PUBLIC

EXECUTIVE COUNCIL

CONFIDENTIAL

Title: Review of the Oil Spill Contingency Plan submitted by Argos Resources

Paper No: 273/11

Date: 14 December 2011

Report of: Director of Mineral Resources

1.0 Purpose

1.1 The purpose of this paper is to seek approval of the Governor in Executive Council to an Oil Spill Contingency Plan submitted by Argos Resources Limited.

2.0 Recommendations

Honourable Members are recommended to advise the Governor to:

i. Approve the Oil Spill Contingency Plan submitted by Argos Resources Limited under the terms of their licence in relation to drilling in the North Falkland Basin subject to Argos Resources providing evidence that they have membership to OSR.

ii. To have the Plan made publicly available and for a copy be placed in the Public Library.

iii. Require Argos Resources Limited to submit a project-specific appendix to the Mineral Resources Committee with more detailed information and a sensitivity area map once the company has finalised the details surrounding a drilling operation.

3.0 Summary of Financial Implications

3.1 None.

4.0 Background

4.1 Production Licences under the Offshore Minerals Ordinance 1994 and Offshore Petroleum (Licensing) Regulations 1995 set out in Schedule 6 that there is a requirement for the licensee to obtain the approval of the Governor to an Oil Spill Contingency Plan (OSCP) before undertaking any licensed activity (excluding seismic surveying).

4.2 Argos Resources have submitted an OSCP to the Falkland Islands Government (FIG) for drilling operations in the area licensed under PL001. The plan has been reviewed by the Director of Natural Resources (the lead department in oil spill response), the Environmental Planning Officer, Falklands Conservation, and the Joint Nature Conservation Council (JNCC).

4.3 Argos Resources have benefitted from the review of several previous OSCPs and have produced a comprehensive and detailed plan that clearly outlines the measures and procedures to be followed in the event of an oil spill. As such, relatively few comments have been received in response to the OSCP.

4.4 Argos have taken on board advice from FIG and DECC and have included in their OSCP oil spill modelling for low probability / high impact events as per standard North Sea deep-water practice following the Macondo blowout and oil spill. Additionally, Argos address the issue of sourcing a relief rig and point out that the water depths involved (< 500m) significantly increase the pool of relief rigs that would be available in the event of an oil spill. The operator predicts that it could take as long as 4 or 5 months to have a relief rig from the North Sea ready to drill in the North Falkland Basin (NFB). Rigs from nearer locations would of course be looked at but they would have to conform to existing regulatory requirements. This is the first OSCP for the relatively shallow NFB to take into account post-Macondo considerations.

Argos have in place call off contracts with oil spill contractor OSR and (through AGR) well control contractor WWC. This provides the company with a wide range of specialist well control and oil spill mitigation equipment and expertise.

4.5 Argos have been able to carry out accurate oil spill modelling due to increased chemical and density data obtained from oil extracted by Rockhopper Exploration. To this end, and in addition to the oil spill modelling included in their EIS, Argos have included as an Appendix to their OSCP an extensive oil spill modelling report carried out by Rockhopper Exploration. Such co-operation between companies is worthy of praise as it shows companies are willing to work together to mitigate the environmental impact of drilling activity in the Islands.

4.6 The Environmental Planning Department (EPD) have not submitted any formal comments and have welcomed Argos' inclusion of Rockhopper's modelling report. Similarly, no comments have been received from the Director of Natural Resources or JNCC.

4.7 Falklands Conservation describe the document as clear and comprehensive, and have suggested that Argos include a map of sensitive areas as part of the OSCP in order to ensure that any clean-up effort would be concentrated in the most sensitive areas.

5.0 Argos Resources response to comments

5.1 Argos Resources have acknowledged all comments, adding that a project-specific appendix with more detailed information and a sensitivity area map

will be produced once the company has finalised the details surrounding the drilling operation.

5.2 Argos Resources have produced a comprehensive plan and have addressed concerns arising from previous OSCPs and their own. As such, all stakeholders are content for the document and recommend its approval in Executive Council. The Mineral Resources Committee, at their meeting on 31 November, also recommended that the OSCP for Argos Resources be forwarded to Executive Council for approval and recommended that an appendix containing a sensitivity area map and details of the drilling programme when known be reviewed by the Committee.

6. Financial Implications

6.1 None.

7. Legal Implications

7.1 None.

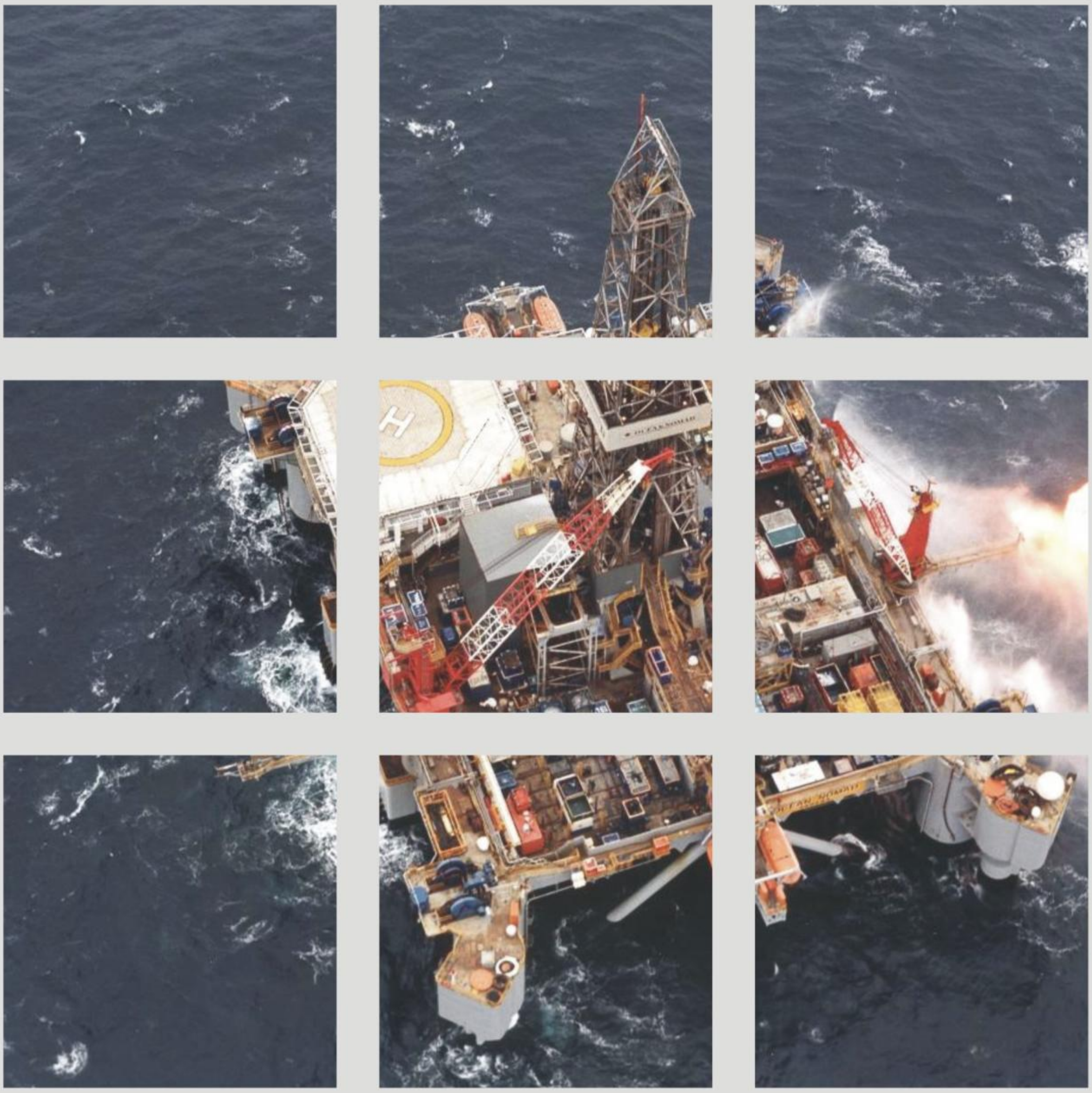
Appendix Argos Resources Oil Spill Contingency Plan & Sea Lion & Johnson Prospect OPEP Modelling Report

Argos Resources Limited

North Falkland Basin Oil Spill Contingency Plan

Date: *October 2011*

Revision: *00*



rpsgroup.com

Argos Resources Limited

North Falkland Basin Oil Spill Contingency Plan

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October 2011

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NORTH FALKLAND BASIN
OIL SPILL CONTINGENCY PLAN

Revision: 00

October 2011

Prepared for Argos Resources Limited
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Controlled Copy Holders

Copy Number	Company	Position
1	Falkland Islands Government - Department of Mineral Resources	Duty Manager
2	Falkland Islands Government - Department of Fisheries	Duty Manager
3	Operator	Corporate Crisis Management Team Leader
4	Operator	HSE Advisor
5	Drilling Contractor	Rig Manager
6	Operator / Drilling Contractor	Drilling Manager
7	Operator / Drilling Contractor	Drilling Superintendent
8	Drilling Contractor	Duty Manager – Incident Support Team
9	Drilling Rig	OIM
10	Drilling Rig	Operator Offshore Drilling Supervisor
11	Standby Vessel	Vessel Master
12	Supply Vessel	Vessel Master
13	Oil Spill Response	Operations Room

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ABBREVIATIONS

ACA	Action Coordination Authority
API	American Petroleum Institute
BAOAC	Bonn Agreement Oil Appearance Code
BFSAI	British Forces South Atlantic Islands
BOP	Blow Out Preventer
CLC	International Convention on Civil Liability for Oil Pollution Damage.
CMT	Crisis Management Team (Operator)
CMTL	Crisis Management Team Leader (Operator)
CPSO	Counter Pollution and Salvage Officer
CPU	Counter-Pollution Unit
DECC	Department of Energy and Climate Change (UK Agency)
DM	Duty Manager
DS	Drilling Supervisor
EA	Environment Agency
EHS	Environment, Health and Safety
ERC	Emergency Response Centre (Drilling Contractor)
FC	Falkland Conservation
FIC	Falkland Islands Company Ltd.
FIDF	Falkland Islands Government Defence Force
FIG	Falkland Islands Government
FIGAS	Falkland Islands Government Air Service
FIPASS	Falkland Islands Port and Storage System
GOR	Gas:Oil Ratio
GRSS	Global Rig Share Solutions network
HSE	Health and Safety Executive
HSEA	HSE Advisor
IR	Infrared
ICT	Incident Command Team (FIG)
IST	Incident Support Team (Drilling Contractor)
ITOPF	International Tanker Owners Pollution Federation
LTOBM	Low Toxicity Oil Based Mud
MCA	Maritime & Coastguard Agency (UK Agency)
MMO	Marine Management Organisation (UK Agency)
MODU	Mobile Offshore Drilling Unit
mPa	Millipascals (viscosity)
MS-ML	Marine Scotland – Marine Laboratory (UK Agency)
NGO	Non Government Organisation
NOSCP	National Oil Spill Contingency Plan
OERT	Operations Emergency Response Team (Drilling Contractor)
OGUK	Oil and Gas UK (formally UKOOA)
OIM	Offshore Installation Manager
OSA	Oil Spill Advisor (to Operator provided by OSR)
OSCP	Oil Spill Contingency Plan

OSR	Oil Spill Response
OSRL	Oil Spill Response Ltd
PCV	Pollution Control Vessel
PWD	Public Works Department (of FIG)
SOPEP	Ship Board Oil Pollution Emergency Plan
SBV	Stand-by Vessel
SLAR	Side Looking Airborne Radar
SRC	Shoreline Response Centre
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UV	Ultra Violet
VHF	Very High Frequency
WBM	Water Based Drilling Mud

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1 Introduction

1.1 Purpose & Scope

This Oil Spill Contingency Plan (OSCP) provides guidance on the actions and reporting requirements in the event of an oil spill originating from any Operators drilling activity within the North Falkland Basin.

