Rockhopper Exploration PLC

ENVIRONMENTAL IMPACT STATEMENT ADDENDUM FOR OFFSHORE FALKLAND ISLANDS EXPLORATION DRILLING

(Licences PL024 and PL032)

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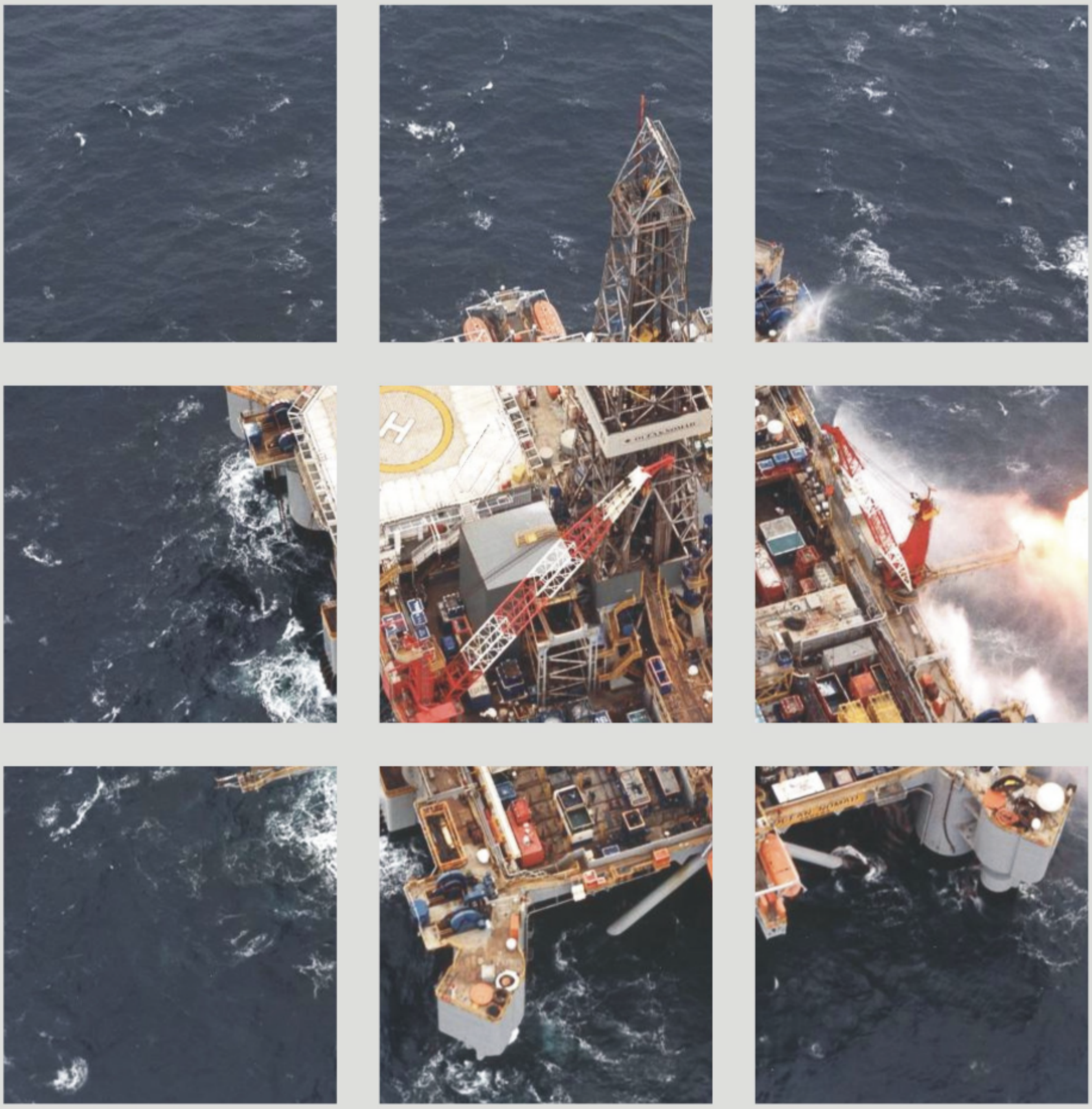

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(Licences PL024 and PL032)

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December 2009

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Table of Contents

Abbreviations

API	American Petroleum Industry
BOP	Blow out Preventor
CEFAS	Centre for Environment Fisheries and Aquaculture Science
CHARM	Chemical Hazard Assessment and Risk Management
CO_2	Carbon Dioxide
DP	Dynamically Positioned
E&P	Exploration and Production
EEM's	Environmental Emissions Monitoring System
EIS	Environmental Impact Statement
EMR	Emergency Mitigation Register
ERP	Emergency Response Plan
FC	Falkland Conservation
FCO	Foreign and Commonwealth Office
FICZ	Falkland Interim Conservation and Management Zone
FIG	Falkland Islands Government
FOCZ	Falkland Outer Conservation and Management Zone
HMCS	Harmonised Mandatory Control Scheme
HOCNF	Harmonised Offshore Chemical Notification Format
HQ	Hazard Quotients
HSE	Health, Safety and Environment
LAT	Lowest Astronomical Tide
LTOBM	Low Toxicity Oil Based Mud
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973,
MIME	Managing Impacts on the Marine Environment
MMO	Marine Mammal Observer
MoD	Ministry of Defence
OCNS	Offshore Chemical Notification Scheme
OSCP	Oil Spill Contingency Plan
OSPAR	Oslo / Paris Convention
OSR	Oil Spill Response
PLONOR	Pose Little or No Risk to the environment
ROV	Remotely Operated Vehicle
RQ's	Risk Assessments
TD	Target Depth
TVD	Total Vertical Depth
UKOOA	United Kingdom Offshore Operators Association
WBM	Water Based Mud

Non Technical Summary

Background

Rockhopper Exploration plc (hereafter referred to as 'Rockhopper') is a UK company set up in 2004 to explore for oil and gas in the Falkland Islands. Rockhopper is the operator of four Production Licences (PL) in the North Falkland Basin; PL023, PL024, PL032 and PL033. PL032 and PL033 were previously licensed to Shell. Rockhopper also holds an interest in licences PL003 and PL004, operated by Desire Petroleum plc.

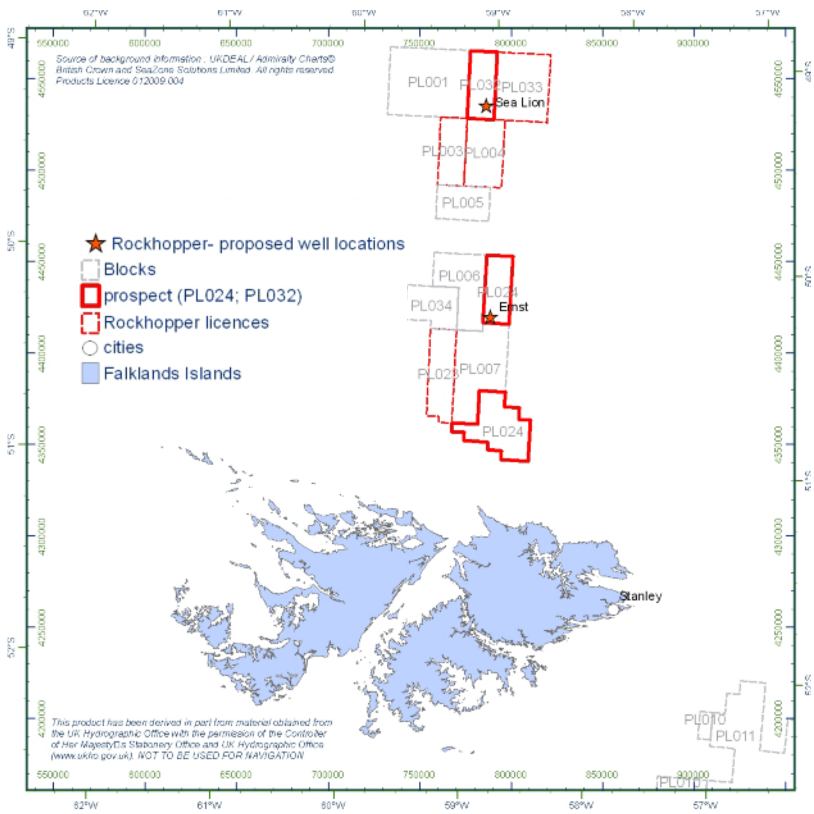
PL023 and PL024

In November 2004 two new licences covering 16 blocks and a total area of 4,200 km2 in the southernmost part of the North Falkland Basin were awarded to Rockhopper. The initial term (Phase 1) was for 3 years and under the terms of the licences Rockhopper moved to the second Exploration Term (Phase 2) in November 2007. During Phase 1 Rockhopper fulfilled their licence commitment to collect a minimum of 640 km of two dimensional (2D) seismic data. At the end of Phase 1, 50% of the licence area was relinquished and the company moved to Phase 2, under which additional seismic data has been acquired and Rockhopper are committed to drilling at least one exploration well.

PL032 and PL033

Licences PL032 and PL033 were granted to Rockhopper in May 2005, covering an area of some 1620 km2. The blocks were previously held and drilled by Shell. Rockhopper have a one well commitment across licences PL032 and PL033 under an initial licence term which has been extended from 5 to 8 years.

Figure1 Location Map Showing Rockhopper Production Licence Areas



In March 2009, Rockhopper submitted an Environmental Impact Statement (EIS) for exploration drilling in PL032 and PL033, and a further EIS for exploration drilling in PL023 and PL024. Both were granted approval on the condition that an Operational Addendum is prepared (to include details of the drilling contractor, drilling unit, location and number of wells to be drilled and proposed dates of operation) and submitted to the Falkland Islands Government (FIG) for comment prior to the commencement of the proposed drilling operations.

Rockhopper plans to drill two wells – Sea Lion in Block 14/10 and Ernest in Block 26/6 - using Ocean Guardian semi-submersible drill rig operated by Diamond Offshore drilling contractor. Figure 1 highlights the Rockhopper's relevant Production License areas in relation to the other license areas in the Falkland.

Existing Environment

The Patagonian Shelf, on which the Falkland Islands sit, is of regional and global significance for marine resources. It comprises rich assemblages of seabirds, marine mammals, fish, squid and plankton populations.

The main fisheries resources in the Falkland Islands are the squid species, *Illex argentinus* and *Loligo gahi*. Other types of fisheries include finfish, ray and longline. However, the main fisheries areas are to the west of the exploration area for *Illex argentines* and to the south west of the Falkland Islands for *Loligo gahi.*

The following species of cetacean may be sighted within the vicinity of the proposed drilling locations during the dates of the exploration campaign: Sie whale, minke whale, sperm whale, long-finned pilot whale and hourglass dolphin. Due to the migratory nature of cetaceans however, it is probable that other cetacean species may also be present. Overall however the area in the vicinity of the proposed wells is not considered to be of particularly high sensitivity for cetaceans.

The Falkland Islands are an area of global importance for birdlife, particularly seabird species. The avifauna of the region is well studied and documented, and seabird distribution, breeding and foraging patterns have been studied extensively. A search of the BirdlLife International website for the International Union for Conservation of Nature Red List of threatened bird species in the Falkland Islands, found 10 species as either 'Endangered' or 'Vulnerable'. Species recorded at their peak within the licence area are the King penguin (June to September), Rockhopper penguin (September to November), Magellanic penguin (November to April) and various species of albatross, petrel, fulmar, prion and shearwater. Other seabirds including shags, ducks, skuas, gulls and terns occur in the near shore areas outside of the licence blocks. Based on recorded distributions, the proposed routine drilling activity will not result in major disturbances to any of the recorded seabird species.

Impacts and Management Measures

The results of the environmental impact assessment indicate that the main sources of potential significant impacts from the drilling campaign on the environment include drill cuttings disposal, the risk of large offshore and near-shore oil spills, international transfer of solid and hazardous wastes and use of resources (i.e. fuel and potable water) should they be sourced from the Falklands. All other sources of potential impacts were deemed to be of low significance. Economic effects from the project are likely to be positive.

The potential impacts of the proposed drilling activity will be mitigated in a number of ways, including:

- Maintaining a spirit of openness and ongoing consultation with the Falkland Islands Government (FIG), the public and key stakeholders.
- Applying international best practice and established UK standards to operations, particularly in offshore chemical use and emissions reporting (Environmental Emissions Monitoring System, EEMS).
- Use of water based drilling muds and low toxicity chemicals approved under the UK Offshore Chemical Notification Scheme.

- Implementing a high level of environmental management offshore and applying environmental procedures for potentially impacting operations (chemical storage, bunkering, waste handling, maintenance programmes, seafloor surveys etc).
- Establishing and implementing a project specific Oil Spill Contingency Plan and carrying out training of key personnel in spill response. Rockhopper are members of Oil Spill Response Ltd which provide outside assistance in the case of a major spill.
- Implementing a waste management plan to minimise the quantity of waste going to landfill, prevent unsuitable disposal of waste, maximise the re-use of materials and establish procedures for the storage, treatment, transfer and disposal of waste materials. It is envisaged that normal waste will be disposed of on the Falkland Islands with hazardous transferred to the UK for safe disposal via Marchwood MOD sailing.
- Collecting and sharing environmental data wherever possible, for example in offshore sightings, seabed surveys and meteorological and oceanographic conditions.

Conclusions

In conclusion, despite the high sensitivity and international importance of the Falkland Islands' waters, there is clear dedication to carrying out these operations to a high environmental standard. Given the current operational commitments and proposed mitigation measures, it is considered that the proposed operations can be undertaken without significant impacts to the Falkland Islands' environment

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1 Introduction

1.1 Document Objective

This document constitutes the Operational Addendum to the following Rockhopper Exploration plc Falkland Islands Offshore Drilling Environmental Impact Statements (EISs):

- Report Ref: EOE0612 submitted in March 2009 to assess the environmental impact from drilling up to three exploration wells within PL032 and PL033.
- Report Ref: EOE0593 submitted in March 2009 to assess the environmental impact from drilling two exploration wells within PL023 and PL024.

The EISs have been approved by the Falkland Islands Government (FIG) pending the submission of an Operational Addendum to provide further details on the drilling programme, which were unknown when the EISs were produced.

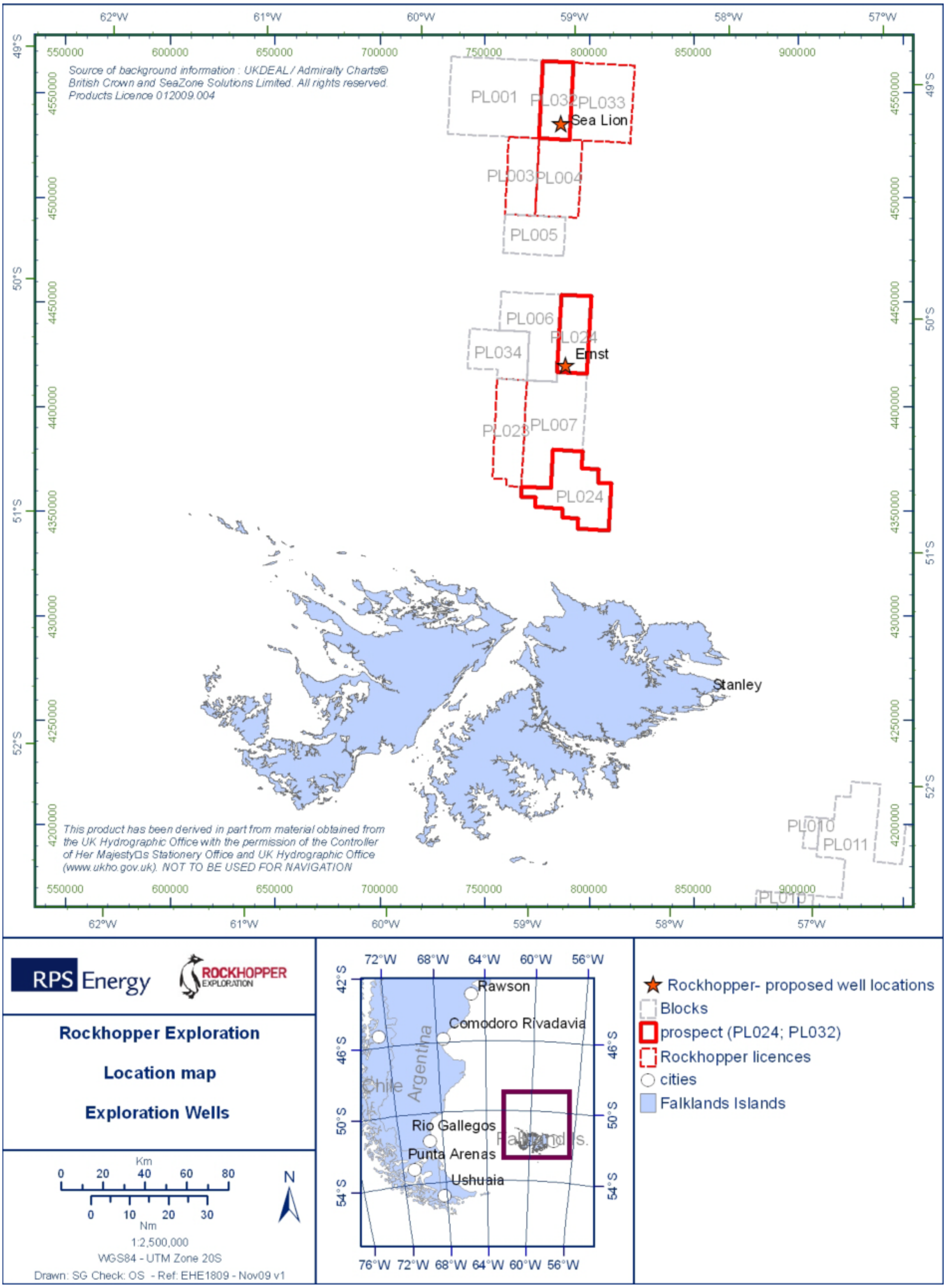
Rockhopper have now finalised their drilling programme and contracted Diamond Offshore's Ocean Guardian semi-submersible drilling rig. It is planned to drill two exploration wells: the Sea Lion exploration well within Block 14/10 (PL032) and the Ernest exploration well within Block 26/6 (PL024). Drilling operations are anticipated to commence on 1st March 2010 at Sea Lion and 1st June 2010 at Ernest. It is estimated that the rig will be 30 to 40 days at each well location.

The location of the proposed exploration wells is shown in Figure 1.1.

This Operational Addendum has been produced by RPS Energy on behalf of Rockhopper to meet the FIG condition. As such, it aims to:

- Provide details of the drilling contractor, drilling rig, location and number of wells to be drilled and the proposed dates of operation;
- Assess seasonal sensitivities within the vicinity of the licence areas at the time of the proposed drilling operations;
- Review and update the impact assessment to identify the environmental hazards, effects and mitigation measures;
- Detail the project Environmental Mitigation Register (EMR), with particular emphasise on waste management and resource use.

Figure 1.1 Location Map showing the proposed Rockhopper well locations



1.2 The Applicant

Rockhopper Exploration plc is a UK company set up in 2004 to explore for oil and gas in the Falkland Islands. Rockhopper is the operator of four Production Licences (PL) in the North Falkland Basin; PL023, PL024, PL032 and PL033. PL032 and PL033 were previously licensed to Shell. Rockhopper also holds an interest in licences PL003 and PL004, operated by Desire Petroleum plc.

PL023 and PL024

In November 2004 two new licences covering 16 blocks and a total area of 4,200 km2 in the southernmost part of the North Falkland Basin were awarded to Rockhopper. The initial term (Phase 1) was for 3 years and under the terms of the licences Rockhopper moved to the second Exploration Term (Phase 2) in November 2007. During Phase 1 Rockhopper fulfilled their licence commitment to collect a minimum of 640 km of two dimensional (2D) seismic data. At the end of Phase 1, 50% of the licence area was relinquished and the company moved to Phase 2, under which additional seismic data has been acquired and Rockhopper are committed to drilling at least one exploration well.

PL032 and PL033
Licences PL032 and PL033 were granted to Rockhopper in May 2005, covering an area of some 1620 km2. The blocks were previously held and drilled by Shell. Rockhopper have a one well commitment across licences PL032 and PL033 under an initial licence term which has been extended from 5 to 8 years.

All operations will be undertaken by contractors under Rockhopper's management and oversight.

1.3 Contact Address

Any questions, comments or requests for additional information regarding this Operational Addendum should be addressed to:

Mr Samuel Moody
Managing Director
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Devizes Road
Salisbury
SP3 4UF

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Web: http://www.rockhopperexploration.co.uk

2 The Proposed Drilling Programme

2.1 Overview

Rockhopper is planning to drill two exploration wells in the North Falkland Basin:

- Sea Lion at Block 14/10 (PL032);
- Ernest at Block 26/6 (PL024).

The objective of the drilling operations is to explore for recoverable hydrocarbons from these prospects.

The wells will be drilled from Diamond Offshore's Ocean Guardian semi-submersible drilling rig with operations currently scheduled to commence on 1st March 2010 at Sea Lion and 1st June 2010 at Ernest. It is estimated that the rig will be 30 to 40 days at each well location.

Following drilling, the wells will be logged and evaluated. Regardless of the evaluation results, the wells will be plugged and abandoned in accordance with Oil & Gas UK guidelines.

The proposed characteristics of each well are summarised in Table 2.1 and their locations are shown in Figure 1.1.

Table 2.1 Proposed Well Characteristics

	Sea Lion	Ernest
License Block	Block 14/10 (PL032)	Block 26/6 (PL024)
Anticipated Drilling Location	49° 16' 4.7" S 59° 3' 32.8" W	50° 18' 17.305" S 58° 56' 37.292" W
Anticipated Drill Rig	Ocean Guardian semi-submersible drill rig	Ocean Guardian semi-submersible drill rig
Support Location	Stanley	Stanley
Water Depth (m)	451	145
Depth of Well (m) (TVDss)	2700	2400
Nearest Landfall (km)	220	105
Anticipated Spud date	March 2010	June 2010
Estimated Time to Reach Total Depth	30.5 days	24.5 days
Total Days Rig will be on Location	28-40 days	25-30 days
Hydrocarbons Anticipated	27° API crude	22-25° API crude, gas possible
ITOPF Category	Group III	Group III
Anticipated Weight of Cuttings (t)	670	707

2.2 Exploration Well Objective and Concept

The objective of this project is to explore for recoverable hydrocarbons from the reservoirs through the drilling and evaluation of two exploration wells.

2.3 Proposed Project Schedule

It is anticipated that the Ocean Guardian semi-submersible rig will be 30 to 40 days at each well location. Drilling operations are anticipated to commence on 1st March 2010 at Sea Lion and 1st June 2010 at Ernest.

2.4 The Drilling Rig

The proposed exploration wells will be drilled by Diamond Offshore Drilling (UK) Limited’s third generation semi-submersible drilling rig: the Ocean Guardian. The rig has an 8 line mooring anchor pattern. Further details on the Ocean Guardian semi-submersible rig are provided in Appendix B.

2.5 Surface Location Selection

The well locations were chosen in order to facilitate a vertical well and therefore reduce section lengths and hence fluid and cuttings volumes. A slim hole well design approach (i.e. omitting the traditional 26 inch section with 15.5 inch casing shoe) was also followed in order to further reduce the fluid and cuttings volumes and therefore the well’s environmental impact.

2.6 Well Construction

Wells are drilled in sections, with the diameter of each section decreasing with increasing depth. During the drilling of the upper well sections the drill string (also called drill pipe) and drill bit are typically left open to the seawater. However, before drilling lower sections of the well, a lining/casing is run and cemented in the well and riser pipe is used between the rig and the seabed with the drill string passing through the riser (from seabed back to rig) and the casing (below seabed).

Once the casing has been run therefore, the drilling fluid can be returned to the rig, in the space (or annulus) between the drill string and the casing / open hole and back up the riser to the rig. The lengths and diameters of each section of the wells have been determined prior to drilling and are dependent on the geological conditions through which the well is to be drilled.

