research - INIP indicated there were 350 vessels, including industrial and larger semi-industrial vessels, fishing in this area or that have fished in this area in the last five years. This data however did not enable a precise understanding of fishing behavior or local pressures on fish stocks as the vessels are licensed to fish along the entire Angolan coast.

The majority of commercial fishing off the Angolan coast is performed over the continental shelf in waters of up to 200 m in depth, particularly for small pelagic species such as sardine and horse mackerel.

Multiple fishing techniques are used by commercial fishermen. These techniques can be categorized as either active or passive. Among active fishing methods, the main ones are

[52]Source: IDPAA, 2012.

trawling (bottom and pelagic) and purse seining. Gillnetting and hook and line fishing are the most important among passive fishing methods. Figure 4.20 illustrates the typical locations, defined as the areas of highest fishing intensity, where Angola´s most important commercial fishing methods take place.

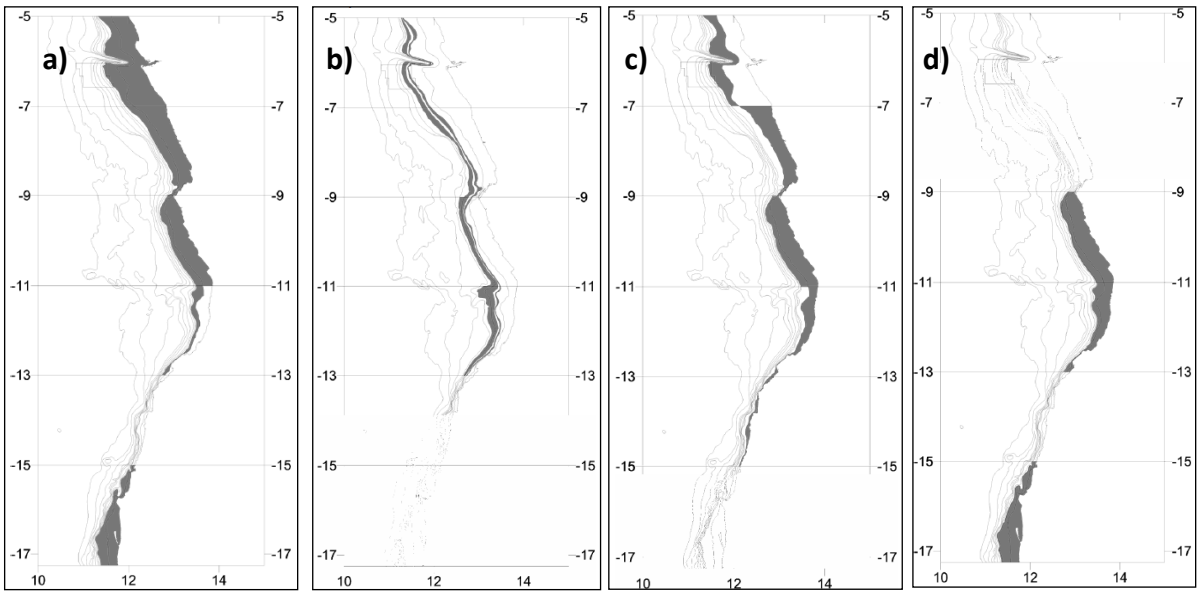


Figure 4.20.Typical fishing locations for (a) bottom trawlers (b) shrimp trawlers; (c) purse seining; and (d) longliners[53].

Trawling boats range in size from 10 to 20 meter-long vessels that net the inshore waters to large ocean going vessels up to 95 meters in length. Pelagic trawlers are the largest vessels and have the highest horsepower engines. Bottom fish trawlers are also quite large, with shrimp trawlers being somewhat smaller and less powerful. In general, smaller vessels tend to be Angolan flag vessels. Those requiring skilled labor like pelagic longliners, or more technologically sophisticated equipment and methods, are foreign flag vessels.

Bottom trawling is performed by dragging a weighted net along the bottom of the ocean to catch shrimp and benthic dwelling fish species. In Angola bottom trawling typically occurs at depths between 30 and 200 m, excluding the area between 13° S and 15° S, where the fishing extends from depths of 30 to 900m. Forty bottom trawlers are licensed to operate in Angola,

[53]Source: National Institute of Fisheries Research - INIP, 2008.

among which 8 are vessels intended for Benguela hake fishing The National institute of Fisheries Research – INIP, 2012). Purse seining is a widely used method in Angola for fishing surface-aggregating, school-forming fish such as small pelagic fish, especially, sardine, horse mackerel, mackerel and tuna. Purse seining consists of encircling a school of fish with a net, and closing the net around and below the school so that the fish are entrapped. There are 130 licensed purse seiners, which have their main harbors in Luanda, Baía Farta (Benguela) and Namibe.

The majority of fishing vessels operate year-round, with the exception of the months of January and February (Table 4.16), which are legally designated as non-fishing months for shrimp trawlers. Each category of vessel exhibits a generally stable pattern of operation, with the exception of the widely fluctuating effort of hand liners, which vary a lot based on time of the year, type of fish and weather conditions.

Table 4.16. Closure season for commercial species fishing[54].

Type of vessel	Non-fishing months	Species
Industrial	January and February	Deep shrimps (*Parapenaeus longirostris* e *Aristeusvaridens*)
Semi-industrial	January and February	Shallow water prawns
Industrial (fishing accessory)	October and November	Crab
Semi-industrial	January, February and March	Lobster
Industrial	July, August and September	Demersal fish
Industrial e Semi-industrial	April, May, June, July, August and September	Cunene horse mackerel
Industrial e Semi-industrial	Unrestricted fishing	Sardine and Cape horse mackerel

Most fishery management in Angola has relied on output control and only in recent years has some form of input control been introduced to manage the stocks. Output controls are limitations on the amount of fish permitted, usually imposed as some form of quota on total catch for the fishery (e.g. total allowable catch - TAC). Input controls are designed to limit either the number of people fishing or the efficiency of fishing, and are the type of measure adopted when a fishery is first managed. It includes restrictions on gear, vessels, area fished,

[54] Source: National Institute of Fisheries Research - INIP, 2012.

time fished, or numbers of people fishing. Input controls are considered to be an indirect means of limiting the exploitation of fish stocks because they do not directly control the amount of catch.

Table 4.17 summarizes the Total Allowable Catch (TAC) owed for main fishing resources, from 2007 to 2011.

Table 4.17.Total Allowable Catch (tons) for primary Angolan fishing resources[55].

Species	2007	2008	2009	2010	2011
Deep water crab	1,200	1,200	1,200	1,200	1,200
Cephalopods	1,400	1,400	1,400	1,400	1,400
Shallow water shrimp	32	32	52	52	52
DEMERSAL SPECIES					
Seabreams	32,187	16,438	16,438	16,438	11,321
Croakers	22,694	10,625	5,435	5,435	15,458
Grunts	8,483	8,483	8,876	8,876	21,312
Big eye grunt	14,046	21,170	10,803	10,803	10,803
Hakes	5,288	4,462	1,841	2,436	2,436
Hair tail	-	-	12,741	12,741	12,741
Flat fish	-	-	1,417	1,417	1,417
PELAGIC SPECIES					
Horse mackerel	33,000	33,000	15,000	0	15,000*
Sardine Sardinella	205,000	500,000	205,000	205,000	150,000

*Managed by input control.

Current deep-sea fishing activities in Angola are believed to be confined to logline tuna fishing, trawling for shrimp (*Parapenaeus longirostris* and *Aristeua varidens*) and potting for deep-water red crab (*Chaceon maritae*). The maximum Angolan water depth fished for these species is understood to be approximately 800 m. There are no records of deep water fisheries, at present, within the Block 39 area, as the water depth exceeds 1,800 m. Sampling demersal fish at such depths has been one of the challenges faced by the National Institute of Fisheries Research –INIP, for this reason the data is not available.

[55] Source: National Institute of Fisheries Research - INIP, 2012.

Oil and Gas Activities

Angola is the second largest producer of oil in sub-Saharan Africa after Nigeria and the lifetime of the country's oil reserves, previously estimated at 20 years (approximately 5.4 billion barrels), was increased to 50 years with the discovery of the pre-salt layer (approximately 13.5 billion barrels).

Historically, Angolan oil production has revolved around shallow water blocks (500 m depth or less). However, more and more concessions have been granted since 1999 for new deepwater blocks (500 – 1,500 m) and ultra-deepwater blocks (1,500 – 2,500 m). In 2011, Sonangol (*Sociedade Nacional de Combustíveis de Angola – Empresa Pública*) announced the first pre-salt discovery in Block 23 at a depth of 5,334 m.

Data from the Ministry of Petroleum indicates that the country's production volume for the first 10 months of 2011 was 1.6 million bl /d, but bounced to 1.7million bl/d in November 2011 after the restart of some fields[56]. In May 2012, Angola´s oil production was 1.73 million bl/d making it second in Africa after Nigeria, with 2.12million bl/d (OPEC, 2012)[57].

The Luanda Refinery has a crude oil processing capacity of 60,000 barrels per day, although in 2011 it refined approximately 41,600 barrels per day[58]. The refinery produces almost all of Angola's domestic requirements of gasoline, kerosene and jet fuel, as well as a small amount of product for export (America's Energy Information Administration).

Angola is developing plans for a new 200,000 barrels per day refinery in Lobito, which is under construction. The majority of products refined at the new facility (80%) are to be exported regionally. Angola has estimated natural gas reserves of 1.6 trillion cubic feet (Tcf).

[56] Revista Rumo - Business Intelligence. Ano 1, No. 5. Maio de 2012. Luanda, Angola.
[57] OPEC Monthly Oil Market Report, June 2012.
[58] *http://www.portalangop.co.ao/motix/pt_pt/noticias/economia/2012/1/8/Refinaria-Luanda-processa-mil-600-barris-petroleo-dia,34a59621-8a19-45de-801e-802bb78e194c.html*.

New discoveries could push Angola's proven gas reserves to 9.5 Tcf, and possibly as high as 25Tcf. These gas reserves are exported via the Angola LNG project in Soyo.

The main oil and gas activities support port is localized in Luanda (Port of Luanda). The port capacity is fully exploited with an estimated accumulation of 18,000 containers. The main exports from this port include petroleum, diamonds, iron ore, and fish products. Among its manufactured goods are refined petroleum, motor vehicles, textiles, and processed food. Major imports include iron, steel, machinery, flour, coal and most building materials.

There are existing marine bases, onshore construction and fabrication yard facilities in Angola mainly used for oil and gas projects. The major Angolan fabrication yards are:

- ✓ **Petromar yard in Soyo**: Owned and fully operated by Kwanda, it extends over 8 ha with a quay of about 570 m long. At least 72% of activity is associated with structure and piping fabrication, such as helideck, laydown areas or riser protector;
- ✓ **Sonamet yard in Lobito**: It extends over 80 ha, including a 25 ha extension quay that is 200 m long. The major fabrication lines are dedicated to suction anchors, piles and riser towers;
- ✓ **Angoflex yard in Lobito**: Situated inside Sonamet yard in Lobito, it is mainly used in manufacturing electro-hydraulic stainless steel tube umbilical and fitting terminations;
- ✓ **Sonils Base in Luanda**: The major fabrication lines are dedicated to manifold suction anchors, bottom structures, jumpers, closed caisson foundation, X-mas tree parts and permanent bases; and
- ✓ **Paenal Yardin Porto Amboim**: The yard is dedicated to construction on CALM buoys, suction piles and MAG anchors.

Commercial Shipping and Navigation

The main Angolan ports are in Luanda (Province of Luanda), Lobito (Province of Benguela), Namibe (Province of Namibe) and Soyo (Province of Zaire). In addition to these larger

commercial ports Angola has a series of smaller ports which mainly serve the fishing sector. The ports have the legal form of state-owned undertakings with independent management, although they abide by the guidelines of their supervising ministry.

Angola's ports are very important to its economy, as 95% of Angolan imports arrive by sea. The port sector is therefore an essential instrument of foreign trade and the state is committed to rebuilding infrastructure and refurbishing the ports in the north and south of the country as required to handle the increase in maritime traffic. Port management is divided into four areas:

- ✓ General cargo services;
- ✓ Multi-services (including container management);
- ✓ Container transport; and
- ✓ Logistical support for oil companies.

The main ports are shown in Figure 4.21. A descriptive paragraph is provided below:

Port of Luanda

This is the country's most important port, situated in the sheltered bay of Luanda, which provides the benefit of calm waters and mild winds. As Angola's main port, more than 70% of the country's imports and exports pass through it (not including oil and crude). A new 290 m dock was handed over to SOGESTER company for exploration and high-investment projects have been undertaken via concession agreements with private-sector companies, all to a value of over USD 130 million.

Port of Lobito

The port of Lobito has an area of 6 km² and handles around 600,000 tonnes a year, mostly unloading of goods such as grain for milling and raw materials for the neighboring industrial area of Catumbela, as well as flour, sugar, rice, construction materials and equipment for the

cities of Lobito and Benguela. In recent years, considerable investment has been made in re-equipping and rebuilding the support systems, through expansion projects to build oil and cement terminals. This port has warranted special attention in recent years after a decision to build Angola's second refinery there. Commencement is expected in 2015, with an initial production of 115,000 barrels per day (total production is approximately 200,000 barrels per day).

Port of Namibe

The port of Namibe is Angola's third port in terms of traffic volume. In order to correspond with the requirements of the Angolan southern region (e.g. adjacent rich fisheries and its proximity to the province of Huíla, which has significant agricultural potential), work is currently under way to rehabilitate and modernize the infrastructure of the Port of Namibe (pier, deck, water system, electrical network, etc.). The first phase of the project was completed in 2010 and after the end of the second stage (no delivery date is set), a 600-meter port expansion will be completed.

Port of Cabinda

The port of Cabinda is located in the Cabinda enclave. The port area extends from the mouth of the Massabi river to the south of Pointe Noire. Angola is committed to substantial renovation of this port, valued at more than USD 55 million, to attract trade from landlocked countries in the central region of Africa. The expansion of its infrastructure is mainly a two-phase redevelopment, which will increase the actual mooring capacity up to eight vessels. The goal of this development project is to provide the Port of Cabinda with the means to handle substantial cargos and accommodate large vessels.

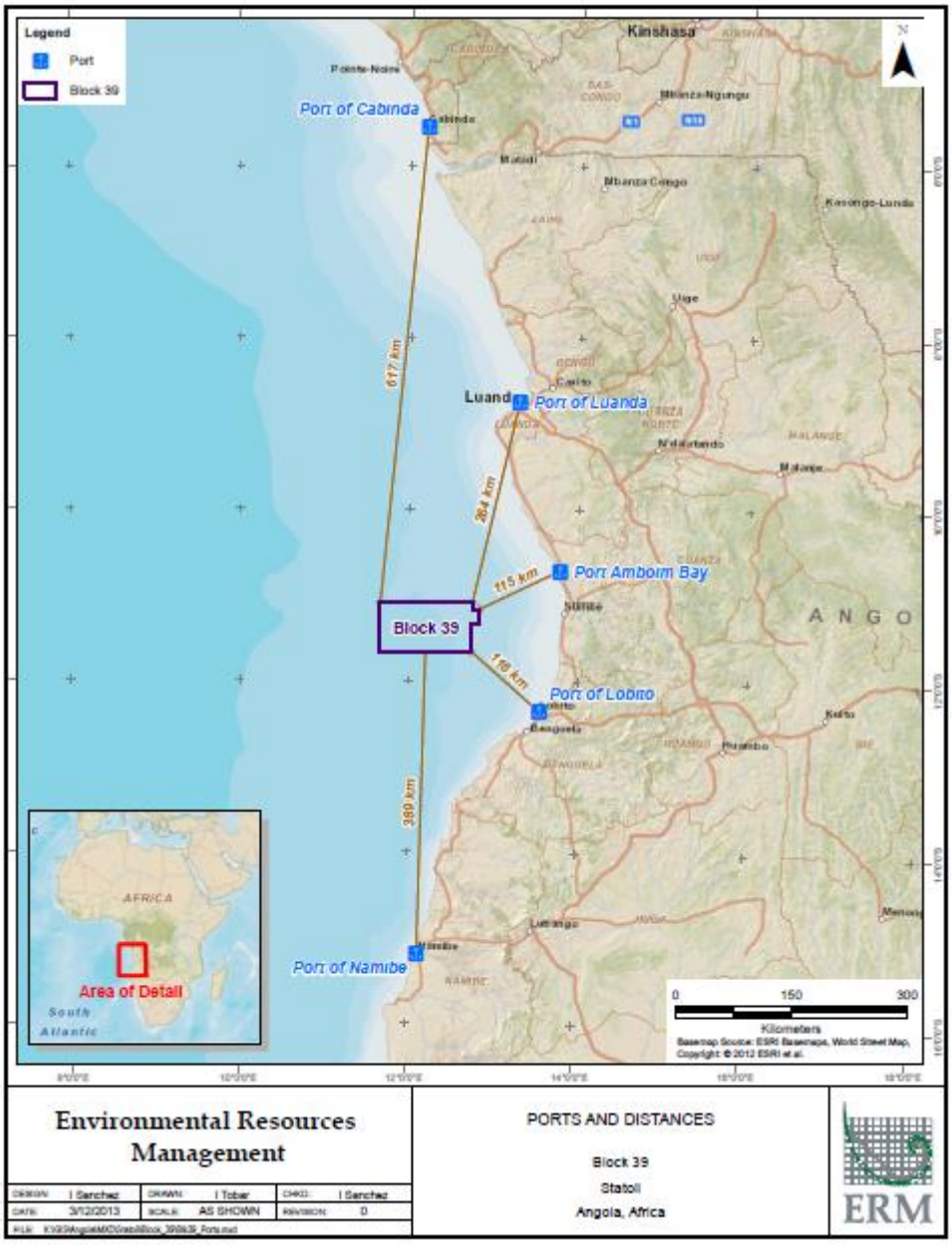


Figure 4.21. Main Angola Ports and its distance to Block 39.