The plan will guide the various onshore and offshore personnel through the various actions and decisions which will be required in the event of an oil spill.

It is stressed that despite the guidance given, the priority in the event of a spill is to take measures to ensure the safety of personnel and the installation, and to prevent escalation of the incident.

Where an oil spillage is part of an emergency situation such as a well control incident, fire or explosion, the emergency aspects of the incident must be addressed as a priority and reference shall be made to the relevant Drilling Contractor's rig and onshore Emergency Response Procedures, Operator's Incident Management Plan, and relevant contractor bridging/interface documents, which include a detailed description of the emergency response arrangements between the Operator and its contractors.

This OSCP also includes a project specific Appendix for active project locations, which contains the following information:

- Details of the proposed drilling programmes;
- Environmental sensitivities;
- Operator specific contact lists.

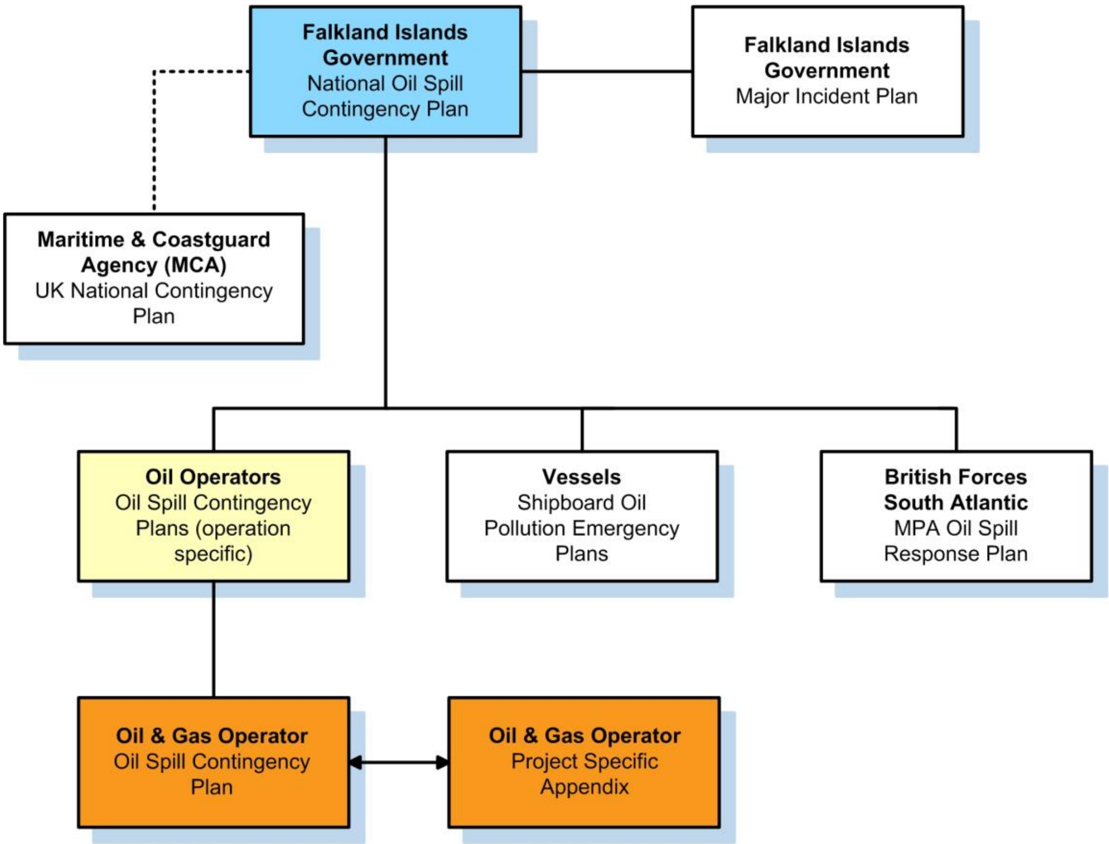
Where exploration project locations are sufficiently close together, these may be grouped into a single project Appendix. Future exploration and appraisal wells/campaigns will be appended to this OSCP as and when appropriate.

This plan provides guidance on oil spill response. However, as every incident will be unique, flexibility and an understanding of the available resources and their limitations are required. The response required for each event will be determined by the exact nature of the spill, as well as the circumstances and environmental conditions prevailing at that time.

1.2 Interface with Falklands NOSCP

This OSCP interfaces with the Falkland Islands National Oil Spill Contingency Plan (NOSCP). The way in which the OSCP interfaces with the NOSCP is shown in Figure 1.1 below.

Figure 1.1. Interface with Falkland Islands NOSCP and Operators OSCP (Adapted from Falkland Islands NOSCP)



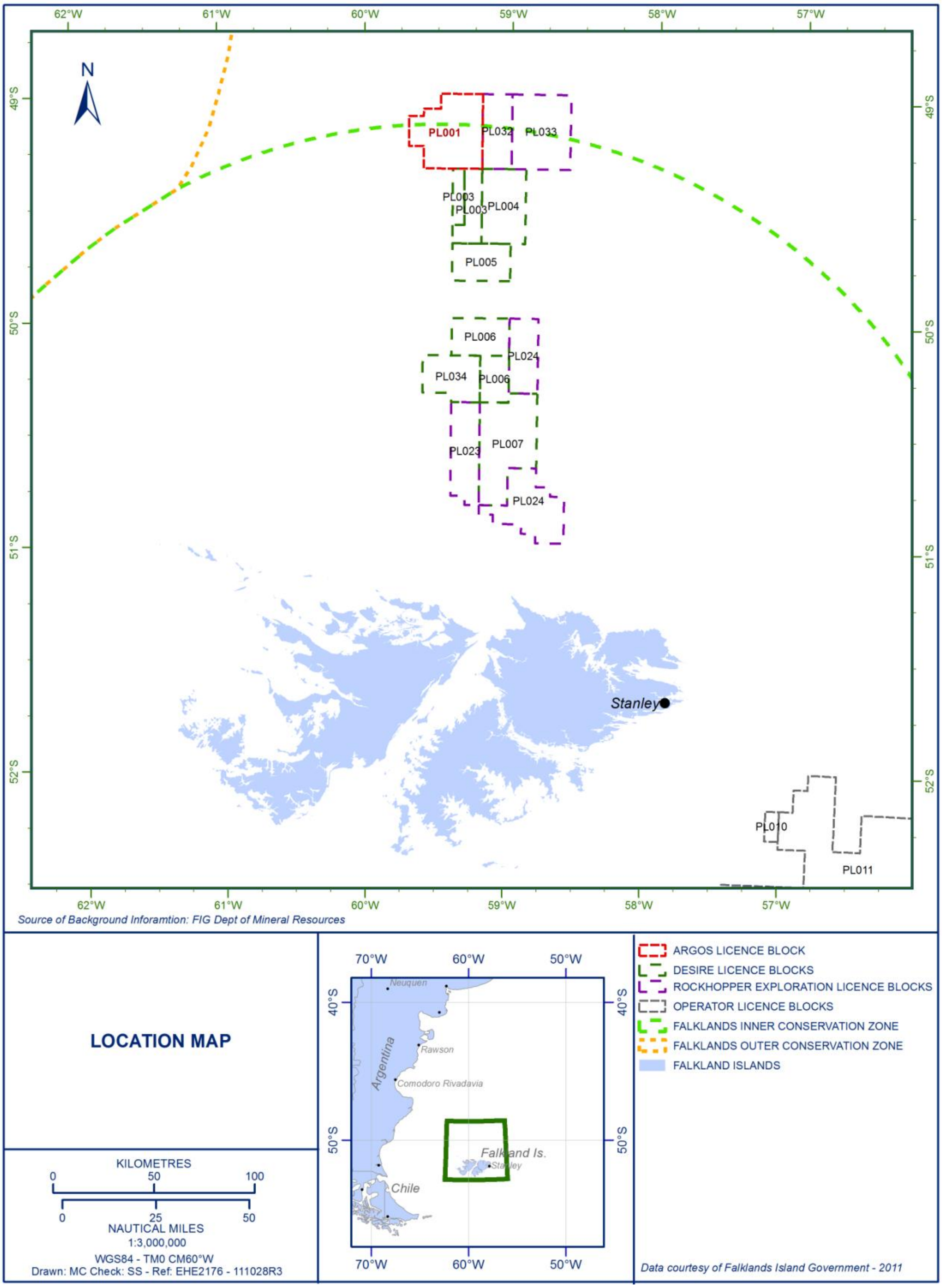
1.3 North Falkland Area Description

The North Falkland Basin comprises a north-south trending graben and a set of subsidiary basins to the west, also controlled by north-south trending extensional faults. The basin appears to be a structurally isolated feature set within a Devonian platform, providing a potentially abundant provenance area for clean reservoir sandstones. Deposition appears to have been fluvio-lacustrine and lacustrine until late in the Cretaceous period, when the southern Boreal Ocean appears to have inundated the area from the southeast (*British Geological Survey, 2011*).

This plan covers areas licensed for oil and gas exploration and production activities in the North Falkland Basin by Argos Resources Limited, Rockhopper Exploration plc and Desire Petroleum plc, as shown in Figure 1.2.

The details in this OSCP for the three operators remain largely the same due to the fact that the same drilling rig (the Diamond Offshore *Ocean Guardian*) and well management company (AGR Petroleum) are being used. However, each operator will submit a separate OSCP, together with project specific Appendices as relevant to their specific offshore drilling operations.

Figure 1.2. Location map of North Falkland Operator's Licences



2 Offshore Response Procedures

2.1 Response Organisation & Management

In the first instance, the Offshore Installation Manager (OIM) will notify the Drilling Contractor's onshore Rig Manager (Stanley) that there has been an oil spill incident

The Operator's Offshore Drilling Supervisor will also notify the Onshore Drilling Superintendent (Stanley), who will mobilise the Stanley Operations Emergency Response Team (OERT[1]).

These are the initial notifications that will be made from the installation in the event of an oil spill emergency.