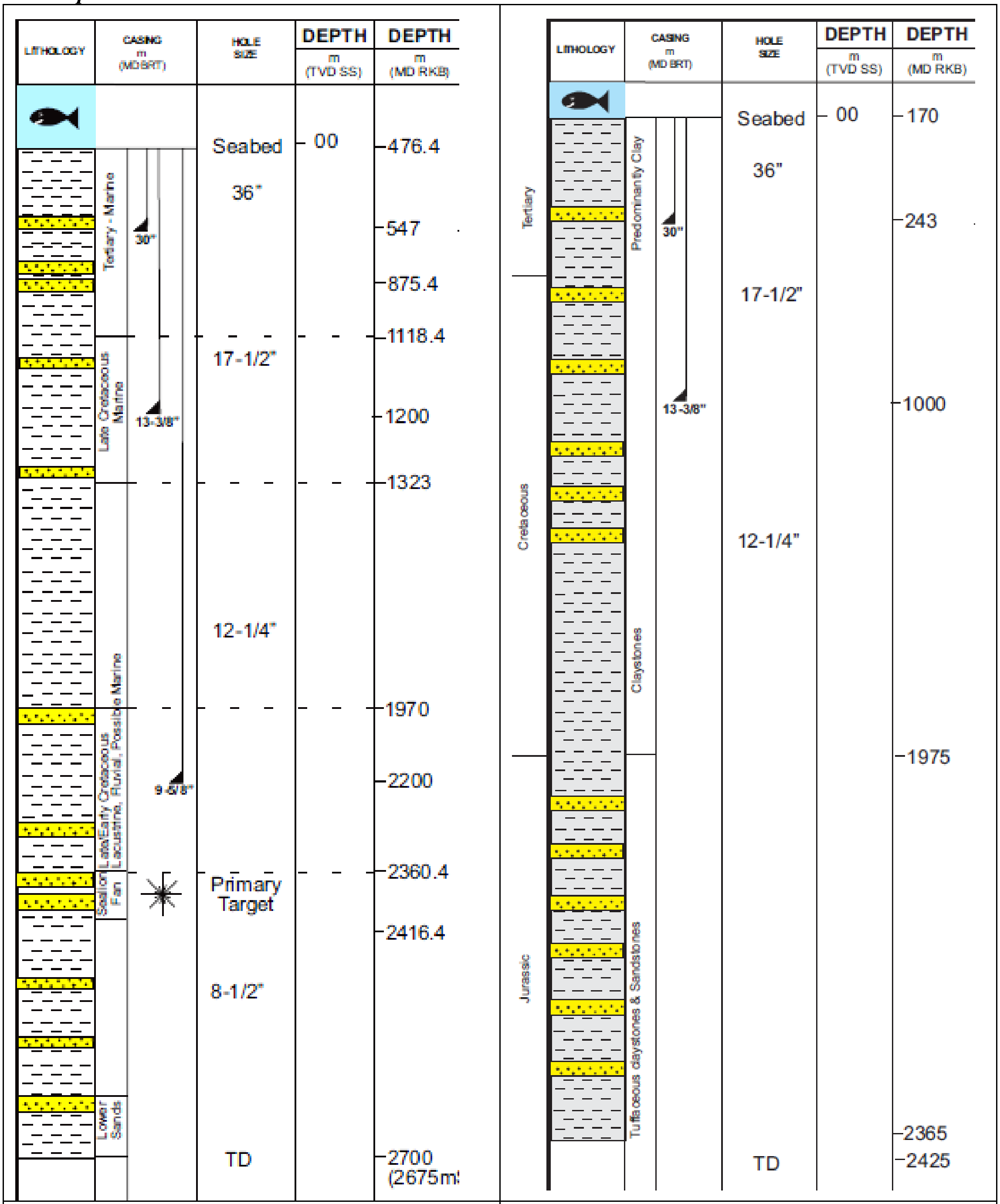
Details of the each well profile are shown in Table 2.2 with well schematics provided in Figure 2.1.

Table 2.2 Proposed Well Profiles

Sea Lion Well Profile			
Hole Size	**Casing Size**	**Section Length (Measured Depth)**	**Proposed Mud Use**
Inches	**Inches**	**Metres**	
36”	30”x20”	476-547	WBM
17$^{1}/_{2}$”	20”x13$^{3}/_{8}$	547-1200	WBM
12$^{1}/_{4}$”	9$^{5}/_{8}$”*	1200-2700	WBM
Ernest Well Profile			
Hole Size	**Casing Size**	**Section Length (Measured Depth)**	**Proposed Mud Use**
Inches	**Inches**	**Metres**	
36”	30”x20”	170-243 m	WBM
17$^{1}/_{2}$”	20”x13$^{3}/_{8}$	243-1000 m	WBM
12$^{1}/_{4}$”	-	1000-2400 m	WBM

*Note applies to Ernest Well only: The 9$^{5}/_{8}$” casing and 8½” hole sections are contingency sections only. 9$^{5}/_{8}$” casing will only be set in the event that the 13 3/8” casing shoe has a lower formation strength than anticipated or significant operational problems are encountered.

Figure 2.1 Proposed Well Schematics



Sea Lion Exploration Well *Ernest Exploration Well*

2.7 Disposal of Drill Cuttings

The top two hole sections for the proposed wells will be drilled open to the seabed and the cuttings generated whilst doing so will be swept out of the hole using seawater. These will be deposited around the well bore. For subsequent sections, the wells will be cased and drilled using a riser whilst circulating drilling mud to remove cuttings, to condition the well bore and provide weight down the hole.

Whilst drilling the wells, a riser will be set between the wellhead and the rig, with a blow-out preventer (BOP) fitted on the seabed near the bottom of the riser. The mud and cuttings will be returned to the rig where they pass through the rigs cleaning system. This reduces the amount of drilling fluid retained on the cuttings to between 5 and 10 percent. The cuttings will be cleaned to the required specification and discharged to the sea. The cuttings are variously sized particles of rock cut from the strata as the drill bit progresses down the well bore and will be comprised of sedimentary rock.

Estimated amounts of cuttings that will be generated for the proposed exploration wells are detailed in Table 2.3.

Table 2.3 Estimate of Cuttings Generated for the Proposed Wells

Sea Lion Well

Hole Size (in)	Hole size diameter (m)	Length (m)	Volume (cu m)	Weight (tonnes)
36”	0.914	71	46.63	121.23
17 1/2”	0.444	624	96.83	251.76
12 1/4”	0.311	1500	114.06	296.55
Total cuttings			**258.98**	**670**
Discharged at Seabed			143.46	372.99
Discharged at Surface			114.06	296.55

Ernest Well

Hole Size (in)	Hole size diameter (m)	Length (m)	Volume (cu m)	Weight (tonnes)
36”	0.914	73	47.94	124.64
17 1/2”	0.444	757	117.47	305.42
12 1/4”	0.311	1400	106.45	276.78
Total cuttings			**272**	**707**
Discharged at Seabed			165.41	430.06
Discharged at Surface			106.45	276.78

Note: Weight of cuttings calculated assuming density of 2.6 tonnes per cubic metre

2.8 Drilling Mud and Casing Cement

A background to the use of drilling muds is given in Appendix C. All wells will be drilled using water based mud (WBM). On the rig, the cleaned mud’s composition will be monitored and its contents adjusted to ensure that its properties remains as specified and it will be recycled through the well. No low toxicity oil based mud (LTOBM) will be used for the proposed wells.

The drilling mud is specially formulated for each section of the well to suit the conditions in the strata being drilled. The selection is made according to the technical requirements for the mud and the environmental credentials of the chemicals.

Once each section of the well has been drilled, the drill string is lifted and the casing is lowered into the hole and cemented into place. The cement is formulated specifically for each section of the well and contains small volumes of additives that are required to improve its performance. It is mixed into slurry on the rig and is then pumped down the string and forced up the space between the well bore and the casing. To ensure that sufficient cement is in place and that a good seal is achieved, a certain amount of extra cement is pumped and some of this will be discharged to the seabed in the immediate vicinity of the wellhead, only in cases where cementing back to seafloor surface (e.g the upper most section of the well). Typically, the quantity discharged is less than 10 percent of the total volume used, however, in case of contingency, the quantity discharged could double.

Other contingency chemicals may be required if problems or emergencies are encountered during drilling or cementing operations.

2.9 Well Clean-up, Testing and Completion

Following drilling and evaluation, the wells will be plugged and abandoned. There are no plans to test these wells.

2.10 Chemicals

Drilling offshore the Falkland Islands will follow the same model of chemical use as is required in the UK. Offshore chemical use in the UK is regulated through The Offshore Chemical Regulations 2002, which apply the provisions of the Decision by the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) for a Harmonised Mandatory Control System for the use and discharge of chemicals used in the offshore oil and gas industry. The Offshore Chemical Notification Scheme (OCNS) ranks chemical products according to Hazard Quotient (HQ), calculated using the CHARM (Chemical Hazard and Risk Management) model (refer to Appendix A for further information).

In the UK, the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) maintains a list of chemicals under the OCNS that have been approved for use offshore for specific functions. Only chemicals on this list may be chosen for use when selecting the components of the drilling mud, cement, completion and general rig chemicals. Chemicals are therefore selected on their technical merits and are screened so that the collateral environmental effects are minimised as far as practical.

All of the planned chemicals, which Rockhopper currently propose to use for the exploration wells, appear on this Ranked Lists of Products approved under the OCNS. They all have an OCNS category of ‘E’ or have a Gold HQ band (i.e. are least toxic) and are naturally occurring products (e.g. barite) that are either biologically inert or readily dispersible or biodegradable.

Certain chemicals will be required for specific purposes on the drilling rig for example lubricant for the drill string threads and detergent to periodically wash rig equipment. These chemicals will be selected to minimise any environmental impact that they might otherwise have.

Tables 2.4 to 2.8 below show the planned chemicals which will be used during drilling operations for the proposed exploration wells.

Table 2.4 Planned Drilling Mud Components (Sea Lion exploration well)

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
36 inch section primary chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.50	0.50	E
M-I BAR (All Grades)	Weighting Chemical	PLO	50.00	50.00	E
M-I GEL	Viscosifier	PLO	20.00	20.00	E
GUAR GUM	Viscosifier	PLO	1.00	1.00	E
Soda Ash	Other	PLO	0.50	0.50	E
36 inch section contingency chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.50	0.50	E
Citric Acid	Water based Drilling Fluid Additive	PLO	1.00	1.00	E
DUO-VIS	Viscosifier	-	2.00	2.00	GOLD
DUO-TEC	Viscosifier	-	2.00	2.00	GOLD
GUAR GUM	Viscosifier	PLO	1.00	1.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	75.00	75.00	E
M-I GEL	Viscosifier	PLO	30.00	30.00	E
Mica	Lost Circulation Material	PLO	2.00	2.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	2.00	2.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	2.00	2.00	E
KWIK-SEAL (All Grades)	Lost Circulation Material	PLO	2.00	2.00	E
SAFE-SURF E	Defoamer (Drilling)	SUB	1.00	1.00	GOLD
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	1.00	1.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
17.5 inch section primary chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.50	0.50	E
M-I BAR (All Grades)	Weighting Chemical	PLO	75.00	75.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
GUAR GUM	Viscosifier	PLO	2.00	2.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Soda Ash	Other	PLO	0.50	0.50	E
17.5 inch section contingency chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	1.00	1.00	E
DUO-VIS	Viscosifier	-	2.00	2.00	GOLD
DUO-TEC	Viscosifier	-	2.00	2.00	GOLD
GUAR GUM	Viscosifier	PLO	4.00	4.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	112.50	112.50	E
M-I GEL	Viscosifier	PLO	75.00	75.00	E
Mica	Lost Circulation Material	PLO	2.00	2.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	2.00	2.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	2.00	2.00	E
KWIK-SEAL (All Grades)	Lost Circulation Material	PLO	2.00	2.00	E
SAFE-SURF E	Defoamer (Drilling)	SUB	1.00	1.00	GOLD
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	0.75	0.75	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
12.25 inch section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	25.00	25.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	110.00	110.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	35.00	35.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.75	0.75	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	17.50	17.50	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	2.75	2.75	GOLD
ULTRAFREE NS	Drilling Lubricant	-	12.50	12.50	GOLD

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
FLO-TROL	Fluid Loss Control Chemical	PLO	3.50	3.50	E
POLYPAC - All Grades	Viscosifier	PLO	3.50	3.50	E
DUO-VIS	Viscosifier	-	2.25	2.25	GOLD
DUO-TEC	Viscosifier	-	2.25	2.25	GOLD
12.25 inch section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	50.00	50.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	220.00	220.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	70.00	70.00	E
SAFE-CIDE	Biocide	-	1.00	1.00	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	1.50	1.50	E
DEFOAM NS	Defoamer (Drilling)	-	1.00	1.00	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	35.00	35.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	5.50	5.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	25.00	25.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	7.00	7.00	E
POLYPAC - All Grades	Viscosifier	PLO	7.00	7.00	E
DUO-VIS	Viscosifier	-	4.50	4.50	GOLD
DUO-TEC	Viscosifier	-	4.50	4.50	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Chemical	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
12.25 inch sidetrack section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	25.00	25.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	110.00	110.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	35.00	35.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.75	0.75	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	17.50	17.50	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	2.75	2.75	GOLD
ULTRAFREE NS	Drilling Lubricant	-	12.50	12.50	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	3.50	3.50	E
POLYPAC - All Grades	Viscosifier	PLO	3.50	3.50	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
DUO-VIS	Viscosifier	-	2.25	2.25	GOLD
DUO-TEC	Viscosifier	-	2.25	2.25	GOLD
12.25 inch sidetrack section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	50.00	50.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	220.00	220.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	70.00	70.00	E
SAFE-CIDE	Biocide	-	1.00	1.00	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	1.50	1.50	E
DEFOAM NS	Defoamer (Drilling)	-	1.00	1.00	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	35.00	35.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	5.50	5.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	25.00	25.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	7.00	7.00	E
POLYPAC - All Grades	Viscosifier	PLO	7.00	7.00	E
DUO-VIS	Viscosifier	-	4.50	4.50	GOLD
DUO-TEC	Viscosifier	-	4.50	4.50	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Chemical	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
8.5 inch section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	20.00	20.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	85.00	85.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	30.00	30.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.50	0.50	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	5.00	5.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	1.50	1.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	5.00	5.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	1.25	1.25	E
POLYPAC - All Grades	Viscosifier	PLO	1.25	1.25	E
DUO-VIS	Viscosifier	-	1.00	1.00	GOLD
DUO-TEC	Viscosifier	-	1.00	1.00	GOLD

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
8.5 inch section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	40.00	40.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	170.00	170.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	60.00	60.00	E
SAFE-CIDE	Biocide	-	1.00	1.00	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	1.00	1.00	E
DEFOAM NS	Defoamer (Drilling)	-	1.00	1.00	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	10.00	10.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	3.00	3.00	GOLD
ULTRAFREE NS	Drilling Lubricant	-	10.00	10.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	2.50	2.50	E
POLYPAC - All Grades	Viscosifier	PLO	2.50	2.50	E
DUO-VIS	Viscosifier	-	2.00	2.00	GOLD
DUO-TEC	Viscosifier	-	2.00	2.00	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	20.00	20.00	E
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Chemical	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
8.5 inch sidetrack section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	20.00	20.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	85.00	85.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	30.00	30.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.50	0.50	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	5.00	5.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	1.50	1.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	5.00	5.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	1.25	1.25	E
POLYPAC - All Grades	Viscosifier	PLO	1.25	1.25	E
DUO-VIS	Viscosifier	-	1.00	1.00	GOLD
DUO-TEC	Viscosifier	-	1.00	1.00	GOLD
8.5 inch sidetrack section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	40.00	40.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	170.00	170.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	60.00	60.00	E
SAFE-CIDE	Biocide	-	1.00	1.00	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	1.00	1.00	E
DEFOAM NS	Defoamer (Drilling)	-	1.00	1.00	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	10.00	10.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	3.00	3.00	GOLD
ULTRAFREE NS	Drilling Lubricant	-	10.00	10.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	2.50	2.50	E
POLYPAC - All Grades	Viscosifier	PLO	2.50	2.50	E
DUO-VIS	Viscosifier	-	2.00	2.00	GOLD
DUO-TEC	Viscosifier	-	2.00	2.00	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	20.00	20.00	E
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB	Weighting Chemical	PLO	10.00	10.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
(ALL GRADES)					
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	1.00	1.00	SILVER
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
TOTALS:			1932.55	1932.55	

Table 2.5 Planned Drilling Mud Components (Ernest exploration well)

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
36 inch section primary chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.50	0.50	E
M-I BAR (All Grades)	Weighting Chemical	PLO	50.00	50.00	E
M-I GEL	Viscosifier	PLO	20.00	20.00	E
GUAR GUM	Viscosifier	PLO	1.00	1.00	E
Soda Ash	Other	PLO	0.50	0.50	E
36 inch section contingency chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.50	0.50	E
Citric Acid	Water based Drilling Fluid Additive	PLO	1.00	1.00	E
DUO-VIS	Viscosifier	-	2.00	2.00	GOLD
DUO-TEC	Viscosifier	-	2.00	2.00	GOLD
GUAR GUM	Viscosifier	PLO	1.00	1.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	75.00	75.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
M-I GEL	Viscosifier	PLO	30.00	30.00	E
Mica	Lost Circulation Material	PLO	2.00	2.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	2.00	2.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	2.00	2.00	E
KWIK-SEAL (All Grades)	Lost Circulation Material	PLO	2.00	2.00	E
SAFE-SURF E	Defoamer (Drilling)	SUB	1.00	1.00	GOLD
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	1.00	1.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
17.5 inch section primary chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	0.50	0.50	E
M-I BAR (All Grades)	Weighting Chemical	PLO	75.00	75.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
GUAR GUM	Viscosifier	PLO	2.00	2.00	E
Soda Ash	Other	PLO	0.50	0.50	E
17.5 inch section contingency chemicals					
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	1.00	1.00	E
DUO-VIS	Viscosifier	-	2.00	2.00	GOLD
DUO-TEC	Viscosifier	-	2.00	2.00	GOLD
GUAR GUM	Viscosifier	PLO	4.00	4.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	112.50	112.50	E
M-I GEL	Viscosifier	PLO	75.00	75.00	E
Mica	Lost Circulation Material	PLO	2.00	2.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	2.00	2.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	2.00	2.00	E
KWIK-SEAL (All Grades)	Lost Circulation Material	PLO	2.00	2.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
SAFE-SURF E	Defoamer (Drilling)	SUB	1.00	1.00	GOLD
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	0.75	0.75	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
12.25 inch section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	30.00	30.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	120.00	120.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	35.00	35.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.75	0.75	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	19.00	19.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	3.25	3.25	GOLD
ULTRAFREE NS	Drilling Lubricant	-	16.00	16.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	4.25	4.25	E
POLYPAC - All Grades	Viscosifier	PLO	4.50	4.50	E
DUO-VIS	Viscosifier	-	2.75	2.75	GOLD
DUO-TEC	Viscosifier	-	2.75	2.75	GOLD
Sodium Chloride Brine	Water based Drilling Fluid Additive	PLO	60.00	60.00	E
Sodium Chloride Powder (Salt PVD or Granular Salt)	Water based Drilling Fluid Additive	PLO	15.00	15.00	E
MEG	Gas Hydrate Inhibitor	PLO	2.00	2.00	E
METHANOL (all grades)	Gas Hydrate Inhibitor	PLO	1.80	1.80	E
Sodium Chloride Brine	Water based Drilling Fluid Additive	PLO	60.00	60.00	E
12.25 inch section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	60.00	60.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	240.00	240.00	E
M-I BAR (All	Weighting Chemical	PLO	70.00	70.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Grades)					
SAFE-CIDE	Biocide	-	1.00	1.00	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	1.50	1.50	E
DEFOAM NS	Defoamer (Drilling)	-	1.00	1.00	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	38.00	38.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	6.50	6.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	32.00	32.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	8.50	8.50	E
POLYPAC - All Grades	Viscosifier	PLO	9.00	9.00	E
DUO-VIS	Viscosifier	-	5.50	5.50	GOLD
DUO-TEC	Viscosifier	-	5.50	5.50	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Chemical	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER

ROCKHOPPER EXPLORATION PLC

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
12.25 inch sidetrack section primary chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	30.00	30.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	120.00	120.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	35.00	35.00	E
SAFE-CIDE	Biocide	-	0.50	0.50	GOLD
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	0.75	0.75	E
DEFOAM NS	Defoamer (Drilling)	-	0.50	0.50	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	19.00	19.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	3.25	3.25	GOLD
ULTRAFREE NS	Drilling Lubricant	-	16.00	16.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	4.25	4.25	E
POLYPAC - All Grades	Viscosifier	PLO	4.50	4.50	E
DUO-VIS	Viscosifier	-	2.75	2.75	GOLD
DUO-TEC	Viscosifier	-	2.75	2.75	GOLD
12.25 inch sidetrack section contingency chemicals					
POTASSIUM CHLORIDE	Water Based Drilling Fluid Additive	PLO	60.00	60.00	E
Potassium Chloride Brine	Water based Drilling Fluid Additive	PLO	240.00	240.00	E
M-I BAR (All Grades)	Weighting Chemical	PLO	70.00	70.00	E
SAFE-CIDE	Biocide	-	1.00	1.00	GOLD

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
MAGNESIUM OXIDE	Acidity Control Chemical	PLO	1.50	1.50	E
DEFOAM NS	Defoamer (Drilling)	-	1.00	1.00	GOLD
ULTRAHIB	Shale Inhibitor / Encapsulator	-	38.00	38.00	SUB
ULTRACAP	Shale Inhibitor / Encapsulator	-	6.50	6.50	GOLD
ULTRAFREE NS	Drilling Lubricant	-	32.00	32.00	GOLD
FLO-TROL	Fluid Loss Control Chemical	PLO	8.50	8.50	E
POLYPAC - All Grades	Viscosifier	PLO	9.00	9.00	E
DUO-VIS	Viscosifier	-	5.50	5.50	GOLD
DUO-TEC	Viscosifier	-	5.50	5.50	GOLD
Caustic Soda	Water based Drilling Fluid Additive	INORGANIC	1.00	1.00	E
Citric Acid	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Dyna Red Seepage Control Fiber	Fluid Loss Control Chemical	PLO	4.00	4.00	E
FORM-A-SQUEEZE	Fluid Loss Control Chemical	PLO	2.00	2.00	E
G-Seal	Lost Circulation Material	PLO	2.00	2.00	E
Guar Gum	Viscosifier	PLO	3.00	3.00	E
Koplus LL	Pipe Release Chemical	PLO	8.00	8.00	E
KWIKSEAL	Lost Circulation Material	PLO	5.00	5.00	E
LIME	OPF Additive	PLO	1.00	1.00	E
M-I GEL	Viscosifier	PLO	50.00	50.00	E
Mica	Lost Circulation Material	PLO	5.00	5.00	E
Nutshells - All Grades	Lost Circulation Material	PLO	5.00	5.00	E
PBS PLUG 500	Fluid Loss Control Chemical	PLO	2.50	2.50	E
PBS Plug Activator	Crosslinking Chemical	PLO	1.25	1.25	E
PBS Plug Retarder	Crosslinking Chemical	PLO	0.50	0.50	E
SAFE-CARB (ALL GRADES)	Weighting Chemical	PLO	10.00	10.00	E
SAFE-SCAV HSB	Hydrogen Sulphide Scavenger	-	2.00	2.00	SILVER
SAFE-SURF E	Detergent / Cleaning Fluid	SUB	2.00	2.00	SUB
SAFE-SCAV NA	Oxygen Scavenger	PLO	1.00	1.00	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
SAND SEAL All grades	Lost Circulation Material	PLO	3.00	3.00	E
SAPP	Water based Drilling Fluid Additive	PLO	2.00	2.00	E
Soda Ash	Other	PLO	2.00	2.00	E
Sodium Bicarbonate	Cement or Cement Additive	PLO	2.00	2.00	E
Sugar	Thinner	PLO	1.00	1.00	E
SUPER SWEEP	Lost Circulation Material	-	0.50	0.50	SUB
Ven Fyber 201	Lost Circulation Material	PLO	2.00	2.00	E
TOTALS:			1455.05	1455.05	

Table 2.6 Planned Cementing Chemicals (Sea Lion exploration well)

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Primary Chemicals					
D095 Cement Additive	Cement or Cement Additive	PLO	0.577	0.060	E
AccuSET D197	Cement or Cement Additive		6.949	1.938	Gold
BARITE D31		PLO	1371.742	524.658	E
Cement Class G D907	Cement or Cement Additive	PLO	694.148	162.977	E
D600G GASBLOK* Gas Migration Control Additive	Cement or Cement Additive	SUB	16.206	4.694	Gold (sub)
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	2.844	1.209	E
Liquid Accelerator D77	Cement or Cement Additive	PLO	4.359	1.704	E
Liquid Antifoam B143	Cement or Cement Additive		0.885	0.320	Gold
Silicate Additive D75	Cement or Cement Additive	PLO	6.136	1.293	E
UNIFLAC-L D168	Cement or Cement Additive		8.103	4.027	Gold
Viscosifier for MUDPUSH II spacer B174	Viscosifier	PLO	0.544	0.209	E
Tros Seadye	Well Stimulation Chemical		0.45	0.075	Gold
Low Temperature Retarder D081	Well Stimulation Chemical	PLO	0.640 MT	0.040 MT	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Antifoam Agent D175A	Antifoam (Hydrocarbons)	SUB	0.133	0.027	Gold (sub)
Iron Stabilizing Agent L001	Completion Additive	PLO	0.451324438	0.224528238	E
Silica Flour D66	Cement or Cement Additive	PLO	24.85614357	3.824022087	E
Surfactant D191	Other		0.445164451	0.14838815	Gold
Mutual Solvent U66	Cement or Cement Additive		0.408824496	0.136274832	Gold
D095 Cement Additive	Cement or Cement Additive	PLO	0.577	0.060	E
AccuSET D197	Cement or Cement Additive		6.949	1.938	Gold
Contingency chemicals					
D095 Cement Additive	Cement or Cement Additive	PLO	0.577	0.060	E
AccuSET D197	Cement or Cement Additive		0.826	0.239	Gold
AccuSET D197	Cement or Cement Additive		0.318	0.208	Gold
AccuSET D197	Cement or Cement Additive		0.103	0.070	Gold
BARITE D31	Cement or Cement Additive	PLO	270.437	120.194	E
Cement Class G D907	Cement or Cement Additive	PLO	34.284	16.983	E
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	0.277	0.181	E
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	0.269	0.183	E
Liquid Accelerator D77	Cement or Cement Additive	PLO	4.359	1.704	E
Liquid Antifoam B143	Cement or Cement Additive		0.036	0.014	Gold
Silicate Additive D75	Cement or Cement Additive	PLO	3.910	0.592	E
UNIFLAC-L D168	Cement or Cement Additive		1.032	0.728	Gold
Viscosifier for MUDPUSH II spacer B174	Viscosifier	PLO	0.102	0.045	E
Antifoam Agent D175A	Antifoam (Hydrocarbons)	SUB	0.133	0.027	Gold (sub)
Iron Stabilizing Agent L001	Completion Additive	PLO	0.451324438	0.22452824	E
Silica Flour D66	Cement or Cement Additive	PLO	24.85614357	3.82402209	E
Surfactant D191	Other		0.445164451	0.14838815	Gold