CHAPTER 5

ASSESSMENT OF POTENTIAL IMPACTS

5. Assessment of Potential Impacts

5.1. Definitions and Methodology

This section assesses potential environmental and social impacts from the planned exploration drilling activities in Block 39. The assessment delves into how the Project could affect the physical, biological and socioeconomic environment within the study area and the wider area of influence. This includes impacts to air, water and sediment quality, marine ecology and socioeconomic receptors (*e.g.* coastal communities).

The section also provides details on the mitigation measures that Statoil has agreed to implement to avoid, reduce and remedy or compensate for potential negative impacts. The significance of the impacts that remain following application of the mitigation measures (*i.e.* the residual impact) is then assessed. Mitigation measures include both 'designed in' (or inherent) mitigation measures as well as additional mitigation and control measures to be implemented to reduce the significance of particular impacts to the extent practicable.

The assessment considers impacts that may result from planned activities (*e.g.* drilling operations) and unplanned events (*e.g.* an oil spill or vessel collision). A series of 'impact designations' or ratings have been adopted to assess the significance of each impact[59].

To identify the environmental resources and receptors most likely to be impacted by the Project ("receptors"), the impact assessment (IA) team completed a scoping exercise, undertaken as an Environmental Issues Identification (ENVID) workshop. Table 5.1 and Table 5.2 present the outcome of the environmental and socioeconomic scoping exercises, respectively.

[59] It should be noted that positive impacts are noted but not quantified.

Table 5.1. Scoping Matrix for Environmental Impacts

Source of Impacts	Environmental Receptors							
	Water Quality	Air Quality	Sediment Quality and Benthic Communities	Fish	Seabirds	Marine Mammals	Turtles	Sensitive Coastal Areas
Operational Discharges								
Black water, grey water and food waste	√			√				
Deck drainage and bilge water	√			√				
Ballast water	√			√				
Drill cuttings and drilling muds	√		√					
Emissions to Atmosphere								
Pollutant emissions		√						
Greenhouse gas emissions		√						
Physical Presence								
Physical presence (including collision risk)				√	√	√	√	
Artificial lighting					√			
Helicopter flights					√	√		
Underwater noise				√		√	√	
Physical footprint on the seabed			√					
Unplanned Events								
Accidental fuel spill	√	√		√	√	√	√	
Accidental chemical spill	√			√	√	√	√	
Oil spill e.g., subsea well blowout	√		√	√	√	√	√	√
Loss of materials or equipment								

Table 5.2. Scoping Matrix for Socioeconomic Impact

Source of Impacts	Social Receptors			
	Economy and Livelihoods	Fisheries	Infrastructure and Services	Community Health & Safety
Operational Discharge				
Black water, grey water and food waste				
Deck drainage and bilge water				
Ballast water				
Drill cuttings and drilling muds				
Emissions to Atmosphere				
Pollutant emissions				√
Greenhouse gas emissions				√
Physical Presence				
Physical presence (including collision risk)		√	√	√
Artificial lighting				
Helicopter flights				
Underwater noise		√		
Physical footprint on the seabed				
Unplanned Events				
Accidental fuel spill		√		
Accidental chemical spill		√		
Oil spill e.g., subsea well blowout	√	√	√	√
Loss of materials or equipment				

5.1.1. Characterization of Potential Environmental Impacts

For environmental impacts, the impact significance rating is based on a consideration of the type of impact, its area of influence and severity criteria (the 'magnitude'), and the characteristics of the impact receptor (its 'sensitivity'). Each impact is assigned two significance ratings. The first rates the impact without consideration of control and/or mitigation measures and the second rates the impact assuming the control and/or mitigation measures have been implemented.

Table 5.3 provides definitions for the environmental impact significance designations, considering the impact characteristics, additional severity criteria and resource/receptor sensitivity.

Table 5.3. Environmental Impact Significance Ratings

Significance Rating	Description
Negligible	Impacts that are practically indistinguishable from the background/ natural level of environmental change, or consist of solely localized or short-term effects on habitat, species or environmental media.
Minor	Impacts such as localized, long-term degradation of sensitive habitat or widespread, short-term impacts to habitat, species or environmental media. A minor impact is sufficiently small (with or without mitigation) and well within accepted standards, and/or the receptor is of low sensitivity/value.
Moderate	Impacts such as localized but irreversible habitat loss or widespread, long-term effects on habitat, species or environmental media.
Major	Impacts such as significant, widespread and persistent changes in habitat, species or environmental media (e.g., widespread habitat degradation). A major impact essentially involves exceeding an accepted (Angolan or International) limit or standard, or large magnitude impacts to highly valued or sensitive resource and receptors.

5.1.2. Characterization of Potential Social Impacts

There is an inherent variability in the significance of social impacts introduced by the human factor. This variability may arise as a result of:

- The range of ways in which individuals making up a group, community or population respond to an impact;
- Preconceived opinions or perceptions of the existing conditions or nature of an impact and how it will affect them; and
- The range of degrees of vulnerability to the consequences of an impact within a community (*e.g.,* due to age, gender, economic status, education).

In applying the ratings set out in Table 5.4, the Team employed professional judgment based on social science expertise and have taken into account previous experience in Angola regarding how individuals and communities have responded to the oil and gas industry in general, and offshore drilling projects in particular.

Table 5.4. Social Impact Significance Designations

Significance Ratings	Description
Negligible	Impacts that are practically indistinguishable from the social baseline, or consist of solely localized or short-term effects that are not deemed to adversely affect local people in any significant way.
Minor	Short-term inconvenience caused but with no consequence on long-term livelihoods or quality of life effects. Those affected will be able to adapt to the changes with relative ease and maintain pre-impact livelihood.
Moderate	Primary and secondary impacts on livelihood and quality of life. Those affected will be able to adapt to changes, with some difficulty, and maintain pre-impact livelihood, but only with a degree of support, such as compensation for economic displacement.
Major	Widespread and diverse primary and secondary impacts likely to be impossible to reverse or compensate. Those affected will not be able to adapt to changes and continue to maintain pre-impact livelihood.

5.2. Environmental Impacts and Mitigation

This section assesses the environmental impacts of the Project. The assessment of impacts from planned events is divided by receptor (water quality, air quality, sediment quality, fish, seabirds, marine mammals, and turtles) and then by the source of impact (*e.g.* underwater noise). Impacts from unplanned or accidental events is assessed by the type of event (accidental large oil spill and accidental duel spill from vessels), and then by the affected receptors. Sections 5.2.1 and 5.2.2 illustrate environmental and social impacts from planned activities. Section 5.3 describes impacts from unplanned events.

5.2.1. **Environmental Impacts from Planned Activities**

Box 5.1 describes the noise sources and sound levels likely to be associated with Project activities. This information forms the basis of the assessment of noise impacts on receptors including fish, marine mammals, turtles and seabirds.

Underwater noise may affect marine fauna, and airborne noise may affect seabirds. The key noise sources of underwater noise are categorized as follows.

- ✓ Drilling noise. MODUs generally produce low-frequency underwater noise in the range of 10 Hz to 10 kHz with major frequency components below 100 Hz and average source levels of 140-190 dB re 1 µPa at 1 m (rms) [60] [61](OSPAR 2009).
- ✓ Propellers and thrusters. When vessels are travelling at speed, cavitation caused by cavities or bubbles that form due to propellers spinning at high speed can occur around the blades of the propeller; which causes noise. Most small ships generate underwater sounds of 170-180 dB re 1 µPa (rms) with a blade rotation tone of 10-11 Hz (Richardson et al. 1995). The thrusters used by the dynamically-positioned MODUs emit noise when operating under load, to maintain position (24 hrs/d). These activities normally produce broadband noise with some low tonal peaks which can be audible for many kilometers.
- ✓ Equipment in water. Equipment such as the marine riser, and valves in the BOP and well head can produce noise. Noise produced tends to be a relatively low frequency.
- ✓ Helicopters. Passing helicopters will contribute both to underwater and airborne noise.

The table below indicates underwater sound levels for Project vessels. These values are indicative only as the noise generated will vary with vessel type, size, mode of operation and noise-reduction measures employed.

Vessel Type	Approximate Highest Sound Levels*	Peak Frequency Band – Indicative Ranges (Hz)**
Supply Vessel	180 dB	10-1,000
MODU	174 dB to 185 dB	10-10,000

* Sound pressure is expressed on a decibel scale (dB) and referenced to 1 micro Pascal at 1 m from the source. [dB re 1 µPa @ 1m]

** Sound frequency is expressed in Hertz. Only the approximate range of peak frequencies is presented, frequencies outside this range are likely to exist but be lower in sound level.

[60] With the higher end of this range from use of bow thrusters.

[61] Noise levels are quoted as rms levels as discussed later.

The propagation of sound through water is affected by spreading (distance) losses and attenuation (absorption) losses, with sound energy decreasing with increasing distance from the source. The MODUs could generate relatively high sound levels of up to 174 to 185 dB, although at relatively low frequencies. Richardson et al (1995) reported that broadband levels did not exceed ambient levels beyond 1 km from a well drilling operation, although weak tones were received approximately 18 km away. Generally noise from MODU activities is at a similar level to noise from shipping activities. Other vessels, such as support vessels, have sound levels of up to approximately 180 dB. It is expected that these sound levels would decay to a level of 120 dB within a 1 km radius of the source.

Other sources of noise which are considered relevant to the assessment include helicopter traffic, which will contribute both underwater and airborne noise, and airborne noise from vessel traffic. Underwater noise from a passing helicopter is generally brief in duration when compared with the duration of audibility in the air. The peak received level in the water as a helicopter passes directly overhead decreases with increasing altitude and with increasing receiver depth. In calm conditions, at angles greater than 13° from the vertical, much of the sound is reflected and does not penetrate the water (Richardson et al. 1995; NRC, 2003). Therefore any potential impacts will be localized. Underwater noise from helicopters will be mitigated through management procedures (i.e., flying height recommendations) in order to reduce impacts to marine fauna to a minimum. Airborne noise from vessels will have a limited and local effect which is expected to be insignificant, and has not been considered further in this assessment. The effect of airborne noise from helicopters has been considered in terms of impacts on seabirds.

Box 5.1. Project-associated noise

- ***5.2.1.1. Water Quality***

Black Water, Grey Water and Food Waste

Discharges from the Project will include liquid and solid wastes from the living quarters onboard the MODUs and support vessels. These discharges are expected to occur during all phases of the Project and include the following.

Black water (treated sewage)

Black water can contain harmful microorganisms, nutrients, suspended solids, organic material with chemical and biological oxygen demand and residual chlorine from sewage treatment. Black water will be treated in an IMO compliant waste treatment facility in accordance with the requirements of MARPOL Annex IV (International Maritime

Organization (IMO) Marine Environment Protection Committee (MEPC) resolution 159(55) – Revised Guidelines on Implementation of Effluent Standards and Performance Tests for Sewage Treatment Plant are provided in Table 5.7) and will only be discharged as specified in Presidential Decree 141/12 (i.e. achieve discharge standards of no floating solids, no discolouration of surrounding water and a residual chlorine content of less than 0.5 $mg.l^{-1}$; and there will be no discharges of treated sewage from vessels within 3 nautical miles of the nearest land).

Any solids removed during the treatment process will be held onboard for transfer to shore. Intermittent discharges of relatively small volumes (18,000l per day – based on an estimate of 100l per person per day and a maximum rig count of 180 POB) of treated black water will be direct to the water column and are expected to dilute and disperse quickly in the offshore environment resulting in a temporary and localized reduction to water quality.

Table 5.5. IMO MEPC Resolution 159(55) Sewage Treatment Plant Effluent Standards

	Faecal coliforms / 100ml	Suspended Solids mg/l	Biochemical Oxygen Demand mg/l	pH
Treatment plant installed before 1st Jan 2010	250	50 (100)*	50	---
Treatment plant installed after 1st Jan 2010	100	35	25 & Chemical Oxygen Demand 125	6.0 – 8.5

**50 mgl^{-1} if tested ashore; 100 mgl^{-1} if tested onboard*

Grey water (domestic wastewater)

Grey water includes drainage from baths, showers, laundry, wash basins and dishwater. Grey water may also include solid or semi-solid food waste which is processed through a macerator to a point where it can pass through a 25 mm screen. Grey water treatment is not required under MARPOL as it is not considered to be a garbage or sewage, however, it may only be discharged at a distance greater than 12 nm from the nearest shore. Grey water will be discharged continuously in relative small volumes (39,600l per day – based on an estimate of 220 l per person per day and a maximum rig count of 180 POB) directly to the

water column. It is expected to dilute and disperse quickly in the offshore environment resulting in a temporary and localized reduction to water quality.

The impact on water quality from discharges of black water, grey water and food waste is initially assessed as of *Negligible* significance given the low sensitivity of receiving water, relatively small discharge volumes and high dilution factor in the offshore environment. All discharges will be compliant with both International Conventions and Angola law. As such, no further mitigation measures additional to those inherent in the Project design will be applied. Therefore the residual impact on water quality is also assessed as of *Negligible* significance.

Deck Drainage and Bilge Water

Water that accumulates in the drains and bilges of the MODUs and support vessels is likely to become contaminated with low levels of hydrocarbons and other chemicals. Unmanaged discharge of this water to the sea represents a potential impact on local water quality and marine organisms. Drainage and bilge water will be directed into a holding tank and routed through an oil / water separator and monitored for oil concentration.

The allowable oil content for discharge is controlled under MARPOL Annex I and also Presidential Decree 141/12. All discharges must not exceed the maximum concentration of 15 parts per million (ppm) of oil content. At this concentration, any impact will be temporary and localized, with no visible sheen and quick dilution in the marine environment. The impact from the discharge of treated deck drainage and bilge water is initially assessed as of *Negligible* significance given the low sensitivity of the receiving water, small volumes of discharge and high dilution factor in the marine environment. No further mitigation additional to oil / water separation is required to meet this discharge limit and therefore the residual impact is also assessed as of *Negligible* significance.

Ballast Water

Ballast water is taken onboard to maintain safe operation and maneuvering of vessels. Depending on where it is taken onboard, it may contain harmful microorganisms, marine organisms from other locations (potentially invasive species) and contaminated sediments in suspension. As the vessels use fuel and transport other fluids (*i.e.* drilling muds) they may be required to take on water during the Project. Ballast water may also be discharged during the Project.

Any ballasting operations will be logged in a record book in compliance with Presidential Decree 141/12. In addition, the Project will comply with IMO regulations and standards and guidelines for ballasting management based on the International Convention for the Control and Management of Ship's Ballast Waste and Sediments (BWM Convention). The impact of any potential ballast water discharges is initially assessed as of *Negligible* significance given the low sensitivity of the water column and high dilution factor of the water column. No further mitigation is required additional to legal compliance and adherence to industry good practice, therefore the residual impact is also assessed as of *Negligible* significance.

Drilling Muds and Drill Cuttings

Discharges of drilling mud and associated cuttings will occur during drilling of the upper well sections (see section 3.2.4). Water based mud (WBM) and cuttings will be deposited on the seabed in piles close to each well. There is the potential for contaminants from these deposits to leach into the water column and reduce water quality. Leaching may also occur from the small quantities of overspill cement that may be released. In compliance with Executive Decree 224/12, there will be no discharges of drill cuttings from drilling the bottom well sections or of the synthetic oil based mud (SOBM) used during this stage. Cuttings and SOBM will be returned to the MODU following the installation of the marine riser and shipped to shore for disposal. Impacts to water quality will therefore only occur during drilling of the upper well sections.

The contaminants of major environmental concern in drilling wastes (due to their potential toxicity and/or abundance in drilling discharges) include hydrocarbons and heavy metals.

Some heavy metals are present in drilling muds as metal salts or organo-metallic compounds; others are trace contaminants/impurities in bentonite clay (*e.g.* arsenic, mercury, cadmium, lead, nickel and zinc) or may be derived from the penetrated rock formation or drill pipe corrosion. Water-based drilling-derived cuttings and muds (which will be released into the sea) tend to have low levels of both hydrocarbons and heavy metals, if at all. The discharge of cuttings on the seabed will result in a plume of increased suspended sediment, which due to low deep-ocean current speeds, is expected to stay close to the seafloor and is not expected to increase the amount of suspended solids in the water column. Cement chemicals and completion fluids will be risk assessed and used downhole, in alignment with OSPAR HOCNF standards. Any leaching of the components of cement into the seawater will be a slow process.