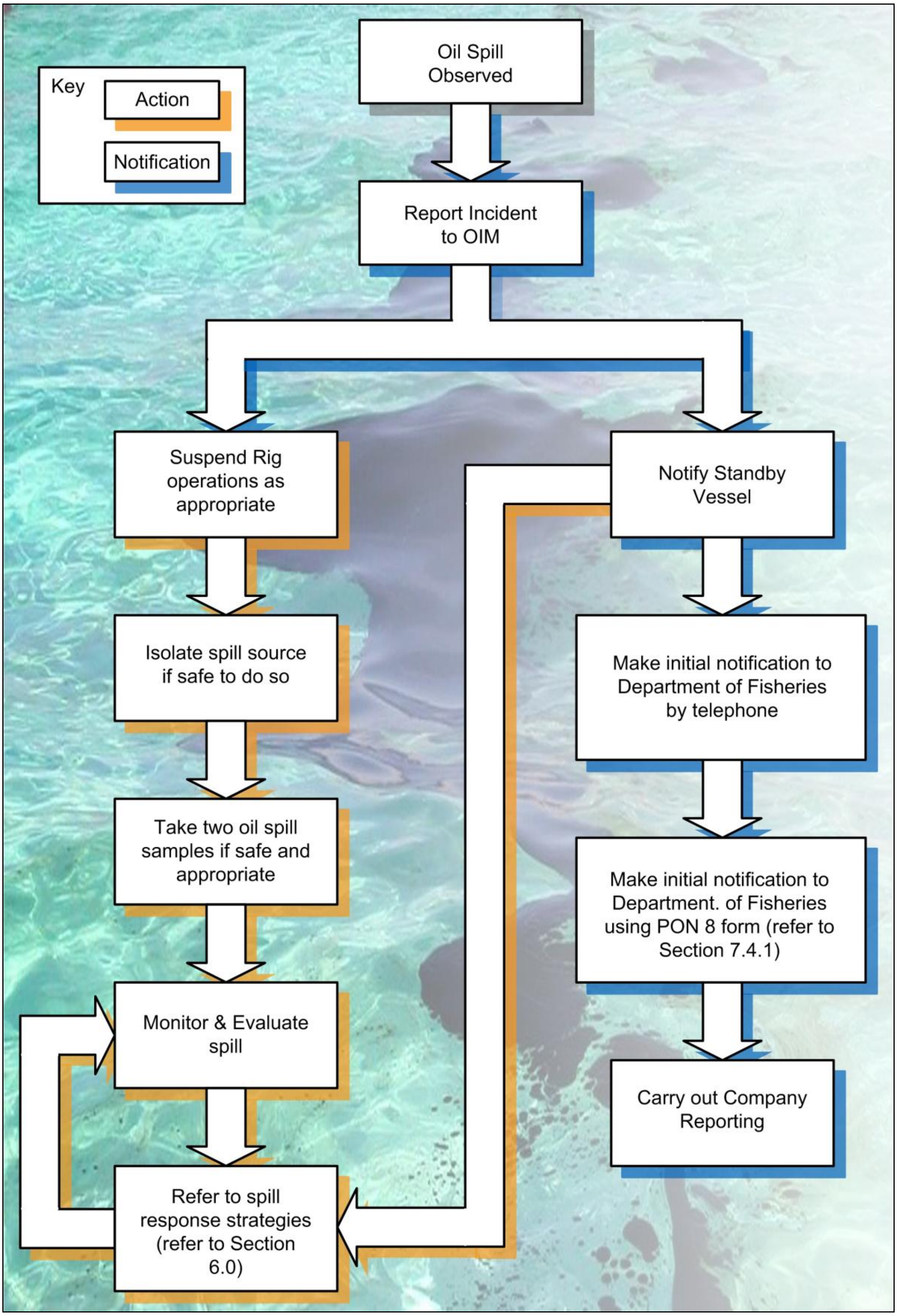
2.2 Initial Offshore Response

The OSCP is based upon a tiered response, as described in Section 6.1. The larger the spill, the more resources are called in to combat it. The initial offshore response is managed by the OIM.

The chain of initial offshore spill response is illustrated in Figure 2.1.

[1] The Operations Emergency Response Team (OERT) will be a combined team from both the Operator, AGR and the Drilling Contractor.

Figure 2.1. Initial Offshore Response Actions and Notifications



2.3 Oil Spill Reporting Requirements

2.3.1 Notification to Onshore Team

The offshore reporting requirements for oil spills are shown in Table 2.1. The incident is to be reported immediately (whatever the size of the oil spill) to the Drilling Contractor's Rig Manager by the Offshore Installation Manager (OIM) and to the Operator's Drilling Superintendent by the Operator's Offshore Drilling Supervisor.

2.3.2 Statutory Reporting Requirements

All spills must be reported to the Falklands Department of Mineral Resources and Department of Fisheries. The first notification should be made by the OIM to both the Department of Mineral Resources and the Department of Fisheries by telephone, giving brief details of the incident.

Where notification is made by telephone, the Petroleum Operations Notice (PON) 8 Form (refer to **Section 7.4.1**) should be filled in (by the OIM) and faxed to the Department of Fisheries without delay, even if some information is missing.

Following the OIM's initial notification to these authorities, all subsequent Government notification will be the responsibility of the Department of Fisheries and liaison with these departments will be the responsibility of the Operations Emergency Response Team (OERT).

If chemical dispersant use is considered, permission must be sought from the **Department of Fisheries** prior to application, except in circumstances where a spill poses an immediate threat to the safety of an installation.

In normal circumstances, the OIM must request the OERT to obtain relevant permission from FIG Department of Fisheries to use dispersants and report back on the use of dispersants after their application. The information required by the Department of Fisheries is provided in the forms in **Sections 7.4.5 and 7.4.6**.

Table 2.1. Summary of Reporting Requirements (Offshore reporting responsibilities are in red italics)

Notify this person or organisation*	Notification to be made by:	<1 tonne (Small Spill)	1-10 tonnes (Medium Spill)	>10 tonnes (Large Spill)	Spill likely to become extensive or reach the coast	Prior to dispersant use unless used to protect the safety of the rig	Following use of dispersant
Drilling Contractor Offshore Installation Manager (OIM)	*Receives notice from oil spill observer.*						
Drilling Contractor Onshore Rig Manager (RM)	*OIM*	✓	✓	✓	✓		
Operator Offshore Drilling Supervisor (DSV)	*OIM*	✓	✓	✓	✓		
AGR Onshore Drilling Superintendent (DS)	*DSV*	✓	✓	✓	✓		
Operator Falkland Islands Representative (FIR)	DS	✓	✓	✓	✓		
AGR ERT Duty Manager, Aberdeen (AGR DM)	DS	✓	✓	✓	✓		
Drilling Contractor IST Duty Manager (OR DM)	RM	✓	✓	✓	✓		
Operator Duty Manager (DM)/Crisis Management Team Leader (CMTL)	FIR	✓	✓	✓	✓		
Operator HSE Advisor (HSEA)	DM/CMTL	✓	✓	✓	✓		
Department of Mineral Resources (DMR)	*OIM* HSEA	✓	✓	✓	✓	✓	✓
Department of Fisheries (DF)	*OIM* HSEA	✓ *Fax PON8*	✓	✓	✓	✓	✓
FIGAS	DF		(✓)	✓	✓		
OSR Aerial Surveillance	CMTL		(✓)	✓	✓		
OSR Advisor to CMT	CMTL		(✓)	(✓)	✓		
OSR Tier 2/3 equipment	CMTL		(✓)	(✓)	✓		
Government Marine Officer	DF	✓	✓	✓	✓		
FIGAS	DF	✓	✓	✓	✓		
Environmental Planning Dept.	DF	✓	✓	✓	✓		
Falklands Conservation	DF	✓	✓	✓	✓		
Public Works Dept.	DF				✓		
Police	DF				✓		
FIDF	DF				✓		

✓ telephone and follow up with a fax (✓) if required

****Note: Refer to Project Specific Appendix for contact telephone & fax numbers***

Key:	
OIM	Offshore Installation Manager
DSV	Offshore Drilling Supervisor (Operator)
RM	Onshore Rig Manager (Drilling Contractor), Stanley
DS	Onshore Drilling Superintendent (Operator), Stanley
AGR DM	Duty Manager AGR ERT (for Operator), Aberdeen
DM	Duty Manager (Drilling Contractor) IST
CMTL	Crisis Management Team Leader (Operator)
EHSA	EHS Advisor (Operator)
DMR	Department of Mineral Resources
DF	Department of Fisheries
FIGAS	Falkland Islands Government Aerial Surveillance

2.4 Roles & Responsibilities

Key responsibilities for offshore personnel are summarised in Tables 2.1, 2.2 and 2.3.

Table 2.1. First Person Sighting the Spill - Responsibilities

First Person Sighting Oil Spill
Notify the OIM and provide details of: • Source of spill; • Current spill location; • Oil type; • Estimation of quantity of oil spilled (refer to Section 5.0); and • Any other relevant actions.
Contact all personnel in the vicinity of the leak or spill and warn of the potential hazard.
Act as instructed by the OIM.
If safe to do so, stay in vicinity of the leak or spill and continue observation.
If safe to do so, take any reasonable action to contain or reduce the leak or spill.

Table 2.2. OIM Responsibilities

OIM
Ensure safety of personnel, the installation/rig and any vessel within the installation 500 metre safety exclusion zone.
Receive report on spill from Oil Spill Observer and take charge of the situation.
If safe to do so, immediately initiate actions to identify source and stop leakage at source.
Inform the Operator's Offshore Drilling Supervisor and jointly assess the situation and the required resources and onshore support to tackle the spill.
Inform the Drilling Contractor onshore Rig Manager and advise of the need to assemble the OERT.
Initiate a chronological log of events and actions taken - maintain this log until stand down.
Confirm source and estimate quantity of oil spilt. Classify spill size and determine likely slick movement (refer to **Sections 13.2.3 and 13.2.4**).
Assess the ongoing nature of the spill and the need to mobilise Tier 2 or Tier 3 resources. Maintain close contact with the Operator's Drilling Supervisor in making this assessment.
If no risk to personnel or installation, request standby vessel to track spill location and take samples of spilt oil.
Notify the Falkland Islands Government Department of Mineral Resources and Department of Fisheries as soon as possible by telephone. Submit PON 8 report form shortly after telephone notification (refer to **Section 7.4.1**).
Send a daily PON8 report for the duration of incident to the Department of Fisheries. If required, delegate this task to the OERT.
If the safety of the installation/rig is under threat, order standby vessel to commence spraying of dispersant to reduce this threat (initial notification to the Department of Fisheries not required, but should be informed after spraying has taken place).
Ensure all other installations and vessels in the vicinity have been informed of the oil spill.

Table 2.3. Offshore Drilling Supervisor Responsibilities

Offshore Drilling Supervisor (Operator)
On being notified of an incident by the OIM, contact the Operator's Drilling Superintendent and provide initial details of spill and action taken. Advise if the Operations Emergency Response Team (OERT) should be mobilised.
Maintain contact with the Drilling Superintendent once the OERT has been mobilised.
Work with the OIM to reduce or prevent further oil leakage without endangering safety of personnel.
Provide regular written (hourly) updates to the OERT on extent of spill, actions taken and any additional equipment / resource requirements.
In the event that shoreline or sensitive features are threatened, request OERT to obtain authorisation from the Department of Fisheries to use chemical dispersant, stating reasons. Following the use of dispersant, report to the same department. Note: In the event of a Tier 1 spill, unless there are compelling reasons to do otherwise, the spill will be monitored and allowed to disperse naturally.
In the event that on site resources are not able to adequately respond to the existing spill or if the existing spill is likely to escalate, request Tier 2/3 assistance from the OERT as appropriate.
Monitor spilt oil and response operations and advise the OERT when spill emergency is over, keeping a chronological log of events.
Collect copies of Incident Logs and forward to the OERT.