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Mutual Solvent U66	Cement or Cement Additive		0.408824496	0.13627483	Gold
TOTALS:			2482.705	853.126	

Table 2.7 Planned Cementing Chemicals (Ernest exploration well)

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
Primary Chemicals					
D095 Cement Additive	Cement or Cement Additive	PLO	0.577	0.060	E
AccuSET D197	Cement or Cement Additive		6.099	1.590	Gold
BARITE D31		PLO	1101.305	404.464	E
Cement Class G D907	Cement or Cement Additive	PLO	426.406	66.134	E
D600G GASBLOK* Gas Migration Control Additive	Cement or Cement Additive	SUB	16.206	4.694	Gold (sub)
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	2.316	0.844	E
Liquid Accelerator D77	Cement or Cement Additive	PLO	4.359	1.704	E
Liquid Antifoam B143	Cement or Cement Additive		0.665	0.217	Gold
Silicate Additive D75	Cement or Cement Additive	PLO	5.909	1.203	E
UNIFLAC-L D168	Cement or Cement Additive		6.000	2.571	Gold
Viscosifier for MUDPUSH II spacer B174	Viscosifier	PLO	0.442	0.163	E
Tros Seadye	Well Stimulation Chemical		0.45	0.075	Gold
Low Temperature Retarder D081	Well Stimulation Chemical	PLO	0.640 MT	0.040 MT	E
Antifoam Agent D175A	Antifoam (Hydrocarbons)	SUB	0.133	0.027	Gold (sub)
Iron Stabilizing Agent L001	Completion Additive	PLO	0.451324438	0.224528238	E
Surfactant D191	Other		0.445164451	0.14838815	Gold
Mutual Solvent U66	Cement or Cement Additive		0.408824496	0.136274832	Gold
Contingency chemicals					
D095 Cement Additive	Cement or Cement Additive	PLO	0.577	0.060	E

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
AccuSET D197	Cement or Cement Additive		0.826	0.239	Gold
AccuSET D197	Cement or Cement Additive		0.318	0.208	Gold
BARITE D31	Cement or Cement Additive	PLO	300.486	120.194	E
Cement Class G D907	Cement or Cement Additive	PLO	123.639	12.288	E
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	0.718	0.208	E
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	0.277	0.181	E
Environmentally Friendly Dispersant B165	Cement or Cement Additive	PLO	0.563	0.180	E
Liquid Accelerator D77	Cement or Cement Additive	PLO	4.359	1.704	E
Liquid Antifoam B143	Cement or Cement Additive		0.037	0.025	Gold
Silicate Additive D75	Cement or Cement Additive	PLO	1.772	0.521	E
UNIFLAC-L D168	Cement or Cement Additive		1.091	0.557	Gold
Viscosifier for MUDPUSH II spacer B174	Viscosifier	PLO	0.091	0.036	E
Antifoam Agent D175A	Antifoam (Hydrocarbons)	SUB	0.133	0.027	Gold (sub)
Iron Stabilizing Agent L001	Completion Additive	PLO	0.451324438	0.22452823 8	E
Surfactant D191	Other		0.445164451	0.14838815	Gold
Mutual Solvent U66	Cement or Cement Additive		0.408824496	0.13627483 2	Gold
TOTALS:			2009.006	621.233	

Table 2.8. Planned Rig Chemicals

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharge d (tonnes)	HQ Band / OCNS group
Aqueous Degreaser 4000	Detergent / Cleaning Fluid	-	3	3	GOLD
ECO-F	BOP Fluid	-	2	2	D
MEG	Gas Hydrate Inhibitor	PLO	3	3	E
Bestolife 3010 NM special.	Pipe Dope	-	0.6	0.06	E
Jet-Lube API-	Pipe Dope	SUB, Cu, Pb,	0.2	0	C

Chemical Name	Chemical Function	Chemical Label Code	Estimated Use (tonnes)	Estimated Discharged (tonnes)	HQ Band / OCNS group
MODIFIED®		Zn			
JET-LUBE®SEALGAURD™ ECF	Pipe Dope	-	0.2	0.1	E
JET-LUBE® RUN N SEAL™ECF	Pipe Dope	-	0.2	0.1	E
TOTALS:			9.2	8.26	

2.11 Resource Use

2.11.1 Equipment and Chemicals

The remote drilling location will require sufficient materials and chemicals, equipment, spares and contingency supplies to be ordered in advance and shipped prior to rig mobilisation. These will be sourced in advance and most likely outside of the Falkland Islands.

2.11.2 Fuel

The Ocean Guardian is likely to consume 10 tonnes of fuel a day during drilling operations and a support vessel 5 tonnes of fuel a day. The Rockhopper drilling campaign will use a maximum of 1,050 tonnes of fuel, if the rig is on Sea Lion and Ernest locations for maximum 30 and 40 days respectively. The fuel will most likely be sourced from the Falkland Islands.

2.11.3 Water

Water will be needed for operational and domestic use onboard the drill rig, and it is estimated that approximately 51,000 litres of drilling water per day and 200 litres of potable water per person per day is required for a typical drilling operation. It is estimated that approximately 1,400,000 litres of potable water will be required (assuming the rig hold 100 people on board). The drilling campaign will require approximately 3,570,000 litres of drilling water.

Potable water will either be sourced from the ocean and treated in the desalination plant or will be obtained from the Falkland Islands, or a combination of both. Drilling water will be sourced from the ocean. The details of this will be confirmed as part of the Base Services tender.

2.11.4 Waste

Non-hazardous waste will be disposed of on the Falkland Islands and the hazardous waste will be be transferred to the UK for disposal. Specific waste handling/disposal routes and procedures will be detailed in a Waste Management Plan.

Hazardous waste composition generated from wells will vary per well, but a typical exploration well would generate between 2 and 100 tonnes of hazardous waste (average of 65 tonnes). However this estimate is based on North Sea wells, which are typically deeper than those of the Falkland so it can be expected that hazardous waste generated would be towards the lower end of the range.

2.12 Support Operations

2.12.1 Accommodation

During routine crew changes, the crew will need to be temporarily accommodated on the Falkland Islands as they wait for their flights. Accommodation will be sourced by Rockhopper and this will be in the form of staff houses and/or hotels.

2.13 Support Operations

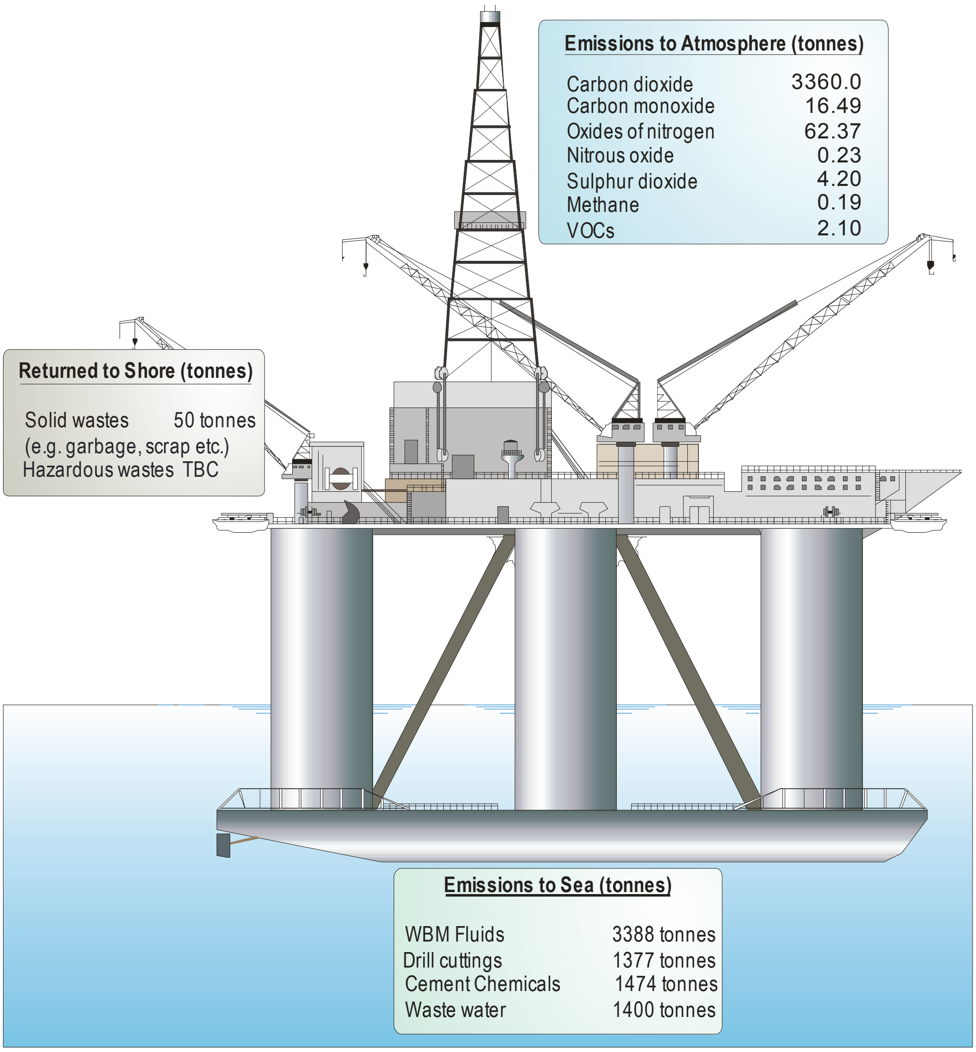
The drilling rig will be supported by three anchor handler vessels providing supply services between the rig and the onshore base in Stanley as well as providing standby duties at the rig and facilitating the rig moves between wells.

A helicopter dedicated to Rockhopper will be available from BIH throughout the drilling programme, This is in addition to the two helicopters BIH currently operate. Helicopter flights for crew changes will take place twice a week. On arrival at Mt Pleasant, the crews will immediately board the helicopter for transfer to the rig. The returning crew will fly to Port Stanley where they will spend the night in the Malvinas hotel before returning to the UK using the Airbridge the following day. Each flight will involve a crew change of 12 people for a total of 24 per week.

2.14 Total Emissions Summary

Figure 2.2 provides a summary of estimated totals of the main emissions and discharges directly arising from routine operations associated with the drilling the Sea Lion and Ernest exploration wells.

Figure 2.2 Emissions summary



Note: Power generation emissions calculations are based on an estimated 70 days on location (worst case).
Atmospheric emissions assume rig consumes @ 10 tonnes fuel/day and safety standby vessel @ 5 tonnes fuel/day for 70 days duration.
Waste water discharges calculated assuming 200 l/man/day with 100 personnel onboard the rig.
Solid waste production based on an estimated average of 24 tonnes/month during drilling operations.

3 Key Seasonal Sensitivities

This section describes the key physical, biological and socio-economic values of the marine environment within and adjacent to the proposed drilling locations specific to the proposed drilling dates of the exploration wells. Extensive reference has been made to the previous EIA's submitted in February 2009 (Ref: EOE0612) and March 2009 (Ref: EOE0593)

3.1 Physical Environment

Refer to Section 7.1 (pages 45 to 58) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.1 (pages 42 to 53) of the Rockhopper EIS for License Areas PL023 and PL024.

3.1.1 Geography

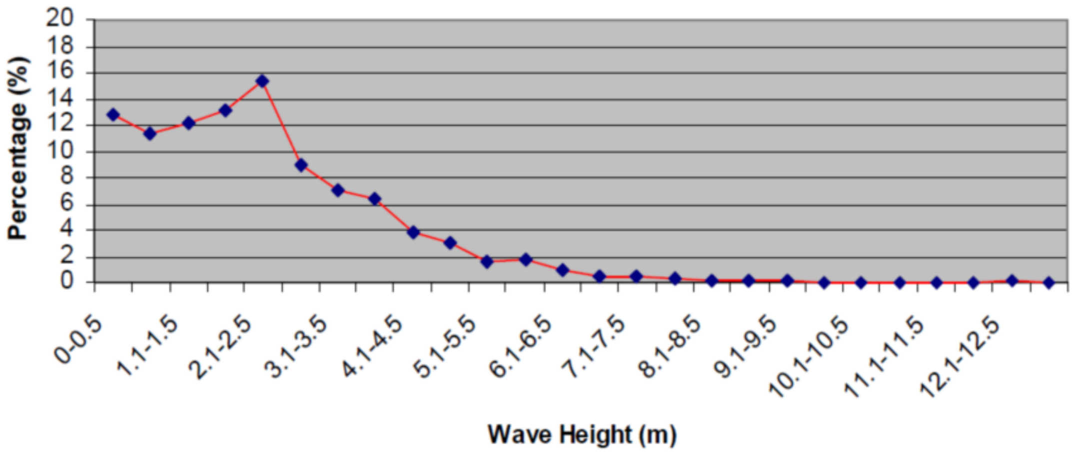
The Falkland Islands are an archipelago of approximately 700 islands in the South Atlantic, the largest of which are East Falkland and West Falkland (Figure 3.1). Situated some 770 kilometres (480 miles) north-east of Cape Horn and 480 km (300 miles) from the nearest point on the South American mainland, the Falklands have a total land area of 12,173 km^2 (4700 square miles) and a permanent population of 2913 (*FCO, 2007*).

The proposed Rockhopper wells lie between 105 kilometres (Ernest well) and 220 kilometres (Sealion well) from the nearest landfall on the Falklands Islands.

3.1.2 Waves

Winds can generate rough sea conditions with waves of variable direction and height. Maximum wave heights in the vicinity of the proposed drilling locations are in the region of 2 to 3 metres (Figure 3.1). Wave height at the start of the proposed drilling programme (March) will be low corresponding to the Southern Hemisphere summer and will gradually increase towards the end of the drilling programme (June and July), becoming energetic. The direction of wave approach was predominantly west to south-west.

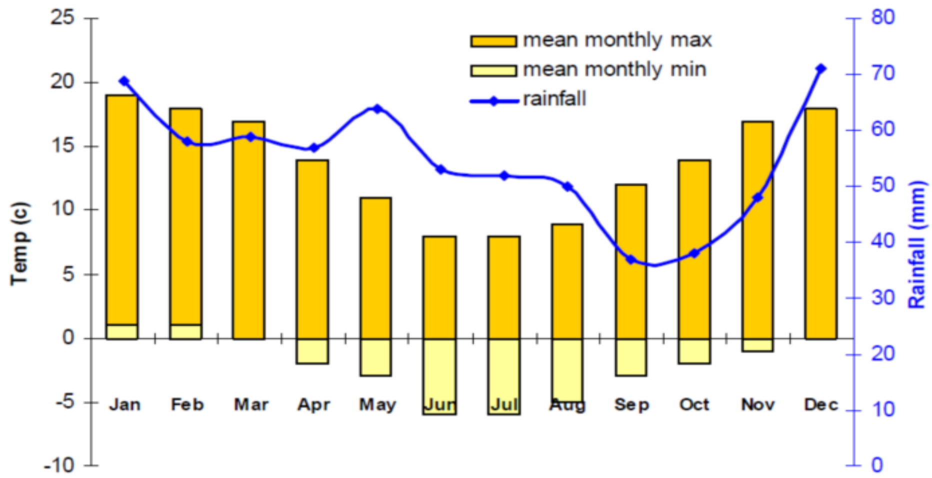
Figure 3.1 Annual Wave Exceedance



3.1.3 Temperature

The Falklands have a narrow terrestrial temperature range with mean annual maximum temperatures of approximately 10°C, mean annual minimum temperatures of approximately 3°C, and mean monthly ranges of between –5°C to 20°C (Figure 3.2). During the proposed drilling months (March to July) temperature is likely to be in start around 15°C and drop to 5°C by the end of the well program.

Figure 3.2 Climate Averages for Stanley Harbour



3.1.4 Precipitation

Figure 3.2 shows the average monthly rainfall for Stanley Harbour, the proposed supply base for offshore drilling operations. Average annual rainfall at Stanley is around 650 millimetres and average annual rainfall for the Falklands is low, but consistent. During the proposed drilling period rainfall is likely to be low (approximately, 60 millimetres per month).

3.2 Biological Environment

The Patagonian Shelf, on which the Falkland Islands sit, is of regional and global significance for marine resources (*Croxall & Wood, 2002*). It comprises rich assemblages of seabirds, marine mammals, fish, squid and plankton populations. Only the sensitivities that have changed or been influenced by the proposed drilling dates of the exploration wells have been discussed below. All other sensitivities are assumed to be the same as stated in the 2009 EISs (Ref: EOE0612 and Ref: EOE0593).

3.2.1 Marine Mammals

Cetaceans

Refer to Section 7.2.8.1 (pages 66 to 73) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.8.1 (pages 62 to 69) of the Rockhopper EIS for License Areas PL023 and PL024.

Cetaceans in Falkland Islands' waters may either occur as a consequence of their passage on migration or when they enter sheltered waters to give birth or to mate.

The following results, unless stated otherwise, have been extracted from the Distribution of Seabirds and Marine Mammals in Falkland Islands' Waters, 2002 and represent the findings of those surveys between 1998 and 2001. Seventeen species of marine mammals were recorded over the period including 14 species of cetacean and three pinniped species. In total, 6,550 individual marine mammals were seen during the survey period.

Table 3.1 details the cetaceans that may be present in the vicinity of the proposed exploration wells during the proposed drilling period (March to July).

Table 3.1 Cetaceans present in the vicinity of the proposed exploration wells during the proposed drilling months (March to July)

Species	Notes
Sei whale (Balaenoptera borealis)	Most sei whale sightings were between November and April, with 45 individuals recorded on 31 occasions. Most records were from Patagonian Shelf waters, with others in relatively shallow waters. It is not expected that the species will be in the vicinity of the wells during the proposed drilling dates (March to July) in any significant number
Minke whale (Balaenoptera acutorostrata)	Minke whale sightings peaked in April and December, with a total of 68 whales recorded on 60 occasions. The majority of records were from Patagonian Shelf waters around East Falklands and in the north-west of the survey area. It is therefore possible that Minke whale could be present at the wells drilled towards the end of the exploration campaign (April to July), although in relatively low numbers.
Sperm whale (Physeter macrocephalus)	A total of 28 sperm whales were recorded on 21 occasions, mainly in July, October and December, but also throughout most months. All sperm whale sightings occurred in deeper waters (>200 m), with records clustered to primarily to the north of the Falkland Islands. Sperm whale could venture in the vicinity of the wells in deeper waters (Rachel, Ninky, Liz and Ann A), although in relatively low numbers.
Long-finned pilot whale (Globicephala melas)	Large numbers of long-finned pilot whale were recorded (872 over 27 occasions), with group sizes of up to 200. Although these whales were recorded in all months except January, they were predominantly recorded between April and September in waters deeper than 200 metres. It is possible that the long-finned pilot whale could be present in the vicinity of the proposed wells in deeper waters (Rachel, Liz, Ninky and Ann A wells) if drilled between April and September.
Hourglass dolphin (Lagenorhynchus cruciger)	Hourglass dolphins were recorded in large numbers, with 866 Sightings over 177 occasions, mainly between September and March and in water depths of greater than 200 metres. Given this it is possible that the long-finned pilot whale could be present in the vicinity of the proposed wells in deeper waters (Rachel, Liz, Ninky and Ann A) if drilled towards the beginning of the exploration campaign.

Overall, the area in the vicinity of the proposed drilling activity is not considered to be an area of particularly high sensitivity for cetaceans during the proposed drilling months.

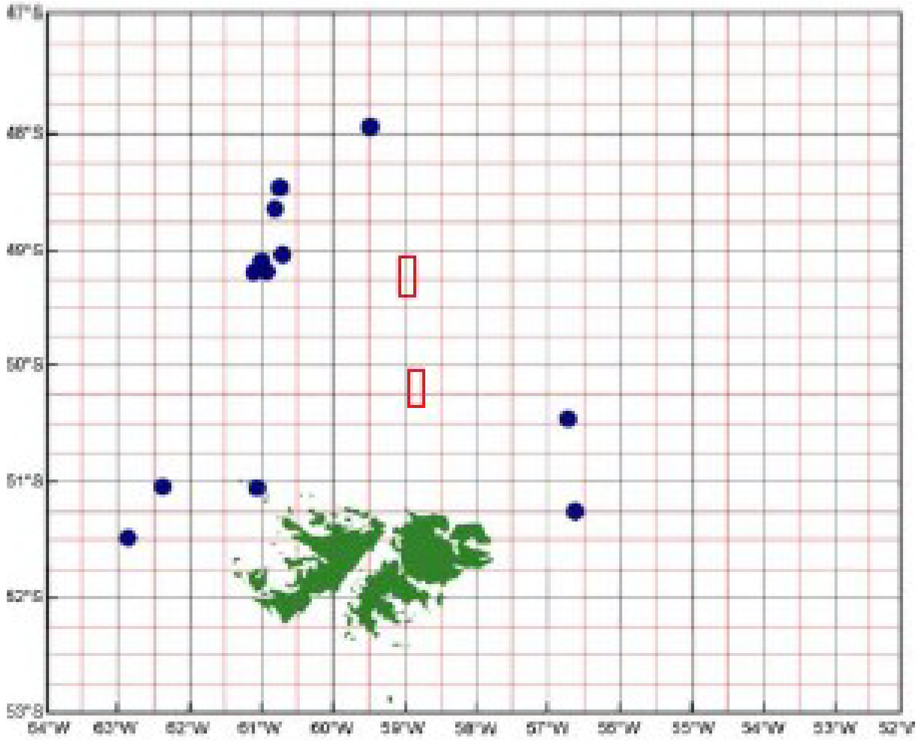
Pinnipeds

Refer to Section 7.2.8.2 (pages 73 to 76) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.8.2 (pages 69 to 72) of the Rockhopper EIS for License Areas PL023 and PL024.

Four seal species occur in the Falklands – three species breeding and one occurring as a vagrant. Seal species include the predominant *Otaridae* (eared seals) group comprising fur seal and sea lion species, and the *Phocidae* (true seals) group comprising southern elephant seal and leopard seal.

The southern elephant seal is the largest of all the pinniped species. Found in most sub-Antarctic waters, the Falklands only hold only a very small percentage of the world population. Only one major breeding colony exists on Sea Lion Island and it is estimated to represent around 90 percent or more of the breeding population of the Falklands, its conservation is therefore very important. Southern elephant seal have been sighted to the north of the Falklands on rare occasions (Figure 3.3); however it is very unlikely they would venture into the vicinity of the exploration well areas.

Figure 3.3 Southern Elephant Seal distribution (surveys from February 1998 to January 2001)



Overall, the area in the vicinity of the proposed drilling activity is not considered to be an area of particularly high sensitivity for pinnipeds during the proposed drilling period (March to July) and it is unlikely that any pinnipeds will be present in the vicinity of the wells.

3.2.2 Seabirds

The Falkland Islands are an area of global importance for birdlife, particularly seabird species of international significance. The North Falklands Current upwells nutrient rich water from Antarctic waters and provides an area of high plankton activity, forming the basis of the marine ecosystem and supporting seabird activity in the region.

The avifauna of the region is well studied and documented, and seabird distribution, breeding and foraging patterns have been studied extensively. A number of publications outlining survey efforts by those such as Croxall et al. (1984), Woods (1988; 1997), Strange (1992) have recently been supplemented by ongoing seabird monitoring and survey programmes conducted by FC/JNCC such as the:

- Falkland Islands State of the Environment Report (Otley et al., 2008). This report documents the current knowledge of the Falkland Islands' environment.
- Origin, age, sex and breeding status of wandering albatrosses (Diomedea exulans), northern (Macronectes halli) and southern giant petrels (Macronectes giganteus) attending demersal longliners in Falkland Islands and Scotia Ridge waters, 2001 –2005 (Otley et al., 2006). The report summarises three years of survey work undertaken in Falkland Islands' waters between 2001 and 2005.
- Patterns of seabird attendance at Patagonian toothfish longliners in the oceanic waters of the Falkland Islands, 2001–2004 (Otley, 2005). The report summarises the surveys of seabirds attending Patagonian toothfish longliners during line setting and hauling activities in deepwater to the east of the Falkland Islands made between July 2001 and June 2004.

- The distribution of seabirds and marine mammals in Falkland Islands' waters (White, 2002). The report summarises three years of survey work undertaken in Falkland Islands' waters between February 1998 and January 2001.
- Vulnerable concentrations of seabirds (White et al., 2001). The report summarises two years of survey work in the form of a vulnerability atlas, with the aim of highlighting the locations of seabird concentrations that would be the most vulnerable to the effects of surface pollution.

These reports have been used extensively to provide a synopsis of seabird species, numbers, locations and sensitivities, and the information presented below and in the following sections has been based on these sources.