The overall volume of material that will be discharged from the top hole drilling of the two planned wells will be relatively small (approximately 1,600 m^3 WBM and 500 m^3 of cuttings per well – see section 3.4.1), and therefore the total quantities of any contaminants present are likely to be low. Discharged material will settle fairly rapidly, reducing contact with the water column, and once settled the leaching of contaminants into the water column will be slow. At most, low concentrations of contaminants will be released to the water column, which will be dispersed and diluted. Following cessation of tophole drilling activities, contaminant concentrations in seawater would be expected to return to background levels, with the assistance of currents and the mixing capacity of the water body. Therefore, the impact from the discharge of drilling-related muds, chemicals and cuttings from the tophole is initially assessed as of *Negligible* significance to water quality. No additional mitigation measures are required additional to those inherent in the Project design, including selection of low toxicity drilling muds and zero discharge of SOBM in compliance with Executive Decree 244/12. As the MODU can typically pump WBM at a rate of 1,800 bbls hr^{-1}, Statoil will need to carefully plan the drilling activities in order to ensure that the maximum discharge flow rate of WBM permitted by Article 7 of the Decree, 1,000 bbls hr^{-1}, is not exceeded, The residual impact is also assessed as of *Negligible* significance.

Well Clean-up and Testing Fluids

Rest hydrocarbons not combusted after well testing and well clean-up will be collected on the MODU and returned to shore base for treatment and disposal.

Secondary Effects to Marine Fauna

Increased nutrients in the water column due to discharges of organic waste may increase localized productivity of phytoplankton, however, any changes are expected to be short-lived and will dilute rapidly in the marine environment and as such these discharges have been initially assessed as of *Negligible* significance. The increased turbidity at the surface from discharges may cause a reduction of light penetration to the water column; however, this is also expected to be of *Negligible* significance, given the small discharge volumes and the high dilution factor.

Discharges of WBM and cuttings at the seabed (assumed to be approximately 1,800 m below sea level) are not expected to impact Pelagic fish species, which occur in predominantly in the upper 200 m of the water column, due to the large separation distance between their habitat and the discharge points. Demersal fish species off the Angolan coast are concentrated at depths between 100 m and 400 m, with species such as the Benguela Hake found at depths of up to 800 m. Little data is available on deep sea species, however, as the increased turbidity in the water column and sediment composition and distribution changes are expected to remain localized to the discharge point, the impact on fish, which may temporarily avoid the area of disturbance, has been assessed as *Negligible*.

- ***5.2.1.2. Air Quality***

The primary sources of pollutant emissions will be from the Project will be from the MODU, associated support vessels, and from helicopters. The dynamically positioned MODU will consume fuel to power its thrusters to maintain position during drilling operations. In

addition, fuel will be required to generate electrical power for the drilling equipment. The three supply vessels and helicopters will also consume fuel in their engines. Other vessel emissions sources will be from power generators, particularly on the MODU. Flaring may also occur during well testing if hydrocarbons are encountered. Project air emissions estimates, and the assumptions used to generate them, are provided in section 3.4.3 of this report. Estimated emissions for the duration of the Project (based on a 256 day-exploratory drilling campaign) excluding flaring, are presented in Table 5.6.

Table 5.6. Estimated Project Air Emissions (Tons)

Types of Pollutants	Drilling Rig Combustion Sources	Support Vessels	Helicopter	Total Estimated Emissions (Tons)
NO_X	2,685	590	0.62	3,276
CO	578	54	2.34	635
VOC	219	10	1.11	230
PM_{10}	189	10	0.00	199
SO_2	177	10	0.15	187
CO_2	99,843	32,064	831	132,738

The release of gaseous pollutants to the atmosphere will affect local air quality; however, the source of the majority of these emissions (the MODU) will be in the vicinity of the wells which are located approximately 110 km from the nearest sensitive receptors, coastal communities in the Sumbe area. Emissions will also be released by supply vessels along the route between the well locations and supply base located at the Port of Luanda and as such will be of a diffuse nature.

The Project will comply with the standards set out in MARPOL Annex VI regarding pollutant emissions. Vessel propulsion systems, exhaust systems and power generation equipment will be maintained to run as efficiently as possible in order to minimize pollutant emissions. The MODU is equipped with low NO_X engines. Any flaring of fluids and gases from well testing will be via burners, mixed with compressed air to increase combustion efficiency, in order to reduce black smoke and any potential fall out onto the sea surface.

The contribution from the support vessels and helicopters which will operate closer to the coast (nearer to potentially sensitive receptors) will be minimal, as shown in Table 5.6. Additionally, emissions released by supply vessels and helicopters along the route between the well locations and supply base and heliport will be of a diffuse nature, which will assist dispersion of pollutants and lessen potential impacts. Nonetheless the Project will look to optimize the number of support vessel trips and helicopter flights through these areas to those strictly necessary where applicable[62].

Pollutants are expected to disperse quickly owing to the good conditions for aerial dispersion at the remote offshore location. Given the prevailing wind direction (south to southwesterly), pollutants are likely to disperse to the north and not towards the nearest coastal receptors, located directly east of the project, in the vicinity of Sumbe. Air quality modeling experience from similar projects in offshore Angola, concluded that emissions from offshore locations would not have a significant impact on air quality or human health at Angolan coastal locations or in marine areas used by fishermen (ERM 2004[63]).

The contribution to greenhouse gas emissions will be inconsequential on the global scale. The impact to air quality from the Project related emissions is initially assessed as *Negligible* significance given the estimated volume of emissions, the good conditions for aerial dispersion, the low sensitivity of the immediate receiving environment and the large distance to the nearest sensitive receptors. There will be no mitigation measures implemented in addition to those inherent in the Project design; therefore the residual impact will also be of *negligible* significance.

- ***5.2.1.3. Sediment Quality and Benthic Communities***

[62] In addition to air quality impacts there will be small contribution to global greenhouse gas emissions.

[63] 'Block 18, Greater Plutonio Offshore Development, Angola. Environmental Impact Assessment: Non-Technical Summary, November 2004. The modeling, undertaken for this project, approximately 60km closer to the coast than Block 39, included emissions from oil tankers and two other oil processing facilities in nearby blocks. The modeling predicted average annual ground level NO_X concentrations, at towns located on the Angolan Coast to the north and west of the facility, of less than 1.5% of the World Health Organization air quality guideline values.

Drilling activity will have a minimal seabed footprint, consisting of the blowout preventers installed on each of the well heads and the deposition of tophole water-based drilling-derived cuttings and muds. As the MODU will be dynamically positioned there will be no seabed footprint from anchoring to the seabed.

In compliance with Executive Decree 224/12, there will be no discharges to the seabed of drill cuttings from drilling of the bottom sections of the wells or of the synthetic oil based mud used during this stage. However, some overspill cement may be released to the seabed surrounding each of the wells which will result in habitat loss over a defined area of seabed.

During drilling of the upper well sections, mud and cuttings will be returned to the seabed. Approximately 1,600 m^3 of WBM and 500 m^3 of cuttings per well are expected to be discharged at the seabed from the drilling of these sections. This will result in short term increases in suspended sediment concentration and the formation of cuttings piles around the drill centers. Impacts will include changes to seabed sediments due to sediment redistribution in the immediate area, and disturbance or loss of benthic habitats and fauna within the footprint as a result of direct smothering or changes to sediment composition.

The finer particles from WBM released at the seabed are likely to form a dense plume, which may interfere with the respiration of benthic and demersal communities in the immediate vicinity of the well. These impacts are expected to occur over a relatively short period (approximately 20 days) during the drilling of these tophole sections and are expected to be local to the well. Smothering by cuttings and sediment are expected to impact sessile organisms, such as some of the mollusc species, to a greater degree than mobile and burrowing species such as arthropds and annelids which together make up approximately 80% of the deepwater benthic fauna in the region. Recovery will be expected over time as the new sediment layers are recolonized, however, in such deep waters it is expected that recovery times are likely to be longer than in shallower waters of the continental shelf.

Leaching of chemicals, hydrocarbons and heavy metals from cement, tophole cuttings and muds deposited on the seabed could contaminate sediments around the wells and result in indirect effects on benthic organisms. The water-based muds used during tophole drilling tend to contain very low levels of contaminants, and chemicals used during the Project will be low-toxicity and conform to relevant OSPAR standards. The low volumes of material involved and the slow leaching process mean that impacts are unlikely to occur. Cuttings and synthetic based muds from the lower well sections will be returned to the drilling rig and will therefore have no impact on the seabed or benthic communities.

A maximum of two exploratory wells will be drilled for the Project in Block 39. The area of seabed affected by the drilling activities will be very small in relation to the concession area, and will be made up of habitat that is widely distributed in the area. Any changes to sediment composition or turbidity are expected to be small, localized and mainly short term (cuttings piles are likely to persist for a longer periods but are likely to be recolonized over time), and therefore unlikely to cause widespread, persistent changes to the seabed, benthic habitats or benthic organisms.

In the absence of site specific environmental baseline survey data, the baseline chapter employed existing sources of information on the benthic habitat in the deep sea waters off Angola. Potentially sensitive benthic receptors identified within these regional surveys include cold water coral (*Lophelia*); carbonate concretions; giant pockmarks supporting mussels (B*athymodiolus sp*.) colonies; and subsea vents supporting vesicomyid bivalves and vestimentiferan tubeworm. Owing to low deep-ocean current speeds, the discharge of cuttings and WBM may cause impacts on lowly productive ecosystems; however, this sensitivity is reduced by their wide geographical extent (Cazes et al 2012). The predicted impacts to sensitive receptors listed above are initially assessed as of *Moderate* significance while impacts to the seabed and to all other benthic communities are assessed as of *Minor* significance.

Remote surveys of the planned well locations conducted prior to drilling will identify any sensitive features, and micro-siting of the wells will allow these features to be avoided. Taking these measures into account, impacts from the Project are anticipated to have *Minor* significance.

- ***5.2.1.4. Fish***

Secondary Effects of Water Column Discharges

Temporary changes to the distribution of fish species may be caused as opportunistic feeders are attracted to organic discharges as a potential source of food. The magnitude of changes will be small and within natural variation. Discharges of treated black, grey and bilge water may result in localized increases in biological oxygen demand and residual chlorine content, however, due to their small volumes, pre-treatment to remove pollutants, and high dilution factor in well-oxygenated surface water their impact on water quality have been initially assessed as *Negligible.* Moreover, fish are sufficiently mobile to avoid any localized areas of polluted waters. As a result, residual impacts to fish are expected to be *Negligible*.

Underwater Noise

Available information on marine fish (recall box 5.1) indicates that they are not particularly sensitive to underwater sound. Fish may be attracted by the noise of operational vessels (Røstad *et al.* 2006) but are likely to avoid areas where noise levels are at a level to cause harm. The noise levels produced by drilling operations, however, have the potential to affect the behavior of some species of fish that are sensitive to sound, 'hearing specialists'.

Behavioral effects in fish have been observed between 182-207 dB re 1 µPa (rms) and between 160 - 186 db re 1 µPa (peak) (Pearson et al. 1992, McCauley *et al.* 2000, Wardle et al. 2001). Sound levels approaching these ranges will only occur very close to the vessels or Project activities, and will decrease to levels unlikely to have effects on fish within 1 to 3 km. The continuous nature of noise produced also reduces the chances of startle reactions in fish. Impacts to fish are therefore expected to be direct, localized, occur for as long as

Project vessels are present and of *Negligible* significance. No mitigation measures will be applied, therefore the residual impact remains of *Negligible* significance.

- ***5.2.1.5. Seabirds***

The presence and movement of vessels and helicopters involved in Project activities may have behavioral impacts on seabirds, causing them to avoid or to be attracted to the area. This impact will occur primarily in the offshore environment, but will be extended to the near shore and coastal environment due to the movements of helicopters and vessels involved in the ship-to-shore transfer of drilling wastes and support operations.

In particular, there may be impacts on birds due to artificial lighting present on the vessels. Birds typically migrate at night and are attracted to artificial light during their migrations. Nocturnally migrating birds may die or deplete their energy reserves during migration as a result of encountering artificial light sources (Poot 2008). The level of impact, however, is dependent on the location of offshore lighting, time of year, and weather conditions. For example, birds tend to be attracted to offshore lighting during poor weather, *i.e.* overcast nights (OSPAR 2009b).

Light emissions from Project vessels during the night may be visible at considerable distances, depending on weather and sea conditions. Birds that are attracted to the light will expend energy reaching the vessels, but this will only cause a small increase in overall energy expenditure to the individual. As this type of behavior is usually seen during nights with fog and/or >80% cloud cover (Van de Laar 2007) the frequency and duration of periods when this impact may occur will be limited. Helicopters and support vessels passing through and near coastal areas may disturb individual or groups of birds in sensitive coastal habitats such as mangrove areas where feeding, resting and breeding takes place.

Disturbance will be localized, only affecting a small number of birds offshore, and will be short term, occurring periodically throughout the Project. As Angola falls within two major flyways, there may be times of year when a higher number of migratory birds are present in

the area and therefore the likelihood of this impact occurring is greater. Given the small number of Project vessels likely to be offshore at any one time, and the distance of the Project area from the coast, the impact to seabirds is initially assessed as of *Minor* significance. The Project will implement the following measure to mitigate disturbance impacts. Helicopters will avoid particularly sensitive coastal areas (see Section 5.3.3) and large aggregations of seabirds on the sea surface.

Taking these measures into account, disturbance impacts from the Project are assessed as of *Negligible* significance.

- ***5.2.1.6. Marine Mammals***

Physical Presence (including Collision Risk)

The presence and movement of vessels may cause marine mammals to avoid the area or result in other behavioral effects, for example on feeding or breeding. This impact will occur primarily in the offshore environment, in the area around each of the drill centers. It is anticipated that three vessels will be involved in these activities over the Project period (the MODU and three support vessels), although not all vessels will be present at all times.

Vessels will be involved in the ship-to-shore transfer of drill cuttings and muds during well drilling and vessels undertaking support operations, extending the impact into the near-shore and coastal environment. It is estimated that somewhere in the region of additional 20-30 vessel movements will be involved in transfer of drilling wastes over the 128 day period for each well[64]. The level of existing vessel traffic in the area is expected to be relatively low but regular, and the Project vessels will represent a small and short term increase over the baseline condition. Given the broad ranges and mobility of the marine mammal species considered, the likelihood that they will be somewhat habituated to the presence of vessels, and the mitigation measures applied by the Project (listed below), it is

[64] Vessel–marine mammal collision risks are increased during the breeding season, for instance between July and October for the humpback whale, which occurs in Angolan waters, predominantly over the continental shelf in waters of less than 200m.

not expected that they will experience great disturbance. Therefore, disturbance to marine mammals caused by the physical presence of vessels is initially assessed as of *Negligible* significance.

In addition to disturbance, the presence of Project vessels increases the risk of collisions. Collisions have been known to occur worldwide and also in West Africa (Félix and Van Waerebeek 2005; Van Waerebeek et al. 2007). The increased risk of collision is considered to be low given the relatively low volume of Project related traffic and the speed that these vessels move at (typically less than 12 knots). Marine mammals are most sensitive in areas with fast moving vessels which frequently change direction and will be more able to avoid the large, relatively slow moving support vessels associated with the Project. Considering the potential for collisions to occur between marine mammals and Project vessels the residual impact from the physical presence of vessels is initially considered to be of *Minor* significance.

Measures to be implemented by the Project to mitigate disturbance impacts and reduce the risk of collision with marine mammals include the following:

- ✓ Vessels will use designated navigation channels where applicable and comply with designated exclusion zones, speed and wake restrictions, particularly when passing through coastal areas.
- ✓ Supply vessel operators should maintain a watch for marine mammals, particularly in the winter and spring months (July to October) and take avoidance action if a collision seems likely, if safe to do so.

With these mitigation measures in place, the residual impact to marine mammals from the physical presence of the Project and collision risk with Project vessels is considered of *Negligible* significance.

Disturbance by Helicopters

The presence, movement and noise generated by helicopters may cause disturbance to marine mammals. Impacts may result in avoidance of certain areas, or behavioral change, including changes in feeding or breeding. Project helicopters will, under normal conditions, travel a sufficient distance (more than 500m in all directions) from an identified marine mammal to avoid disturbance.

Underwater Noise

Marine mammals rely on sound for echolocation, detection of predators and prey, and communication within or between social groups. The effects of underwater noise emissions on marine mammals can be physiological (*i.e.* cause injury), if sufficiently loud, or behavioral. Behavioral effects may include changes to diving patterns and avoidance behavior, particularly when the noise source is intermittent. Continued exposure often results in habituation to the sound, followed by a recommencement of normal behavior. As discussed in Southall et al (2007), marine mammals can be divided into groupings with similar sensitivity to noise. Within the Project area marine mammals can be classed as either 'low frequency' cetaceans, including baleen whales, or 'mid frequency' cetaceans, including most toothed whales.

The work of Southall et al (2007) suggests that, in order to cause instantaneous injury to marine mammals resulting in a permanent loss in hearing ability that is referred to as Permanent Threshold Shift (PTS), the sound level must exceed 230 dB re 1 micro Pascal (peak). However, criteria differ somewhat for activities involving multiple noise pulses as compared to more continuous, non-pulsed, noise such as vessel engine noise. Physiological damage is primarily associated with very loud noise sources such as seismic surveys. None of the noise sources from the Project are capable of causing instantaneous injury, as the source levels do not approach the 230 dB criterion, even at very short ranges. As most noise sources from the offshore operations will be continuous or near continuous it is considered very unlikely that marine mammals would approach the source of noise sufficiently close for auditory damage to occur.