3 Onshore Response Procedures

3.1 Response Organisation & Management

The Operator's onshore Drilling Superintendent (Stanley) will receive notification of an incident from the drilling rig. The Offshore Installation Manager (OIM) will also notify the Drilling Contractor's onshore Rig Manager (Stanley). The Operator's Offshore Drilling Supervisor will notify the Operator's Drilling Superintendent, who will mobilise the Stanley Operations Emergency Response Team (OERT[2]).

In the event of an oil spill (where there is no safety risk), the Operator's Drilling Superintendent shall lead the onshore response effort with the support of the OERT. The Drilling Contractor's Rig Manager will be part of the OERT and will liaise closely with the Drilling Superintendent and shall be in direct communication with the rig OIM offshore.

If further support is required (i.e. escalation of the event) then the AGR Emergency Response Team in Aberdeen and the Drilling Contractor's Incident Support Team (IST) will both be mobilised.

The Drilling Contractor's IST and the AGR Emergency Response Team will establish communications with the Operator's Corporate Management Team (CMT). If required, the CMT will establish contact with OSR to mobilise additional oil spill resources.

The Operator's Drilling Superintendent in Stanley will also be empowered to make direct contact with OSR in Southampton, and mobilise such resources as he sees fit, as the situation dictates.

[2] The Operations Emergency Response Team (OERT) will be a combined team from both the Operator, AGR and Drilling Contractor.

3.2 Onshore Response Teams

The oil spill plan is based upon a tiered response, as described in Section 6.1. The larger the spill, the more resources are called in to combat it. The response to an oil spill is managed by designated onshore teams.

3.2.1 Operations Emergency Response Team (OERT) - Stanley

The Operations Emergency Response Team (OERT) in Stanley will provide primary onshore support and first point of contact, for any offshore emergency. This is a joint team consisting of the Operator, AGR and Diamond Offshore personnel. The three companies share a common Emergency Response room. The principal members of the OERT are as follows:

- Drilling Superintendent (AGR);
- Rig Manager (Diamond Offshore);
- Falkland Islands Representative (Operator);
- Logistics personnel (AGR & Diamond Offshore);
- Administration Assistant / Logkeeper (AGR).

The OERT will be trained in the principles of oil spill response in order to provide effective support to the offshore team and to be competent to mobilise additional resources as required. In the event that the Operator's Falkland Island Representative is not available, the Operator will nominate an appropriate person to take on this role.

3.2.2 Diamond Offshore Incident Support Team (IST) – Dyce, Aberdeen

The principal aim of the Drilling Contractor's Incident Support Team (IST) is to provide support to the Diamond Offshore Rig Manager and the OERT in Stanley and to liaise with the AGR Emergency Response Team in Aberdeen. The principal members of the IST are as follows:

- Duty Manager ;
- Chief Operating Officer;
- VP Operations;
- VP HSE;
- Drilling Manager;
- Human Resources Manager;

The IST is located at the Diamond Offshore office in Dyce, Aberdeen. The IST will be trained to be conversant in the general principles of oil spill response and management in order to provide effective support to the OERT in Stanley.

3.2.3 AGR Emergency Response Team (ERT) – Aberdeen, UK

The principal aim of the AGR Emergency Response Team (ERT) is to provide support to the AGR Drilling Superintendent and the OERT in Stanley and to liaise with the Diamond Offshore Incident Support Team (IST) in Aberdeen and the Operator's Crisis Management Team (CMT). The principal members of the AGR ERT are as follows:

- Duty Manager;
- Engineering Manager;

- Operations Manager;
- Well Team Leader;
- HSE Advisor;
- Family Liaison.

The ERT is located at the AGR office in Aberdeen, UK. The ERT will be trained to be conversant in the general principles of oil spill response and management in order to provide effective support to the OERT in Stanley.

3.2.4 Operator's Corporate Crisis Management Team (CMT)

The principal role of the CMT is to initiate oil spill response operations for Tier 2/3 incidents. This team would consist initially of the CMT Leader, Operations Personnel and HSE Advisor, but may be supplemented by an Oil Spill Advisor (OSA) provided by OSR and other Operator personnel.

The role of the CMT in oil spill response is to:

- Develop a comprehensive and up to date understanding of the incident;
- Provide support to the ERT and OERT where applicable (e.g. mobilisation and communication with OSR);
- Communicate with the Diamond Offshore IST in the co-ordination and deployment of resources;
- Notify and liaise directly with Falkland Islands Government agencies;
- Co-ordinate internal and external information about the incident;
- Provide information to the Operator's Management Board;
- Co-ordinate and manage media response to the emergency;
- Provide information to the AGR ERT family liaison regarding relatives of personnel involved in the emergency; and
- Provide commercial and legal support.

3.3 Oil Spill Reporting Requirements

3.3.1 Notification to Onshore Team

The onshore reporting requirements for oil spills are shown in Table 3.1. The Drilling Contractor's Rig Manager will receive initial notification of an oil spill from the Offshore Installation Manager (OIM). The Operator's Drilling Superintendent will also receive initial notification that an oil spill incident has occurred from the Operator's Offshore Drilling Supervisor.

If required, the OERT will then be mobilised. The Drilling Superintendent and Rig Manager will immediately notify the AGR Duty Manager in Aberdeen and the Drilling Contractor's Duty Manager that a spill event has occurred.

The Drilling Superintendent and Rig Manager will make an initial assessment of the incident and decide whether or not to mobilise their respective onshore response teams and the Operator's CMT.

Upon mobilisation of the Operator's CMT, leadership of this team will pass from the Operator's Duty Manager to the Crisis Management Team (CMT) Leader (although in practice, depending on the duty roster, this could be the same person).

3.3.2 Statutory Reporting Requirements

All spills must be reported to both the Falkland Department of Mineral Resources and the Department of Fisheries, according to the National Oil Spill Contingency Plan (NOSCP). The first notification should be made by the OIM to both the Department of Mineral Resources and the Department of Fisheries by telephone, giving brief details of the incident.

Where notification is made by telephone, the Petroleum Operations Notice (PON) 8 Form should be filled in (by the OIM) and faxed to the Department of Fisheries as soon as possible, even if some information is missing (refer to Section 7.4.1).

Following the OIM's initial notification to these authorities, all subsequent Government notification will be the responsibility of the Department of Fisheries and liaison with these departments will be the responsibility of the OERT.

If chemical dispersant use is considered, permission must be sought from the Department of Fisheries prior to application. This will be the responsibility of the OERT. In circumstances where a spill poses an immediate threat to human health or the safety of an installation, the OIM may commence dispersant spraying if he sees fit without seeking prior permission. However, following the use of dispersant in this manner, the Department of Fisheries must be notified.

The information required by the Department of Fisheries is listed in **Section 7.4.5**, and following the use of dispersant, **Section 7.4.6**.

Table 3.1. Summary of Reporting Requirements (*Onshore responsibilities are in red italics*)

Notify this person or organisation*	Notification to be made by:	<1 tonne (Small Spill)	1-10 tonnes (Medium Spill)	>10 tonnes (Large Spill)	Spill likely to become extensive or reach the coast	Prior to dispersant use unless used to protect the safety of the rig	Following use of dispersant
Drilling Contractor Offshore Installation Manager (OIM)	Receives notice from oil spill observer.						
Drilling Contractor Onshore Rig Manager (RM)	OIM	✓	✓	✓	✓		
Operator Offshore Drilling Supervisor (DSV)	OIM	✓	✓	✓	✓		
Operator Onshore Drilling Superintendent (DS)	DSV	✓	✓	✓	✓		
Operator Falkland Islands Representative (FIR)	*DS*	✓	✓	✓	✓		
AGR ERT Duty Manager, Aberdeen (AGR DM)	*DS*	✓	✓	✓	✓		
Drilling Contractor IST Duty Manager (OR DM)	*RM*	✓	✓	✓	✓		
Operator Duty Manager (DM)/Crisis Management Team Leader (CMTL)	*FIR*	✓	✓	✓	✓		
Operator HSE Advisor (HSEA)	*DM/CM TL*	✓	✓	✓	✓		
Department of Mineral Resources (DMR)	OIM *HSEA*	✓	✓	✓	✓	✓	✓
Department of Fisheries (DF)	OIM *HSEA*	✓ Fax PON8	✓	✓	✓	✓	✓
FIGAS	*DF*		(✓)	✓	✓		
OSR Aerial Surveillance	*CMTL*		(✓)	✓	✓		
OSR Advisor to CMT	*CMTL*		(✓)	(✓)	✓		
OSR Tier 2/3 equipment	*CMTL*		(✓)	(✓)	✓		
Government Marine Officer	*DF*	✓	✓	✓	✓		
FIGAS	*DF*	✓	✓	✓	✓		
Environmental Planning Dept.	*DF*	✓	✓	✓	✓		
Falklands Conservation	*DF*	✓	✓	✓	✓		
Public Works Dept.	*DF*				✓		
Police	*DF*				✓		
FIDF	*DF*				✓		

✓ telephone and follow up with a fax (✓) if required

****Note: Refer to Project Specific Appendix for contact telephone & fax numbers***

Key:	
OIM	Offshore Installation Manager
DSV	Offshore Drilling Supervisor (Operator)
RM	Onshore Rig Manager (Drilling Contractor), Stanley
DS	Onshore Drilling Superintendent (Operator), Stanley
AGR DM	Duty Manager AGR ERT (for Operator), Aberdeen
DM	Duty Manager (Drilling Contractor) IST
CMTL	Crisis Management Team Leader (Operator)
EHSA	EHS Advisor (Drilling Contractor)
DMR	Department of Mineral Resources
DF	Department of Fisheries
FIGAS	Falkland Islands Government Aerial Surveillance

3.4 Roles & Responsibilities

The Drilling Contractor's IST is located at the Drilling Contractor's offices in Dyce, Aberdeen. The location of the Operator's CMT will be specified in the Project Specific Appendix. The overview of onshore personnel responsibilities in Table 3.4 is provided for guidance. It provides an expectation of the roles for others involved in the response. Contractor bridging documents put in place for drilling operations should include descriptions of roles/responsibilities for those specific operations.