Between 1998 and 2001 a total of 218 species were recorded along with some unconfirmed sightings and have been included within this list. There were 21 resident landbirds, 18 waterbirds, 22 breeding seabirds, 18 annual non-breeding migrants and at least 139 occasional visitors (*Woods et al., 2004*). Between 2001 and 2005 a total of 547 sightings of 291 banded wandering albatross *Diomedea exulans* and 21 sightings of 14 banded giant petrels *Macronectes* spp. were made (*Otley, 2005*).

There are five different species of breeding penguin in the Falkland Islands (rockhopper, Magellanic, gentoo, king and macaroni). The Falklands are the most important world site for the endangered rockhopper penguin and are also home to 80% of the world's breeding population of black-browed albatross. Several rare and threatened species of petrel nest on offshore islands.

Penguins

Refer to Section 7.2.9.1 (pages 78 to 80) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.9.1 (pages 74 to 76) of the Rockhopper EIS for License Areas PL023 and PL024.

Nine penguin species have been recorded in the Falkland Islands with the following six species identified during the at-sea survey period (1998–2001). Of these, only the Chinstrap penguin (p. *Antarctica*) is not considered to be a locally breeding species:

- King penguin (*Aptenodytes patagonicus*);
- Gentoo penguin (*Pygoscelis papua*);
- Rockhopper penguin (*Eudyptes chrysocome*);
- Macaroni penguin (*Eudyptes chrysolophus*);
- Magellanic penguin (*Speniscus magellanicus*);
- Chinstrap penguin (*P. antarctica*).

Of the above species only rockhopper penguins and magellanic penguin have been observed at significant distance from the Falkland Islands during the proposed drilling period for the wells. King penguin are, however, present during the southern hemisphere winter months.

Between December and March the majority of recorded rockhopper sightings are from near-shore areas and to the west of the Falkland Islands, with very few scattered sightings within the vicinity of the proposed drilling operations. However, from September to November distribution is more widely spread across Falkland Islands' waters and scattered sightings are likely in the vicinity of the exploration area. Putz et al (2003) tracked the foraging patterns of ten male rockhopper penguins from the Falkland Islands during the incubation period Three foraging trips were directed towards the slope of the Patagonian Shelf approximately 140 kilometres to the northeast of the breeding colony and these trips had a duration of 11–15 days. The seven other rockhopper penguins travelled approximately 400 kilometres towards the edge of the Falkland Islands' waters; all these foraging trips followed an anti-clockwise direction and lasted 16–27 days.

Between April and August there are fewer sightings and these are primarily to the north and west of the Falkland Islands, with only occasional records within the vicinity of the proposed drilling operations. It is therefore unlikely that rockhopper penguins will be present in the vicinity of the well for any significant time during the proposed drilling months (March to July).

Magellanic penguin populations in the Falkland Islands have decreased over the past decade. The post-breeding migration (November to April) may be the period in which the birds are most vulnerable (*Putz et al, 2000)*. Putz et al (2000) tracked ten magellanic penguins with satellite transmitters to investigate the movements of the species over the post- breeding season. The movements of the penguins were tracked for between 15 and 99 days until transmission ceased. All birds initially migrated to the northwest of the Falklands. However, four birds entered Argentinean coastal waters, and then headed northeast following the coastline, The other penguins remained offshore, but also changed to a northeasterly course (*Putz et al, 2000).* The highest densities of magellanic penguin have been recorded between December and February, primarily in inshore waters. It is therefore possible that magellanic penguin may be present over the well locations in low number towards the beginning of the drilling campaign when the birds venture offshore post-breeding.

Albatrosses

Refer to Section 7.2.9.2 (pages 80 to 83) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.9.2 (pages 76 to 79) of the Rockhopper EIS for License Areas PL023 and PL024.

Albatross species are globally declining with populations in the Falkland Islands reported to have dropped by 28% in the last 20 years (*Woods, 1988*). Eleven species of albatross have been recorded in the Falkland Islands, although only the black-browed albatross is a resident breeding species.

Ten of the 11 species of albatross recorded in the Falkland Islands are afforded conservation status, and include:

- Black-browed albatross (*Thalassarche melanophris*) – Endangered
- Buller's albatross (*Thalassarche bulleri*) – Vulnerable
- Grey-headed albatross (*Thalassarche chrysostoma*) – Vulnerable
- Light-mantled sooty albatross (*Phoebetricia palpebrata*) – Near Threatened
- Northern royal albatross (*Diomedea sanfordi*) - Vulnerable
- Shy albatross (*Thalassarche cauta*) – Near Threatened
- Sooty albatross (*Phoebetria fusca*) – Endangered
- Southern royal albatross (*Diomedea epomophora*) - Endangered
- Wandering albatross (*Diomedea exulans*) - Vulnerable
- Yellow-nosed albatross (*Thalassarche chlororhynchos*) – Endangered

Of the above, Southern Royal albatross, Black-browed albatross and Grey headed albatross can be expected to be found within the vicinity of the drilling activity during the drilling period (refer to Table 3.2).

Table 3.2 Likely distribution of Albatross during the proposed drilling period (March to July)

Species	Notes
Royal albatrosses	The Royal albatrosses are a visiting species, breeding in New Zealand and using South Pacific and Patagonian feeding grounds. The Southern Royal albatross is classified as 'Vulnerable' where as the Northern is 'Endangered'. Of the 4114 Royal albatrosses recorded (1998–2001), 3252 were identified as Southern and 447 as Northern (with 415 not determined). Highest numbers of Southern royal albatross were seen between March and June, particularly to the north-west of the Falklands. Highest numbers of Northern Royal albatross were seen between March and July, generally in the same areas as the Southern. It is therefore likely that the southern Royal albatross will be present in the vicinity of the wells during the months of March to June and the northern Royal Albatross will be present in the vicinity of the proposed wells during the months of March to July.
Black-browed albatross	Black-browed albatross were recorded in all months (1998–2001), with a total of 84,614 birds recorded, reaching a peak in March. Between November and January the highest densities occurred in inshore waters to the west of the Falklands. Between February and June high densities occurred throughout Patagonian Shelf waters to the north-west of the Falklands and between July and October high densities shifted to the south-west of the Falklands. Given the recorded distribution of Black-browed albatross in the Falklands it is likely that the species will be present over the proposed well locations during the proposed drilling dates (March to July).
Grey-headed albatross	A total of 1321 Grey-headed albatross were recorded, covering all months (1998–2001) with a peak between May and September. Distribution varied throughout the year, with species recorded over the proposed well locations occurring between February and September. It is therefore possible given the drilling dates (March to July) that Grey-headed albatross will be present.

Petrels and Shearwater

Refer to Section 7.2.9.3 (pages 84 to 86) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.9.3 (pages 80 to 82) of the Rockhopper EIS for License Areas PL023 and PL024.

Petrels and shearwaters form the largest group of oceanic birds, remaining at sea throughout their lives, except for a few months each year when they return to land to breed. The most common breeding species is the southern giant petrel (*Macronectes giganteus*) (*Otley et al., 2008*). As many as 26 species have previously been recorded in the Falkland Islands with nine species breeding on the Islands:

- Northern giant petrel (*Macronectes halli*)
- Southern giant petrel (*Macronectes giganteus*)
- Antarctic petrel (Thalassoica Antarctica)
- Cape petrel (Daption capense)
- Antarctic fulmar (Fulmarus glacialoides)
- Blue petrel (Halobaena caerulea)
- Kerguelen petrel (Pterodroma brevirostris)
- Soft-plumaged petrel (*Pterodroma mollis*)
- Atlantic petrel (Pterodroma incerta)
- Prion spp (Pachyptila spp)
- Grey petrel (Procellaria cinerea)
- White-chinned petrel (Procellaria aequinoctialis)
- Great shearwater (*Puffins gravis*)
- Sooty shearwater (*Puffins griseus*)
- Little shearwater (*Puffins assimilis*)
- Wilson's storm-petrel (*Oceanites oceanicus*)
- Grey backed storm-petrel (*Garrodia nereis*)
- Black-bellied storm-petrel (*Fregetta tropica*)
- White-bellied storm-petrel (*Fregetta grallaria*)
- White-bellied storm-petrel (*Fregetta grallaria*)
- Northern giant petrel (*Macronectes halli*)
- Southern giant petrel (*Macronectes giganteus*)

Several of the above species may be present in the vicinity of the proposed wells given the timing of the exploration campaign (refer to Table 3.3).

Table 3.3 Likely distribution of Petrel and Shearwater during the proposed drilling period (March to July)

Species	Notes
Northern giant petrels	Northern giant petrels have been recorded throughout the year. Between March and August densities were highest to the north and west of the Falklands. From September to February sightings were less concentrated and more widely scattered. Northern giant petrels were less likely to be recorded in coastal or inshore waters. It is possible that Northern giant petrels may be present in the vicinity of the exploration wells over the months of the drilling campaign (March to July) particular from March onwards.
Cape petrels	Cape petrels were recorded every month, with a total of 15,199 records made over the survey. Highest numbers were recorded between May and September with very few records occurring between December and April. Cape petrels were only recorded in abundance to the north of the Falklands over this period, lessening off between October and November with very few records in this area throughout the rest of the year. It is therefore possible that Cape petrels may be in the vicinity of the exploration wells over the months of the drilling campaign (March to July), however only from May.
Soft-plumaged petrels	Soft-plumaged petrels are non-breeding late summer visitors to the Falklands, with records occurring between November and April, peaking in January. In total, 861 soft-plumaged petrels were recorded, mainly in deep waters to the north-east of the Falkland Islands. It is therefore possible that Soft-plumaged petrels may be in the vicinity of the exploration wells given the timing of the drilling campaign.
Grey petrels	Grey petrels were recorded mainly between December and March, with peak numbers in February. A total of 45 grey petrels were recorded, all in deep waters to the north and east of the Falklands. Although widely distributed, grey petrels are more likely to be sighted to the east and south-east of the Falkland Islands. It is possible that Grey petrels may be in the vicinity of the exploration wells over the months of the drilling campaign (March to July) particularly during March, however in low numbers
White-chinned petrel	The white-chinned petrel breed on the Falkland Islands and survey work from summers of 2004/2005 and 2005/2006 indicate that this accounts for less than 1% of the global population. A total of 8044 white-chinned petrel were recorded from the at-sea survey (1998–2001), encompassing all months but with the highest numbers between January and May. Most records were to the north and west of the Falklands. It is possible that white-chinned petrel may be in the vicinity of the exploration wells over the months of the drilling campaign (March to July) however in low numbers.
Great shearwaters	Great shearwaters were recorded primarily between December and April during the at-sea survey, with almost none recorded between June and October. Total number of records was 6,468, mainly over shelf slope and oceanic waters to the north and east of the Falkland Islands. Although of importance at a local level, the population is not globally significant as an estimated five million breeding pairs are found on the Tristan da Cunha and Gough Island group. It is therefore possible that great shearwaters may be in the vicinity of the exploration wells over the months of the drilling campaign (March to July) primarily from March to April.
Grey-backed storm-petrels	The Falkland Islands support between 1000 and 5000 breeding pairs of grey-backed storm-petrels (*Woods & Woods, 1997*). A total of 2758 grey-backed storm-petrels were recorded, mainly between September and March. Records occurred on all sides of the Falklands, with high densities recorded to the north of the Falklands from November to March. It is therefore possible that Grey-backed storm-petrels may be in the vicinity of the exploration wells over the months of the drilling campaign (March to July) with greater numbers during March.
Wilson's storm-petrels	Of the six species of storm petrels recorded during the at-sea survey within Falkland Islands' waters, four species were recorded during at-sea surveys. Wilson's storm-petrel breeds on the Falklands with an estimated population in excess of 5000 pairs (*Woods & Woods, 1997*). A total of 21,019 Wilson's storm-petrels were recorded, mainly between October and June. Most records were to the west and north-west of the Falklands, although high densities also occurred to the north-east between November and February. It is therefore possible that Wilsons storm-petrels may be in the vicinity of the exploration wells over the months of the drilling campaign (March to July).

Shags

Refer to Section 7.2.9.4 (page 86) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.9.4 (page 82) of the Rockhopper EIS for License Areas PL023 and PL024.

Three species of shags have been recorded in Falkland Islands' waters (*Woods, 1988*), of which only two are resident breeding species: rock shag (*Phalacrocorax magellanicus*) and imperial shag (*Phalacrocorax atriceps*). These species however do not venture to the further than 30 kilometres offshore and therefore very unlikely to be present in the vicinity of the exploration wells.

Gulls Laridae

Refer to Section 7.2.9.7 (page 87) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.9.7 (page 83) of the Rockhopper EIS for License Areas PL023 and PL024.

Seven species of gull have been recorded in the Falkland Islands, of which the following three species are known to breed in the Falklands (listed below) and were recorded during the at-sea surveys:

- Dolphin gull (*Larus scoresbii*);
- Kelp gull (*Larus dominicanus*);
- Brown-hooded gull (*Larus maculipennis*).

All the above species have been sighted in near shore areas (up to 50 kilometres from shore) and are unlikely to be sighted over the proposed exploration drilling area given its distance from shore (the nearest well is 105 kilometres from shore).

3.2.3 Seabird Vulnerability

Refer to Section 7.2.10 (pages 88 to94) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.10 (pages 84 to 90) of the Rockhopper EIS for License Areas PL023 and PL024.

Seabirds are affected by a number of anthropogenic factors including, competition with commercial fisheries, mortality through longline fishing and contamination from various forms of pollution. Within Falkland Islands' waters, negative impacts on seabird productivity through competition for food with commercial fisheries have not yet been identified (*White, 2001*). Death from entanglement and snagging with longline hooks is considered to be of low risk due to a well managed fishery and a relatively low amount of longlining.

To date, reports of adverse effects to seabirds from surface pollution such as oil is low in the Falkland Islands. Hence, the increasing oil and gas exploration activities in the area are a potential threat to seabird populations.

The following information has been sourced from '*Vulnerable Concentrations of Seabirds in Falkland Islands Waters' (1998–2000),* a report produced by the JNCC under contract to Falklands Conservation, with funding support from the FIG.

Seabird vulnerability was assessed with regard to species-specific aspects of their feeding, breeding and population ecology. Maps produced in the report can be used to identify areas supporting seabird concentrations at greatest risk to the threat of surface pollution. Methods used for development of the vulnerability atlas are complex and well documented (*White et al., 2001*) and are not expanded upon further here.

A summary of the seabird vulnerability survey results for the proposed exploration campaign period is shown in Figure 3.4.

It can be seen from the maps provided in Figure 3.4 that 'High' vulnerability is likely to be encountered in the vicinity of the exploration area primarily during March, with areas of 'High' vulnerability also bordering the exploration area in June.

The months of lowest seabird vulnerability in the vicinity of the proposed exploration area are April, May and July.

It can therefore be concluded that the area over the proposed exploration wells will show some levels of significant seabird vulnerability to surface pollution, primarily at the start of the drilling campaign (March).

Figure 3.4 Monthly Vulnerability of Seabird Concentrations to Surface Pollution (1998-2000) March

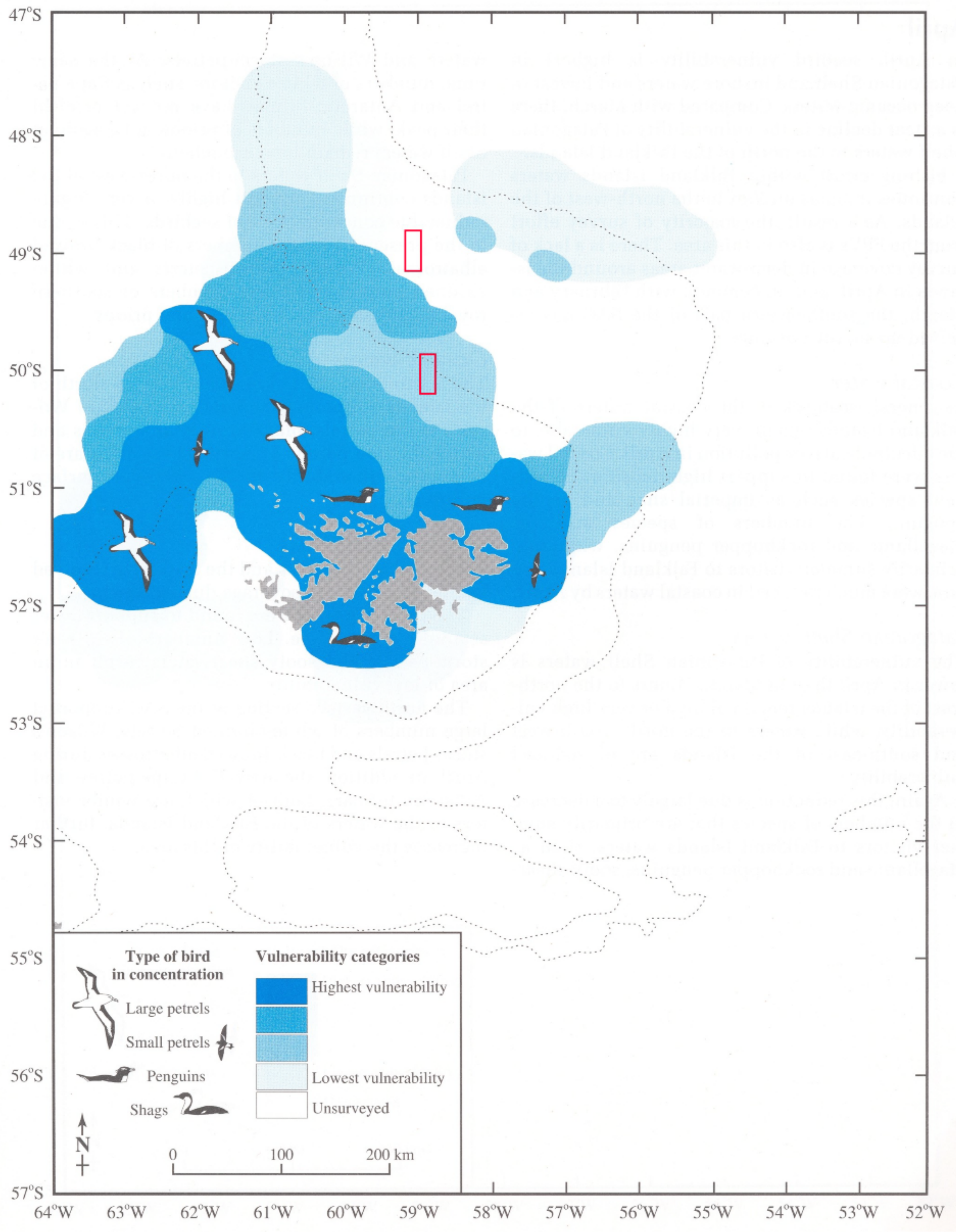


Figure 3.4 (continued) Monthly Vulnerability of Seabird Concentrations to Surface Pollution (1998-2000) April

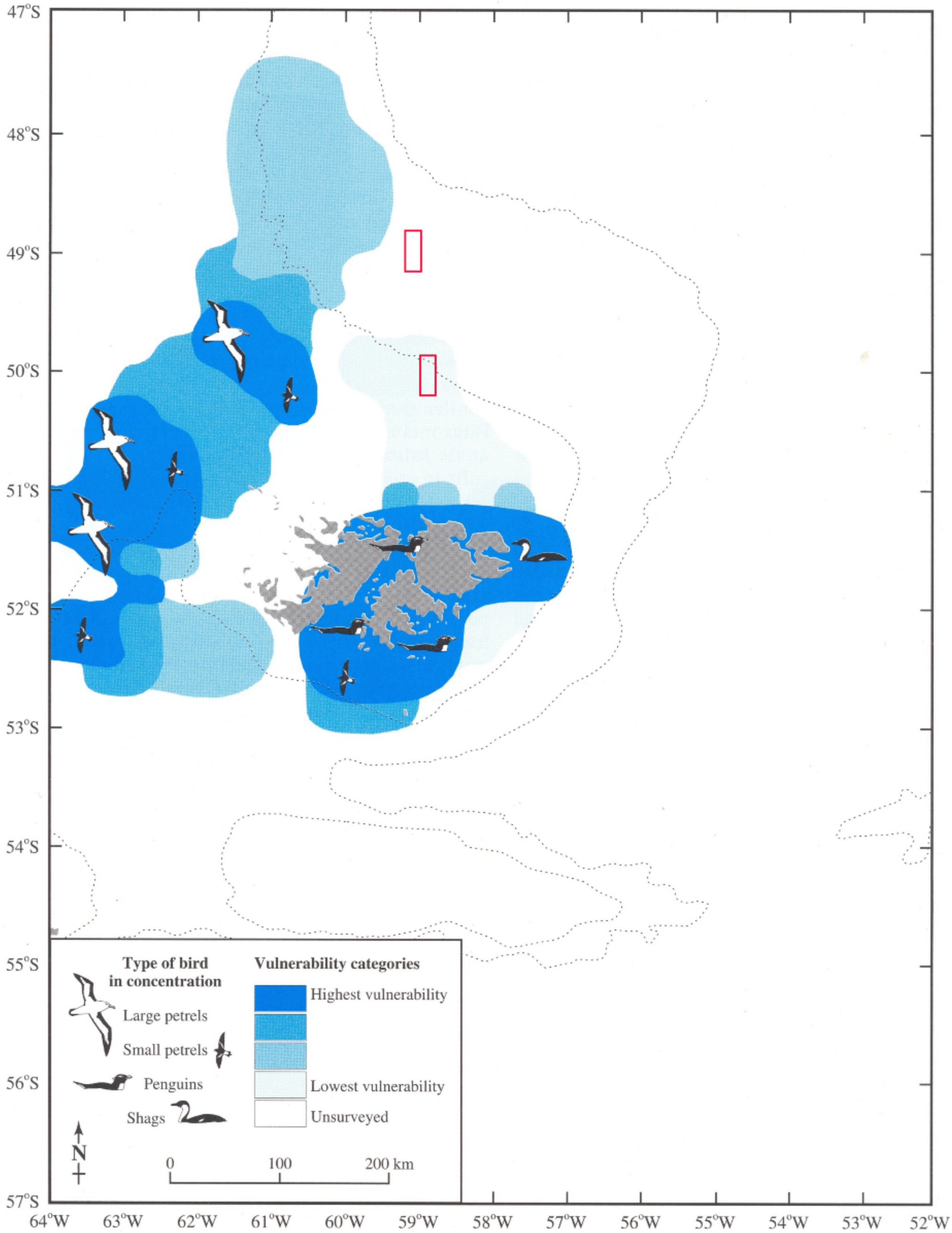


Figure 3.4 (continued) Monthly Vulnerability of Seabird Concentrations to Surface Pollution (1998-2000) May

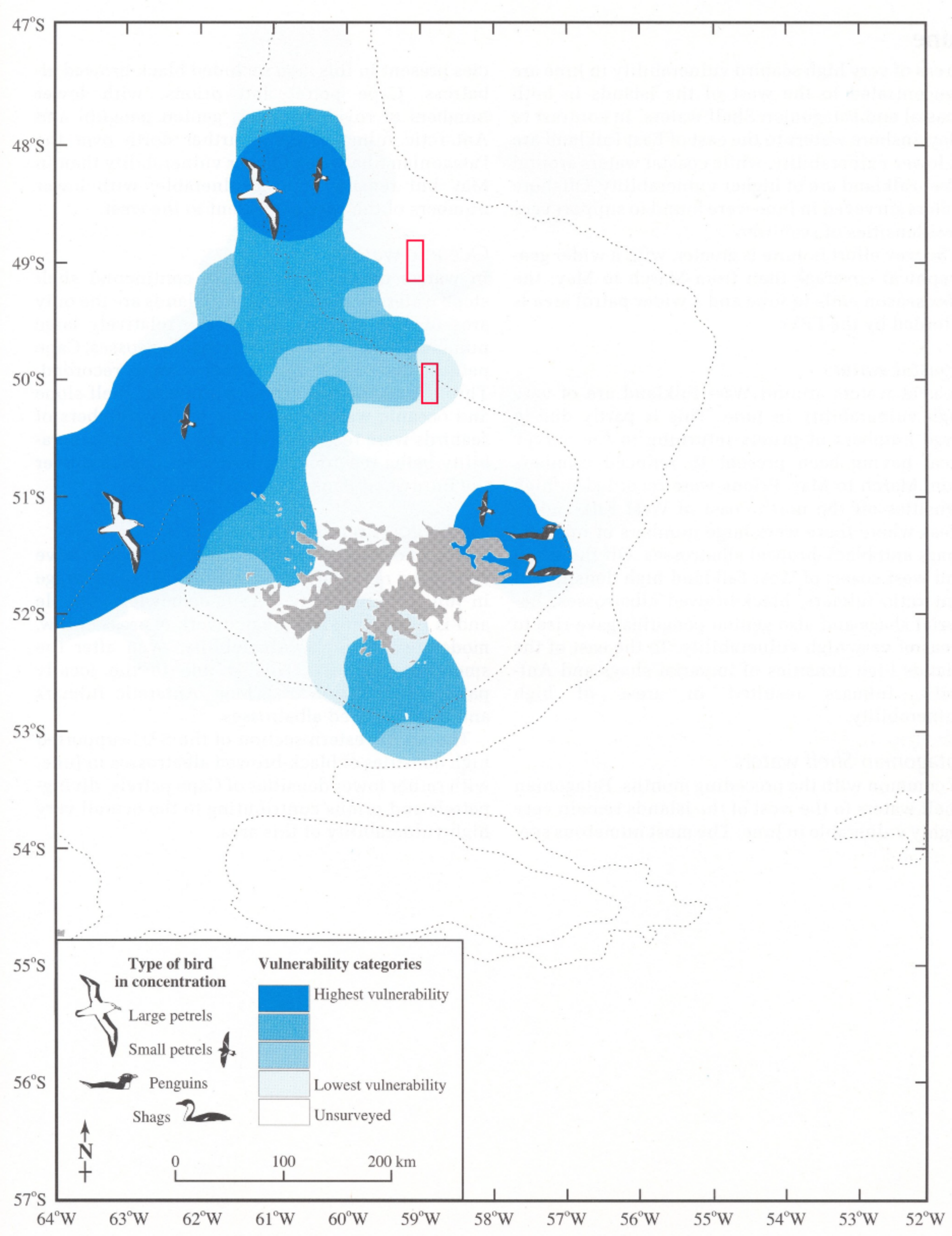


Figure 3.4 (continued) Monthly Vulnerability of Seabird Concentrations to Surface Pollution (1998-2000) - June