Behavioral responses to noise differ for the different groupings of marine mammals. Cetaceans that hear or communicate at low frequency have been found to exhibit behavioral responses to continuous sound similar to that produced by the Project at levels above 120 dB, significant responses at 140 to 160 dB and avoidance behaviors at levels greater than 150 to 180 dB (McCauley 1994, 2000; Malme et al 1985; Southall et al 2007). A conservative criterion of 120 dB re 1 µPa (rms) has been adopted for behavioral responses in all low frequency cetacean species for this assessment. For mid frequency cetaceans a criterion of 160 dB re 1 µPa (rms) has been adopted as the level at which behavioral disturbance is likely, following the results of the United States Geological Survey (USGS) review of data (Haley et al 2010), and the recommendations of the National Marine Fisheries Service (NMFS) of the USA.

Noise levels above the 120 dB criterion are likely from a number of Project activities but will be limited to an extent of less than 1 to 3 km from the vessel or activity, or up to 6 km for deep diving species (*e.g.* sperm whale). Offshore activities associated with the Project may therefore cause behavioral disturbance to low frequency cetacean species, with somewhat less pronounced impacts on mid-frequency cetacean species. The impacts will be localized, and given the wide range and mobility of the species considered, it is expected that avoidance of this area will not lead to significant impacts (marine mammals in the general area would have already been exposed to noise from shipping activity and other oil and gas developments). Therefore, marine mammals occupying or passing through the area will be accustomed to a degree of anthropogenic underwater noise, disturbance will also be reduced by Project mitigation measures set out below. The residual impact to marine mammals from underwater noise is assessed as of *Minor* significance depending on the affected species. Mitigation measures to be implemented by the Project include the following:

- ✓ Vessels will use designated navigation channels where applicable and comply with speed and wake restrictions, particularly when passing through or near to sensitive habitats.

- ✓ Supply vessel operators should maintain a watch for marine mammals, particularly in the winter and spring months (July to October) and take avoidance action if a collision seems likely, if safe to do so.

Taking these measures into account, the residual impact of underwater noise to marine mammals assessed as of *Negligible* significance.

- ***5.2.1.7. Turtles***

Physical Presence (including Collision Risk)

Turtles are less mobile than marine mammals and cannot move out of the path of fast moving vessels as easily. There is evidence that turtles are less able to detect fast moving vessels early enough to avoid them, as compared to slower moving vessels. A precautionary speed of around 2 knots has been suggested to ensure successful avoidance of vessels by turtles (Hazel et al. 2007). Project vessels will travel at speeds higher than this precautionary level, but speeds will still be relatively low (typically less than 12 knots).

The chances of collisions between vessels and turtles are considered to be relatively low in offshore areas. A higher risk exists in the offshore areas in the months from July to September, when turtles aggregate prior to moving to nesting beaches. The risk of a collision is considered to be highest between September and January, in the coastal waters on the approach to the Port of Luanda which are in close proximity nesting sites used by Olive Ridley turtles along the beaches, approximately 20km to the north of the Bengo River Mouth).

Given the relatively low volume of Project-related traffic and the likelihood that turtles may already have been displaced from the areas of Project activity, the increased risk of collision is considered to be low. The consequence of a vessel collision with a turtle may range from minor disturbance or injury to a worst case of fatality to an individual. Taking this into account, the impact to turtles from vessel collisions is assessed as of *Negligible* significance.

The presence and movement of vessels may cause disturbance to turtles, causing them to avoid the area or result in other behavioral effects, for example on feeding or breeding. Project vessel movements will occur primarily in the offshore environment where turtles are expected to be widely dispersed, but will also extend into the nearshore and coastal waters on the approach to the Port of Luanda (movements of vessels involved in the ship-to-shore transfer of drilling wastes and support operations). Given the existing traffic in the area, the broad ranges and mobility of the turtle species considered, the likelihood that they will be somewhat habituated to the presence of vessels, and the mitigation measures applied to the Project (listed below in Table 5.7), it is not expected that they will experience great disturbance. Therefore, the impact is initially assessed as *Negligible* significance

Turtles and turtle hatchlings in particular are attracted to artificial light sources, which can make the susceptible to increased predation. As the Project area is over 100km from the coast, the artificial light associated with the drilling spread will not be visible at any turtle nesting or foraging areas, no impacts are expected to turtles from artificial lighting.

The Project will use designated navigation channels where applicable and comply with speed and wake restrictions, particularly when passing through or near to sensitive habitats to mitigate and reduce disturbance impacts and collision risk to turtles. Taking this into account, the residual impact to turtles remains as of *Negligible* significance.

Underwater Noise

Although no studies definitively determine marine turtle hearing thresholds or detection limits, it is considered that turtles are less reliant on sound than animals such as fish and marine mammals. Turtles are thought to be more sensitive to low tones, and have been shown to respond to noise levels from air gun arrays of 166 dB re 1 µPa (rms) and display agitation at 175 dB re 1 µPa (rms) for pulsed sources. They are likely to be less sensitive still for continuous non-pulsed sounds such as those produced by Project activities. Given that noise from the Project will only approach the levels likely to result in impacts on marine

turtles within a few meters of the vessel or activity in question it is unlikely that turtles will be seriously affected by underwater noise from the Project. Impacts from underwater noise produced by overflying helicopters will be avoided as helicopters will not approach, hover over or follow turtles. Therefore, impacts from underwater noise to marine turtles are assessed as *Negligible* significance. No additional measures will be applied to mitigate underwater noise impacts to turtles, therefore the residual impact remains as *Negligible* significance.

5.2.2. Social Impacts from Planned Activities

The social impacts arising from the Block 39 exploratory drilling in terms of public health and safety, population influx and social infrastructure are expected to be *Negligible* as the Project is located offshore and will not require large number of personnel. Most onshore Project's support operations[65] will occur at the existing Sonils base at the Port of Luanda. As such, the social impacts discussed here are confined to potential significant negative impacts with regards to disturbance to fishing activities offshore Angola and to increase in marine traffic.

- ***5.2.2.1. Fishing activities***

Fishing is an important source of livelihood and nutrition for the people of Angola and occurs all year round. Artisanal fishing is known to mainly occur within approximately 7.5 km of the shoreline; however, small motorized boats may venture as far out as 22 km. Exploratory drilling in Block 39 is anticipated to have little or no impact on artisanal fishing activities as the field is located approximately 110 km off the Angolan coast. The only potential interference to artisanal fishing activities could be from increased movement of supply and

[65] Onshore activities will be mainly confined to waste management facilities, contractor facilities and logistical facilities for transport of manpower, equipment and materials to and from the Sonils base to the Project area.

support vessels as they navigate between ports and the Project area, or in the unlikely event of an oil spill from a well affecting the coastal waters.

Industrial fishing on the other hand occurs between 6 and 321 km offshore Angola[66], and Block 39 lies within this zone (with the nearest proposed well approximately 110 km off the Angolan coast). The Project may temporarily interfere with and/or present a hazard to fishing activities and may restrict access to fishing grounds as fishing activities are not allowed within 500 m of any offshore installation or structure (including the MODU). Any Project-related reduction in the fish stock in the area as a result of Project activities is unlikely. The size of the area which the Project will restrict from industrial fishing is very small relative to available fishing areas (noting that the entire size of Block 39 represents about 0.02% of the Angolan Exclusive Economic Zone).

It is likely that existing fishing grounds/activities will be temporarily affected by the Project; although the area to be affected will be relatively small in relation to the available fishing grounds in the surrounding areas. Therefore, the impact is initially assessed as of *Negligible* significance. Mitigation measures to be implemented by the Project include the following:

- ✓ Appoint a fisheries liaison officer to provide a direct link with the fishing community;
- ✓ Ensure procedures are in place for dealing with claims in the event of damaged fishing gear;
- ✓ Establish exclusion zones around facilities;
- ✓ Communicate clear instructions regarding access limitations to exclusions zones;
- ✓ Ensure position of facilities and exclusion zones are marked on nautical charts; and
- ✓ Notify relevant authorities, fishing associations and industrial fishermen of field development plans, timing, location, and vessel activities.

[66] Industrial fishing in Angola has primary delineation zones of 12 nautical miles (approximately 22 km) from shore. Beyond this, internationally-registered industrial fishing fleets (under agreement with Angola) are allowed to fish.

- ***5.2.2.2. Marine Traffic and Navigation***

The waters surrounding Block 39 support shipping routes/lanes to major ports of Angola. Within the baseline section three common shipping and navigation routes which pass through Angolan waters were identified i.e. Luanda to/ from the north; South Africa to/from Pointe-Noire or Cabinda; South Africa to/ from Europe or USA. In addition, these waters may potentially be utilized by small freighters and cargo vessels that operate along the coastal waters, outside the remit of the shipping routes identified above.

Project activities will involve the mobilization of the MODU to drill site locations and movements of supply vessels between the MODU and the Port of Luanda. Within the Project area (drilling locations and associated exclusion zone) vessel traffic will be disrupted[67]. To reduce the potential for this impact, the Project will implement the following:

- ✓ Inform other ships through NTM (Notice to Mariners) and NAVAREAs (warnings and radio announcements) of vessel mobilization and infield activities. This information should be shared with Port Authorities, Navy, and Minister of Transport, and it should communicate clear instructions regarding project activities, vessel mobilization, infield activities and access limitations to exclusion zones;
- ✓ Establish exclusion zones around Project facilities;
    - Communicate clear instructions regarding access limitations to exclusions zones;
- ✓ Ensure position of facilities and exclusion zones are marked on nautical charts; and
- ✓ Ensure that vessels are equipped with collision risk reducing devices i.e. navigational lights and beacons, marker buoys, etc.

[67] However, this area will be small relative to existing vessel traffic areas in the region.

Based on the above-referenced mitigations, it is considered that the potential Project impacts to non-Project marine traffic during the construction and operation phases will be *Negligible*.

Table 5.7 summarizes predicted environmental and social impacts from planned activities.

Table 5.7. Summary of Impacts and Mitigation from Planned Activities

Receptor	Project Activity	Impact Description	Impact significance	Mitigation and Control Measures	Residual Impact
Seawater Quality	Drilling of exploration wells, installation of well infrastructure, routine and operational discharges during the Project (*e.g.* black and grey water, water-based mud, etc.)	Potential localized reduction in water quality, including increased turbidity, BOD and hydrocarbons, from: - Drilling of bore holes, pilot holes, and installation of subsea infrastructure - Black/Grey Water and Food Waste Discharge - Deck Drainage and Bilge Water Discharge - Ballast Water Discharge	Negligible (Bore Holes and Subsea Infrastructure) Negligible (Black/Grey Water and Food Waste) Negligible (Deck Drainage and Bilge) Negligible (Ballast Water)	• Statoil Operational Discharge Management Plan and Waste Management Plan. • MODU will have a closed drain system to allow zero discharge operation. • Oily discharges treated in an water/ oil separation • No discharge of synthetic oil based muds or associated cuttings. SOBM and associated cuttings will be skipped and shipped to shore for treatment/disposal. • Ballast Water Management Plan for MODU.	Negligible (Bore Holes and Subsea Infrastructure) Negligible (Black/Grey Water and Food Waste) Negligible (Deck Drainage and Bilge) Negligible (Ballast Water)
Air Quality	Routine vessel (MODU and Support) operation (including ships to shore cuttings), helicopter	• Potential reduction in localized air quality and contribution to greenhouse gases	Minor	• Maintain systems and equipment to run efficiently as possible • Flared fluids and gases will be mixed with compressed air to increase combustion efficiency • Compliance with MARPOL Annex VI • Low NO_X engines onboard MODU and	Negligible

Receptor	Project Activity	Impact Description	Impact significance	Mitigation and Control Measures	Residual Impact
	operations and flaring during well testing			exhaust scrubber fitted on MODU • Optimize number of helicopter flights and support vessels	
Sediment Quality and Benthic Communities	Installation of sub-sea BOP; discharge and deposition of drilling muds / cuttings and cement	• Loss of seabed, habitats and fauna in the direct footprint of the well and where cuttings and cement are deposited • Potential localized, short term increase in suspended sediment in the water column • Impacts on sediment quality and organisms from low levels of contaminants contained in water-based drilling muds and cements	Minor	• No SOBM or drill cuttings from the lower sections will be discharged offshore. SOBM and associated cuttings will be skipped and shipped to shore for treatment/disposal) • Mercury and cadmium content (mg kg^{-1}) will be measured at each new barite batch and for each well • Cement chemicals will conform to OSPAR HOCNF standards • Use of low toxicity chemicals (as listed on OSPAR's OCNS list and those on the PLONOR list) • Pre-drill surveys and micro-siting well locations to avoid areas of sensitive habitat	Minor
Seabirds	Vessel and helicopter	• Disturbance related impacts from helicopter flights and	Negligible	• Helicopters to avoid sensitive coastal areas and large aggregations of seabirds	Negligible

Receptor	Project Activity	Impact Description	Impact significance	Mitigation and Control Measures	Residual Impact
	operations	vessel presence; artificial lighting			
Fish	Drilling activity, routine operation of project vessels (MODU, support helicopter), including discharges and additional vessels trips for the cuttings ship to shore[1].	• Disturbance to fish from: -Secondary effects from water column discharges -Discharges of ballast water -Underwater noise (drilling)	Negligible (Water Column Discharges) Negligible (Ballast Water) Negligible Not Significant (Noise)	• None required – please see footnote.	Negligible
	Underwater noise from Project vessels	• Fish may be locally affected by underwater noise generated by Project activities	Negligible	• None required	Negligible
Marine Mammals	Vessel operations	• Disturbance to Marine Mammals from: -Physical presence (noise) of	Negligible (Vessel Presence)	• Use of designated navigation channels where applicable and comply with speed	Negligible (Vessel Presence) Negligible

[1] All discharges will be legally compliant with Angolan regulations, Angola-ratified treaties, and in alignment with Statoil's HSSE policies.

Receptor	Project Activity	Impact Description	Impact significance	Mitigation and Control Measures	Residual Impact
		Project vessels disturbing marine mammals -Potential collision risk between Project vessels and marine mammals	Minor (Collision)	and wake restrictions • Supply vessel operators should maintain a watch for marine mammals, particularly in the winter and spring months (July to October) and take avoidance action if a collision seems likely, if safe to do so	(Collision)
	Helicopter flights	• Physical Presence of helicopters may impact marine mammal behavior	Negligible	• Flight altitude of at least 500 m	Negligible
	Vessel and drilling activity generating underwater noise	• Marine mammal may be affected by underwater noise. Extreme cases may result in physical injury although unlikely	Minor	• Use of designated navigation channels where applicable and comply with speed and wake restrictions	Negligible
Sea Turtles	Vessel operations	• Physical presence of Project vessels disturbing turtle behavior • Potential collision risk between Project vessels and turtles	Minor (Vessel Presence) Minor (Collision)	• Use of designated navigation channels where applicable and comply with speed and wake restrictions	Negligible(Vessel Presence& Vessel collision)
	Vessel and drilling	- Disturbance to Sea		• Use of designated navigation channels	Negligible

Receptor	Project Activity	Impact Description	Impact significance	Mitigation and Control Measures	Residual Impact
	activity generating underwater noise	Turtles from underwater noise	Minor	where applicable and comply with speed and wake restrictions	
Industrial Fishing	Vessel operations and drilling activity	• Physical presence of Project vessels disturbing industrial fishing activities	**Negligible**	• Appoint a fisheries liaison officer to provide a direct link with the fishing community	Negligible
Marine Traffic and Navigation	Vessel movements operations inclusive of transportation of drill cuttings offshore and drilling activity	• Project vessel's movements may disrupt marine traffic in the area	Negligible	• Ensure procedures are in place for dealing with claims in the event of damaged fishing gear • Establish exclusion zones around facilities • Communicate clear instructions through NTM (Notice to Mariners) and NAVAREAs (warnings and radio announcements) regarding access limitations to exclusions zones. • Ensure position of facilities and exclusion zones are marked on nautical charts • Notify relevant authorities (Port Authorities, Navy, and Minister of Transport), fishing associations and industrial fishermen of field development plans, timing, location, tow-out routes	Negligible

Receptor	Project Activity	Impact Description	Impact significance	Mitigation and Control Measures	Residual Impact
				and vessel activities	

5.3. Environmental and Social Impacts from Unplanned Events

The assessment of unplanned events from the Project has been the subject of a comprehensive environmental risk assessment (ERA) study (Statoil Angola Environmental Risk Assessment, ERM, 2013). This section of the impact assessment provides a brief overview of the scope and methodology of the ERA, together with a discussion of its findings, including the significance of potential impacts to environmental and social receptors. The ERA report has been provided for reference in Appendix F of this EIS.

5.3.1. Overview of the Environmental Risk Assessment Process

Scope

The ERA was undertaken to address unplanned events associated with Statoil's proposed exploration drilling activities in Angola's offshore Blocks 38 and 39. Unplanned events considered in the ERA were limited to potential oil spill events which were considered to pose risks to environmental and social receptors. The Project activities considered in the ERA included mobilization of the MODU, drilling, well clean-up and testing, and demobilization of the MODU. The ERA findings are equally applicable to activities within either block.

Assessment Methodology

Risk is defined as the combination of the likelihood of an event occurring and the consequences of that event. Assessing the impact significance from accidental events therefore requires consideration of:

- ✓ The likelihood of an event happening;
- ✓ The probability of an event affecting a particular area;
- ✓ The sensitivity of the receptor (such as marine / coastal resources) that may be affected;
- ✓ The mitigation measures the Project will implement.