Table 3.4. Key Roles and Responsibilities

Operator Onshore Drilling Superintendent
On being notified of an incident by the Drilling Supervisor, contact the Diamond Offshore Onshore Rig Manager and discuss initial details of spill and action taken. Assess if the Operations Emergency Response Team (OERT), AGR Emergency Response Team (ERT) and Diamond Offshore Incident Support Team (IST) should be mobilised.
Report the spill to the AGR Duty Manager in Aberdeen providing details of spill and actions taken and advise if the Aberdeen ERT should be mobilised.
Contact the Operator's Falkland Islands Representative and provide initial details of spill and actions taken and proposed course of action for the current situation (this step must take place regardless of the size of spill and regardless of whether the OERT has been mobilised)
Maintain contact with AGR ERT once mobilised.
Work with the offshore Drilling Supervisor and OIM to reduce or prevent further oil leakage without endangering safety of personnel.
Provide regular written (hourly) updates to the ERT (copied to CMT and IST) on extent of spill and actions taken.
Ensure that a daily PON8 report for the duration of incident is being sent to the Department of Fisheries by the OIM. If the OIM requests, take over the sending of the PON8 report.
In the event that shoreline or sensitive features are threatened, request authorisation from the Department of Fisheries to use chemical dispersant, stating reasons. Following the use of dispersant, report to the same departments. Note: In the event of a Tier 1 spill, unless there are compelling reasons to do otherwise, the spill will be monitored and allowed to disperse naturally.
In the event that on site resources are not able to adequately respond to the existing spill or if the existing spill is likely to escalate, request Tier 2/3 assistance from the ERT as appropriate. (Note: should the situation dictate, the Drilling Superintendent is authorised to make direct contact with OSR and mobilise such resources as he deems necessary. However, the normal communications channel for mobilising the Tier 2/3 packages will be via the ERT & CMT.)
Ensure a log keeper is assigned to monitor spilt oil and response operations and keep a chronological log of events and conversations.
Issue a regular status report in writing to the ERT, IST and CMT.
Advise the ERT (copy to CMT/IST) when spill emergency is over.
Collect copies of Incident Logs and forward to the ERT (copy to CMT).

Diamond Offshore's Onshore Rig Manager
On being notified of an incident by the OIM, contact the Operator's Drilling Superintendent and discuss initial details of spill and action taken. Assess if the Operations Emergency Response Team (OERT), AGR Emergency Response Team and Diamond Offshore Incident Support Team (IST) should be mobilised.
Mobilise Diamond Offshore IST if appropriate. Provide technical support to the OIM.
Make contact with Operator's Drilling Superintendent.
Maintain contact with Diamond Offshore IST, once the IST has been mobilised.
Provide logistical support and communications with the rig and standby vessel.
Ensure a log keeper is assigned to monitor spilt oil and response operations and keep a chronological log of events and conversations.
If the Falkland Islands Government decides to mobilise the Incident Command Team (ICT), provide every assistance and appropriate representation at the Incident Command Centre (refer to **Section 5.0**).
Ensure that a "lessons learned" profile is available quickly so that remedial action and the possible upgrading of procedures can take place.

Operator's Falkland Islands Representative
On being notified of an incident by the Drilling Superintendent, contact the Operator's CMT Leader and provide initial details of the spill, actions taken and current forward plan. Advise if the Drilling Superintendent has requested the CMT to be mobilised and whether additional resources may be required from OSR (tier 2 / 3 package etc.).
Make contact with FIG Incident Command Team and mobilise to that location if requested. Maintain close contact with the Onshore Emergency Response Team in this scenario.
Make contact with FIG statutory authorities (Dept of Fisheries and Dept of Mineral Resources) to ensure that they are receiving regular and accurate information.
Maintain close contact with the Operator's CMT and provide regular updates.
Ensure a log keeper is assigned to monitor spilt oil and response operations and keep a chronological log of events and conversations.
If the Falkland Islands Government decides to mobilise the Incident Command Team (ICT), provide every assistance and appropriate representation at the Incident Command Centre (refer to **Section 5.0**).
Ensure that a "lessons learned" profile is available quickly so that remedial action and the possible upgrading of procedures can take place.

AGR Emergency Response Team Leader
Mobilise ERT members as appropriate.
Manage and coordinate efforts of the ERT to support the OERT in Stanley.
Make contact with the Operator's CMT and request mobilisation of additional resources from OSR if required.
Liaise and provide support to the Diamond Offshore IST as appropriate throughout the process of spill response.
Record all details of incident and all incoming information, maintaining a chronological log of events and conversations.
Assess scope and potential of incident and the probable effects on the project.
Manage family liaison for AGR, Operator and Third Party personnel, via the Family Liaison Officer. Note: Family Liaison for Diamond Offshore will be via the Diamond Offshore IST HR Manager.
Initiate "stand down" only when satisfied that all matters relating to the incident have been dealt with as far as is practicable and that the OERT / IST no longer require support.
Request return of all personnel logs, incident reports, communications copies etc. This may be in the form of a collated report. All original documentation from all working locations must be preserved.
Ensure that a comprehensive report of the incident with chronological log of events, persons notified and all supporting documentation is prepared for subsequent incident investigation and any legal action. Provide a copy of this report to the Operator's CMT.
Ensure that a "lessons identified" profile is available quickly so that remedial action and the possible upgrading of procedures can take place.

Diamond Offshore Incident Support Team Leader
Mobilise IST members as appropriate.
Manage and coordinate efforts of the IST to support the OERT in Stanley.
Make contact with the Operator's CMT.
Liaise and provide support to the ERT as appropriate throughout the process of spill response.
Record all details of incident and all incoming information, maintaining a chronological log of events.
Record all details of conversations.
Manage family liaison for Diamond Offshore personnel, via the Family Liaison Officer.
Request return of all personnel logs, incident reports, communications copies etc. This may be in the form of a collated report. All original documentation from all working locations must be preserved.
Ensure that a comprehensive report of the incident with chronological log of events, persons notified and all supporting documentation is prepared for subsequent incident investigation and any legal action. Provide a copy of the report to the AGR ERT and the Operator's CMT.
Ensure that a "lessons identified" profile is available quickly so that remedial action and the possible upgrading of procedures can take place.

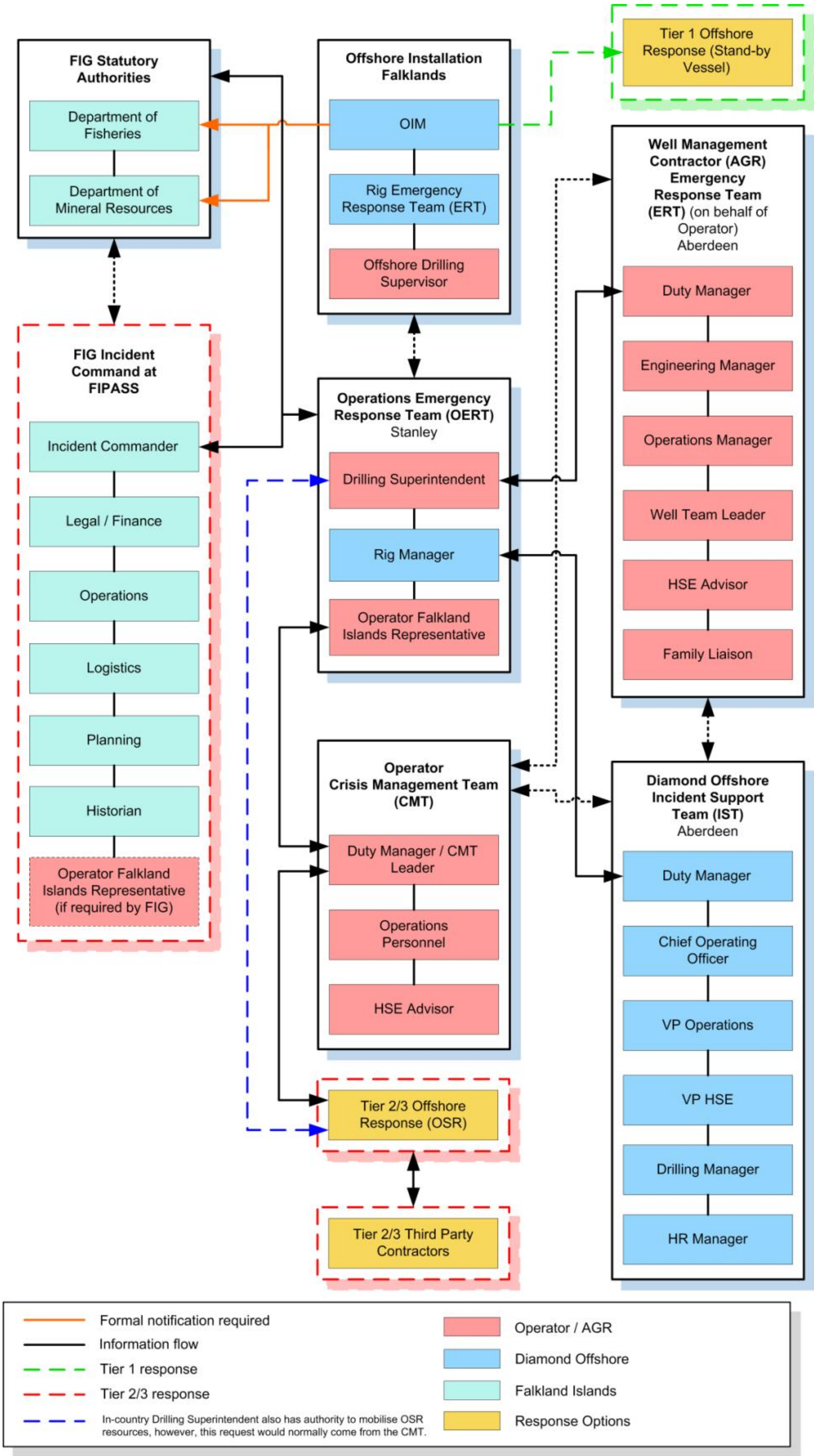
Operator's Crisis Management Team Leader
Mobilise CMT members as appropriate.
Manage and coordinate efforts of the CMT in supporting the ERT, IST and OERT.
Liaise with FIG statutory bodies throughout the process of spill response.
Appoint a log keeper to record all details of incident and all incoming information, maintaining a chronological log of events and conversations.
Assess scope and potential of incident and the probable effects on the project and company.
Authorise OSR support if required, including tier 2 / 3 response equipment.
Keep Operator's Corporate Management informed of progress and request further assistance if required.
Maintain contact and ensure full briefing of Media Response Team is being achieved.
Initiate "stand down" only when satisfied that all matters relating to the incident have been dealt with as far as is practicable and that the ERT, IST and OERT no longer require support.
Request return of all personnel logs, incident reports, communications copies etc. This may be in the form of a collated report. All original documentation from all working locations must be preserved.
Ensure that a comprehensive report of the incident with chronological log of events, persons notified and all supporting documentation is prepared by the ERT and IST for subsequent incident investigation and any legal action.
Ensure that a "lessons identified" profile is available quickly so that remedial action and the possible upgrading of procedures can take place.