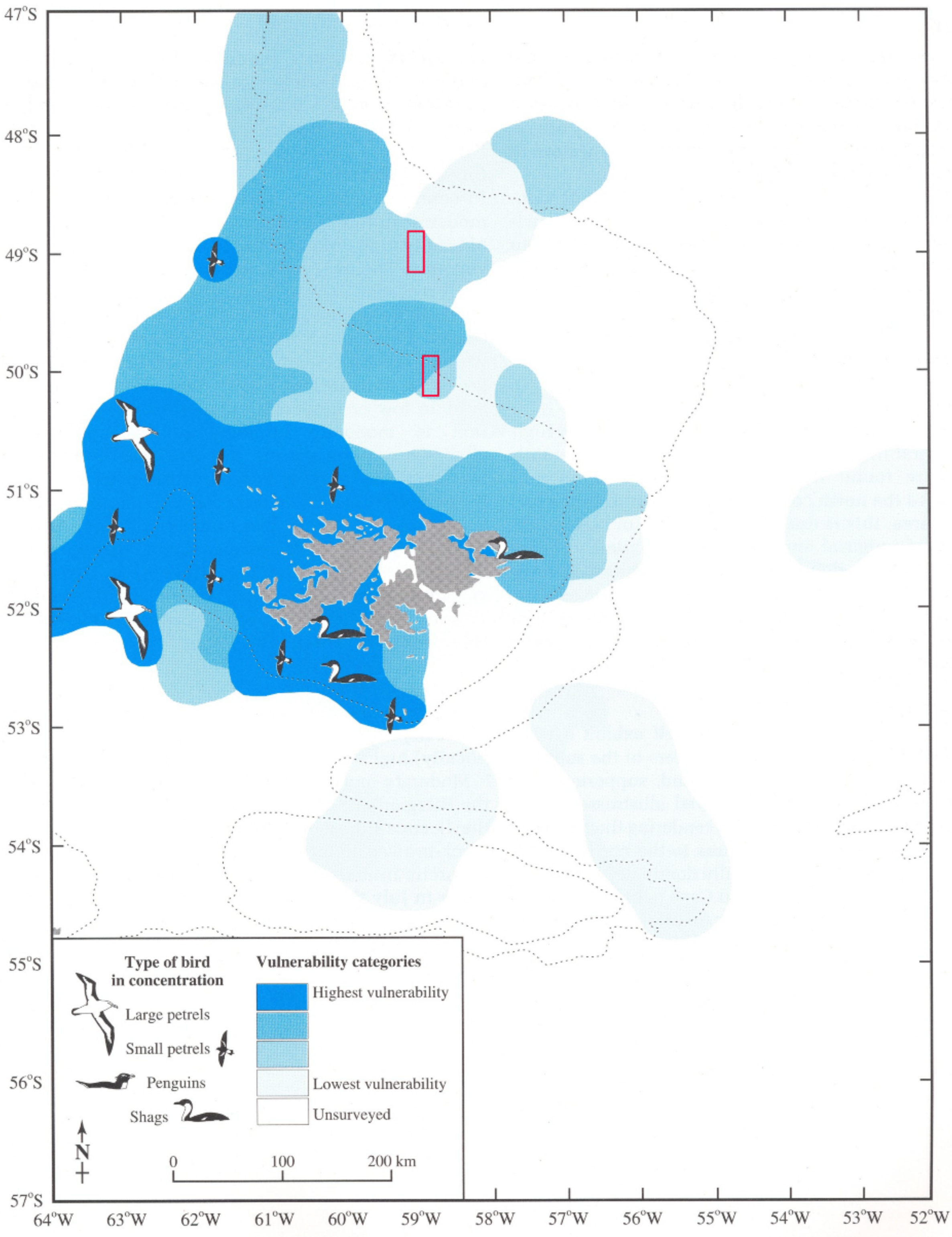


Figure 3.4 (continued) Monthly Vulnerability of Seabird Concentrations to Surface Pollution (1998-2000) - July

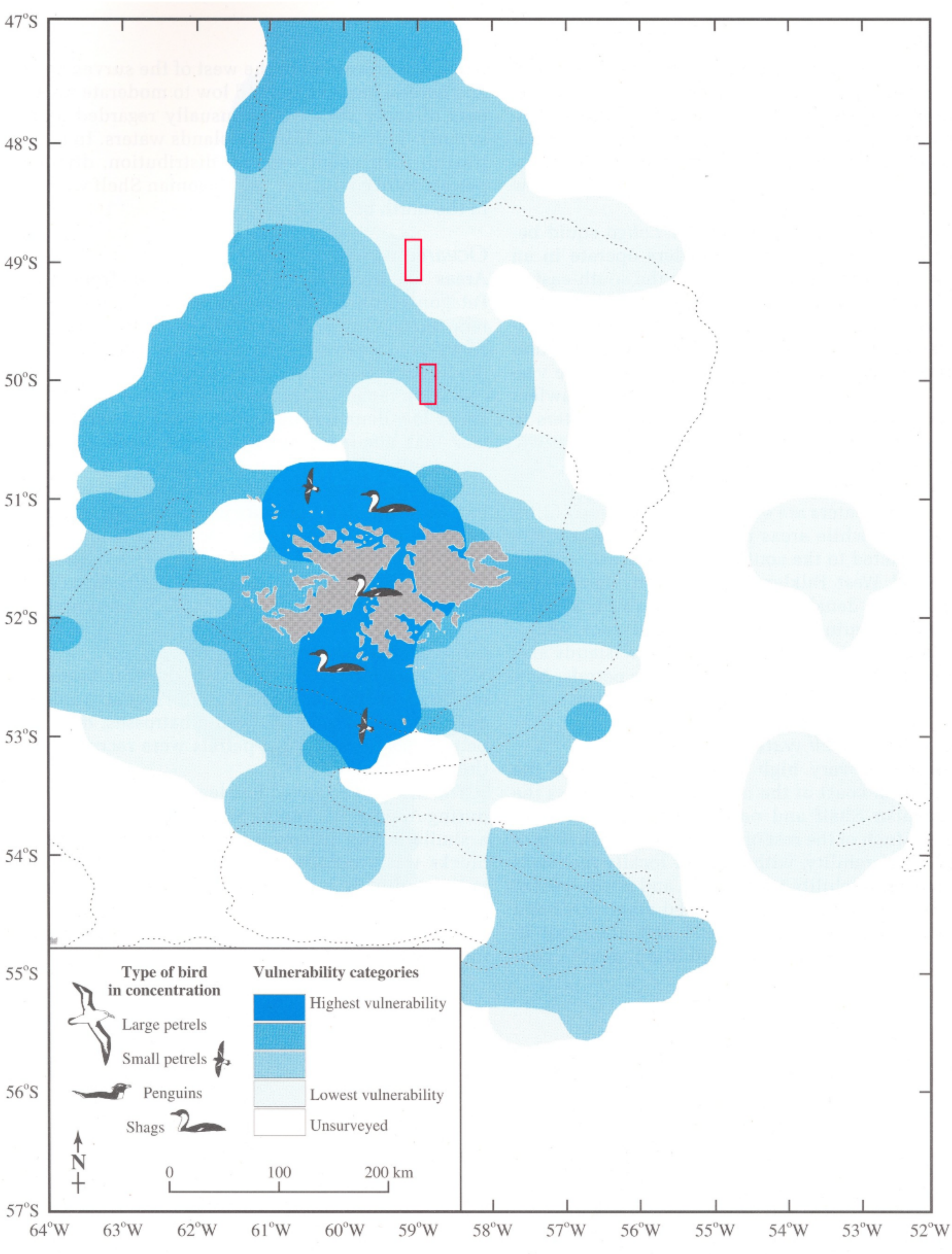


Figure 4.7 Vulnerability of seabird concentrations in July.

3.3 Fisheries and Aquaculture

Refer to Section 7.3.1.3 (pages 98 to102) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.3.1.3 (pages 94 to 99) of the Rockhopper EIS for License Areas PL023 and PL024.

Commercial fisheries are the largest source of income for the Falkland Islands. All fishing within 200 nautical miles of the Falklands is subject to licensing by the FIG. The fisheries generate over £21 million per annum in licence fees, roughly half the government revenue. Since 1990 Britain and Argentina have worked together to conserve fish stocks under the auspices of a UK/Argentine South Atlantic Fisheries Commission (*FCO, 2005*). Approximately £6 million of fisheries income is spent each year on catch and conservation monitoring, research and administration.

Target species for the commercial fisheries operating in the Falkland Islands are:

- Argentine shortfin squid (*Illex argentinus*)
- Patagonian squid (*Loligo gahi*)
- Southern blue whiting (*Micromesistius australis australis*)
- Hoki (*Macruronus magellanicus*)
- Patagonian toothfish (*Dissostichus eleginoides*)
- Patagonian hake (*Merluccius australis*)
- Common hake (*Merluccius hubsii*)
- Red cod (*Salilota australis*)
- Skates & rays (*Rajidae*)

The key catches are the squid species: *Illex argentinus* and *Loligo gahi*, followed by the southern blue whiting (Figure 3.5). Approximately 2.4 MT of Illex, 1.2 MT of Loligo, and 20,500 tonnes of southern blue whiting were caught in 2006.

Illex had been in decline since 2002, but resurged in 2006 after oceanographic conditions returned to normal following years of warm anomalies. Seasonal jigging fishery for the Illex takes place between February and June and is concentrated over the Patagonian Shelf to the north and west of the Falklands. The trawl fishery for Loligo squid operates between February and May and between August and November off the east coast of the Falklands.

Figure 3.5 Key catch by species during 2006

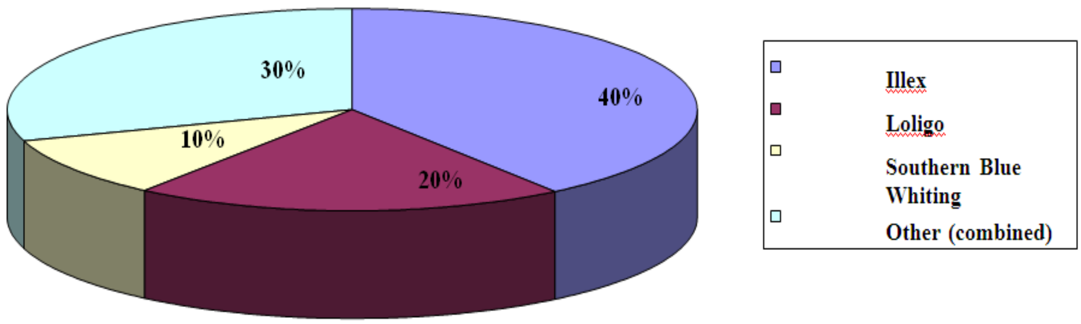


Figure 3.6 Illex argentinus catches (tonnes) by grid for Jan–Jun 2006

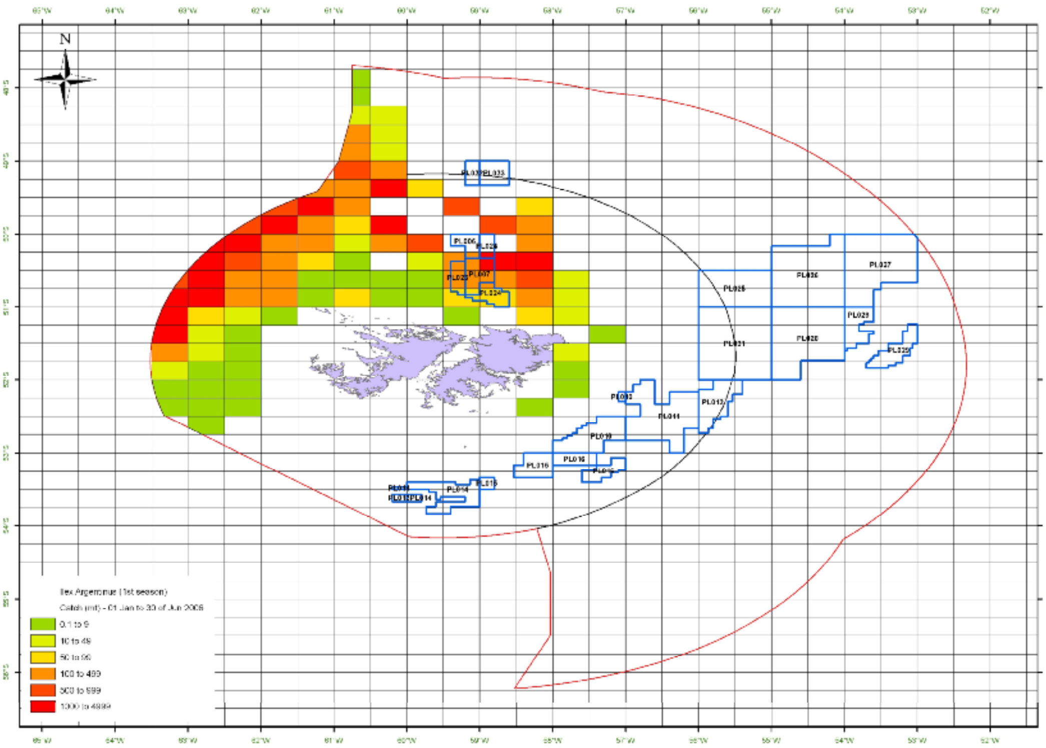


Figure 3.7 Illex argentinus catches (tonnes) by grid for Jul–Dec 2006

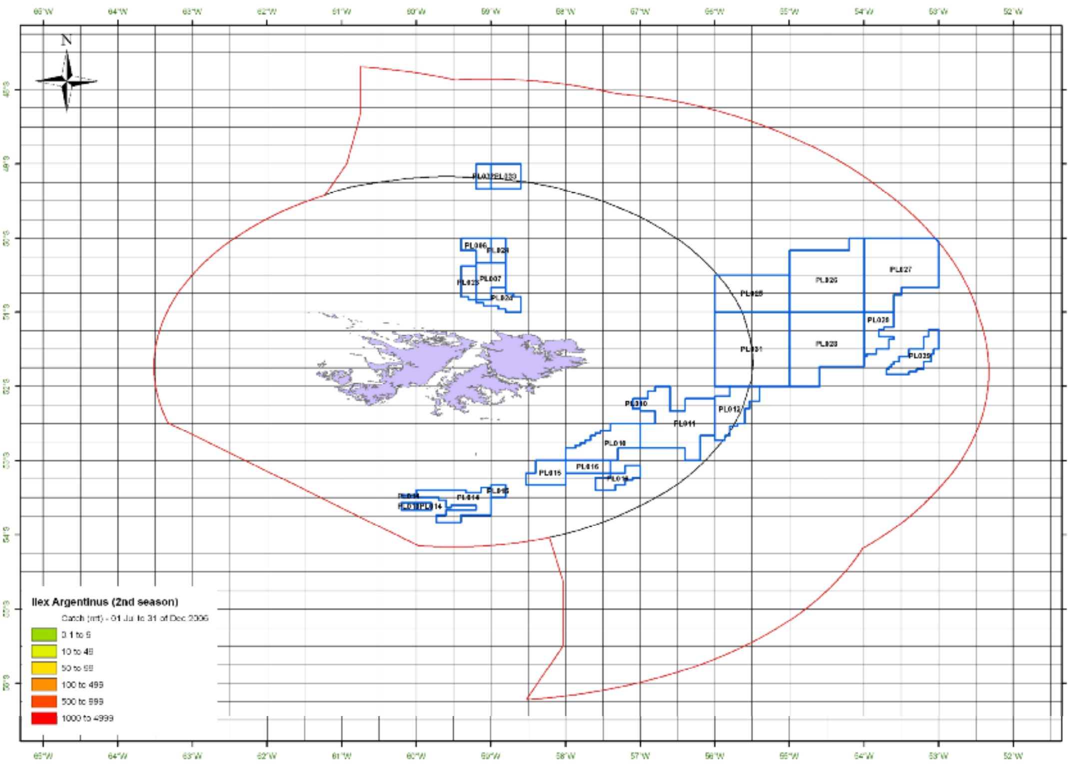


Figure 3.8 Loligo gahi catches (tonnes) by grid square for Jan–Jun 2006

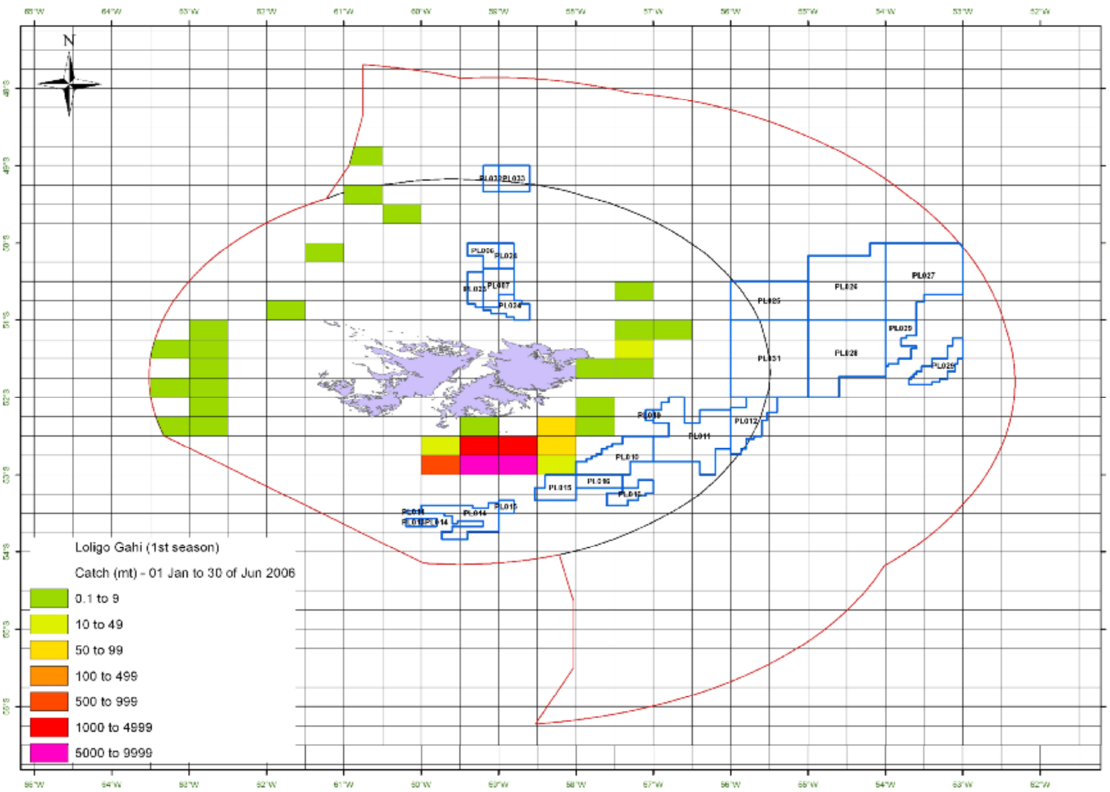


Figure 3.9 Loligo gahi catches (tonnes) by grid square for Jul–Dec 2006

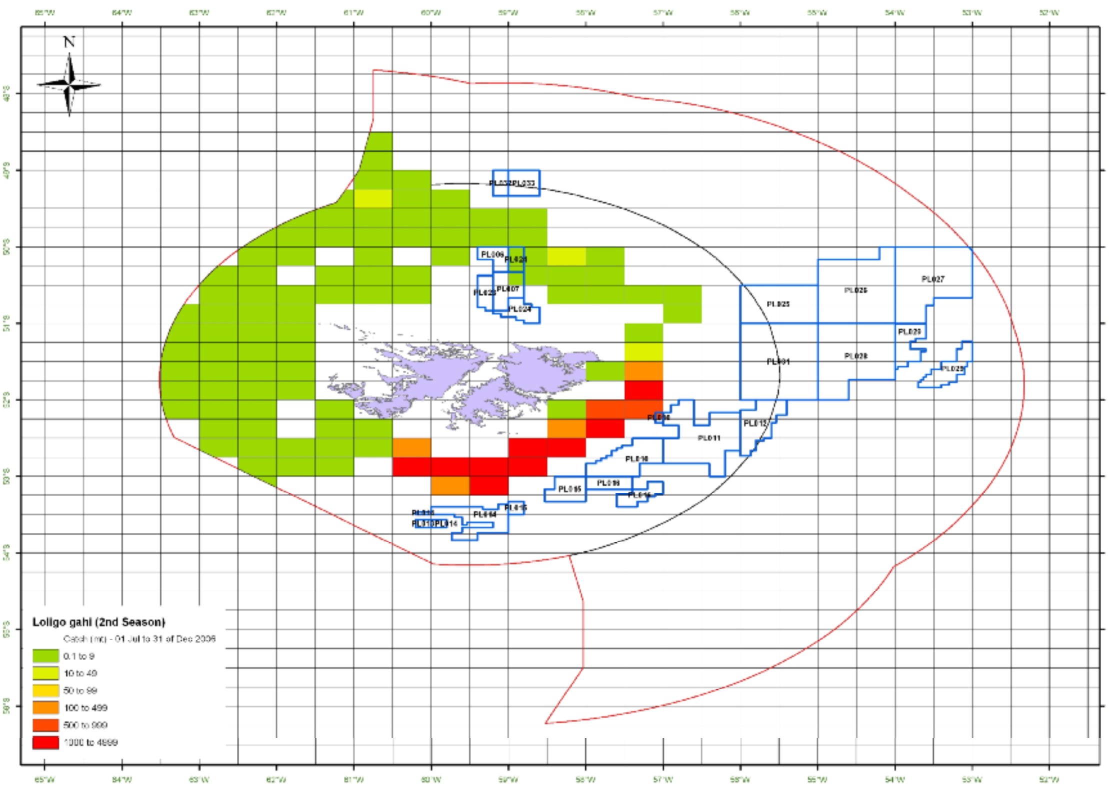


Figure 3.10 Micromesistius australis catches (tonnes) by grid square for Jan–Jun 2006

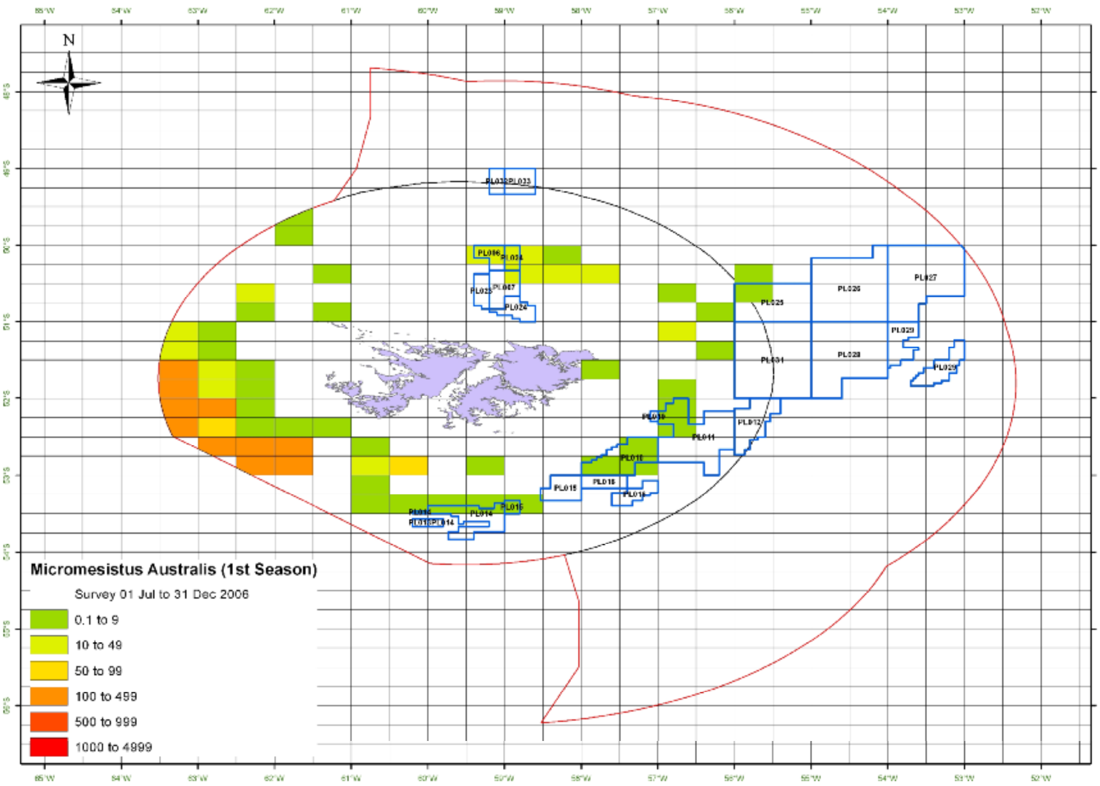
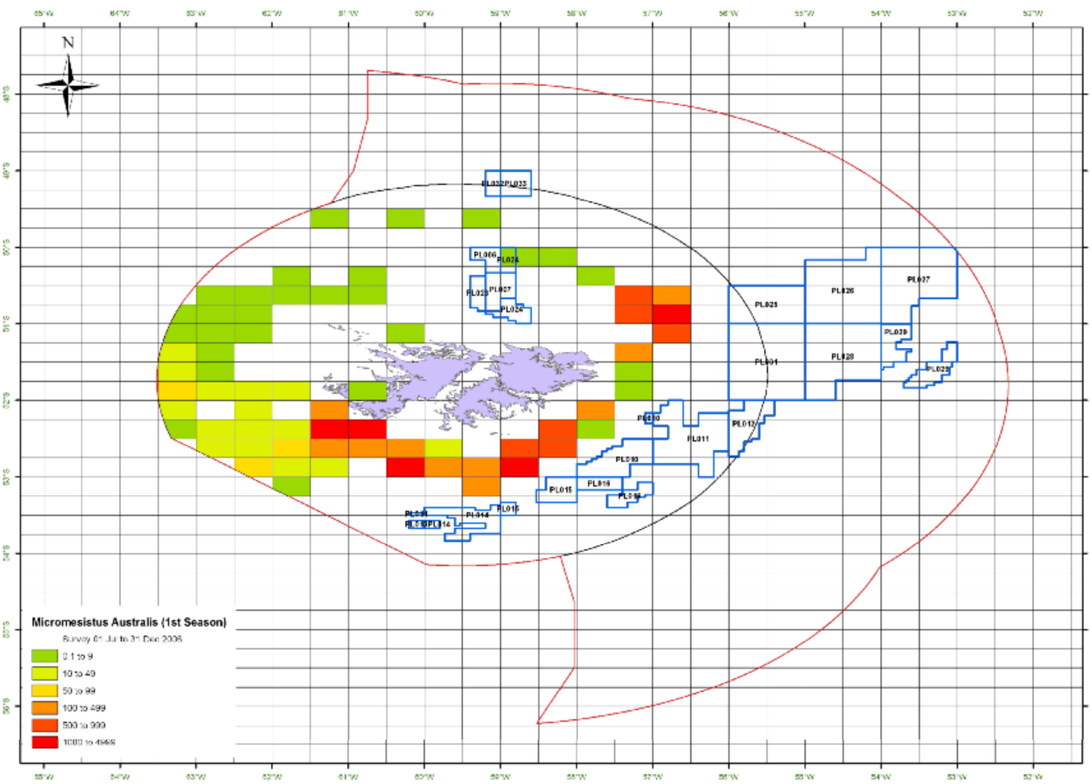


Figure 3.11 Micromesistius australis catches (tonnes) by grid square for Jul–Dec 2006



The above figures demonstrate that during the proposed drilling period (March to July) the proposed exploration area has potential for high Illex catch (Figure 3.6). In addition there is also a recorded catch of southern blue whiting over the proposed exploration area during the proposed drilling period however, the exploration area lies a considerable distance from the main catch areas for blue whiting and the potential for any disruption to this fishery is considered to be minimal (Figures 3.10 and 3.11).