The ERA process comprised the following stages:

- ✓ Identification of potential release scenarios via an ENVID workshop (facilitated by ERM and attended by Statoil and Holísticos) and from a semi-quantitative risk analyses provided by Statoil;
- ✓ Definition of release scenarios (e.g. location, contaminant characteristics, discharge rates and durations) and the likelihood, or frequency, of their occurrence derived from Statoil and industry data (e.g. from UKOOA and OGP technical reports and databases);
- ✓ Oil spill modeling of selected release scenarios using the Generalized Environmental Modeling System for Surface waters (GEMSS) and its oil spill module - Chemical/Oil Spill Impact Module (COSIM) - to define an area of influence (i.e. potentially exposed to oil from the release scenarios);
- ✓ Identification of environmental and social receptors within the area of influence, together with an assessment of their vulnerability/sensitivity to oil contamination;
- ✓ Calculation of the oil spill drift time to, and the exposure of, the identified environmental and social receptors to spilt oil;
- ✓ Qualitative assessment of the short and long term impacts on the environmental and social receptors from the spilt oil;
- ✓ Calculation of the environmental risk level for release scenarios as a combination of the probability of the scenario causing an effect on, and the severity of the resulting consequence (or impact) to an environmental or social receptor; and
- ✓ Comparison of the levels of environmental risk for release scenarios to risk tolerability criteria and consideration of the ALARP (As Low As Reasonable Practicable) principle.

5.3.2. **Identification of Oil and Diesel Fuel Release Scenarios**

Scope of Assessment

Consideration of the results of the ENVID workshop and Statoil's semi-quantitative risk assessment identified five release scenarios for further consideration *Table 5.8*.

Table 5.8. Block 39 Exploration Drilling Project Release Scenarios

Hazardous scenario number	Hazardous scenario description
1	Well blowout due to a major loss of positioning of the MODU during exploration drilling operations (while drilling in the hydrocarbon rich zone).
2	Well blowout event during exploration drilling in the hydrocarbon rich zone (this considers all the predefined technical barriers to have failed).
3	Base oil spill and release to marine environment during its transfer from a supply vessel.
4	Diesel spill and release to marine environment during its transfer from a supply vessel.
5	Discharge of untreated drilled material from the MODU topsides to the marine environment.

These release scenarios were subject to further analysis (Event Tree Analysis) to produce a number of sub-scenarios to which release volumes and frequencies could be assigned. Full details of this assessment are available in the ERA Report (Appendix F).

5.3.3. Oil Spill Modeling

Overview

The GEMSS COSIM model was used to assess the fate and transport of hypothetically spilled oil under the release scenarios identified. The model simulates the movement of oil using current and wind information. The transport computation is combined with a fate computation that uses oil properties along with other environmental data to calculate evaporation, volatilization, dissolution, and entrained oil droplet formation. Properties (aliphatics, dissolved nitrogen and carbon dioxide) of crude oil for modeling were taken from reservoir fluid samples from Blocks 38 and 39, provided by Statoil, and in the absence of analysis of aromatics, from database information. The model uses a stochastic approach which allows a probabilistic estimate of spill behaviour over a range of conditions.

Based on an analysis of wind and current data, two months were selected for the crude spill (well blowout) simulation, March and September; and two different months for the diesel spill, October and November. The wind and current analysis indicated that these months will capture oil transport in different directions and illustrate a representative envelope of spill behaviour. Four release scenarios for crude oil were considered within the blocks, a shallow blowout and a deep blowout, each at a medium and high discharge rate. All crude spill origins were assumed to occur at a location approximately in the centroid of the Block 38 and 39 (at coordinates 187,167 m easting, 8,773,271 m northing in UTM Zone 33 South WGS 1984). A fifth scenario for vessel diesel spill was assumed to originate at a point halfway between the Block centroid and the Port of Luanda (at coordinates 239,681 m easting, 8,898,080 m northing in UTM Zone 33 South WGS 1984, with a water depth of approximately 1180 m). Table 5.9 shows the volume released for each scenario and the spill duration. The model was run to simulate two weeks after the release has ended.

Table 5.9. Oil Spill Scenarios

Number	Description	Volume/ Flow rate	Duration
1	Block 38 and 39 centroid Surface Blowout - Medium rate	2,900 $m^3 d^{-1}$	15 days (29 day simulation)
2	Block 38 and 39 centroid Surface Blowout - High Rate	5,600 $m^3 d^{-1}$	15 days (29 day simulation)
3	Block 38 and 39 centroid Deep Blowout - Medium rate	1,300 $m^3 d^{-1}$	79 days (93 day simulation)
4	Block 38 and 39 centroid Deep Blowout - High Rate	17,000 $m^3 d^{-1}$	79 days (93 day simulation)
5	Midway to Port of Luanda Surface Release - vessel diesel	1,100 m^3	1 hour (14 day simulation)

The oil spill modelling was performed assuming no intervention activities take place, in order to show the unhindered trajectory of the spill, and the full extent of all possible shorelines that could be oiled.

Model simulations were run with random start dates throughout the study period. Randomization allows development of the probabilities of occurrence of oiling at the water

surface and at the coastline. The maximum oil thickness and highest concentration of dissolved phase aromatic hydrocarbons (DAH) over space and time as well as the travel time of the surface slick, the latter being useful for determining the minimum time for oil to reach the shoreline, were also calculated.

Table 5.10 summarizes the significance of these outputs and how they are applied to the overall risk assessment.

Table 5.10. Model Outputs

Output component	Importance of information	Potential use of information
Geographic distribution and probability of the slick	Understanding relative risk and extent of a spill event	Risk analysis and response planning
Geographic distribution of oil thicknesses	Understanding extent of significant oil mass per area and the smothering effects on biota	Response planning and ecological effects
Probability of shoreline impact and time to impact	Understanding risk to coastal receptors and extent of shoreline response	Risk analysis and response planning (clean-up extent after impact)
Travel time	Assist in spill response planning to understand the range of times when oil may contact shorelines	Response planning (time to intercept before shoreline impact)
DAH concentrations	Dissolved fractions present a different risk and response issue than solid and free liquid product forms and have implications for aquatic life	Aquatic toxicity assessment and ecological risk

Two critical threshold assumptions are used in the design of the models and interpretation of results. These assumptions address critical thresholds for oil slick thickness and DAH concentrations and relate directly to the ecological effects. Table 5.11 summarizes these assumptions.

Table 5.11. Model Critical Assumptions

Assumption	Value	Importance	Source
Significant slick thickness	0.1 µm	Smothering of aquatic organisms. Converted from the 1-10 µm	French et al. (2009); NOAA (1996)

Assumption	Value	Importance	Source
		smothering thickness cited in the literature, decreased by a safety factor of an order or magnitude to 0.1 µm.	
DAH critical concentrations	5 parts per billion (ppb)	Acute narcotic effects to aquatic organisms.	ANZECC and ARMCANZ (2000) and French (2000)

Summary of Oil Spill Modelling Results

A summary of the results of the oil spill modeling for the different scenarios is provided in *Tables 5.12* to *5.14* below. It is important to note that the information presented on the total shorelines at risk has been derived from probabilistic modeling and does not indicate the expected extent of oiling from a single spill event. The full oil spill modeling report, including figures illustrating the probabilistic oil spill trajectory modeling, is available as Appendix F of this EIS (ERM & Holísticos, 2013a).

Table 5.12. Surface Blowout Scenario Oil Spill Results

Simulation	Month	Total Water Surface at Risk of Visible Oiling (km²)	Surface Area with Dissolved Aromatics > 5 ppb (km²)	Minimum Arrival Time to Shoreline (days)	Total Shorelines at Risk of Oiling (km)
1a	Medium rate March	110,459	24,651	20.8	238
1b	Medium rate September	61,841	34,201	18.4	446
2a	High rate March	133,679	35,497	24.1	125
2b	High rate September	59,356	60,684	16.0	433

For the surface blowout in March, the south-easterly directed currents dominate the transport direction, and combined with the winds pressing toward the coast, drives the slick to the north and east until it is captured by the dwindling Congo River flow and the westerly currents that turn the slick offshore Gabon. In September, the slick is driven to the east where it intercepts the coast south of Luanda and spreads out north and south.

Table 5.13. Subsurface Blowout Scenario Oil Spill Results

Simulation	Month	Total Water Surface at Risk of Visible Oiling (km²)	Surface Area with Dissolved Aromatics > 5 ppb (km²)	Minimum Arrival Time to Shoreline (days)	Total Shorelines at Risk of Oiling (km)
3a	Medium rate March	533,679	1,588	32.9	848
3b	Medium rate September	316,120	1,588	23.0	889
4a	High rate March	521,979	10,428	30.10	1,287
4b	High rate September	313,291	13,662	20.77	1,259

For the subsurface scenarios in both March and September, there is a general north-west trajectory on the surface. In March, the majority of the plume heads out to sea, with 1% to 30% likelihood of the slick spreading towards the shoreline. However, in September, the surface trajectory is mostly towards the northeast, with subsequent transport to the northwest, north of Luanda, as per the March scenario. This results in a high likelihood (up to 100%) of shoreline oiling of central Angola south of Luanda.

Table 5.14. Diesel Spill Scenario Results

Simulation	Month	Total Water Surface at Risk of Visible Oiling (km²)	Surface Area with Dissolved Aromatics > 5 ppb (km²)	Minimum Arrival Time to Shoreline)	Total Shorelines at Risk of Oiling (km)
5a	October	29,512	21,679	5.0	362
5b	November	40,327	18,407	6.8	139

The diesel spills show distinct transport northeast and due east to the coast around Luanda, Angola. In October, the trajectory is directed eastward, similar to the September crude scenarios while the November simulations shows the north to northeast trajectory more similar to the March crude simulations. A greater area of water surface is at risk of oiling in November than in October.

5.3.4. Identification of Area of Influence and Sensitive Receptors

Area of Influence

The results of the oil spill modelling for all the release scenarios were critically examined in order to select a 'dimensioning scenario' that would highlight an area of influence from potential oil spills, within which sensitive receptors were to be identified. The high rate, deep blowout scenario was selected as the dimensioning scenario (Statoil Angola Environmental Risk Assessment, ERM, 2013).

The area of influence was determined by incorporating the statistical oil spill modelling (stochastic) outputs and the location of sensitive environmental and socio-economic receptors, identified through a desktop study utilizing available information, into a sensitivity map (*Figure 5.1*). The area of influence was specified as those areas with probabilities of > 10% of oiling in the event of a subsea blowout. This information was used to delineate the areas of high risk, which includes the region south of the Bengo River Mouth to Ngunza River Mouth which is the focus of the consequence evaluation.

A full set of maps illustrating the coastal areas at risk from surface oiling, DAH concentrations, oil thickness, travel times for a high release rate subsurface blowout during March and September can be found in the ERA report (Appendix F, ERM & Holísticos, 2013b).

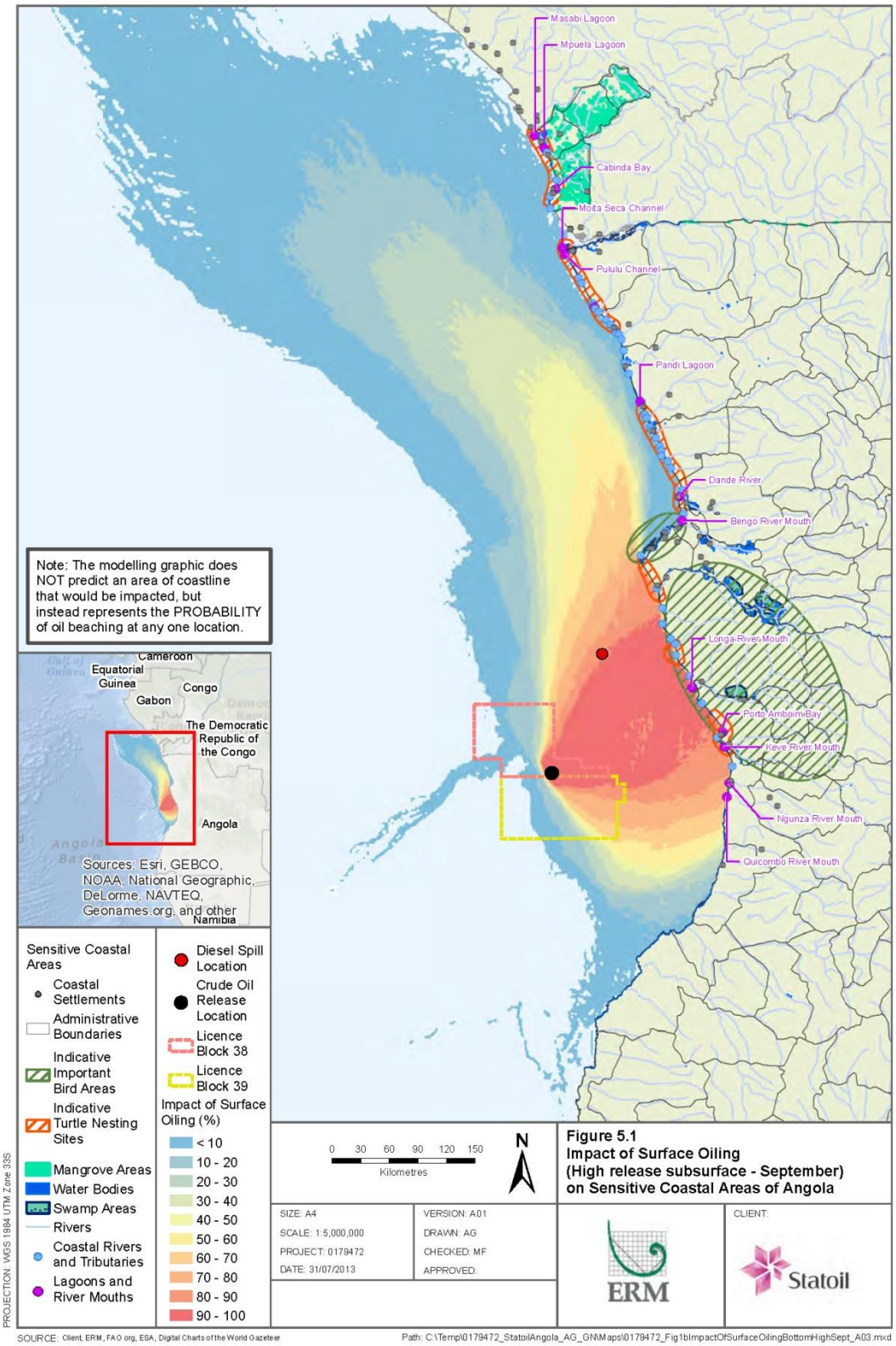


Figure 5.1. Area of Influence

Identification of Sensitive Receptors

As identified in Section 4.5.10 of this EIS report, there are a number of protected areas on the coast of Angola, as well as along the coast of Gabon, Republic of Congo and the Democratic Republic of Congo. Protected areas within the high risk areas within the area of influence (as identified in the ERA Report) include the:

- ✓ Ilhéu dos Pássaros Integral Nature Reserve (Located 8 km west of Luanda, Angola, The nature reserve comprises a tidally inundated island of mudflats and mangroves and represents an important habitat for wading birds and mangroves (including *Rhizophora* and *Aricennia* species); and
- ✓ Quiçama National Park (IUCN Category II status, critical site for biodiversity and is an Important Bird Area (IBA). The 125km of coastline consists of high cliffs and isolated sandy beaches. Green turtles and Leatherback turtles nest along the coast, and Olive Ridley turtles have also been observed in the area.

The environmental and socio-economic receptors at risk along the coast of the Quiçama National Park (between Bengo River Mouth and Ngunza River Mouth) are described in Tables 5.15and 5.16. A sensitivity ranking has been assigned to each site in line with IMO/IPIECA guidelines (Statoil Angola Environmental Risk Assessment, ERM, 2013).

Table 5.15. Environmental and Socioeconomic Receptors at Risk along the Luanda Coast.