Operator's HSE Advisor
Record all details of incident and all incoming information, maintaining a chronological log of events.
Record all details of conversations.
Ensure primary notifications and submission of formal reports, giving full information on location of incident, time, quantity spilled, movement and current status. Record times of notifications. • Confirm Department of Mineral Resources and Department of Fisheries have already been contacted by the OIM by telephone; • Ensure PON8 report form (**Section 7.4.1**) has been submitted to the Department of Fisheries by the OIM; • Ensure that a daily PON8 report for the duration of the incident is being sent to the Department of Fisheries by the OIM or OERT.
Provide assistance to OERT in determining response strategy. Assist OERT / ERT to determine whether aerial surveillance should be mobilised to monitor the spill. Daylight aerial monitoring should be carried out using Operator's crew change helicopter and/or FIGAS aircraft (if available). Surveillance should be carried out twice daily until the oil has completely dispersed. Normally, aerial surveillance alone is sufficient to monitor natural dispersion of diesel, however if safety or environmental sensitivities are threatened, see below. If requested by the ERT / OERT, liaise with FIG Department of Fisheries, determine environmental sensitivities and obtain FIG approval prior to mobilising dispersant treatment and advise them following spraying. UK Marine Management Organisation (MMO) and Marine Scotland - Marine Laboratory (MS-ML) advice is given in **Section 13.4.1** (refer also to reporting forms in **Section 7.4.5 and 7.4.6**).
Track slick and determine likely movement (towards other installations / environmentally sensitive areas / coastal regions) using OSR oil spill modelling service as necessary.
Arrange for photographs and samples to be taken of the slick.
Ensure aerial surveillance has been mobilised if required. In the event of sustained aerial surveillance, the slick must be observed twice daily and reports made to FIG (use Aerial Observation Log **Section 7.4.4**). A bird observer may join the surveillance operation if required. In consultation with the Conservation Agencies and trained observers seek advice on the following: • Overall extent of oil slick; • Direction of movement, especially noting other installations and vessels in the vicinity; • Proximity to environmentally sensitive areas; • Areas in need of urgent clean-up measures; • Need for additional assistance and back-up services; • Progress and dispersion of slick during clean-up operations.
Ensure adequate supervision of all clean-up operations is by trained personnel.
When instructed by the CMT Leader, commence "stand-down" procedures as follows: • Ensure FIG are informed of final state of clean-up procedures. • Ensure all local authorities, contractors, vessels, aircraft, external resource suppliers, etc. are contacted, notified of the end of the incident and stood down. • Remain accessible to support personnel in compiling their reports.
Ensure that a "lessons identified" profile is available quickly so that remedial action and the possible upgrading of procedures can take place.

4 Communications Interface with Onshore & Offshore Teams

The communications interfaces between the various onshore and offshore teams is summarised in the communications schematic diagram in Figure 4.1 below.

Figure 4.1. Communications Schematic



FIPASS - Falkland Islands Port and Storage System

Note: Falkland Islands Government Incident Command Facility at FIPASS will be mobilised in the event of activation of the National Contingency Plan (NOSCP).

5 The Role of the FIG Incident Command Team (ICT)

In accordance with the NOSCP, the FIG Marine Officer (Incident Commander) may monitor the management of large oil spills. Upon notification from the Department of Fisheries, the FIG Marine Officer will decide whether to activate all or part of the incident command structure. The full structure is shown below in Figure 5.1. Representatives from the Operator may need to be part of this team.

In the event of a major Tier 2/3 spill, FIG may activate the full incident command structure and Incident Command Team (ICT) based at the Falkland Islands Port and Storage System (FIPASS).

Once the ICT is activated, its function is to manage the spill response process and monitor the Operator's plans for control and prevention of pollution and to provide a forum for discussion of response planning, environmental impacts and the interests of other key parties, States and organisations, which may be affected by the incident. Both the Operator and Drilling Contractor should provide full cooperation and compliance with the ICT directions and to assign full time representatives to attend the Incident Command Centre.

The full incident command structure is detailed in Figure 5.1. The principal roles and responsibilities within the ICT are summarised in Table 5.1.

Figure 5.1. FIG Incident Command Team (ICT) (Falkland Islands NOSCP)

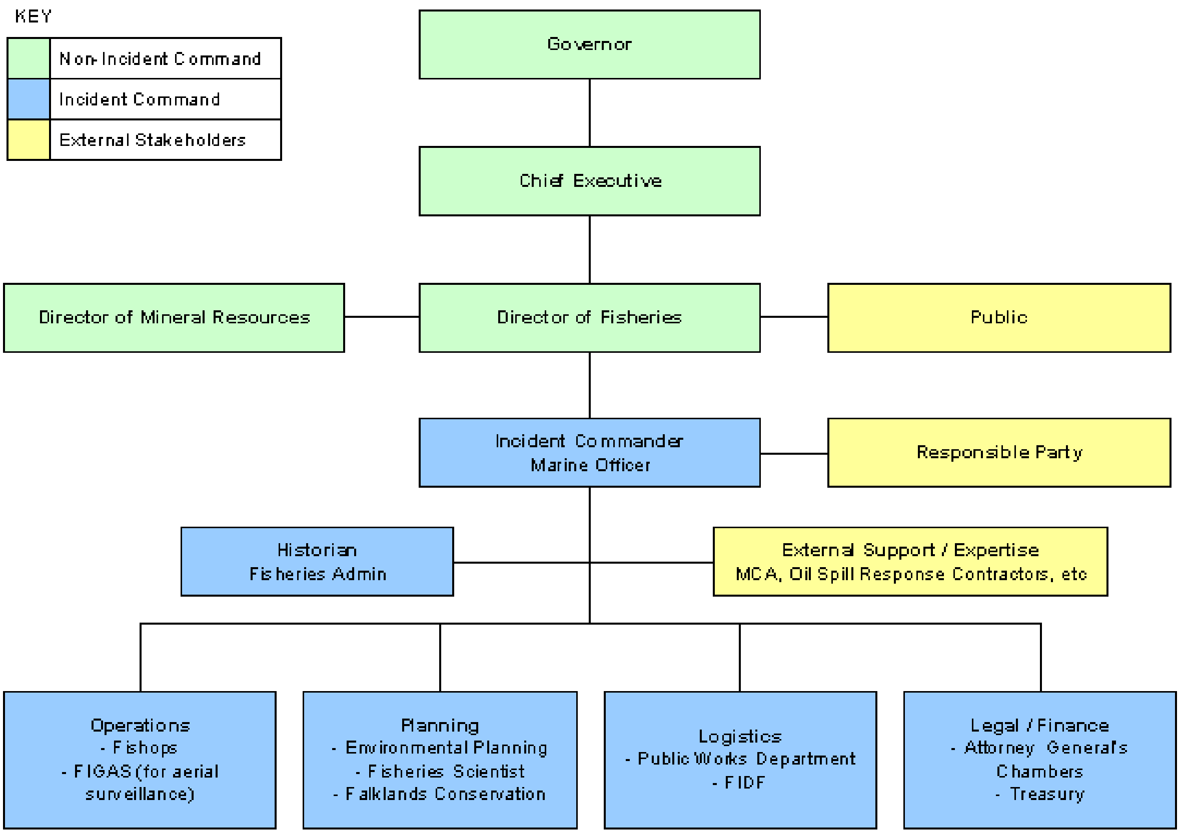


Table 5.1. ICT Roles and Responsibilities (Falkland Islands NOSCP)

Roles	Responsibilities
Incident Commander	Assume overall responsibility for the spill response management. Report to the director of Natural Resources.
Legal / Finance	Ensure all legal issues are addressed. Record all costs incurred and ensure compensation/ cost recovery issues are addressed.
Operations	Implement/manage response operations. Ensure safe and effective mobilisation and deployment of field equipment and manpower.
Logistics	Provide logistical support to operations. Assess required logistical support for external agencies that may be mobilised and ensure support is provided.
Planning	Formulate response strategies. Advise on environmental/socio-economic sensitivities.
Historian	Coordinate the flow of information between functions within the incident command. Log all action points and information discussed in briefings; Ensure any status boards are kept up to date in FIPASS.

5.1 Incident Command Centre

The fisheries operations facilities at FIPASS, Stanley Harbour have been identified as the Incident Command Centre. The facility consists of two rooms with the following:

- two HF/MF radios;
- two VHF radios;
- two standard telephones;
- dedicated fax / phone line;
- e-mail facilities;
- marine charts and limited desk space.

No more than six persons can operate from this facility. Further office space, telephones and a fax machine are available within The Department of Fisheries at the FIPASS facility.

6 Response Strategies

6.1 Tiered Response

The strategy that will be adopted in the event of an oil spill will depend upon several factors:

- The size and characteristics of the spilt oil;
- Its probable and predicted behaviour in the sea;
- Consideration of the environmental sensitivities in the path of the oil; and
- Consideration of the consequences of the different response options on the environment as a whole if they were to be adopted.

Taking into account the risk of oil spills occurring as determined by the risk assessment (refer to **Section 10.0**), the following three-tiered response approach has been adopted:

- **Tier 1** response is that which is immediately available on site, geared for the most frequently anticipated oil spill;
- **Tier 2** response is for less frequently anticipated oil spills of larger size and for which external resources will be required to assist in monitoring and clean-up;
- **Tier 3** response is in place for the very rarely anticipated oil spill of major proportions and which will possibly require national and international resources to assist in protecting vulnerable areas and in the clean-up.

The general strategy to be adopted for different oil types and tiers of oil spills is outlined below (Table 6.1).

The response options selection decision chart shown in Figure 6.1 will help to assist in selecting an appropriate response strategy. It is recommended that the Oil Spill Response contractor be contacted for advice on response strategies in all situations.

The dispersant use selection chart shown in Figure 6.2 will help if the application of dispersant has been selected as the primary response strategy.

FIG Policy on various oil spill response strategies is also displayed in Table 6.2.

Table 6.1 Tiered Oil Spill Response

Tier	Probability	Preferred Response	Equipment and Personnel Requirement	Resources and Mobilisation Time
1	Highest probability	Natural dispersion and monitoring. Chemical dispersant if installation/rig safety or sea surface vulnerabilities are identified (i.e. seabirds)**.	Resources in the field are able to monitor and (only) if agreed by the Department of Fisheries or for safety reasons, to treat the oil with dispersant from the supply vessels, without outside assistance.	The attending vessel, if available, to monitor oil slick. The attending supply vessels are each equipped with 4 m^3 of chemical dispersant and spray system, able to treat up to 80 tonnes of oil, with a contact rate of approximately 10 tonnes per hour. Additional stock of 7 m^3 of dispersant held at supply base in Stanley. Response will be immediate and short in duration.
2	Moderate probability	Natural dispersion and monitoring, which may require mobilisation of aerial surveillance. The additional use of aerial chemical dispersant treatment may be required, if safety or sensitive areas are threatened. Containment and recovery systems available if required and if weather conditions are favourable.	Requires the mobilisation of aerial surveillance to monitor the movement and dispersion of the oil. The additional use of aerial chemical dispersant treatment may be required, only if safety dictates or sensitive areas are threatened and approval has been given by the Department of Fisheries. This would be mobilised internationally from OSR Southampton.	Initial aerial surveillance provided by either: - Crew change helicopter (if available). - Local aircraft charter (5 x Britten Norman Islander aircraft are available in the Falklands). - Use of FIGAS spotter plane if available (one of the 5 Britten Norman Islander aircraft is on contract to the Fisheries Department as a spotter plane). - Additional aerial surveillance support provided by OSR trained observer flown in from UK and local plane chartered. Aerial dispersant application capability provided through OSR. Aircraft mobilised from UK. Dispersant stocks located at OSR Southampton base. Mobilisation time 30 to 60 hours. Government dispersant stocks located at Falklands Interim Port and Storage System (FIPASS).**
3	Low probability	The additional use of further aerial chemical dispersant treatment may be required, if safety or sensitive areas are threatened. If weather conditions permit, consideration would be given to deployment of containment and recovery systems.	In addition to Tier 2 response capability, large spills may require rapid mobilisation of regional / international resources to effectively tackle the spill. Response may be of long duration (weeks / months). Containment and recovery systems available as part of the international Tier 3 package, if required and if weather conditions are favourable.	Access to all Tier 2 resources plus aerial chemical dispersant treatment** from OSR (Hercules with the ADDs pack or Nimbus system). Mobilisation time 30 to 60 hours. If shoreline is threatened, specialised mechanical containment and recovery equipment and skilled technicians to lead clean-up operations held by OSR. 'Unskilled' labour mobilised locally together with general purpose equipment and transport.