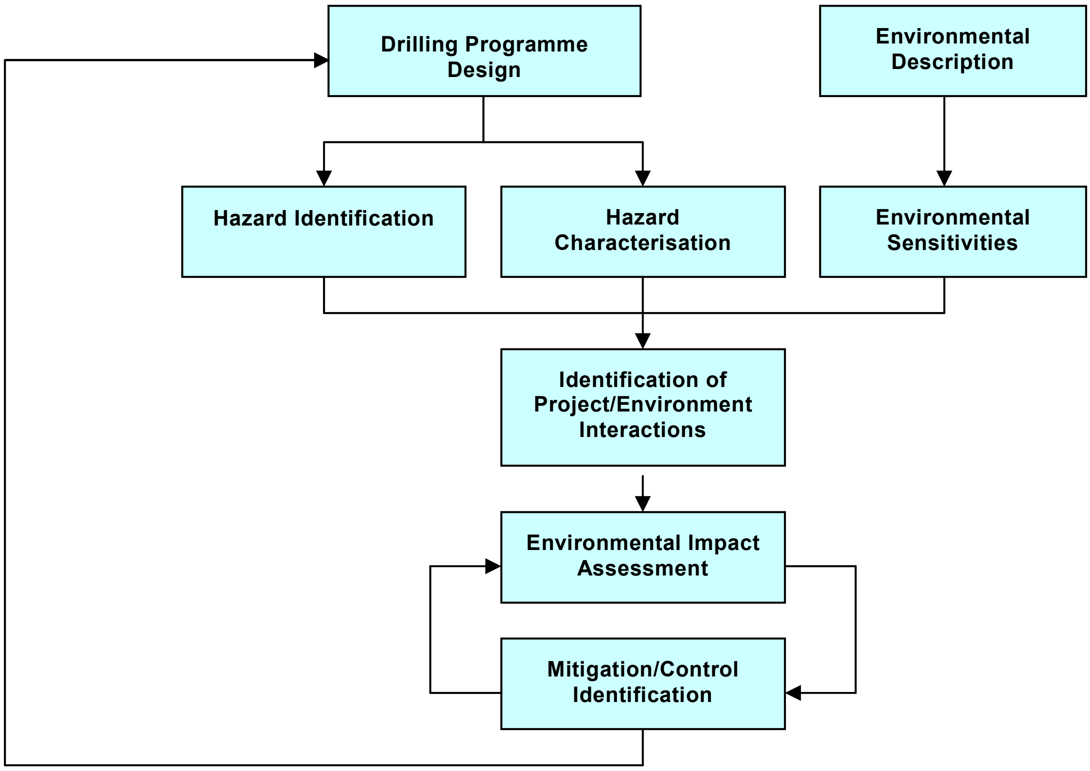
There are no significant fisheries interests on the landward side of the licence area, which would indicate that there is also low vulnerability to disturbance from vessel movements to and from the licence area during the proposed drilling months.

4 Environmental Hazards, Effects and Mitigation Measures

4.1 Introduction

The methodology used for environmental impact assessment follows the sequence summarised in Figure 4.1, with consultations incorporated into every phase.

Figure 4.1 Methodology for Environmental Impact Assessment



The main supporting information required for an assessment includes a description of both the project and the environment in which it will take place.

In this section, the interactions between the project and the environment during the proposed drilling period (March to July) are identified and an environmental impact assessment is undertaken by establishing a matrix of hazards against environmental sensitivities.

The results of this qualitative risk assessment exercise are presented in the form of a matrix that highlights areas where some interaction is expected and provides a measure of the expected significance based on the criteria provided in Table 4.1. This qualitative scale helps to rank issues on a relative basis and identify areas where additional control measures may be required.

Table 4.1 Assessment of Significance of Effect or Hazard (from UKOOA, 1998)

1	**Severe** Change in ecosystem leading to long term (>10 years) damage and poor potential for recovery to a normal state. Likely to effect human health. Long term loss or change to users or public finance.
2	**Major** Change in ecosystem or activity over a wide area leading to medium term (>2 years) damage but with a likelihood of recovery within 10 years. Possible effect on human health. Financial loss to users or public.
3	**Moderate** Change in ecosystem or activity in a localised area for a short time, with good recovery potential. Similar scale of effect to existing variability but may have cumulative implications. Potential effect on health but unlikely, may cause nuisance to some users.
4	**Minor** Change which is within scope of existing variability but can be monitored and/or noticed. May affect behaviour but not a nuisance to users or public.
5	**Negligible** Changes which are unlikely to be noticed or measurable against background activities. Negligible effects in terms of health or standard of living.
	None No interaction and hence no change expected.
B	**Beneficial** Likely to cause some enhancement to ecosystem or activity within existing structure. May help local population.

4.2 Identification of Interactions

Table 4.2 summarises the interactions between the proposed exploration wells and the sensitivities of the local and regional environment during the proposed drilling period (March to July).

Table 4.2 Potential Hazards and Associated Impacts from the Proposed Drilling Operations

Hazard	Water & Air		Flora & Fauna							Socio-economic								Other		
	Water Quality	Air Quality	Plankton	Seabed Fauna	Fish Spawning	Offshore Sea Birds	Coastal Birds	Marine Mammals	Sensitive Coastal Sites	Fishing	Shipping	Military Activity	Pipelines, Wells & Cables	Drilling & Support Crews	Dredging	Archaeology	Tourism / Leisure	Land Use	Sediments	Resource Use
Physical Presence										5	5						5			5
Seabed Disturbance				4												5			4	
Noise & Vibration					5	5		4												
Atmospheric Emissions		5																		
Marine Discharges	5		5	4	5															
Solid Waste									5									3		
Minor Loss of Containment	4		4		5	4		5		4	5						5			
Major Loss of Containment	3		3		3	2	4	4	4	3	3						3			

Key to Significance of Effect (see Table 4.1 for definitions)

1 Severe	2 Major	3 Moderate	4 Minor	5 Negligible	None	B Beneficial

4.3 Design Control Measures

Environmental performance has been a key consideration in option selection and through the design process. Environmental studies and controls, implemented during the design stage of the project, ensure that additional control and mitigation measures required during the operational phases of the project are limited.

The major design controls have included:

- Extensive planning prior to commencing operations to ensure that no strains are placed on current onshore capacities.
- Mud selection: use of WBM as the preferred option for the well sections with careful selection of components to reduce potential environmental effects.
- Waste: currently, any solid waste, excluding drill cuttings, that can be returned to shore for appropriate disposal will be skipped and shipped to the Falkland Islands.
- Management procedures will be in place to ensure environmental controls are operating effectively and efficiently. These are detailed in Section 5 of this Addendum.
- Oil Spill Contingency plan (OSCP) and emergency response procedures will be in place.

The environmental impact assessment undertaken for each phase of the project uses the design basis, with its integral design controls, as the benchmark for assessing potential impacts and identifying any additional control or mitigation methods required.

4.4 Physical Presence

There is no subsea infrastructure, such as cables or pipelines, in the areas of proposed wells, and so no interference is expected.

There are no known shipping lanes passing through the proposed well sites. However, there is a high catch of Illex during the proposed drilling period (March to July), although the majority of catch is made to the west of the exploration drilling area. Vessel collision risk is minor and has not changed since the submission of the 2009 EIS. The following mitigation measures will be implemented:

- A safety exclusion zone that will be established during the drilling operations, and the presence of project related vessels will minimise the risk of vessel collision.
- The planned activities will be promulgated in advance through Notice to Mariners, Navtex and VHF broadcast for the duration of the operations.

Resource consumption from acquisition of drilling consumables and equipment (casing, cement, mud, and chemicals) is assessed to be of low importance to the Falkland Islands as it is unlikely that these resources will be sourced in the Falkland, and are more likely to be sourced from elsewhere. The remote drilling location will require sufficient materials, equipment, spares and contingency supplies to be ordered in advance and shipped prior to rig mobilisation. Reordering and transporting replacement parts or additional materials during drilling will be financially and logistically impractical.

Fuel consumption throughout the drilling campaign is considered to be of medium importance to the Falkland Islands as it is likely that the fuel will be sourced from the Islands. The consumption of helifuel, aviation fuel for flights, diesel and marine fuel oil is an operational necessity, although fuel consumption can be minimised by a regular programme of maintenance and servicing. Advanced planning will be undertaken and should help to ensure flights and transfers are kept to a minimum, however regular crew changes are a necessity both for operational and health and safety reasons.

Water for drilling and domestic use is assessed to be of low importance to the Falkland Islands as some of it will be sourced from the sea and used as untreated seawater, some seawater will be treated in the desalination plant onboard the rig and a portion will be sourced locally in the Falkland Islands. However, if potable water has to be sourced from the Falkland Islands, it can be loaded outside peak times to minimise any impacts to the local community. In addition, water needs have been discussed with local authorities, and with adequate advance planning can be provided without effect to local needs.

4.5 Seabed Disturbance

4.5.1 Anchoring

The proposed 8 line moorings pattern of the Ocean Guardian rig will directly impact the seabed as they anchor onto the seabed surface. The impact is assessed to be minor as the benthic survey results show a homogenous environment with no habitats of conservation value. The small footprint and short duration of the drilling programme will limit potential impacts to the seafloor. It is anticipated that once the rig moves off location seabed communities will recover relatively quickly.

4.5.2 Deposition of Drill Cuttings

Refer to Section 8.2.1.2 (pages 111 to 113) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 8.3.1.2 (pages 107 to 109) of the Rockhopper EIS for License Areas PL023 and PL024.

The main potential source of seabed disturbance from the proposed exploration wells will be caused by the deposition of drill cuttings on the seabed in the vicinity of the drilling locations. The major physical waste product of a drilling operation is the generation of rock cuttings together with fine solids from the centrifuges. Other waste products include the discharge of drilling muds with the cuttings and the discharge of cement during cementing of well casings.

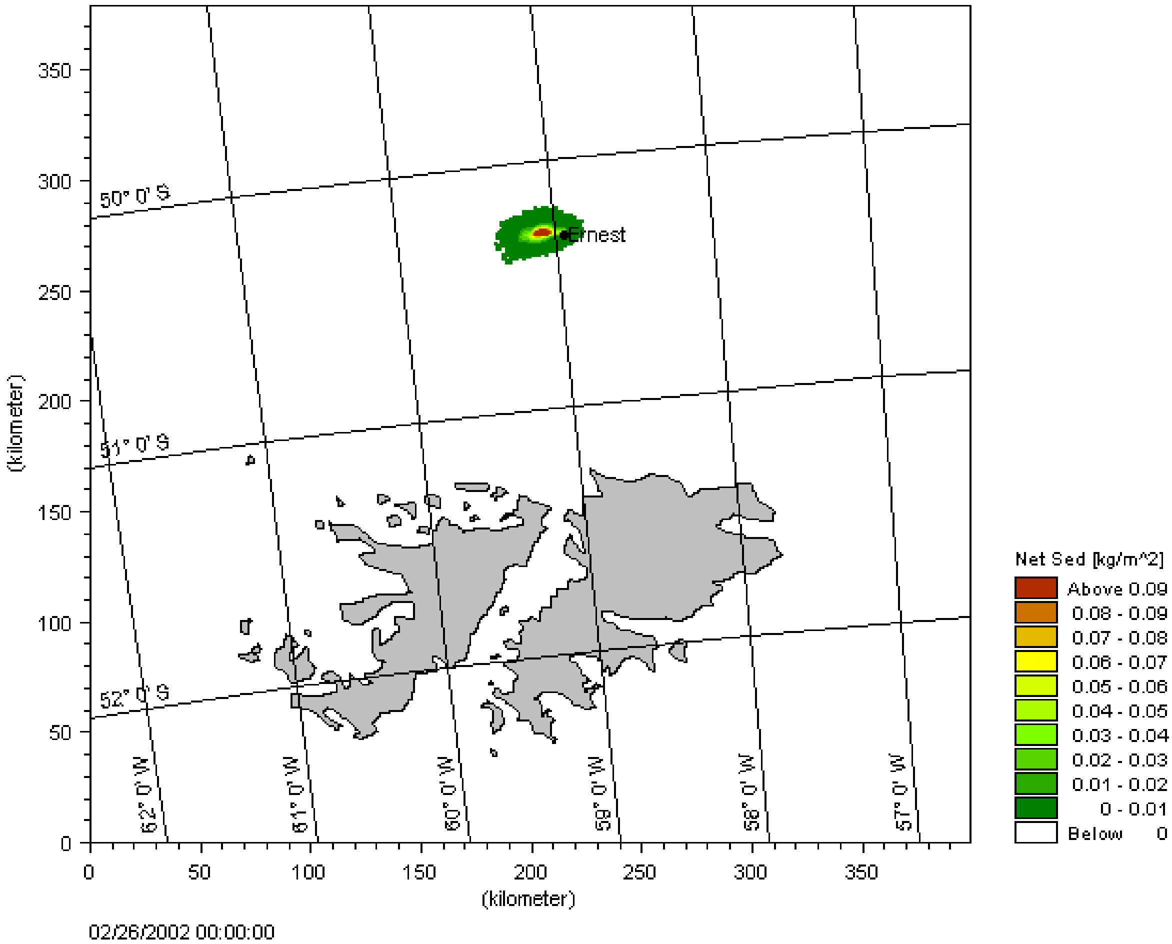
WBM will be discharged as mud on cuttings and fine solids and, upon the completion of drilling each section of the wells, the spent WBM will be discharged to sea. The drilling mud composition is essentially a brine solution, with naturally occurring bentonite clay. Small amounts of chemicals are added to this to maintain the properties of the mud and to prevent damage to the well bore and the reservoir. The proposed exploration drilling campaign will produce between 881 tonnes (Ernest well) and 1,040 tonnes (Sealion well) of cuttings (refer to Table 2.3 in Section 2.7).

The fate of discharged WBM cuttings was previously modelled for Ernest well (nearest to shore of the proposed wells) in Section 8.3.1.2 (page 107) of the Rockhopper EIS for License Areas PL023 and PL024. Modelling assumed a total of 2,722 tonnes of cuttings would be discharged. The release rate of sediment was estimated at 1.5 kg/second and the fate of the drill cuttings material was simulated over a total period of 21 days. The sediment release was assumed to be continuous over this period.

The results of the modelling showed that the net sedimentation of 0.05 kg/m^2 was less than one grain size in thickness putting it in the same order of magnitude as naturally occurring sedimentation due to the prevailing organic and inorganic suspended material in the sea water. The plumes appeared to cover a large area but the actual amount on the seafloor is below the measureable value (Figure 4.1)

The modelling results are considered to be representative of the fate of cuttings from the proposed exploration wells as there will be a maximum of 1,040 tonnes or less of cuttings discharged from each of the wells. The Sealion well lies in a water depth of 451 metres and it can be expected that the cuttings from this wells will travel further distance, although the net sedimentation will be reduced.

Figure 4.1 Cuttings modelling pattern for the Ernest well (Section 8.3.1.2, page 108, of the Rockhopper EIS for License Areas PL023 and PL024)



The deposition of cuttings and fine solids described above has the potential to directly affect the seabed fauna. Smothering effects and changes in the sediment grain size and chemistry combine to favour certain species over others. As a result, the population of seabed fauna within the area influenced by cuttings deposition may differ from that of the surrounding unaffected sediments. Such effects have been well studied and indicate an effect broadly mirroring the area of deposition of the cuttings. Studies have shown that impacts from smothering can occur where the depth of cuttings is one millimetre or more (*Bakke et al., 1986*).

As there are no toxic components within the discharge of the vast majority of cuttings, the impacted area will begin to recover soon after drilling operations have ceased. Recolonisation of the impacted area can take place in a number of ways including mobile species moving in from the edges of the area, juvenile recruitment from the plankton or from burrowing species digging back to the surface.

For example in 1987 a benthic environmental survey was undertaken at a single well site in the Central North Sea (*AUMS, 1987*). The well had been drilled five years prior to the survey using a WBM and a total of approximately 800 tonnes of cuttings had been deposited on the seabed. The results of the survey indicated that, with the exception of a slightly elevated barium concentration, levels of sediment metals and hydrocarbons were similar to background. The analysis of the benthic fauna indicated that, even at sites closest to the wellhead, full recovery of the impacted sediments had taken place. his well site was revisited by Oil and Gas UK (formerly UKOOA) in 2005 and results now show that the area is completely consistent with background conditions (*Hartley Anderson Ltd, 2005*). In addition, field studies in the United States of America have shown that recovery of benthic communities impacted with water based drilling discharges is likely to be very rapid (i.e. within a few months) (*Neff, 1982*).

Given the shallowness of the predicted cuttings deposition and the action of movement of the bottom currents, it is likely that any cuttings will soon become mixed with the natural sediments and will eventually be dispersed.

4.5.3 Noise and Vibration

Refer to Section 8.2.1.3 (pages 113 to 114) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 8.3.1.3 (pages 109 to 110) of the Rockhopper EIS for License Areas PL023 and PL024.

Operational activities at the proposed well sites will generate noise, both above and below the sea surface, mainly during drilling activities. Noise is thought to have the potential to disturb animals in the area, particularly cetaceans.

Typical subsea noise levels from offshore operations are shown in Table 4.3.

Table 4.3 Typical Noise Levels Associated with Offshore Operations

Source	Noise Level (dB)	Dominant Frequency(s) (Hz)
Piling	135-145 *	50-200
5m Zodiac with an out-board motor	152 *	6,300
Jack-up drilling rig	140-160*	100
Semi submersible drilling rig	150	100
Typical fishing vessel	150-160 **	-
Tug/barge traveling at 10 knots (18 kilometres per hour)	162 *	630
Large tanker	177 *	100
Seismic air gun	210 (average array)* 259 (large array)*	10-1,000

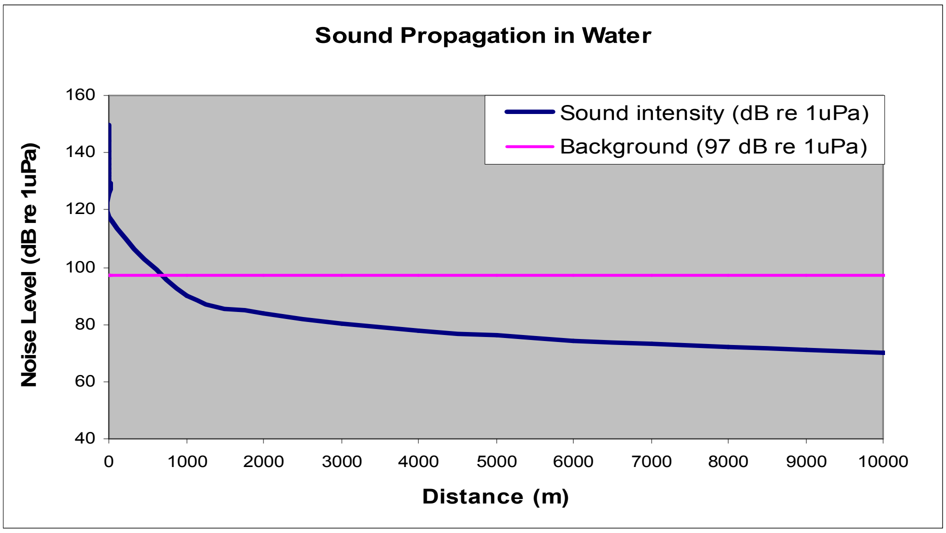
* *Richardson* et al *(1995)* ** *Gulland and Walker (1998)*

(dB) The magnitude of the sound manifests itself as pressure, i.e. a force acting over a given area. It is expressed in terms of 'sound levels', which use a logarithmic scale of the ratio of the measured pressure to a reference pressure (Decibels (dB)). In this report all dB reported are re 1μPa @ one metre in water. Source: *Richardson et al 1995.*

Taking 150dB as an example of the typical noise level generated from drilling operations using a semi-submersible drilling rig and assuming a spherical propagation of noise from the source, it can be seen from Figure 4.2 that background noise levels will be reached within a kilometre of the source. An anchored semi-submersible will generate less noise than a dynamically positioned semi-submersible, which is more dependent on its thrusters for maintaining position.

Studies from drilling / production platforms off the Californian coast have indicated that the noise emitted was low frequency and was so weak as to be virtually undetectable from alongside the platform during sea states greater than three on the Beaufort scale (*Gales, 1982 in Richardson et al., 1995*). The winds in this region predominantly range between 11 to 21 knots (Beaufort scale 4 to 5). Noise from offshore operations is produced over a relatively large frequency range (typically between 7-4,000 Hertz), greater than that produced by ships (20-1,000 Hertz) (*Richardson et al., 1995*).

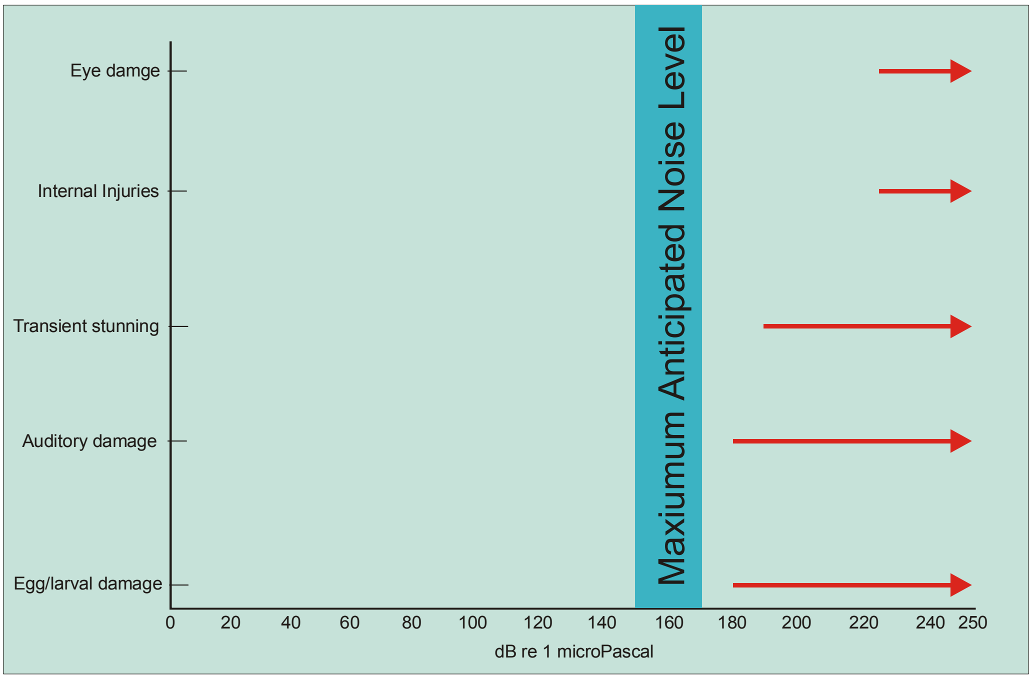
Figure 4.2 Propagation of Sound in Water (from Richardson et al., 1995)



Fish are generally sensitive to noises within the frequency range of less than 1 Hertz to 3,000 Hertz, however, it has been reported that they will respond consistently to very low, or very high frequency noises (*Knudsen et al. 1992, 1994*). Sounds in the range of 50 to 2,000 Hertz, such as the peak sound levels produced by many anthropogenic activities, only produce short-term startle response at the outset of sound production with subsequent habituation to noise (*Knudsen et al. 1992, 1994; Westerberg, 1999*).