Site	Environmental	Socio-economic	Oiling Probability (%)	Sensitivity to Oil Pollution
Buraco	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed and sheltered tidal flats • The vegetation is dominated by mangroves and grass. • Sheltered tidal flats provide a feeding and spwaning ares for fish and birds including wading birds, gulls, terns, herons, raptors, passerine birds and birds of prey. • Olive Ridley and Leatherback turtle species are present in the area. • Cetaceans including finfish whale, the Atlantic humpback and the common dolphin are present.in offshore waters.	• The population is estimated at at 886 inhabitants who depend on the fishing, mainly aritisinal fishing. • The main fish species include cacusso, macoa, cod, sardines, small croaker, lobster, and mackerel. • The highest catch period is from May to September.	40%	Very High
Barra do Kwanza	• Covers an area of approximately 960,000 hectares. • The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed rock shores and exposed tidal flats. • The vegetation is dominated by mangroves. • The estuary serves as a feeding and spawning ground for fish and birds. • Green, Olive Ridley and Leatherback turtle species are present in the area. • The area is know for the presence manatees in river systems. • Cetaceans including finfish whale, the Atlantic humpback and the common dolphin are present.in	• The population is estimated at at 213 inhabitants who depend on the fishing and trade. • The houses of fishermen, totaling 49, are located about 150 meters from the beach and others along the road linking the diversion to the mouth of the Kwanza river.	50%	High

Site	Environmental	Socio-economic	Oiling Probability (%)	Sensitivity to Oil Pollution
	offshore waters.			
Sobe e Desce	• The shoreline comprises of coarse grained sandy beaches and exposed tidal flats. • The vegetation is predominantly savannah • Inshore waters are potential fishing grounds for fish and shellfish. • Most of the birdlife are casual visitors • Marine turtle species include the Olive Ridley and Leatherback turtles. • Whales have been observed, in offshore waters and different species of dolphins have been sighted in the coastal waters.	• The population is estimated at 360 inhabitants, of which about 93 are artisanal fishermen. • The main activity of the region is artisanal fisheries, the main species include pungo, black and white sea bass, grouper, hake, and lobster. • The biggest catch recorded is from May through December, while January to April is considered the lowest catch period.	90%	Medium to High
Cabo Ledo	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed rock shores and exposed tidal flats. • The beach of Cabo Ledo is set within a bay that extends from the southern part of the region. • Vegetation is predominantly savannah with the presence of *Euphorbia conspicuous* and *Sterculia sp.* • Potential fishing grounds, where the seasonal presence of fish such as pungo, sole and lobster is common • Most bird species are casual visitors that use the beach as feeding and resting grounds, the common tern is known to occur in the area • Cetaceans observed offshore include different species	• The population is estimated at 681 inhabitants. • The main activity of the region is artisanal fisheries. • The monthly biomass capture in this area is estimated at 122,609 kg/month and the main species include pungo, tuna, sea bass, snappers, mackerel, sardines and lobster. • The biggest catch is recorded, from May to November and the lowest during December to April • The Lighthouse (old) and the quarry are important historical site	50 %	High

Site	Environmental	Socio-economic	Oiling Probability (%)	Sensitivity to Oil Pollution
	of dolphins that come close to the coast.	• Cabo Ledo is a reserved area to promote tourism		
Sete Irmãos	• Sete Irmãos has an extensive coastline that stretches 22 kilometres to the Cape of Cabo Ledo. • The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed rock shores and exposed tidal flats. • The predominant vegetation is usually rhizomatous, creeping or prostrate. • The inshore waters has a fishing potential, with a seasonal presence of fish, pungões and lobsters. • Most of the birds are casual visitors that use the beach as feeding and resting ground. Sea gulls, common terns and waders are very common. • Presence of the Olive Ridley and Leatherback turtles. • Cetaceans observed in offshore waters include common dolphins.	• There is a small village consisting of fishermen and their immediate families. • The beach is often visited by tourists and fishing enthusiasts.	60%	Medium
Praia de São Bras	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed rock shores and exposed tidal flats. • The dominant vegetation in the area is savannah with a presence of Euphorbia conspicua; grassy layer composed of several species. • Potential fishing grounds for lobsters, shrimps and crabs. • Most birds (especially the common tern) are casual visitors that use the beaches for feeding and resting.	• The population is estimated at 773 inhabitants, about 203 are residents and 33 occasional fishers. • Fish caught in the area: include cod, southern meagre, tuna, cassava croaker, white and black skate, barnard dentex (in the cold months), lobster, white grouper, malesso. • The Bay of São Brás beaches are frequented by tourists.	70 %	High

Site	Environmental	Socio-economic	Oiling Probability (%)	Sensitivity to Oil Pollution
	• Presence of Leatherback turtles. • Cetaceans observed in offshore waters include the Atlantic humpback whale and the common dolphin.			
Kitoba	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed tidal flats. • The dominant vegetation in the savannah area is the Euphorbia, *Acacia welwitchi* and *Aloe zebrine.* • The inshore waters has a fishing potential, with a seasonal presence of fish, pungões and lobsters. • Casual visiting birds use the beaches for feeding and resting. • A large presence of common stern. • Presence of Olive Ridley and Leatherback turtles.	• The population is estimated at 301 inhabitants. • The main activity of the region is artisanal fisheries. • The fish catch of the region is estimated at 36,000 kg/month and the main species include: white croaker, halibut, skate, grouper, and mackerel. • Biggest catch occur during the months of June to December, while the period of January to May is considered the lowest yield for fishing.	50%	Medium

Table 5.16. Areas at risk along the Kwanza Sul Coast

Site	Environmental	Socio-economic	Probability of Oiling	Sensitivity
Cabo das Três Pontas	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed rock shores, exposed steep slopes, tidal flats and man-made structures. • Fisheries resources include the presence of lobster and white grouper. • Potential area for sea turtles. • Coastal and marine birds include waders, terns and seagulls. • Marine mammals observed offshore include the fin whale, Atlantic humpack and common dolphin.	• There are no communities living near the coast, because the area is surrounded by farms. A total 127 people live in adjacent areas (Ngola beach). • Fishing activities are carried out in inshore waters and there is a total of 62 fishermen. • There are no places of historical or cultural importance; no tourist activities.	100%	Medium to High
Ponta do Morro de Quissonde	• The shoreline comprises of coarse grained sandy beaches which are interspersed by steep scarps, slopes and exposed tidal flats. • The dominant vegetation in the area is the savannah with the dominance of *Euphorbia conspicua sp.* • The presence of migratory marine birds such as the common tern and other species including cape glossy starlings, seagulls and herons have been observed along the coastline.	• The beach was once frequented by 329 fishermen, but due to the construction activities by the companies Paenal and Hereema, people stopped to fish at this location and were moved to the bay of Porto Amboim and the Keve river. • There is no tourism due to location and access, but we highlight the tourism potential of the area, especially the beaches south of the ponta de Quissonde. • The Lighthouse of Quissonde is a historical-cultural site.	80%	Medium
Keve River Mouth	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed tidal flats. • The vegetation along the river mouth is predominantly	• There are two neighbourhoods near the river mouth with 187 and 169 people respectively.	70%	High

Site	Environmental	Socio-economic	Probability of Oiling	Sensitivity
	grassy savannahs and mangroves. • The most important fishery resources in this area are oysters, lobster, white groupers, swords, croakers, tilapia, and other species. • The presence of heron, terns, raptors have been observed. • Marine mammals observed offshore include the fin whale, the Atlantic humbacked dolphin and common dolphin.	• The houses are located approximately 100 meters from the coast. • Livestock and crop farming is the second most important activity after fishing, The beaches near the river mouth are frequented by many tourists especially at weekends and holidays. • Ttraditional festivals, called "Kitutas," are held in this area.		
Ngunza River Mouth	• The shoreline comprises of coarse grained sandy beaches which are interspersed by exposed tidal flats. • The vegetation is dominated by meadows with the occurrence of *Cyperus papyrus* • High incidence of anthropogenic cultures, the most obvious being the palm(*Elaeis guineensis*), banana (*Musa sp.)* and sugarcane (*Saccharum sp*). • The presence of birds associated with wetlands include gray heron, little egret, black-headed heron and others. • Marine mammals observed offshore include the fin whale, Atlantic humbacked dolphin and common dolphin.	• An estimated 3,803 people live in the area. • Houses are situated 200 meters from shore and less than 100 meters from the river. • Soils are not suitable for agriculture, therefore the population mainly dependent on fishing.	70 %	Medium

5.3.5. **Assessment of Impacts**

This section summarises the potential impacts on the most sensitive receptors that would likely be exposed to impacts from the oil spill (including base oil of SOBM) and diesel spill scenarios described above. The impacts to the receptors are considered on the basis of the oil spill release selected in the dimensioning exercise, the high rate deep blowout for 79 days. This scenario was selected on the basis of the deep blowout scenarios having the largest amount of coastlines at risk of potentially contacting oil; the high rate deep blowout scenarios had the shortest arrival times to the shoreline (Statoil Angola Environmental Risk Assessment, ERM & Holísticos, 2013b). The impact assessment ratings, based upon this worst case scenario, are therefore considered to be conservative. In the event of an actual incident the extent of the impacts would be directly related to the volume, duration and location of the oil release, and the prevailing tide and weather conditions.

In the unlikely event of an oil spill, the most vulnerable components of the ecosystem in offshore and coastal environments are seabirds, marine mammals and turtles, due to their close association with the sea surface. Fish species and larger invertebrates in deeper water can be expected to be less exposed to impacts from oil spills as they will tend to avoid the impacted area in the event of an oil spill.

Water Quality

Water quality impacts, delineated to areas where DAH concentrations of greater than 5 ppb (which can cause acute narcotic impacts to aquatic organisms – see Table 5.11), will occur in the vicinity of the spill. Oil spill modelling results (ERM & Holísticos, 2013a) indicated that, depending on the release scenario, surface DAH concentrations would be expected to remain within 50 km to 500 km of the release point. Amongst the crude oil scenarios modelled, only one scenario (Scenario 2; High Rate in September) seemed to indicate encounter with the coast while for the remaining scenarios, DAH concentrations seemed to remain offshore. For the diesel spill scenario however, surface DAH concentrations would

be expected to intercept with the shoreline at Luanda and at 75 km and 150 km south of the peninsular and extend up to 200 km south, north and northwest of the origin.

In the event of oil reaching the coastline, impacts could include contamination of sensitive coastal habitats such as mangroves, wetlands, lagoons and turtle nesting beaches and impacts on species that frequent such habitats such as coastal birds and fish. An additional impact of oil reaching the coastline would be the potential impacts on local communities whose livelihoods depend on coastal resources.

Even with the application of the latest industry standards and consideration of the highest standards of safety, accidental events may still occur due to human error, equipment failure and other procedural aspects. Impacts are therefore evaluated to be of Major, due to the possible widespread nature of the spill and the surface area which will be covered by oil in the event of a spill (between 2,299 km^2 and 60,684 km^2).

Sediment Quality

Potentially sensitive benthic receptors identified from secondary regional surveys include cold water coral (*Lophelia*); carbonate concretions; giant pockmarks supporting mussels (B*athymodiolus sp*.) colonies; and subsea vents supporting vesicomyid bivalves and vestimentiferan tubeworm.

The oil spill modelling results for the dimensioning scenario illustrated that due to the properties of the oil, approximately 30% of the spilt volume will rise and remain suspended in the water column in less than 24 hours, a further 70% undergoes dissolution (dissolves in the water) within 24 hours. The oil is therefore not expected to cause a smothering effect on benthic organisms in the deep-sea environment. The predicted impacts to the seabed and to all other benthic communities are assessed as of *Minor* significance.

Seabirds and Coastal Birds

The seabirds located in the Project area are discussed in Section 4.5.8 of this EIS report. The Quiçama National Park, located within the high risk zone of the area of influence is an IBA. It comprises a diversity of bird habitats, including the most southerly patch of extensive mangrove forest in the country (in the Kwanza estuary). As identified in the ERA report, a total of 68 waterbird species (47% of the Angolan list) have been observed in the Quiçama National Park area, and some occur in numbers that are nationally significant. The mudflats along the tidal mouth of the Kwanza River are important foraging areas for Palearctic waders in the austral spring and summer (Holísticos, 2012).

Direct mortality of birds in the event of an oil spill is often the most widely perceived risk. While impacts to birds can occur offshore in the marine environment, the more pronounced impacts are often experienced if oil reaches coastal waters. Spills affecting coastal waters near major bird colonies during the breeding season can be particularly severe since birds are feeding intensively and often dive through the surface oil to feed on fish. Birds are affected by oil pollution in the following three key ways.

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

Given the sensitivity of birds to the effects of oiling and the importance of the habitat in the zone of influence, in particular the Ilhéu dos Pássaros Integral Nature Reserve and the Quiçama National Park, the impacts to seabirds and coastal birds from a potential oil spill have been assessed as being of *Major* significance.

Marine Mammals

The area offshore Angola is known to support significant marine mammal populations including protected and sensitive species which are discussed in Section 4.5.6 of this report. Many of the species found in Angolan waters are listed by the IUCN (International Union for the Conservation of Nature), including the Fin and Sei Whale (both endangered), and Sperm Whale and West Africa Manatee (both vulnerable) and therefore should be deemed sensitive to disturbance. The humpback whale (*Megaptera novaeangliae*) is the best–documented cetacean species occurring offshore Angola due to its abundance in West African waters during the winter and spring months when it uses the region as a breeding ground. Humpbacks are found in Angolan waters primarily between July and October (austral winter and spring), when the species utilizes West Africa for mating and calving.

The portion of the water column most affected by a spill is the water surface and the top few meters of the water column beneath the slick (except for the deep blowout scenario), particularly in the first week of the spill before many hydrocarbon compounds evaporate or degrade.

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

In all spill scenarios modelled, DAH concentrations >5ppb are likely to be present which may potentially cause acute toxicological impacts due to narcosis. Acute narcotic effects are caused by sustained exposure to dissolved compounds from the liquid oil droplets, especially the soluble aromatics. Acute impacts are typically defined as occurring within four days. Ingestion or contact with tiny liquid droplets may cause additional stress or mortality upon the organisms in this region. Dilution and biodegradation will typically reduce these concentrations to sub-lethal levels within days to weeks. However, even at sub-lethal levels,

impacts may occur due to chronic impacts from prolonged exposure to these dissolved concentrations.

Symptoms of acute exposure to DAH include irritation to the eyes and lungs, lethargy, poor coordination and difficulty with breathing. Individuals may then drown as a result of these symptoms. Studies conducted following the Exxon Valdez tanker oil spill identified direct mortality of marine mammals (primarily seals, with increased pup mortality reported in areas of heavy oil contamination compared to un-oiled areas) resulting from exposure to oil. The general consideration is that marine mammals will avoid the affected area, the impacts to marine mammals are therefore considered to be *Moderate*.

Marine Turtles

The distribution of marine turtles within the Project area is discussed in Section 4.5.7 of this report. Marine turtles spend most of their life at sea, but during the breeding season they go ashore and lay their eggs on sandy beaches. Green (*Chelonia mydas*) and Leatherback (*Dermochelys coriacea*) turtles nest on the isolated beaches found along the coast of Quiçama National Park. The areas of the coastline north of Luanda to Mpuela lagoon is also know to support turtle nesting, including the Olive Ridley (*Lepidochelys olivacea*).

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

- ✓ Increased egg mortality and developmental defects;
- ✓ Direct mortality due to oiling in hatchlings, juveniles and adults; and
- ✓ Negative impacts to skin, blood, immune systems and salt glands.

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

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

Given the sensitivity marine turtles to the effects of oiling and the importance of the habitat in the high risk zone of the area of influence, south of the Bengo River Mouth to Ngunza River Mouth (including the beaches of the Quiçama National Park), the impacts marine turtles from a potential oil spill have been assessed as being of *Major* significance.

Coastal Habitats

The oil spill modelling identified a high risk zone between the Bengo River Mouth and Ngunza River Mouth. This section identifies coastal habitats in the area that may be particularly sensitive to impacts from oil spills including:

- ✓ Sandy marine shore ecosystems;
- ✓ Rocky marine shore ecosystems;
- ✓ Coastal lagoon ecosystems; and
- ✓ Estuarine wetland ecosystems.

The various sensitivities of each ecosystem are summarised below:

- ✓ Species diversity on sandy beaches is typically low, especially on beaches with coarse sand and steep slopes. However, sandy beaches serve as important nesting sites for sea turtles and in some cases are important sites for coastal bird species.
- ✓ Rocky shores occur as rocky out-cropping alternating with sandy bays. The rocks are substrate for a wide variety of species of macro algae, barnacles and snails. Ecologically, algae mats on rocky shores serve as important micro-habitats for epifauna (ie crustacean, macro-invertebrates) and fish.
- ✓ Coastal lagoon habitats are particularly important ecosystems. They support mangrove habitats and significant populations of fish, shrimps, crabs and mollusc species; in addition they are important nursery sites for many fish species. Coastal lagoon habitats also support significant numbers of waterfowl species.
- ✓ Estuarine areas and wetlands are generally exposed when the tide is out and are seasonally inundated during the rainy season. They support stands of mangrove and other species typical of swamp forests and act as important nursery habitats for fish and feeding areas for waterfowl species.

Each type of coastal habitat is considered sensitive to oil spills, however, lagoons and estuarine areas and wetland habitats are considered particularly sensitive as they tend to support more significant numbers of species, and include fish nurseries and bird feeding areas. If an oil spill beached in these areas toxic concentrations of oil may develop in the shallow water and due to the long persistence time of the oil effects may be encountered for a long period. If oil enters into an open lagoon or wetland, natural removal rates are slow because there is no wave action to remove the oil and it tends to adhere to the flat substrate preventing removal by tides.

In mangrove stands, such as those found in the Quiçama National Park, oil slicks may enter the mangroves when the tide is high and are deposited on the aerial roots and sediment

surface as the tide recedes. The oil clogs the pores in the aerial roots and if many roots are oiled, the respiratory system collapses and the trees die.

Taking into account the sensitivity of the coastal habitats within the high risk zone in the area of influence from a spill, the impacts to them from a potential oil spill are considered to be of *Major* significance.

Fish Stocks

The offshore and coastal waters in Angola support a significant diversity of fish species, many of which are targeted by the artisanal and commercial fisheries. Most fishing activities occur from close to inshore to the edge of the continental shelf. Fish nursery areas that exist along the coastline are vital at sustaining fish stocks in coastal areas.