Note: The National Oil Spill Contingency Plan (NOSCP) may be activated by FIG if the spill is likely to require national resources. Activation of the NOSCP is the responsibility of the Department of Fisheries.

** FIG Department of Fisheries approval required prior to chemical dispersant use except where safety of personnel or rig is threatened.

Figure 6.1. Response Options Selection Decision Chart

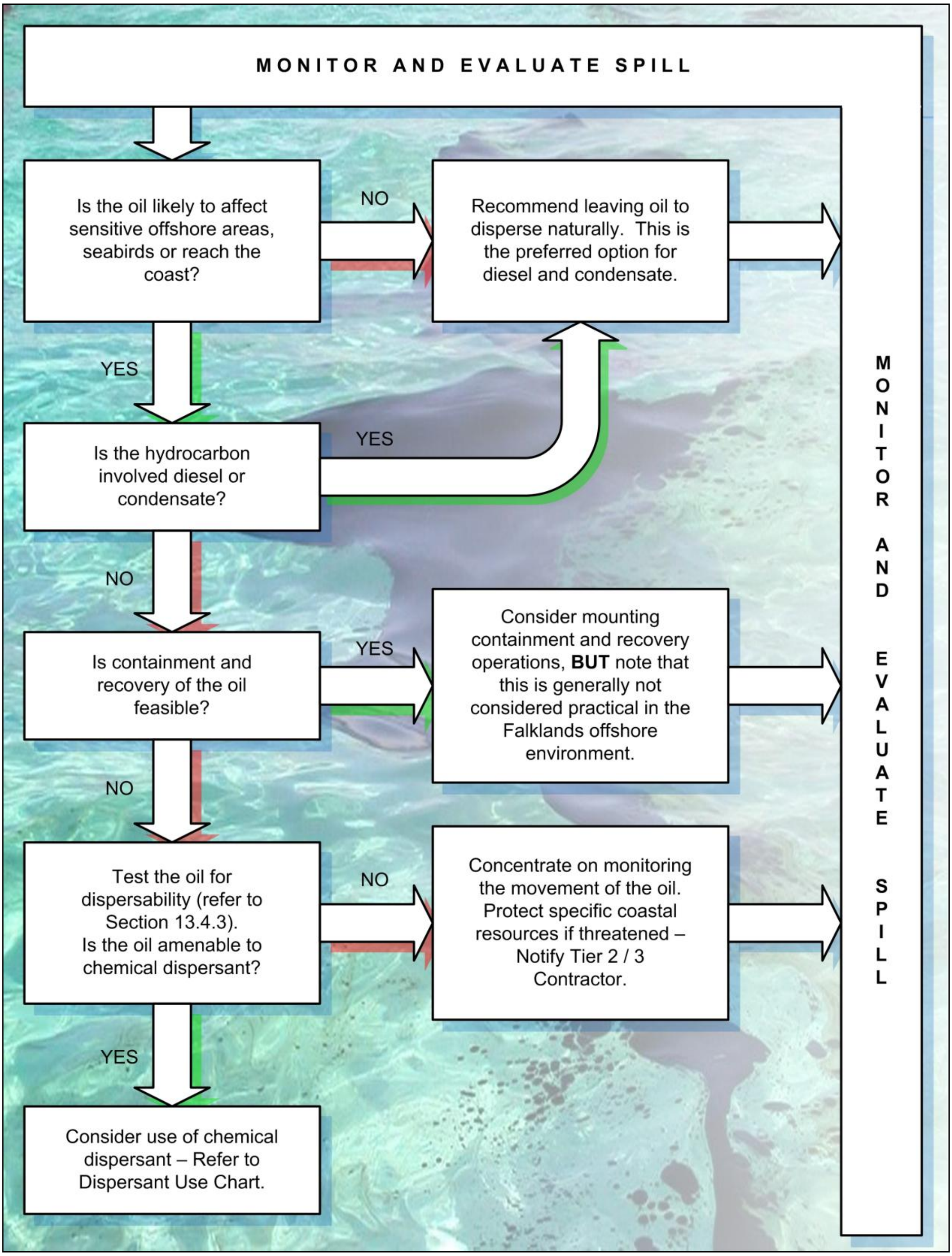


Figure 6.2. Dispersant Use Decision Chart

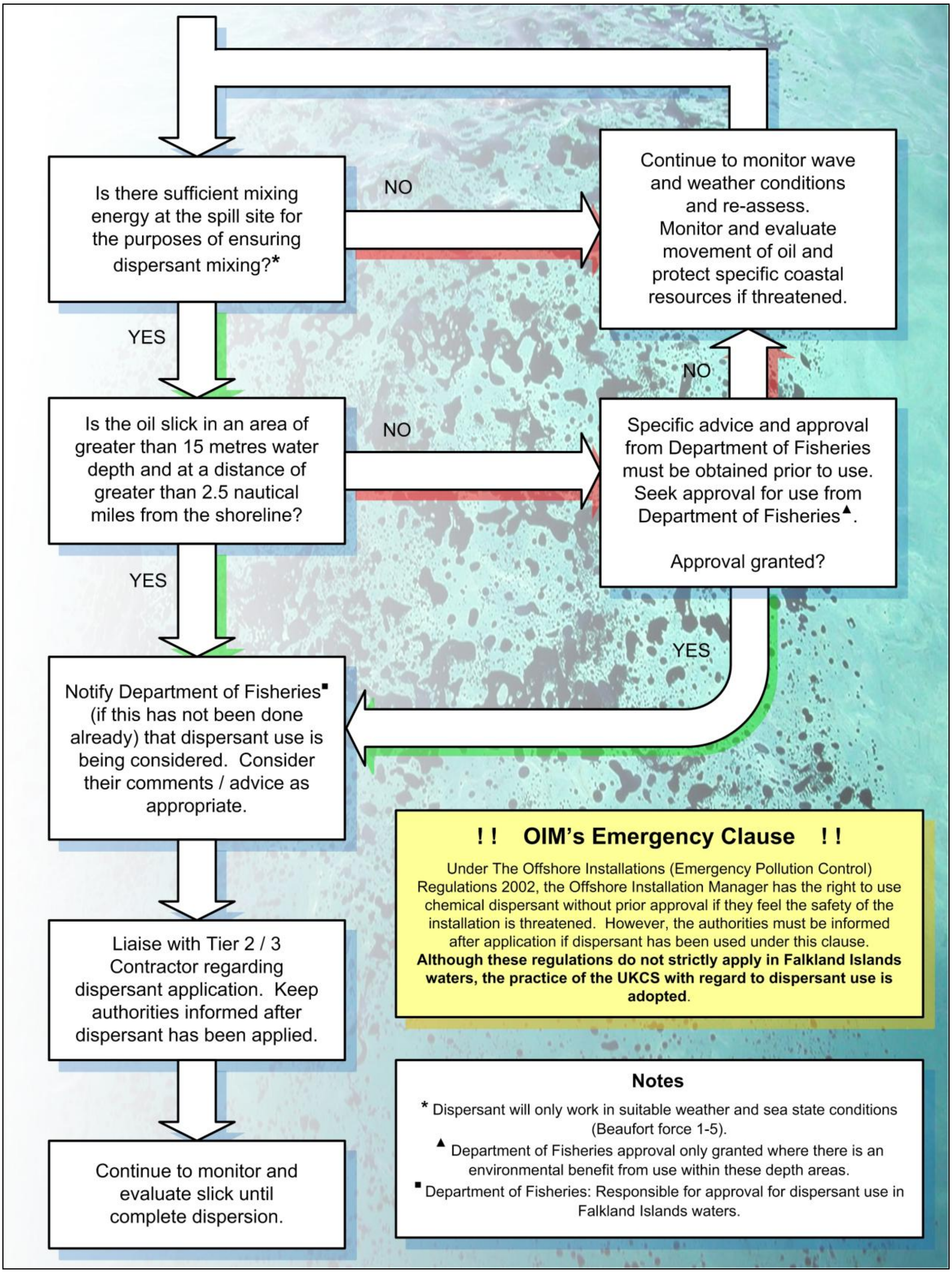


Table 6.2. FIG Policy on Oil Spill Response Strategies as per the NOSCP (FIG NOSCP)

<table>
<tr><th>Response Strategy</th><th>Aim</th><th>FIG Policy</th></tr>
<tr><td>Monitor & Evaluate</td><td>To locate and track the slick, estimate the amount spilled and the oil type, and predict where impact may occur.</td><td>Monitor and evaluate is the primary strategy for oil spills that pose no significant threat to the coastline or sensitive resources, as the normally high energy conditions will naturally break up the spill. It is recognised that it is essential to monitor the spill. Where surveillance from a vessel is insufficient, FIG will request that aerial surveillance is undertaken.</td></tr>
<tr><td>Containment & Recovery</td><td>To contain oil so that is can then be recovered from the sea surface.</td><td>Where feasible, containment and recovery is a primary response strategy for inshore waters.</td></tr>
<tr><td>Dispersant Application</td><td>To remove the spill from the sea surface and disperse the oil into the water column.</td><td>Where the application criteria are met and approval from the Fisheries Department is given, dispersant application is a primary response strategy. The application criteria is described below:
<table>
<tr><th>Amount of pollution to be dispersed</th><th>Minimum water depth (metres)</th><th>Minimum distance from shore (nautical miles)</th></tr>
<tr><td>Up to 10 tonnes of oil</td><td>5</td><td>0.5</td></tr>
<tr><td>Up to 100 tonnes of oil</td><td>10</td><td>1.0</td></tr>
<tr><td>Up to 1,000 tonnes of oil</td><td>15</td><td>2.5</td></tr>
<tr><td>Over 1,000 tonnes of oil</td><td colspan="2">FIG would consult with technical experts</td></tr>
</table>
</td></tr>
<tr><td>Shoreline Protection & Cleanup</td><td>To protect shorelines from impact and to recover any stranded oil.</td><td>To prioritise the most sensitive areas (highest Environmental Sensitivity Index (ESI)) that have suitable access and where there is presence of wildlife that may be at risk of oiling. Also, areas where there is heavy contamination and floating oil will be prioritised to limit further oil mobilisation and contamination.</td></tr>
<tr><td>Oiled Wildlife Response</td><td>To limit the impact of the oil spill on wildlife of the Falkland Islands and assist with the recovery of affected animals and improve survival rates.</td><td>Where animals are at risk, response measure will be employed to limit the impact. In the event of oiled wildlife the policy will be to capture and rehabilitate the animals wherever possible.</td></tr>
</table>

6.2 Selection of Strategy by Oil Type

Once the initial strategy has been selected a more reasoned, long term response strategy needs to be developed. The appropriate response will depend not only on the potential limitations of each of the possible response options but also on the type of oil spilt and the environmental sensitivities that are potentially threatened by the spill (Table 6.3).