Given the magnitude of sounds expected to be produced by the proposed drilling activities, there are not expected to be any physical impacts on fish (Figure 4.3).

Figure 4.3 Sound Pressure Level Thresholds for the Onset of Fish Injuries (after Turnpenny & Nedwell, 1994)



4.5.4 Potential Impacts on Cetaceans

Cetaceans are in general believed to be fairly tolerant to noise disturbance and are unlikely to be affected by the magnitude and frequency of noise produced during planned offshore operations

(*Richardson et al., 1995*). The distribution of cetaceans appears to be unaltered by the presence of a facility, with sightings rates reported to be similar with or without the presence of a rig, although it has been suggested that cetaceans will react within five kilometres of a noise source (*Richardson et al., 1995*). Studies have indicated that even when the noise generated by a drilling rig is well above the ambient (background) level, baleen whales and toothed whale exhibit no measurable change in behaviour and it is only at a distance of tens of metres from the rig that sound levels are likely to be high enough to initiate avoidance action (*Richardson et al., 1995*). In addition, anecdotal evidence indicates that cetaceans are not disturbed by the noise generated by large vessels.

Sei whale, Minke whale, Sperm whale, Long-finned pilot whale and Hourglass dolphin have all been sighted in the vicinity of the proposed exploration wells during the proposed drilling period (March to July) (refer to Section 3.2.1). Overall, however, the area in the vicinity of the proposed drilling activity is not considered to be an area of particularly high sensitivity for cetaceans.

Given the above, therefore, the impact to cetaceans from the proposed drilling operations are anticipated to be negligible.

4.5.5 Potential Impacts on Protected Birds

Refer to Section 7.2.10 (pages 88 to 94) of the Rockhopper EIS for License Areas PL032 & PL033 and Section 7.2.10 (pages 84 to 90) of the Rockhopper EIS for License Areas PL023 and PL024.

Although the majority of seabird species in the Falkland are observed in coastal and nearshore areas, a number have been recorded in the vicinity of the proposed exploration wells during the proposed drilling period (March to July) (refer to Section 3.2.2). Overall, the area in the vicinity of the proposed drilling activity is not considered to be an area of particularly high sensitivity as the higher densities of seabirds have been sighted at locations further inshore during the proposed drilling months.

Impacts to seabirds from the proposed drilling operations are therefore anticipated to be negligible.

4.6 Atmospheric Emissions

The main sources of atmospheric emissions during drilling operations will result from diesel burnt for power generation for the drill rig and associated standby vessels. There are no plans to test these wells.

Diesel burnt for power generation will give rise to minor emissions of carbon dioxide (CO_2), oxides of nitrogen (NOx), nitrogen dioxide (NO_2), sulphur dioxide (SOx) and unburned hydrocarbons (refer to Table 4.4). These types of emissions are anticipated to disperse rapidly under most conditions to levels approaching background within a few tens of metres of their source. Although all such emissions will contribute in a small way to the overall pool of greenhouse and acidic gases in the atmosphere, local and transboundary environmental effects will be negligible.

Practical steps to limit atmospheric emissions that will be adopted during the drilling programme include advanced planning to ensure efficient operations, well maintained and operated power generation equipment and regular monitoring of fuel consumption.

Table 4.4 Predicted Atmospheric Emissions from Power Generation from the Proposed Exploration Drilling Programme

Gas[1]	Drill Rig [2]	Standby Vessels[3]	Total
Carbon dioxide	2240.00	1120.00	3360.00
Carbon monoxide	10.99	5.50	16.49
Oxides of nitrogen	41.58	20.79	62.37
Nitrous oxide	0.15	0.08	0.23
Sulphur dioxide	2.80	1.40	4.20
Methane	0.13	0.06	0.19
Volatile organic chemicals	1.40	-	-

Note 1: Emission factors used from UKOOA 2002a based on methodology proposed by OGP

Note 2: Rig is estimated to consume @ 10 tonnes fuel/day for 70 days duration.

Note 3: Standby vessel is estimated to consume @ 5 tonnes fuel/day for 70 days duration.

A simple dispersion model has been used to predict the concentration of some of the key gases in the air at various distances from the exploration well locations during drilling activities (Table 4.6).

For the drilling phase a combined fuel consumption rate of 15 tonnes per day for the rig and safety standby vessel is assumed.

These calculations show that atmospheric emissions disperse rapidly and are orders of magnitude below health or environmental guidelines within a short distance of the facility.

Well drilling activities will be controlled through careful planning to minimise the travel times of vessels, the number of vessels required and the amount of time spent. Rockhopper will ensure that contract specification and control processes require all equipment and generators to be well maintained and operated.

Table 4.5 Predicted Combustion Gases Contributions to Atmospheric Concentrations Downwind during the Propsoed Exploration Drilling Programme

Pollutant	Concentration (µg/m³)									
	0.5km	1km	2km	3 km	4km	5 km	10 km	20km	30km	50km
CO2	4.06E-26	8.54E-06	0.75	2.33	1.65	1.10	0.77	0.56	0.22	0.07
CO	1.99E-28	4.19E-08	0.004	0.011	0.008	0.005	0.004	0.003	0.001	0.000
NOx	7.55E-28	1.59E-07	0.0139	0.0432	0.0306	0.0205	0.0143	0.0104	0.0040	0.0014
SO2	5.08E-29	1.07E-08	0.0009	0.0029	0.0021	0.0014	0.0010	0.0007	0.0003	0.00009
CH4	2.29E-30	4.81E-10	0.00004	0.00013	0.00009	0.00006	0.00004	0.00003	0.00001	0.000004
VOC	2.54E-29	5.34E-09	0.0005	0.001	0.001	0.001	0.0005	0.0004	0.0001	0.00005

All values based on UKOOA emission factors for fuel emissions during drilling

4.7 Marine Discharges

Sources of marine discharges for the proposed wells are:

- Water based mud (WBM) and drill cuttings;
- Cement;
- Drainage water;
- Sewage.

These discharges are discussed in the following sections.

4.7.1 Water Based Mud (WBM) and Drill Cuttings

WBM will be discharged as mud on cuttings and fine solids and, upon the completion of drilling each section of each well, the spent WBM will be discharged to sea. The drilling mud composition is essentially a brine solution, with naturally occurring barite and bentonite clay. Small amounts of chemicals are added to this to maintain the properties of the mud and to prevent damage to the well bore and the reservoir.

The main components of WBM will comprise natural products (for example, brine, bentonite and barite), which are biologically inert. The muds typically have a very low toxicity, with an LC_{50} of more than 50,000 parts per million (*Jones et al., 1986; Leuterman et al., 1989*). In fact, the WBM comprises approximately 90 percent water and the vast majority of WBM discharged for the well (approximately 96 percent) are classified under Annex 6 of the OSPAR convention (*OSPAR, 1999*) as substances, which are considered to Pose Little Or No Risk to the environment (PLONOR chemicals).

Of the limited quantity of chemicals not classified as PLONOR and anticipated to be discharged along with the WBM, all are categorised as Category E or Gold (the lowest environmental risk category) under the UK Harmonised Offshore Chemical Notification Scheme (see Appendix A for a description of the UK Harmonised Offshore Chemical Notification Scheme, CHARM and Hazard Quotients).

Studies of the discharge of WBM into the water column in areas where currents are weak have found dilutions of 500 to 1,000 times within one to three metres of discharge *(Ray and Meek, 1980)*. Dilution will therefore be rapid and this, together with the low toxicity, indicates that any impacts within the water column will be undetectable shortly after discharge. Discharge of the WBM will not contribute to any impacts on the local seabed communities through toxicity, bioaccumulation, low biodegradability or other aspects such as the endocrine disruption.

In some cases drilling muds may be associated with elevated levels of heavy metals. However, a wide range of studies have shown that these are not bio-available and do not therefore result in any direct affects on marine fauna and flora (*Neff et al., 1989*).

4.7.2 Cement Chemicals

During drilling of the wells, some surface returns of cement and associated chemicals will be lost to the seabed in the immediate vicinity of the wells. Only a small volume of cement will be lost from the well.

All chemicals to be discharged which are non-PLONOR have a HQ band of GOLD or E (lowest environmental risk category) for the purposes of CHARM assessment.

4.7.3 Drainage Water and Sewage

Water generated from rig washdown and rainfall from the open deck areas may contain trace amounts of mud, lubricants and residual chemicals from small onboard leaks derived from activities such as re-fuelling of power packs or the laying down of dirty hoses or dope brushes etc. It should be stressed, however, that these would be relatively low volume discharges containing small residual quantities of contaminant. Rockhopper will ensure that the rig is equipped with suitable containment, treatment and monitoring systems as part of the contract specification.

In addition, the Rockhopper Drilling Representative will also ensure good housekeeping standards are maintained onboard the rig to minimise the amount of hydrocarbons and other contaminants entering the drainage systems. Liquid storage areas and areas that might otherwise be contaminated with oil are generally segregated from other deck areas to ensure that any contaminated drainage water can be treated or accidental spills contained. All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons (<15 parts per million hydrocarbons in water) as required under the MARPOL Convention and discharged to sea. Residual hydrocarbons will be routed to transit tanks for processing onshore.

4.8 Solid Wastes

Wastes will be disposed of on the Falkland Island. Specific waste handling/disposal routes and procedures will form part of the overall drilling programme. Careful consideration is given to minimising the amount of waste generated and controlling its eventual disposal.

Typically, 24 tonnes of general waste are generated per month from a single well drilling programme. Bulk wastes (e.g. garbage, scrap, etc.) generated on the drilling rig will be segregated by type, stored in covered, four tonne capacity skips. Periodically these will be transported to shore and the waste recycled or disposed of in a controlled manner through authorised waste contractors. Rockhopper will ensure that a waste management programme is implemented to minimise the amounts generated and to ensure material such as scrap metal, waste oil and surplus chemicals are sent for re-cycle or re-use as far as practicable.

Hazardous waste generated from wells differs greatly per well, but a typical exploration well would generate between 2 and 100 tonnes of hazardous waste (average of 65 tonnes). However this estimate is based on North Sea wells, which are typically deeper than those of the Falkland so it can be expected that hazardous waste generated would be towards the lower end of the range.

All discharges from the supporting vessels will be treated and discharged according to the MARPOL Convention (as relevant to the Atlantic Ocean). The MARPOL Convention prohibits discharge of any garbage or solid wastes into the North East Atlantic Ocean.

All vessels, including the rig, will implement appropriate waste management plans and store and dispose of all solid wastes onshore accordingly. Procedures for dealing with special wastes will be implemented in accordance with regulatory guidelines.

4.9 Accidental Spills

Spill modelling has been re-run from that shown in 2009 EIA's now that a rig has been contracted and well locations have been confirmed. Modelling was carried out using the BMT Oil Spill Information System (OSIS) 4.2 model. Diesel modelling was undertaken only at the Ernest well location to represent a worst case scenario as this well location is closest to the Falklands Islands coast (approximately 105 kilometres). Overall, the following scenarios were simulated:

1. The weathering of a 10 tonne operational spill of diesel with a 30 knot onshore wind (the impact radius is insignificant);
2. The weathering of a full rig inventory (1108 tonnes) instantaneous diesel spill with a 30 knot onshore wind (Figure 4.4)
3. The weathering of a full rig inventory (1108 tonnes) diesel spill released instantaneously under typical wind conditions (Figure 4.5).
4. The weathering of a 10 tonne operational spill of the expected reservoir crude oil with a 30 knot onshore wind;
5. The weathering of a 2000 bopd blow-out of the expected reservoir crude oil released over 24 hours with a 30 knot onshore wind;
6. The weathering of a 2000 bopd blow-out of the expected reservoir crude oil released over 24 hours under typical wind conditions (stochastic). (Figure 4.6 -4.7).

Modelling of a 10 tonne operational spill of diesel fuel from the Ernest well location with a worst case 30 knot onshore wind indicated that the oil would disperse offshore within 1 hour and would have very small impact area. Modelling of the full diesel inventory of the rig released instantaneously (representing a total catastrophic loss of the drilling rig) from the Ernest well location with a worst case 30 knot onshore wind showed that the oil dispersed offshore within 8 hours without reaching the shore (Figure 4.4). Stochastic modelling, using typical for June wind and current conditions, indicated that diesel would weather offshore drifting and dispersing in north, south and easterly direction (Figure 4.5). The modelling indicated a zero percent chance of the oil beaching.

Modelling of a 10 tonne operational spill of crude oil from each of the proposed well locations with a worst case 30 knot onshore wind indicated that the oil would disperse offshore and would not reach the coastline. In all cases, the oil showed a net drift to the south-east, under the influence of the onshore wind and residual current.

Modelling of 2000 bopd blowout of crude oil from Ernest well with a worst case 30 knot onshore wind indicate that the oil would disperse offshore and would not reach the coastline. A similar simulation for Sea Lion well however shows that oil will start beaching after 170 hours with a total of 37m3 oil reaching the coastline in absence of any response operations. The main factor contributing to the beaching is a lower speed of residual currents during March (compared to June for Ernest) deducing from northerly oil movement. For both blowout simulations, the oil showed a net drift to the south-east, under the influence of the onshore wind and residual current.

Stochastic modelling of the same blowout scenario for both wells under typical wind conditions (based on wind roses for March and June) indicate that the oil would weather offshore with the oil drifting and dispersing in a north-easterly direction and zero percent beaching (Figures 4.6 - 4.7).

Given that the above modelling has shown a zero percent chance of oil beaching under typical weather conditions, it can be concluded that the risk of shoreline pollution remains very low as the oil weathers offshore in most cases. Strong onshore winds of 30 knots are very unlikely and even in the assumed worst case scenario oil would not reach the shore for 7 days. This suggests that pollution response to an oil spill incident would primarily be offshore. The use of dispersant remains the most viable oil pollution response strategy given the distance of the wells offshore, and the associated difficulties and dangers of deploying offshore recovery equipment. Onshore response may be needed in exceptional circumstances.

High seabird vulnerability to oiling is likely to be encountered over a significant part of the licence area primarily during March, and to a lesser extent in June. The months of lowest seabird vulnerability in the licence area are April through to June. It can be concluded that the area over the exploration wells will show significant levels of seabird vulnerability to surface pollution, primarily at the start of the drilling campaign (March).

Further information on the spill probabilities and proposed and Emergency Response measures are available in the Rockhopper Falkland Onshore and Offshore Oil Spill Contingency Plan.

Figure 4.4. Trajectory model run of total fuel inventory loss from the rig (1108 tonnes) with a 30 knot onshore wind at the Ernest well location

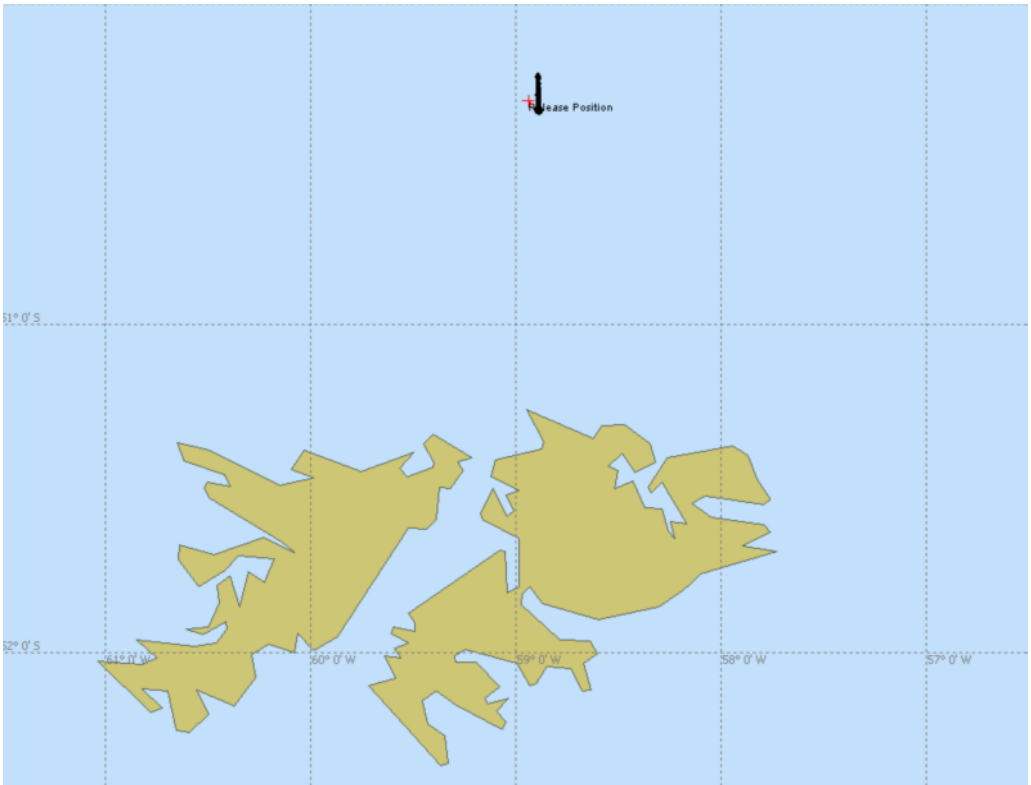


Figure 4.5. Stochastic model run of total fuel inventory loss from the rig (1108 tonnes) released instantaneously at the Ernest well location under typical wind conditions

Figure 4.6. Stochastic model run of a 2000 bopd blow-out of 22° API oil released over 24 hours under typical wind conditions (June wind rose) at Ernest well location

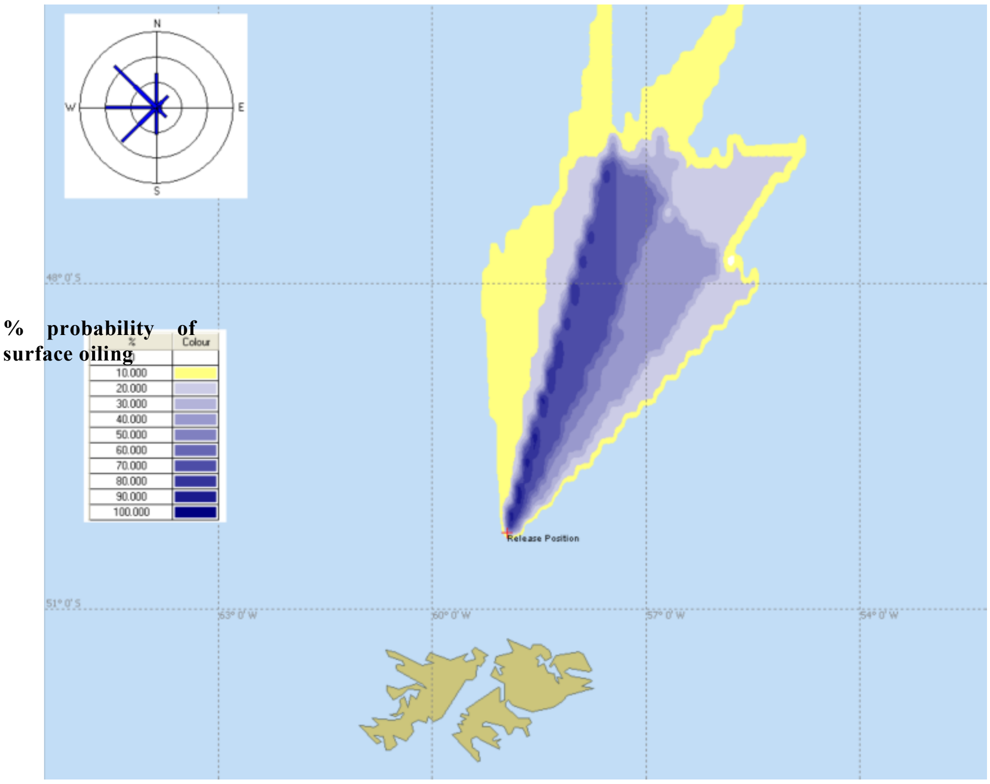
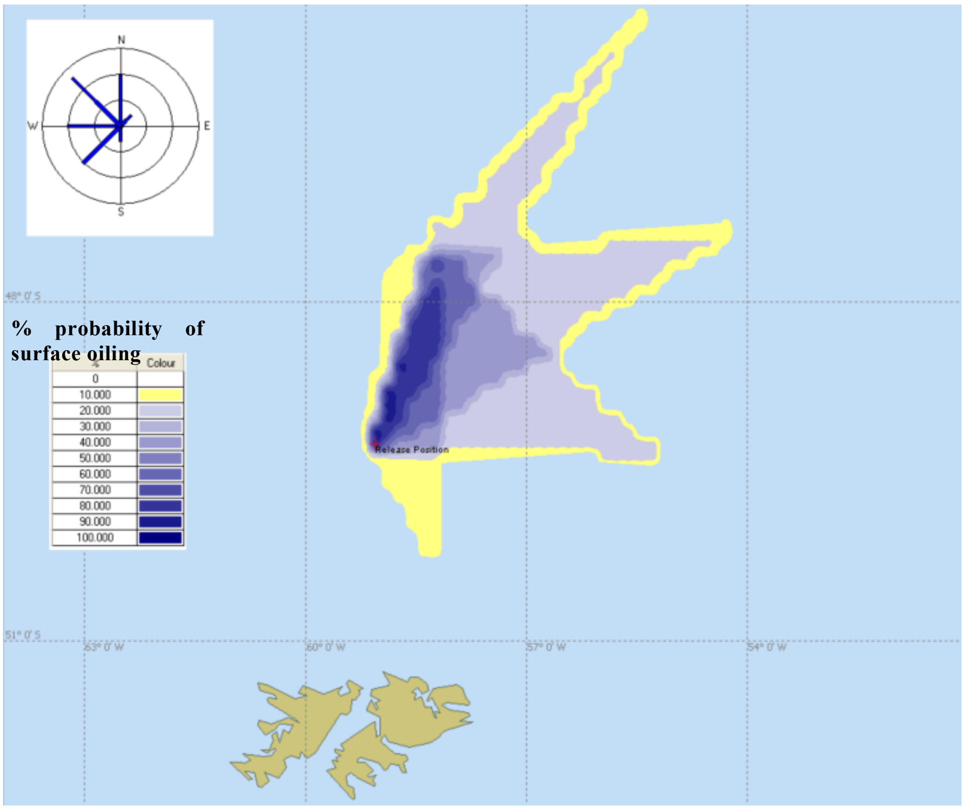


Figure 4.7. Stochastic model run of a 2000 bopd blow-out of 27° API oil released over 24 hours under typical wind conditions at the Sea Lion well location



4.10 Cumulative Impacts

The potential for cumulative impacts will arise from the drilling operation itself during which time the rig and support vessels will pose an additional shipping hazard in the area and from the legacy it will leave in terms of atmospheric greenhouse gases and cuttings and mud discharged. However it is not anticipated that the short-term exploratory drilling campaign will significantly, or permanently, add to these existing cumulative impacts.

The rig will be shared by a number of operators, each drilling their respective wells in a programmed sequence, there is unlikely to be any temporal overlap in operations. In addition, the wells being planned by other operators are located a considerable distance from each other, so the likelihood of any spatial overlap of impacts from different drilling operations must be considered to be remote.

Cuttings modelling have shown that the suspended cuttings do have the potential to travel some distance from the wells. However, cuttings deposition will be in the same order of magnitude as naturally occurring sedimentation due to the prevailing organic and inorganic suspended material in the sea water and therefore no cumulative impact from the discharged cuttings is expected.

Cumulative environmental effects from the planned exploration programme are unlikely given the short term nature of the wells, the fact that they will be plugged and abandoned and that exploration activities are planned over a wide area. Over time, impacts from drilling will be undetectable so there is no cumulative impact. Positive socio-economic effects are possible over time as they will be concentrated in a single location (Stanley) for all drilling operations both to the north and south of the island.

5 Management Framework

5.1 Introduction

Rockhopper Exploration plc operates under an integrated Health Safety and Environmental Management System (HSE MS).

HSE management procedures are incorporated into relevant business functions which reinforce the Company philosophy that management of HSE issues is an integral part of Rockhopper's business activities.

The application of the HSE MS during the drilling of the proposed exploration wells offshore the Falkland Islands will ensure that the Rockhopper HSE Policy (Figure 5.1) is followed and that the Company's responsibilities under all relevant regulations are met.