Typically, adult fish are not considered highly sensitive to impacts from oil spills. Adults are mobile and generally able to detect heavily contaminated areas or areas of low water quality. In open waters, fish have the ability to move away from an area of pollution, and are therefore either unaffected by oil or affected only briefly. As discussed above, oil contamination (DAH concentration) in the water column below an oil slick is generally low. As such, it is unlikely that fish are significantly affected by oil in open water.

Fish kills may occur as a result of high exposure to emulsified oil / freshly spilled diesel in shallow waters (such as in lagoons) and oil pollution may clog fish gills causing asphyxiation. In all the oil spill scenarios modelled, the DAH concentrations in the top few meters of the water column beneath the slick in the first days after release, before many hydrocarbon compounds evaporate or degrade, are likely to be present at magnitudes which may cause acute toxicological effects due to narcosis.

At the population level effects can be short lived due to the death of affected individuals and the persistence of healthy individuals unaffected by contamination. Non-lethal negative effects are more usual and fish can be affected in the long term in some circumstances,

especially when oil spills into shallow or confined waters. Fish exposed to elevated concentrations of hydrocarbons absorb contaminants though their gills, accumulating it within their internal organs which can lead to long-term, sub-lethal effects. In addition, spilled oil in confined and shallow waters, such as lagoons, poses a threat to fish eggs and larvae which cannot actively avoid oil. Fish eggs and larvae are mostly in the upper planktonic layers, and hence are affected and heavy mortalities often result. Lethal effects on the population as a whole are rare but long-term, sub-lethal effects are possible, particularly if a major spawning area is affected.

In terms of the vulnerability of impacts to fish stocks from an oil spill, while fish in open waters are not particularly sensitive, the species found in coastal lagoons are highly sensitive. These areas are spawning grounds and nursery areas for young and small fish. Taking these factors into account, the impacts to fish stocks from potential oil spills are considered to be of *Moderate* significance.

Fisheries

Angolan waters are particularly rich in commercially relevant species and the fishing activities along the coast are important from a socio-economic perspective (fish exports, employment and source of food). These species are conventionally grouped into crustaceans, demersal fish and pelagic fish (pelagic fish are distributed along the Angolan coast and make up about 80% of the total fish landed in Angola).

Artisanal fishing activities are scattered along the coast with the majority of registered artisanal fishermen landing their catches at some 105 controlled landing places, predominantly in Benguela and Luanda provinces, which have the greatest concentration of artisanal fishing areas.

In the event of an oil spill that reaches either coastal waters, or beaches within coastal lagoons, fisheries are usually suspended by the regulatory authorities to avoid contamination of fish being lifted through the slick on the surface waters and to prevent

gear contamination. Fishing is difficult or impossible in areas directly affected by an oil spill. Vessels and gear will be smeared in oil and the catch might be spoiled. The fishermen might for a period be forced to stop or temporarily move to other fishing grounds nearby free of oil slicks. These fisheries closures will directly affect fishing communities along the coastline by preventing them from maintaining their livelihood during the period of closure, resulting in a reduction in both food and economic resources.

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

Given the importance of artisanal fishing to the communities along the Angolan coast, and along the Luanda and Kwanza Sul Province coasts (identified within Table 5.15 and 5.16) located within the high risk zone of the area of influence from a potential spill, the impact to fisheries from a potential oil spill that reaches coastal waters is considered to be of *Major* significance.

Tourism and Recreation

There are three beaches in the area influence identified that are used frequently for tourism and recreation; Sete Irmãos, Praia de São Bras and Keve River Mouth.

In the event of an oil spill contacting at or near tourist beaches, direct access to the shore and activities such as swimming and fishing are likely to be banned for health protection purposes. Actual, or perceived, oil contamination in coastal areas would be likely to result in loss of tourist income due to cancellations of hotel bookings, even in areas not directly affected. In the longer term, the perception among tourists of a polluted coastline might adversely impact the tourism industry. Tourism is not currently a source of significant income for local communities, however, any oil spills would have a detrimental impact on the areas reputation and the potential for future economic growth. Taking this into account,

the impact of potential oil spills to tourism and recreation is considered to be of *Minor* significance.

Community Health and Safety

The *ITOPF Technical Information Paper on Oil Spill Effects on Fisheries* reported that the toxic effect of oil on marine life depends on the duration of exposure and oil concentration in the environment (*ITOPF, 2004*). Adult free-swimming fish, squid, shrimp and wild stocks of other commercially important marine animals and plants seldom suffer long term damage from oil spill exposure. Oil concentrations in water were reported to rarely reach sufficient levels to cause harm and therefore usually temporary and localised (*ITOPF, 2004)*. The greatest impact according to the same paper was likely to be found on shorelines were animals and plants may be physically coated and smothered by oil or exposed directly to the toxic components in oil *(ITOPF, 2004)*.

The modelling study reported that spills may spread towards the east, impacting land and coastal resources.

Oil spills could also result in tainting of fisheries resources and other marine organisms either through direct contact with the spill or by consuming other smaller marine life that have ingested oil. Consumption of oil tainted marine life would result in public health issues as the uptake of potentially carcinogenic polycyclic aromatic hydrocarbons (PAH) could lead to health issues such as cancer.

Oil spills are harmful to human health from evaporation or smoke as oil is burned and inhalation of volatile organic compounds and other hydrocarbons. Oil vapors can cause headaches, dizziness, nausea, vomiting, eye and throat irritation, and breathing difficulties. Inhalation of large amounts of fumes could lead to chemical poisoning called hydrocarbon pneumonia (WSWS, 2010).

Even with the application of the latest industry standards and consideration of the highest standards of safety, accidental events may still occur due to human error, equipment failure and other procedural aspects. Impacts of spills on community health and safety are therefore evaluated to be of *Moderate* significance.

5.3.6. **Environmental Risk Summary**

As can be seen from the discussion above, in the event of an oil or diesel spill, impacts could occur to sensitive environmental and socio-economic receptors ranging from Major to Minor significance. The spill modelling scenarios and dimensioning scenarios undertaken in the ERA, as illustrated in Figure 5.1 indicate that oil spills would be most likely to impact the coast lines of Luanda and Kwanza Sul Provinces.

Lower probabilities exist that impacts to sensitive resources from an oil spill event could be observed to further south, along the coast of Benguela Province. The oil spill modelling identified a general trend of surface slicks to be driven to the northeast from the spill site. Accordingly oil spill impacts could also potentially be observed in the waters and to the coastlines of the Angolan provinces to the north of Luanda, and of the countries to the north of Cabinda including the Democratic Republic of Congo, Congo Brazzaville and Gabon.

As previously stated, the level of environmental risk to these receptors is derived from a combination of the likelihood of a spill occurring, the likelihood (between <1 and 100% based on stochastic oil spill modelling) of oil reaching a receptor, and the magnitude of consequence of the resulting impacts. The ERA assigned frequencies of occurrence to the release scenarios identified, together with consequence ratings for each to determine a risk level for each. Note that mitigation and control measures in place were taken into account when calculating the scenario frequencies used in the determination of risk levels.

The risk levels for the release scenarios were then compared to risk tolerability criteria agreed with Statoil. Risks were classified within three levels:

- ✓ **Acceptable risk** (remedial action is discretionary; procedures are to be put in place to ensure that this risk level is maintained);
- ✓ **Tolerable risk if ALARP** (require remedial action to be taken and are tolerable if it can be demonstrated that they are 'As Low As Reasonably Practicable'); and
- ✓ **Intolerable risk** (intolerable or unacceptable; immediate action, further review, consultation or risk assessment required; operations not permissible except in rare or extraordinary circumstances).

All of the release scenarios examined in the ERA were determined to be either 'Acceptable' or 'Tolerable if ALARP'. In order to achieve ALARP, Statoil will implement a number of prevention and mitigation measures to minimize the risk of oil spills.

Full details of the risk assessment process and tolerability assessment are included in the ERA report (Appendix F).

Mitigation Measures

The primary mitigation measure for avoiding the impacts of an oil spill is to prevent any such spill from taking place. This is done through both technology applications as well as operational controls. In the event of an oil spill incident, the Project will implement a response system to mitigate the consequences of oil spills. A summary of the mitigation measures to be implemented by Statoil during the drilling program is provided below:

- ✓ Following established drilling safety standards to manage potential drilling hazards and minimize the risk of control loss;
- ✓ Comprehensive operational planning, risk assessment and provision of suitably specified equipment for drilling;
- ✓ Two BOPs (described in Section 3.2.5) will be installed during the drilling activities;
- ✓ Ensure access to Capping stack

- ✓ An Oil Spill Response Plan (OSRP) and Emergency Response Plan (ERP) will be implemented;
- ✓ Interface of the OSRP with the Angolan National Oil Spill Contingency Plan will be undertaken to ensure the availability of aerial surveillance services, dispersant spraying equipment, near-shore response equipment (i.e. shoreline booms), as well as trained personnel;
- ✓ Training of personnel with respect to the handling and deployment of oil spill response equipment;
- ✓ All vessels and the MODU will comply with IMO codes for prevention of oil pollution and have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs) and suitable storage and disposal procedures for waste oil;
- ✓ Approach procedures and poor weather operational restrictions for visiting vessels and transfer operations at the MODU;
- ✓ Audits of the MODU and vessels including detailed list of contract requirements in terms of spill prevention procedures that must be in place;
- ✓ Regular maintenance and inspection of equipment and high spill risk points (in particular bunkering hoses, bunds, storage tank valves etc.);
- ✓ Procedures in place for bunker transfer to minimise the risk of spillage;
- ✓ Use of bulk handling methods and non-return valves for diesel transfer to reduce the risk of spillage;
- ✓ Lube and hydraulic oil will be stored in tanks or sealed drums and will be well secured and stored in bunded areas, all of which will be properly maintained and inspected; and
- ✓ Issue Notice to Mariners to inform other sea users on field activities.

Statoil has taken a number of additional control measures post-Macondo, including the following standards and procedures, equipment and personnel training and certification. These have been reviewed and adapted where required to ensure safe and reliable operations and well integrity taking into account Macondo lessons[1].

[1] For example, the casing design manual and well control manual have been updated. In addition, relief well planning is now a standard part of the well delivery process.

Despite comprehensive prevention measures in place, the residual risk of an oil spill remains. Integral to Statoil's operations is the development of detailed and fully tested contingency response plans appropriate to the local environment and commensurate to the predicted risk. An Oil Spill Response Plan (OSRP) will be in place for the proposed drilling operations, including access to Tier 1 and 2 resources. Tier 3 resources will be provided through Statoil's membership with Oil Spill Response Limited. Further details on response resources can be found in the 'Statoil Blocks 38 and 39 Oil Spill Response Analysis Report'. Table 5.17 summarizes predicted environmental and social impacts from unplanned activities.

Table 5.17. Summary of Impacts and Mitigation from Unplanned Events

Receptor	Project Activity	Impact Description	Impact Designation	Mitigation and Control Measures	Residual Impact
Water Quality	Oil Spill (Well blowout)	DAH concentrations of greater than 5ppb can cause acute narcotic impacts to aquatic organisms Surface DAH concentrations would be expected to intercept with the shoreline.	Major	• Drilling safety standards • Comprehensive operational planning, risk assessment and provision of suitably specified equipment for drilling • Two BOPs • Ensure access to Capping stack • Oil Spill Response Plan (OSRP) and Emergency Response Plan (ERP)[1] • Interface of the OSRP with the Angolan National Oil Spill Contingency Plan	Moderate (ALARP)
Sediment Quality and Benthic Communities	Oil Spill (Well blowout)	Limited block-specific data does not allow the Project to confirm presence or absence of sensitive receptors. It is assumed therefore that sensitive receptors are present and will be impacted through direct mortality and sub-lethal health impacts.	Moderate		Minor
Fish	Oil (Well blowout) and Diesel Spill	Direct mortality Sub-lethal health impacts Avoidance of oil contaminated areas in open water	Moderate		Minor

[1] Draft plans are completed and will be tested and finalized through internal workshops in Luanda in Q32013. The purpose of such alignment workshops is to calibrate response approaches by working closely with those parties assigned ownership of and accountability for mitigations related to unplanned events.

Receptor	Project Activity	Impact Description	Impact Designation	Mitigation and Control Measures	Residual Impact
Seabirds	Oil Spill and Diesel Spill	Stains of oil on the plumage may destroy the insulating and water repelling properties which may ultimately cause the death of the bird. Toxic effects after the ingestion of oil during preening, ingestion of oiled prey, inhalation of oil fumes or absorption of oil through skin Indirect effects may result from destruction of bird habitats or food resources.	Major	• Handling and deployment of oil spill response equipment training[1] • MODU and vessels will comply with IMO codes for prevention of oil pollution and have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs) • Approach procedures and poor weather operational restrictions • Audits of the MODU and vessels • Regular maintenance and inspection of equipment and high spill risk points	Moderate (ALARP)
Marine Mammals	Oil (Well blowout) and Diesel Spill	Symptoms of acute exposure to DAH may include irritation to the eyes and lungs, lethargy, poor coordination and difficulty with breathing. Heavy contamination by oil could also lead to mortality.	Moderate		Minor
Marine	Oil (Well blowout)	Increased egg mortality and	Major		Moderate

[1] Q31013 internal workshops will build on previous risk characterization efforts (i.e, oil spill modelling; spill response planning; impact assessment and mitigation exercises) to build the technical and management capacity of parties assigned responsibility of spill response.

Receptor	Project Activity	Impact Description	Impact Designation	Mitigation and Control Measures	Residual Impact
Turtles	and Diesel Spill	developmental defects; Direct mortality due to oiling in hatchlings, juveniles and adults; and Negative impacts to skin, blood, immune systems and salt glands Behavioral effects (e.g. disorientation) resulting from loss of smell sensors; Contamination of food supply and reduction in available food levels; and Influences on sea turtle development and behavior caused by subtle changes in sand temperature color and when spills impact the shoreline (e.g. because sex determination in turtles is temperature dependent)		• Procedures in place for bunker transfer to minimise the risk of spillage • Use of bulk handling methods and non-return valves for diesel • Lube and hydraulic oil will be stored in tanks or sealed drums and will be well secured and stored in bunded areas. • Issue Notice to Mariners to inform other sea users on field activities	(ALARP)
Sensitive Coastal Areas	Oil (Well blowout)and Diesel Spill	Damage to or loss of fish nurseries and bird feeding areas in lagoons, estuarine areas and wetlands.	Major		Minor

Receptor	Project Activity	Impact Description	Impact Designation	Mitigation and Control Measures	Residual Impact
		Destruction of mangrove stands – exposure of aerial roots to oil clogs the and if many roots are oiled, the respiratory system collapses and the trees die Toxic concentrations of oil may develop in shallow water and persist for a long time due to low rates of tidal flushing.			
Fisheries/ Fish Stocks	Oil (Well blowout) and Diesel Spill	• Loss of revenue from fishing bans • Damage to fishing vessels and equipment • Contaminated coastal spawning and nursing grounds may reduce fish stocks	Major (Fisheries) Moderate (Fish Stocks)	As above	Moderate (ALARP)
Tourism and Recreation	Oil (Well blowout)and Diesel	• Loss of income from visitors avoiding area	Minor	As above	Minor
Community Health &	Oil Spill (Well blowout)	• Impact land and coastal resources	Moderate	As above	Minor

Receptor	Project Activity	Impact Description	Impact Designation	Mitigation and Control Measures	Residual Impact
Safety		• Tainting of fisheries resources and other marine organisms • Consumption of oil tainted marine life resulting in health issues. • Inhalation of oil vapors resulting in headaches, dizziness, nausea, vomiting, eye and throat irritation and breathing difficulties.			

CHAPTER 6

ENVIRONMENTAL MANAGEMENT PLAN

6. Environmental Management Plan

6.1. Introduction

This section summarizes the mitigation measures and monitoring plans associated with the identified potential impacts of the Project (see previous Section and refer to Tables 5.5 and 5.6). Against the legislative context described in Chapter 2 (regulatory framework applicable to the environmental permitting of the Project), Statoil has assigned ownership of and accountability for all commitments made in Chapter 5 (impact assessment and related mitigations). This Chapter recognizes that regulatory obligations are commitments that the Project will meet in order to comply with applicable laws, regulations, standards, and agreements.

6.2. Mitigation Measures and Monitoring Plans

Mitigation measures are aimed to avoid, minimize and reduce potential environmental impacts and enhance the Project benefits. As previously tabulated (Table 5.5), all residual impacts associated with planned Project activities were predicted to be of *Minor* significance or below. Impacts from unplanned events, namely those associated with the scenarios discussed in the ERA and captured in the OSRP, are predicted to have impact significance ranging from *Moderate to Minor* (Table 5.6).

The oil spill scenarios associated with unplanned events associated with the Project were subject to a comprehensive Environmental Risk Assessment (ERA) (Appendix F). This included the examination of calculated levels of risk for each of the identified spill scenarios against tolerability criteria agreed with Statoil. All of the scenarios examined in the ERA were determined to be either 'Acceptable' or 'Tolerable if ALARP[72]'.

[72] In order to achieve ALARP, Statoil will implement a number of prevention and mitigation measures to minimize the risk of oil spills.

Table 6.2 herein links potential Project impacts to mitigation measures to form a 'Commitments Register, which will be implemented throughout the life of the Project by Statoil and its Partners.

In addition to the mitigation measures proposed in Chapter 5, the Angolan General Environmental Law, Decree on Environmental Protection for the Petroleum Industry (Article 6.3.d), and Decree on Environmental Impact Assessment require that an EIS Report describes the environmental monitoring that will be conducted to support the Project.

Table 6.2 herein captures impacts (by environmental receptor) and broadly maps mitigation measures to regulatory drivers, monitoring programs and responsible parties. Further, monitoring programs will be implemented via Statoil's HSE Management System and guided by Angolan-driven operational documents (Operational Discharges Management Plan and Waste Management Plan, both provided in the Appendices).

6.3. Issue-Specific Management Plans & Managing Contractors

In addition to the Project EMP, and aligned with its recently submitted Decree 224/12-driven Implementation Plan, Statoil is updating specific management plans to address areas related to environmental impact and environmental management. On a parallel track to the EIS compilation, Statoil finalized a number of emergency response and planning-related plans (Oil Spill Response Plan and Emergency Response Plan), as operational safety is critical to project sustainability. Table 6.1 lists a few critical regulatory requirements that will provide assigned parties with the legal basis for monitoring the implementation and effectiveness of proposed mitigation measures.

Table 6.1. Key Regulatory Guidance for Monitoring Programs.

Item	Decree/Regulatory Guidance	Topic Covered
A	Decree 39/00	Spill Prevention Plan (A1); Spill Response Plan (A2); Operational Discharge Management Plan (A3); Waste Management Plan (A4).
B	Executive Decree No. 8/05	Waste Management, Removal and Deposit (B1)
C	Decree No. 146-75 Concerning Water, Beaches and Shore Pollution	Water, Beaches and Shore Pollution (C1)
D	Executive Decree No. 11/05	Regulation on Notification of the Occurrence of Spill (D1)
E	Law 6-A/04	Biological and Aquatic Resources (E1)
F	Executive Decree 224/24	Operational Discharge (F1); Monitoring and Reporting (F2)
G	Presidential Decree 141/12	Pollution Prevention on National Waters (G1)
H	Executive Decree 190/12	Waste Management (H1)
I	Decree 38/09	Safety, Hygiene and Health in Petroleum Activities (I)
J	Law No. 2/00	General Labor Law (J1)
K	Decree No. 31/94	Health, Safety and Hygiene at Work (K1)

Recognizing that the implementation of the Project comprises the collaborative effort of Statoil and its contractors, Statoil will ensure that roles and responsibilities s are clearly defined, and communicated in the EMP. Statoil is committed to ensuring that Project-related staff are familiar with proposed mitigation measures and environmental protection procedures. The Project will also have a verification and critical analysis process in place (i.e., audits and process assessments) to ensure that the EMP is continuously monitored and revised accordingly.

Table 6.2. Project Mitigation and Monitoring Activities

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
Planned Activities					
Localized reduction in water quality, including increased turbidity and BOD	• Black water: Treatment in approved STP to achieve discharge standards in accordance with IMO MEPC 159(55); no floating solids or discolouration of surrounding water. If chlorine is used as disinfectant, best practice is to have a residual chlorine content of less than 0.5 mgl^{-1}; No discharges of treated sewage from vessels within 3 nmi of the nearest land	• Verification that selected MODU has a valid International Sewage Pollution Prevention Certificate	A3, A4, B1, C1, E1, F1, F2, G1	Statoil	Prior to engaging the MODU Contractor Throughout the campaign (regulatory requirements will dictate the frequency of monitoring, analysis, and reporting)
		• Monitor chlorine concentration of treated sewage discharges		MODU Contractor	Monthly
		• Visual observation of the sea surface for floating solids and discolouration of the water surrounding the discharge point		MODU Contractor	Daily
		• Record estimated volume, time and location of treated sewage disposed		MODU Contractor	At the time of discharge
	• Grey water (including food waste): Organic food wastes generated will be macerated to pass through a 25 mm mesh and discharged more than 12 nmi from land with no floating solids or foam	• Visual observation of the sea surface for floating solids and foam surrounding the discharge point		MODU Contractor	Daily
		• Record total quantity of macerated food waste discharged in Garbage Record Book (estimate kg based on		MODU Contractor	At the time of maceration

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
		Persons On Board)			
	• Deck drainage and bilge water: treatment in an oil/water separator to achieve a maximum concentration of 15 ppm oil and grease) • Liquids from the MODU closed drain system will be returned to the process system and dirty liquids sent to shore for treatment • Chemical, fuels and oil storage will be bunded to contain leaks and spills. Other sources will have drip trays to contain accidental spills or leaks • Equipment in unbunded areas will be provided with drip trays to contain spills/ leaks • Absorbents will be available on board MODU and support vessels to deal with accidental spillages	• Continuous oil in water content (automatic online) monitoring at the drainage discharge points • Collect samples from the drainage discharge points for oil in water analysis onshore by a third party certified laboratory to verify the online meter measurement • Record volume of water discharged; visual sheen check • Record oil in water concentration recorded in an Oil Record Book		MODU Contractor MODU Contractor MODU Contractor MODU Contractor	Continuous Monthly Daily Daily
	• No discharge of SOBM or associated cuttings. SOBM and associated cuttings will be returned to shore for treatment and disposal	• Monitor and record volume (m^3) and type of drilling fluids discharged into the sea • Record cuttings and slops returned to shore		MODU Contractor MODU Contractor	At the time of discharge When the activity is undertaken
	• Ballast Water: treatment in an oil/water separator to achieve a maximum concentration of 15 ppm oil and grease); Ballast Water Management Plan in place	• Continuous oil in water content (automatic in-line) monitoring • Take oil in water samples and analyze onshore to verify the online meter measurement, or other measurement performed on the		MODU Contractor MODU Contractor	Continuous

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
		MODU will be provided			
		• Record volume of ballast water discharged and location (per ballasting operation) in a Ballast Water Record Book		MODU Contractor	At the time of discharge
		• Record oil in water content of water discharged in Oil Record Book		MODU Contractor	At the time of discharge
	• Well clean-up and test fluids will be collected on the MODU and returned to shore for treatment and disposal	• Record volume of well clean-up and test fluids returned to shore		MODU Contractor	When the activity is undertaken
Potential reduction in localized air quality and contribution to greenhouse gases	• Maintain systems and equipment to run efficiently as possible • Flared fluids and gases will be mixed with compressed air to increase combustion efficiency • Compliance with MARPOL Annex VI • Minimize number of helicopter flights and support vessels to those strictly necessary	• Record volume of fuel used by MODU	F2	MODU Contractor	Monthly
		• Record volume of fuel used by support vessels support vessels		Marine Logistics Contractor	Monthly
		• Record aviation fuel used in helicopter transfers		Aviation Contractor	Monthly
		• Calculate volume (mmscfd/bbls) of hydrocarbons flared during well testing		Well Testing Company	When the activity is undertaken
		• Ensure MODU has valid Engine International Air Pollution Prevention Certificate in place (marine diesel engines >130kW)		Statoil	-
		• Calculate project air emissions using emission factors		Statoil	Montly
Sediment Quality and Benthic Communities – loss of habitat in direct footprint; localized increase in	• No SOBM or drill cuttings from the lower sections will be discharged offshore • Volume/rate of WBM and cuttings discharged to the sea will be	• Monitor and record volume (m^3), rate (bbls hr^{-1}) and type of drilling fluids and cuttings discharged into the sea	A4, B1, C1,F1, F2, H1	MODU Contractor	When the activity is undertaken
		• Record volume (m^3) of SOBM and		MODU Contractor	When the activity

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
suspended sediment; low levels of contaminants in WBM	monitored to ensure compliance with 1000 bbls hr^{-1} limit • Cement chemicals will conform to OSPAR HOCNF standards. • Use of low toxicity chemicals (as listed on OSPAR's OCNS list and those on the PLONOR list) • Pre-drill surveys and micro-siting well locations to avoid areas of sensitive habitat	cuttings returned to shore for disposal • Review drilling chemicals against OSPAR's ONCS list and PLONOR list • Obtain pre-drill site survey report		Statoil Statoil	is undertaken Prior to using the drilling chemicals Prior to drilling
Seabirds – disturbance related impacts from helicopter flights and vessel presence **Marine Mammals – behavioral impacts from presence of vessels and helicopters**	• Project vessels to avoid sailing through areas with large aggregations of seabirds where possible • Use of designated navigation channels where applicable and comply with speed and wake restrictions • Flight altitude of at least 500 m based on the circumstances and weather conditions	• Monitor compliance with agreed routes for example using satellite tracking system such as Sky Router	E1, F2 E1, F2	Aviation Contractor Vessel Contractor Discussed above	During drilling During drilling
Marine Mammals – behavioral and potential injury from underwater noise	• Use of designated navigation channels where applicable and comply with speed and wake restrictions	• Supply vessel operators should maintain a watch for marine mammals, particularly in the winter and spring months (July to October)	E1, F2, G1	Vessel Contractor	During drilling
Marine Turtles – project vessels present collision risk and underwater noise	• Use of designated sailing route where applicable and comply with speed and wake restrictions	• Monitor vessel movement	E1, F2, G1	Vessel Contractor	During drilling

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
may disturb behavior					
Presence of project vessels may disturb industrial fishing activities	• Appoint a fisheries liaison officer to provide a direct link with the fishing community • Ensure procedures are in place for dealing with claims in the event of damaged fishing gear • Establish exclusion zones around facilities • Communicate clear instructions regarding access limitations to exclusions zones • Ensure position of facilities and exclusion zones are marked on nautical charts • Notify relevant authorities, fishing associations and industrial fishermen of field development plans, timing, location, tow-out routes and vessel activities	• Monitor engagement with fishing communities to check for adherence to communications protocol and grievances follow up	F1, F2, G1	MODU Contractor/ Marine Logistics/ Statoil	During drilling
		• Monitor vessels' adherence to exclusion zones		MODU Contractor/ Marine Logistics/ Statoil	During drilling
Presence of project vessels may disrupt marine traffic in the area	• Inform Marine Authorities of vessel mobilization and infield activities • Establish exclusion zones around project facilities • Communicate clear instructions regarding access limitations to exclusions zones • Ensure position of facilities and exclusion zones are marked on nautical charts	• Ensure information is communicated to Marine Authorities is clear and understood	B1	Statoil/ Vessel Contractor/ MODU Contractor	Prior to drilling/ during drilling
		• Monitor vessels adherence to the exclusion zone		Vessel Contractor	During drilling

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
	• Notify mariners and shipping about the project and activities expected by radio announcements in ports of Soyo and Luanda • Equip vessels with collision risk reducing devices i.e. navigational lights and beacons, marker buoys				
Accidental oil spill to sea as a result of well blowout or other major equipment failure					
Toxic effects to biological resources (Seabirds, Turtles, Marine Mammals and Fish), including potential for oiling or exposure to elevated dissolved phase constituent concentrations. **Habitat damage in the event of oil slicks reaching shoreline.**	• Drilling safety standards to be followed • Comprehensive operational planning, risk assessment and provision of suitably specified equipment for drilling • Two BOPs • Provision of Capping stack • Oil Spill Response Plan (OSRP) and Emergency Response Plan (ERP) • Interface of the OSRP with the Angolan National Oil Spill Contingency Plan • Handling and deployment of oil spill response equipment training • MODU and vessels will comply with IMO codes for prevention of oil pollution and have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs) • Approach procedures and poor	• Verify compliance Contract supplier for provision of stack • In case of an accidental spill, Statoil will monitor the release and associated response measures, including effectiveness of containment and cleanup, in accordance with the ODMP and OSRP	A1, A2, C1, D1, G1	Statoil MODU Contractor Statoil	Prior to drilling/ During drilling Prior to drilling In the event of an accidental spill

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
	weather operational restrictions • Audits of the MODU and vessels • Regular maintenance and inspection of equipment and high spill risk points • Regular maintenance and inspection of oil spill equipment on vessels • Procedures in place for bunker transfer to minimise the risk of spillage • Use of bulk handling methods and non-return valves for diesel • Lube and hydraulic oil will be stored in tanks or sealed drums and will be well secured and stored in bunded areas • Issue Notice to Mariners to inform other sea users on field activities,	• For additional risk reduction, Statoil will review the Contractor's fuel spill response plan for adequacy and recommend upgrades as appropriate to response plans or equipment • Audits to ensure safeguards built into the design and implementation of the drilling activities are undertaken as planned • Audits of Implementation of ODMP, OSRP		Statoil MODU Contractor and Vessel Contractor MODU Contractor and Vessel Contractor	Prior to drilling Prior to drilling/ During drilling Prior to drilling/ During drilling
Interruption of, or interference with, fishing activities as a result of oil slick presence (and associated livelihood impacts) Food chain impacts as a result of fish populations exposure to oil or elevated dissolved phase	In addition to mitigation measures identified above: • Establish a point of contact with the community to manage community interactions in the event of a release, and to effectively address grievance/ complaints in a timely manner	• Statoil to coordinate in engaging local government authorities and local fishing leaders both prior to the establishment of exclusion zones and throughout the project lifecycle	A1, A2, C1, D1, F2, G1	Statoil	Prior to drilling Second quarter of 2013

Potential Impact	Mitigation Measures	Monitoring Activities	Applicable Regulation/Driver	Responsible Party	Timing (daily, monthly, yearly)
constituent concentrations Impacts on Tourism and Recreation					

CHAPTER 7

CONCLUSION

7. Conclusion

Statoil Angola plans to begin an exploratory drilling campaign in Block 39 in Q1 2014. The proposed drilling campaign will comprise the drilling of five (5) exploratory wells and additional appraisal wells intended to confirm the presence of hydrocarbons.

Block 39 is located in Benguela Basin, approximately 110 km west off Sumbe's coastline (as described in Table 7.1 below), in water depths ranging from 1,500 m to 2,500 meters, covering an area of 7.809 km^2.

Table 7.1: Proposed Block 39 exploration well coordinates.

Well Names	Proposed Coordinates	
	Latitude	Longitude
Dilolo-1[73]	11°16'39,71''S	12°26'45,00''E
Dilolo-2	Not Available	Not Available
Dilolo-3	Not Available	Not Available

Notes: Datum: Camacupa – EPSG: 4220; Projected CRS: Camacupa / UTM; ZONE 33S – EPSG: 22033 – *Source: Statoil, 2013.*

This Environmental Impact Study is developed per Angolan legislation (inclusive or recently promulgated regulation such as Presidential Decree 141/12, Presidential Decree 190/12 and Executive Decree 224/12) and accounts for recommendations from multilateral environmental agreements ratified by Angola (i.e., international treaties, conventions, and protocols related to biodiversity, climate change, and marine pollution, among others). In addition to following regulatory requirements, proposed mitigation measures and built-in controls for predicted impacts are aligned with Statoil Health, Safety and Environment (HSE) policy.

[73] Dilolo-1 being is an exploration well and Dilolo-2 and Dilolo-3 are appraisal wells.

The EIS documents current baseline conditions of the physical and chemical environment, marine biodiversity, human activities in the marine environment, and the national and regional socio-economic context. The study also incorporates details on the marine mammals' biodiversity from observations compiled during in the third quarter of 2011 seismic campaign as well as block-specific 2012 physical, chemical, biological and social-economic data purchased from the National Institute of Fisheries Research.

Potential environmental and social impacts from the proposed exploratory drilling campaign in Block 39 were assessed in accordance with a tried and tested methodology. The approach explored how the project would affect the physical, biological and socioeconomic environment (air, water and sediment quality; marine ecology; and coastal communities) within the study area and the wider area of influence. Based on aspects and impacts related to the project, the study provides fit-for-purpose mitigation measures that Statoil (and its Partners) agreed to implement to avoid, reduce and remedy or compensate for potential negative impacts.

The assessment considers impacts that may result from **planned activities** from regular drilling operations as well as **unplanned events** (such as an oil spill or a vessel collision).

For environmental impacts, the impact significance rating considered the type of impact, its area of influence and severity criteria (the 'magnitude'), and the characteristics of the impact receptor (its 'sensitivity'). Each impact was then assigned two significance ratings (pre-mitigation and a residual impact, post-mitigation). In determining the significance social impacts, the assessment accounted for the inherent variability introduced by the human factor (i.e., preconceived opinion, range of vulnerability to the consequence of an impact).

We then assessed impacts from planned events by receptor (water quality, air quality, sediment quality, fish, seabirds, marine mammals, and turtles) and then by the source of impact (*e.g.* underwater noise). Impacts from unplanned or accidental events was assessed

by the type of event (accidental large oil spill and accidental duel spill from vessels), and then by the affected receptors.

All residual impacts associated with planned activities were predicted to be of ***Minor*** significance or below. Impacts from unplanned events, were predicted to have impact significance ranging from ***Moderate to Minor***. Further, monitoring programs are proposed to be implemented via Statoil's HSE Management System and guided by Angolan-driven operational documents (Operational Discharges Management Plan and Waste Management Plan).

Based on the assessment undertaken, the Project does not introduce any potentially significant negative environmental or socioeconomic impacts. With proposed control measures, all potentially significant impacts from planned activities are reduced to minor (i.e., potential impacts that are small in scale and will not have a large measurable or observable consequence) and all unplanned events are managed to moderate to minor.

As no significant changes to potential impacts have been identified, and based on the proposed built-in controls and mitigation measures, Statoil respectfully seeks an expedient approval from regulators.

CHAPTER 8

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