5.2 The Rockhopper Health, Safety and Environment Management System

Rockhopper's business comprises acquisition of acreage and exploration for oil and gas in the Falkland Islands. Operational activities include geological and geophysical surveys, design, construction, and testing of wells and assessment of hydrocarbon reserves. In the future it is anticipated that this may lead on to field development and production operations.

The HSE MS establishes the main requirements and provides the framework for managing HSE issues within the business. It ensures:

- Clear assignment of responsibilities;
- Efficient and cost effective planning and operations;
- Effective management of HSE risks;
- Compliance with legislation; and
- Continuous improvement.

The system structure is illustrated in Figure 5.2. At the top, the HSE policy demonstrates the commitment and intentions of the Company. The HSE MS provides guidance on the implementation of policy requirements across the Company. At the second level are the project specific HSE Plans and Procedures; these provide the specifics of how things are done within each project. At the base of the structure are the Bridging Documents linking Rockhopper's system with its contractors' HSE Operating Systems/Procedures.

Figure 5.1 The Rockhopper HSE Policy

ROCKHOPPER EXPLORATION

oil and gas exploration

HSE Policy Statement

Rockhopper Exploration plc is committed to effective corporate governance; foremost this includes preventing accidents to people and damage to the environment. Maintaining high standards of Health, Safety and Environmental (HSE) protection throughout its operations is an integral part of this and is achieved through:

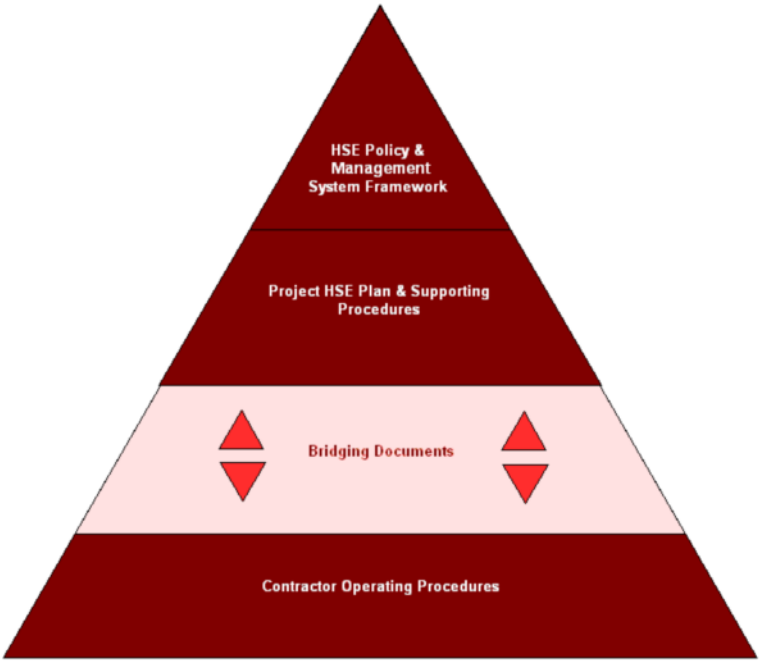
- Strong leadership and clearly defined responsibilities and accountabilities for HSE at all levels of the organization, from the directors, managers to individuals;
- Selection of competent personnel responsible for both managing our activities and HSE performance;
- Compliance with regulatory and other applicable requirements, or where regulations do not exist, application of industry standards;
- Identifying, assessing and managing HSE risks and preventing pollution;
- Developing specific HSE targets and plans for each operational project;
- Selecting competent contractors and ensuring that they manage HSE in line with this HSE policy and supporting management systems;
- Preparing and testing response plans to ensure that any incident can be quickly and efficiently controlled, reported and investigated to prevent recurrence;
- Continual improvement of HSE performance through monitoring and regular reporting against targets and periodic audits;
- Periodic management reviews to identify and implement improvements to our HSE systems.

This policy is implemented through our HSE Management System which provides a systematic approach to HSE management designed to ensure compliance with the law and to achieve continuous improvement in performance. Our policy is used to guide all our activities and it will not be compromised by other business priorities.

Sam Moody
Managing Director

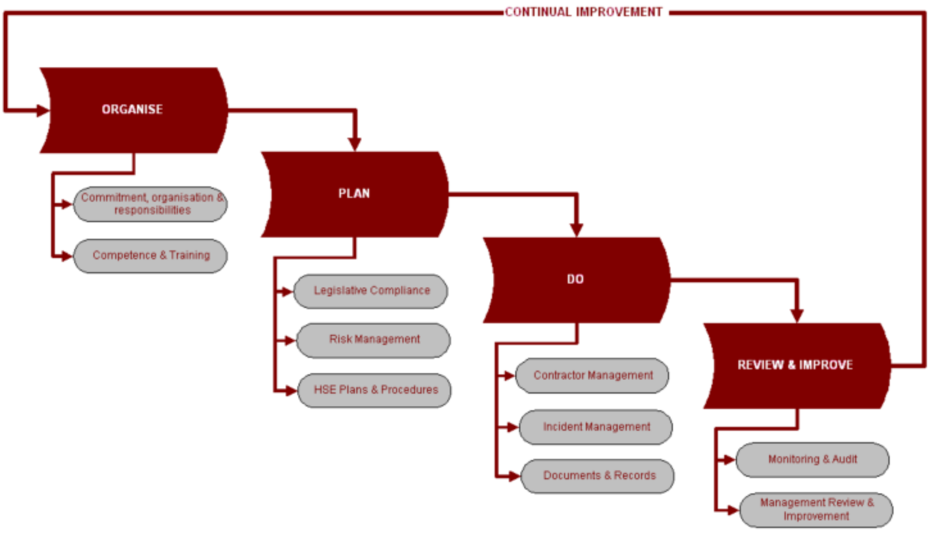
Date: 6 March 2009

Figure 5.2 HSE Management System Structure



The HSE Management System is consistent with existing international models for health, safety and environmental management (e.g. ISO14001, OHSAS 18001, OGP). The system is structured around an 'organize, plan, do, review and adjust' process, with a feedback loop to assure continual improvement in performance. The system can be visualised as illustrated in Figure 5.3. It is made up of a number of elements and requirements and is relevant throughout the business lifecycle.

Figure 5.3 HSE Management System Framework



5.3 Environmental Mitigation Register (EMR)

In order to ensure that appropriate mitigation measures, identified following the EIA process, are implemented during the planning and drilling of the proposed exploration wells, an Environmental Mitigation Register (EMR) has been prepared (refer to Tables 5.1 and 5.2).

The Register identifies actions required, assigns responsibilities and sets target dates for completion. The register will act as a ‘live’ document to track progress through to cessation of drilling activities. It will provide guidance for the drilling contractor and can also be used by Rockhopper to monitor contractor performance with regard to environmental issues. Should monitoring indicate unacceptable environmental performance, the EMR provides a mechanism to initiate remedial action.

Table 5.1. Environmental Mitigation Register – Routine Operations

ROUTINE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Cement, Drill Cuttings & Drill Fluids Smothering & toxic effects on benthic communities in the immediate vicinity of the well.	Planned use of Water Based Mud. Selection of most environmentally benign mud & cement chemicals where possible. WBM comprised mainly of chemicals considered to pose little or no risk to the environment. Cuttings & mud treatment equipment to ensure the separation of WBM from cuttings before discharged to sea with cuttings. Management procedures to ensure optimal performance of cuttings treatment equipment & continuous mud mass balance maintained during drilling.	Liaise with mud suppliers to ensure appropriate chemical selection Verify appropriate functioning Continuous monitoring of mud mass balance.	Drilling Manager Mud Man & Rockhopper Company Man Mud Man & Rockhopper Company Man	
Physical Presence Restrictions on fishing & shipping.	Exclusion zone surrounding the drill rig (500 metres) implemented monitored & patrolled by a standby/supply vessels. Drill rig to carry relevant navigational & communication aids.	Ensure continuous 'on site' monitoring from standby vessel. Ensured during contracting process/ Pre operation inspection to ensure all vessels meet required standard.	OIM / Rockhopper Company Man Procurement/ Rockhopper Company Man	
Atmospheric Emissions Localised emissions from power generation (rig, supply / standby vessels & helicopter operations will affect air quality.	Well maintained and operated equipment and generators. Regular monitoring of fuel consumption. It is currently proposed to test the wells. Well testing operations will occur as follows: 30 minute flow period, 2 hours shut in for Pressure Build Ups (PBU), 8 hours flow period, 8 hours shut in for PBU, and 12 hours flow period. This programme will be subject to the well results and reservoir conditions. During the well test up to up to 8,000stb/d of oil or 25MMscf/d of gas will be flared dependant on the reservoir fluids encountered and if the reservoir is found to be capable of delivering these rates. Volume flared will be kept to a practical minimum.	Review of drilling contractor procedures prior to contact award Monitoring to ensure appropriate procedures are adhered to. Volumes flared will be kept to a practical minimum.	Procurement/ HSE Manager Rockhopper Company Man Drilling Manager	

Table 5.1 (continued). Management Plan - Mitigation Measures (Routine Operations)

ROUTINE OPERATIONS				
Hazard & Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Solid Wastes Wastes will include galley wastes, scrap metal, waste oil & surplus chemicals.	Rockhopper will ensure that the rig has an appropriate system of waste management in place	-	Procurement/ HSE Manager	
	Garbage will be processed in a compactor & stored in a designated area on the rig. Other wastes will be stored in suitable containers & periodically these will be transported to shore.	Pre operation inspection to ensure onshore waste disposal facilities meet required Rockhopper standards.	Rockhopper Company Man	
	Material such as scrap metal, waste oil & surplus chemicals will be far as practicable, sent for re-cycle or re-use and will be disposed of in a controlled manner through authorised waste contractors.	'On site' monitoring to ensure appropriate procedures adhered to.	Rockhopper Company Man	
	All galley wastes separated & ground to less than one inch in diameter before being discharged overboard.	'On site' monitoring to ensure appropriate procedures adhered to.	Rockhopper Company Man	
Drainage & Sewage Water from rig wash down may contain trace amounts of drill fluid, lubricants & residual chemicals. There will be discharge of sewage & grey water.	Rockhopper will ensure that good housekeeping measures are implemented to minimise the amount of mud & associated chemicals entering the rig drainage system.	Ensured during contracting process	Procurement/ HSE Manager	
	Marine Sanitation Device on rig for treatment of sewage effluent.	The Marine Sanitation Device and discharge inspected daily to ensure that no pollution or non permitted discharge occurring	Maintenance	
	All discharges from the rig & supporting vessels will be treated & discharged in according to the MARPOL convention.	Pre operation inspection to ensure all vessels meet required MARPOL standards.	Rockhopper Company Man	
		'On site' monitoring to ensure good housekeeping measured adhered to.	Rockhopper Company Man	

Table 5.2. Management Plan - Mitigation Measures (Non-Routine Operations)

NON ROUTINE OPERATIONS				
Hazard/Effect(s)	**Proposed Mitigation**	**Required Actions**	**Responsible**	**Completion**
Spill of Hydrocarbons Potential impacts on marine fauna and flora / seabirds/ & other sea users.	*Unburnt hydrocarbons during testing* Volume flared will be kept to a practical minimum.	None required	-	-
	Fuel base oil or other utility fluids (e.g. diesel, lubricants) Any re-fuelling required will only be undertaken during daylight, if practicable, and in good weather conditions. Non-return valves will be installed on fuel transfer hoses, and operations will be supervised at all times from both the supply boat and drill rig.	Pre operation inspection to ensure refuelling system and procedures meet required standards. 'On site' monitoring to ensure appropriate procedures adhered to.	Rockhopper Company Man Rockhopper Company Man	
	Loss of rig (ship collision) Dedicated personnel to keep watch for incoming vessels. Standby vessel monitoring exclusion zone. Drill rig will carry all relevant navigational & communication aids. Notification of planned drilling programme with all relevant maritime authorities and representative fishing organisations.	Ensure continuous 'on site' monitoring from standby vessel. Ensure during pre-spud checks Pre operation inspection to ensure vessels meet required standard. Notification of Drilling Programme	OIM Procurement Rockhopper Company Man HSE Manager	
	Risk of a loss of well control Minimised through details of mud programme, detailed study of the known geological conditions of the area, BOP design, and use, appropriate training and drills and good drilling practice.	Well monitoring equipment to detect influx from reservoir. Observation of drills and reaction times by Rockhopper representatives. Pressure detection service provided by Mud-logging contractor. Blowout preventors tested on installation and routinely during operations.	Senior Toolpusher Rockhopper Company Man Senior Toolpusher Rockhopper Company Man Senior Toolpusher Rockhopper Company Man	
	Spill Response (For all spills) The support vessel will be equipped with 5 m3 of chemical dispersant and	Ensured during contracting process & pre-op inspection to ensure all spill kits present and meet required standard.	Procurement/	

NON ROUTINE OPERATIONS				
Hazard/Effect(s)	Proposed Mitigation	Required Actions	Responsible	Completion
	spray system, able to treat up to 100 tonnes of oil, with a contact rate of approximately 10 tonnes per hour. Oil Spill Contingency Plan in place providing guidance on actions to be taken in event of spill.	 All spills reported	Rockhopper Company Man Rockhopper Company Man / OIM	

6 Conclusions

This EIS Operation Addendum makes a thorough assessment of the potential impacts that may arise from the planned drilling of up to 6 exploration wells offshore the Falkland Islands. It has assessed seasonal sensitivities within the vicinity of the wells during the proposed drilling period (March to July) with reference to the previously submitted Rockhopper Falkland Islands Offshore Drilling EISs.

The Addendum has also re-assessed the potential impacts from the proposed drilling campaign in light of the seasonal sensitivities and the further detailed project information, which is now available. Mitigation measures have been proposed for all potential impacts with extra attention given to those deemed to be of high to medium significance, in particular waste management and the accidental loss of containment. This will allow operations to proceed without any significant long lasting impacts to the marine or coastal environment of the Falkland Islands.

In conclusion, given the current operational commitments and proposed mitigation measures as detailed in Sections 4 and 5 of this Addendum, it is considered that the proposed exploration drilling campaign can be undertaken without significant impacts to the Falkland Islands' environment.

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Appendix A: HOCNS & HMCS

Until recently the control of offshore chemical discharges was controlled under the Offshore Chemical Notification Scheme (OCNS). Within the UK, the OCNS has been succeeded by The Offshore Chemicals Regulations 2002, which introduced a new approach to the consideration of chemical use and their discharge, the Harmonised Mandatory Control Scheme (HMCS). Both the OCNS and the HMCS are discussed below.

Offshore Chemical Notification Scheme (OCNS)

The Offshore Chemical Notification Scheme (OCNS) requires that all chemicals used in offshore exploration and production be tested using standard test protocols. Chemicals are then classified based on their biological properties e.g. toxicity and biodegradability. The OCNS scheme was adopted in the UK in 1979 and formed the basis of the Oslo and Paris Commissions (OSPARCOM) Harmonised Offshore Chemical Notification Format (HOCNF) which was established under cover of the Paris Commission Decision 96/3. The objectives of the OCNS and HOCNF are to regulate and manage chemical use by the oil and gas industry and consequently to prevent unacceptable damage to the marine environment through the operational or accidental discharge of chemicals.

The scheme was originally voluntary in the UK and all chemicals were given an OCNS Category ranging from 0 to 4. The system was later altered to harmonise the system with those operated by other countries bordering the North Sea. The HOCNS classifies all chemicals into five groups, A to E with Category A chemicals being the most toxic and least biodegradable and Category E chemicals considered to be the least harmful to the offshore environment.

In addition to being placed into one of the five HOCNS categories, substances known or expected to cause tainting of fish tissue or substances known or expected to cause endocrine disruption, if lost or discharged, will be identified with a special taint or endocrine disrupter (ED) warning.

Chemicals are categorised on the basis of a series of laboratory tests with particular reference to their ecotoxicological effect, the biodegradability of the chemical and the potential for bioaccumulation in marine species. The ecotoxicological data used to classify the toxicity of chemicals are the results of laboratory tests on aquatic indicator organisms. Acute toxicity is assessed and expressed as either:

- An LC_{50} – the concentration of the test substance in sea water that kills 50 percent of the test batch; and
- An EC_{50} – the concentration with a specified sub-lethal effect on 50 percent of the test batch.

The HOCNS grouping for a chemical is determined by comparing the results of toxicity tests for that chemical with the toxicity data given in Table A.1.

Table A.1. HOCNS Grouping Toxicity values (ppm) (Source: CEFAS, 2007)

HOCNS Grouping	A	B	C	D	E
Results for aquatic toxicity data (ppm)	<1	>1-10	>10-100	>100-1,000	>1,000
Results for sediment toxicity data (ppm)	<10	>10-100	>100-1,000	>1,000-10,000	>10,000

Aquatic toxicity - refers to the *Skeletonema costatum* EC_{50}, *Acartia tonsa* LC_{50}, and *Scophthalmus maximus* (juvenile turbot) LC_{50} test

Sediment toxicity - refers to the *Corophium volutator* LC_{50} test.

The categorisation also takes into account the chemicals potential to bio-accumulate and biodegrade and other aspects such as potential endocrine disruption. The bioaccumulation potential and biodegradation rate relates to the fate of a chemical within the marine environment. Bioaccumulation potential describes the net result of uptake, distribution, biodegradation and elimination of a substance within an organism, subsequent to exposure but within the environment. The partition coefficient between octanol and water (expressed as Log Pow) is used as an indication of the potential for a substance to be bioaccumulated. A high value indicates a tendency to accumulate in lipophilic ("oil liking") phases such as the fatty tissues of organisms, suspended particles or sediments. However, because of biodegradation and elimination processes, a high Log Pow does not necessarily imply bioaccumulation will occur. The classification outlined in Table A.2 is generally used to describe bioaccumulation potential.

Table A.2. Classification of Bioaccumulation Potential

Bioaccumulation Potential	Log P_{OW}
Low	<2
Medium	2-4
High	>4

Biodegradation of a substance refers to primary breakdown of the substance by living organisms, normally bacteria. A substance is considered readily biodegradable if 60 percent or more is broken down in 28 days during a biodegradation tests. Values below this are considered not to be readily biodegradable.

Harmonised Mandatory Control Scheme (HMCS)

The OSPAR Decision introducing an HMCS for the use and discharge of chemicals offshore came into force through the Offshore Chemicals Regulations 2002. The regulatory regime requires operators to obtain a permit to use and discharge chemicals in the course of oil and gas exploration and production operations offshore.

The OSPAR Decision and its supporting Recommendations entered into force on 16 January 2001. The Decision requires offshore chemicals to be ranked according to their calculated Hazard Quotients relating to each chemical discharge under standardised platform conditions (HQ = ratio of Predicted Environmental Concentration (PEC) to Predicted No Effect Concentration (PNEC). It also obliges authorities to use the CHARM "hazard assessment" module as the primary tool for ranking. In the UK this is carried out by a multidisciplinary team at the CEFAS Burnham Laboratory. From this information, operators assess and select their chemical need, calculating PEC:PNECs for actual conditions of use (utilising the CHARM module as appropriate) and bearing in mind the objective of the HMCS to identify substances of concern for substitution and ranking of others to support moves towards the use of less harmful substances. Inorganic chemicals and organic chemicals with functions for which the CHARM model has no algorithms will continue to be ranked using the existing HOCNS hazard groups defined above.

A series of ranked lists are maintained on the CEFAS web site which use a banding system to rank organic chemicals of similar function according to PEC: PNEC “Hazard Quotients” calculated using the CHARM model. The band definitions are given in Table A.3.

Table A.3. Classification of Bioaccumulation Potential

HQ Banding	HQ Value
Gold	0>x<1
Silver	1=<x<30
White	30=<x<100
Blue	100=<x<300
Orange	300=<x<1000
Purple	1000=<x

The minimum data set of actual values and the parameters used by CEFAS to calculate them are disclosed to chemical suppliers on “templates”. The suppliers then pass these on to operators to enable the calculation of site-specific risk assessments (RQs) for any chemicals they may want to use. Some chemicals are generated and or used in-situ on offshore installations, e.g. Sodium Hypochlorite, and don't fall under the remit of any one supplier.

The properties of substances on the OSPAR List of Substances/Preparations Used and Discharged Offshore, Which Pose Little Or No Risk to the Marine Environment (PLONOR) are sufficiently well known that the UK Regulatory Authorities do not require them to be tested. This list is reviewed annually and the notification requirements for these chemicals are given in the PLONOR document.

Appendix B: Drilling Operations – Rig Information

The exploitation of hydrocarbons requires the construction of a conduit between the surface and the reservoir. This is achieved by the drilling process. Offshore wells are typically drilled by mobile drilling units of which there are three broad designs currently in use: drill ship, semi-submersible drilling rig and jack-up drilling rig. The proposed Desire Falkland Island exploration wells will be drilled using the Ocean Guardian – a third generation drill rig. The rig specifications are provided below.

Rig Type	Semisubmersible
Rig Location	UK North Sea
Rig Design	Earl & Wright Sedco 713 Series
Year Built	1985
Yard Built	Scott Lithgow, Glasgow, Scotland
Class	ABS AI Column Stabilized Drilling Unit
Registry	Marshall Islands
Water Depth - Ft	1,500
Drilling Depth - Ft	25,000
Quarters	100 + 2 bed hospital
Dimensions	227.5' x 197'
Helideck	89' x 83' for Chinook 22T
Drilling Draft	83.5'
Variable Deckload - Operating	3,125 LT
Variable Deckload - Transit	1,800 LT
Number of Columns	8
Max Combined Structure Load	758 kips
Moonpool Dimensions	19.25' x 20.75'
Operating Displacement	25,406 LT
Bulk Mud & Cement	18,166 cu ft
Liquid Mud	1,893 bbls
Fuel Oil	1,108 ST
Drill Water	1,103 ST

Brine	3,154 bbls
Base Oil	3,154 bbls
Potable Water	224 ST
Sack Storage	13,000 sacks
Drawworks	Oilwell E-3000 w/1-1/2" drill line
Derrick	Dreco 50' x 40' x 185', 1,333 kips static hook load
Top Drive	Varco TDS-4S
Pipe Handling System	Victoria RJT-336 Racking Arm, Varco AR 3200 Iron Roughneck
Rotary	Oilwell A-495, 49-1/2"
Top of Rotary Table to Bottom of Barge	170 Ft.
Mud Pumps	(3) Oilwell A1700-PT
Main Engines	(3) Ruston 12 RKCM, 3320 BHP ea., (1) Bergen KVG12, 3044 HP
Annular BOP	(2) Cameron "D" 18-3/4"10K
Ram BOP	(2) Cameron Type U-II (double) 18-3/4" 15K
Diverter	Regan KFDS 24" 500 psi
Riser	Mannesmann 24" w/21" Shaffer DT-1 connections
Riser Tensioning	Brown Brothers 10 x 80K
Solids Control	(4) Thule VSM-300 Cascade system
Cranes	(1) Clarke Chapman NEI w/128' boom, 45 MT; (1) SeaTrax 9036 w/140' boom, 55 T
Mooring System	(8) Vicinay K4 stud link chains w/Bruce 12 MT MK4 anchors

Appendix C: Drilling Mud

During drilling operations drilling mud is pumped through the drill string down to the drilling string down to the bit but only after running a BOP and riser will mud returns will be taken to the rig.

Drilling mud is essential to the operation. It performs the following functions:

- The hydrostatic pressure generated by the mud's weight controls the downhole pressure and prevents formation fluids from entering the well bore;
- It removes the rock cuttings from the bottom of the hole and carries them to the surface and when circulation is interrupted it suspends the drill cuttings in the hole;
- It lubricates and cools the drill bit and string; and
- It deposits an impermeable cake on the wall of the well bore effectively sealing and stabilising the formations being drilled.

The mud is recycled and maintained in good condition throughout the operation. The mud and suspended cuttings are processed on the rig through screens called "shale shakers" to maximise recovery of the mud. The recovered mud is then passed for treatment provided by a centrifuge. This additional equipment removes the fine colloidal solids, the particles too small to be removed by the conventional equipment, which if allowed to build up can make the mud too viscous.

Three major types of mud are typically used in offshore drilling:

- Water based mud (WBM) – water forms the continuous phase of the mud (up to 90 percent by volume);
- Low toxicity oil based mud (LTOBM) – base oils, refined from crude oil, form the continuous phase of the mud; and
- Synthetic based mud (SBM) – the continuous phase is refined from a number of organic compounds chosen because they act like base oil but are selected to be more biodegradable.

The base muds form a viscous gel to which a variety of additives may be added for various reasons, including:

- Fluid loss control. The layer of mud on the wall of the wellbore retards the passage of liquid into the surrounding rock formation. Bentonite is the principal material for fluid loss control although additional additives such as starch and cellulose, both naturally occurring substances, are also used.
- Lost circulation. Naturally occurring fibrous, filamentous, granular or flake materials are used to stop lost circulation when the drill bit enters a porous or fractured formation. Typical materials include ground nut shells and mica.
- Lubricity. Normally the drilling mud alone is sufficient to adequately lubricate and cool the bit. However, under extreme loading, other lubricants are added to prevent the drill string from becoming stuck. No oil based chemicals will be required for Desire's drilling programme.
- pH control. Caustic and lime are used to control the alkalinity of the mud to a pH of 9 to 10. This ensures the optimum performance of the polymers in the mud and controls bacterial activity.
- Pressure control. Barite is generally used as a weighting agent to control downhole pressure.

Figure C.2. A Typical Mud Recycling System, once Marine Riser is in Place.