Table 6.3. Response Strategy by Oil Type

Tier & Resources	Diesel/Aviation Fuel/Condensate	Persistent Oil (Crude, Hydraulic and Lube Oils)
1 (small spill) On site	Natural dispersion and monitoring (using support vessel). If safe to do so, agitate using standby vessel propeller ('prop-wash'). Chemical dispersion only if rig safety or environmental sensitivities are threatened following consultation with Department of Fisheries. In the event of an immediate threat to human health or the installation, OIM may use dispersant without prior permission.	Natural dispersion and monitoring. If safe to do so, agitate using standby vessel propeller ('prop-wash'). Mechanical recovery where possible. Chemical dispersion following consultation with Department of Fisheries. In the event of an immediate threat to human health or the installation, OIM may use dispersant without prior permission.
2/3 (medium/large spill) OSR	Natural dispersion and monitoring (aerial surveillance if required). Chemical dispersion only if rig safety or environmental sensitivities are threatened following consultation with Department of Fisheries. In the event of an immediate threat to human health or the installation, OIM can use dispersant without prior permission.	Continue to monitor and evaluate strategy – aerial surveillance. Aerial dispersant application likely to be primary response strategy – liaise with Tier 2/3 contractor. Consider mechanical recovery where possible. Consult OSR spill response technical advisor. Mobilise shoreline containment and recovery equipment if shoreline is threatened.

7 Response Resources

7.1 Oil Spill Response

The Operator has a contract for oil spill response operations with Oil Spill Response (OSR). The Operators are associate members of OSR and can call upon their resources to monitor and combat an oil spill as required for:

- Aerial surveillance;
- At sea/coastal containment and clean-up; and
- Aerial dispersant spraying.

All Tier 2/3 resources for combating a threat of oil pollution and mitigating its effects will be dealt with by OSR where it is feasible to mobilise equipment from OSR's Southampton base to a potential spill site.

7.2 Tiered Response

Details of the resources available are displayed below in Tables 7.1 and 7.2.

Table 7.1. Tier 1 Resources

TIER 1 OIL SPILL RESPONSE EQUIPMENT STOCKPILES		
RESPONSE RESOURCES	**EQUIPMENT & CAPABILITIES**	**MOBILISATION**
Standby Vessel	Quantification, Sampling and tracking Equipped with 4 m^3 of chemical dispersant and spray system, able to treat up to 80 tonnes of oil, with a contact rate of approximately 10 tonnes per hour.	Authorised by: OIM or Offshore Drilling Supervisor Activated by: OIM Response time: Immediate

Table 7.2. Tier 2 & 3 Resources

TIER 2 & 3, AERIAL SURVEILLANCE AND OIL SPILL RESPONSE EQUIPMENT.		
RESPONSE RESOURCE	**EQUIPMENT & CAPABILITIES**	**MOBILISATION**
Aerial Surveillance	Initial aerial surveillance provided by crew change helicopter and/or FIGAS aircraft (if made available). Aerial surveillance capability provided through OSR. Observer mobilised from UK and local aircraft chartered.	Authorised by: Operator's Drilling Superintendent Activated by: OSR Response times: Initial aerial surveillance – 4 hrs (local plane charter or use of FIGAS aircraft). OSR aircraft mobilisation time – 30 - 60 hours.
Offshore	Aerial dispersant application capability provided through OSR. Aircraft mobilised from United Kingdom. Dispersant stocks located at OSR Southampton base. Mobilisation time 30 - 60 hours. Specialist offshore oil recovery equipment available from OSR if required. Local offshore vessels chartered for offshore response.	Authorised by: Operator's Drilling Superintendent Activated by: OSR OSR aircraft and equipment mobilisation time – 30 - 60 hours (en-route within 1 hour)
Shoreline	Offshore, coastal and shoreline containment and recovery equipment together with oil spill response specialists mobilised from OSR.	Authorised by: Operator's Drilling Superintendent Activated by: OSR OSR aircraft and equipment mobilisation time – 30 - 60 hours. (en-route within 1 hour)

7.3 Mobilisation of Oil Spill Response

The method for mobilising OSR is by a single telephone call to **+44 2380 331551** on a 24 hour basis.

The initial call will be answered by the security front desk and the caller should request the duty manager and detail the nature of the incident.

The security officer will record some initial details, and the caller will then be contacted by the OSR Duty Manager within 10 minutes.

7.4 Response Forms

7.4.1 PON 8 Oil Spill Reporting Form

All reports of oil pollution at sea should be directed to The Department of Fisheries either by VHF radio or telephone immediately after observation and assessment. The Department of Mineral Resources should also be notified by telephone. Reports should be confirmed by a written (preferably faxed) report in the form of the PON 8 form (below).

Observers of spillage should not delay sending a report. If certain information is lacking this may be provided at a later date.

OIL SPILL REPORT FORM

To:	**Falkland Islands Government Fisheries Department** (for all incidents)			
	During office hours (08:00 – 16:30)	VHF Channels: 16 and 10 Telephone: + 500 27260/6 Fax: +500 27264/5 Email: director@fisheries.gov.fk or fishops@fisheries.gov.fk		
	Out of office hours	Call Fisheries Duty Officer as per monthly roster, or Marine Officer Home Telephone: +500 21867 Email: mjamieson@fisheries.gov.fk		
To:	**Department of Mineral Resources** (for incidents related to oil exploration)			
	Contact numbers	Telephone: +500 27322 Fax: +500 27321		
Or, to:	If unable to contact either of the above, contact the **Royal Falkland Islands Police**:			
	Contact numbers	Tel: +500 28100 Fax: +500 28110 Email: admin@police.gov.uk		
A	Date:	Time (local) pollution observed:		
B	Identity of observer / reporter:			
	Contact details:			
C	Name of installation / vessel:			
D	Latitude:		Longitude:	
E	Location of spill (for example 500m to NE of headland):			
F	Estimate of pollution extent:			Units:
G	Wind speed (knots):		Wind direction:	
H	Sea state (circle):	Calm Slight Moderate Rough Very Rough		
I	Name / type of oil:			
	API / S.G.:	Viscosity:	Pour Point:	Asphaltene:
	Other Properties:			
J	Source of Pollution:			
K	Cause of Pollution:			
L	Photos taken?:	Yes / No	Samples taken?	Yes / No

7.4.2 Request for OSR Aerial Surveillance

Form 4.2 – Surveillance Aircraft Deployment			
To Duty Manager +44 (0)2380 331 972 (Fax)			
From		Sender (Tick box)	
	Tel: +44 (0)2380 331 551		Date:
	Fax: +44(0)2380 331 972		
			Time:
URGENT Attention – Priority Fax			
Work Order No		SURV/ /01	

A) Mission requirement

i) Nature of incident ……………………………………………………………………………………………………

ii) Detail of slick (Length – Breadth) ………………………………………………………………………………

iii) Time of initial report (UTC) ……………………………………………………………………………………

iv) Tasking instructions

☐ Locate ☐ Investigate ☐ Report

B) Location

Latitude………

Longitude……

Installation name………………………………………………………………………………………………………

On-site contacts (if any) ……………………………………………………………………………………………

C) Weather

Wind direction and speed……………………………………………………………………………………………

Visibility………

Sea state……………………………………………… Other information………………………………………

D) Customer details – Report to be returned to :-

Contact details…………………………………………………………………

Authorised by (for customer) ………………………………………………

Authorised by For OSR

Signature Date _______________

Distribution: Copy – OSR
Copy – Customer
Copy – Spill file Version 1.0

7.4.3 Request form for OSR Aerial Dispersant Resource

Form 4.3 – Dispersant Aircraft Deployment

To Duty Manager – +44 (0)2380 331 972 (Fax)

From		Sender (Tick box)	
	Tel: +44 (0)2380 331 551		Date:
	Fax: +44 (0)2380 331 972		
			Time:

URGENT Attention - Priority Fax

Work Order No.	DISP/ /01

A) Mission Requirement

1) Mobilise ADDS Pack/Nimbus dispersant spray system from Southampton

2) Mobilise additional dispersant stocks via jet from Southampton Yes / No* (Delete as appropriate)

3) Deploy to site

4) Dispersant release agreed with Authorities Yes / No* (Delete as appropriate)

(If no further advice must be sought from operator response team)

B) Oil Type To Be Treated & Dispersant Type

C) Location

Latitude:

Longitude:

Installation Name (if known)

D) Customer contact reference

Authorised by (for customer) ……………………………………………………

Authorised by For OSR

Signature Date _______________

Distribution: Copy – OSR

Copy – Customer

Copy – Spill file

7.4.4 Aerial Surveillance Observers Log

Survey Details

Incident	Date	Observers		
Aircraft Type	Call Sign	Area of Survey		
Survey Start Time	Survey End Time	Average Altitude	Remote Sensing Used	

Weather Conditions

Wind Speed (knots)	Wind Direction
Cloud Base (feet)	Visibility (nm)
Time High Water	Time Low Water
Current Speed (knots)	Current Direction

Slick Details

Slick Grid Parameters by Lat/Long				Slick Grid Parameters by Air Speed		Slick Grid Dimensions	
Length Axis		Width Axis		Length Axis	Width Axis	Length	Nm
Start Latitude		Start Latitude		Time (seconds)	Time (seconds)	Width	Nm
Start Longitude		Start Longitude				Length	Km
End Latitude		End Latitude		Air Speed (knots)	Air Speed (knots)	Width	Km
End Longitude		End Longitude				Length	Km
						Total Grid Area	Km^2

Oil code	**Colour**	**% cover observed**	**Total grid area**	**Area per oil code**	**Factor**	**Oil volume**			
						Min		Max	m^3
0	Clean		Km^2	Km^2	0 m^3/km^2		-		m^3
1	Silver		Km^2	Km^2	0.04 - 0.3 m^3/km^2		-		m^3
2	Rainbow		Km^2	Km^2	0.3 – 5 m^3/km^2		-		m^3
3	Metallic		Km^2	Km^2	5 - 50 m^3/km^2		-		m^3
4	Discontinuous True Colour		Km^2	Km^2	50 - 200 m^3/km^2		-		m^3
5	Continuous True Colour		Km^2	Km^2	200 - <200 m^3/km^2		-		m^3

7.4.5 Falklands Department of Fisheries - Required Information for Dispersant Use

The UK Marine Management Organisation (MMO) has published on its internet web site a list of the latest chemical dispersants approved for use on the UK Continental Shelf. Although the regulations do not cover the Falkland Islands out-with territorial waters, the list of dispersant provided by the MMO has been considered fit for use offshore the Falkland Islands by FIG Department of Fisheries in the event of an oil spill:

http://www.marinemanagement.org.uk/protecting/pollution/documents/approval_approved_products.pdf.

Prior to dispersant application, the following information is required by the FIG Department of Fisheries:

THIS TABLE PROVIDES A CHECKLIST OF THE INFORMATION TO ASSIST THE DEPARTMENT OF FISHERIES OFFICIALS WHEN APPROVAL FOR THE USE OF CHEMICAL DISPERSANT IS SOUGHT.
Name of authority or organisation requiring approval.
Name of contact, telephone and fax number to be used.
Locality of spill – (in degrees of Latitude and Longitude).
Oil type or description of appearance if not known. If crude oil, what type?
Volume of oil spilled – preferably in tonnes.
Source of oil spill.
Potential for further spillage.
Description of slick – including dimensions and colour.
Volume and name of dispersant for which approval is requested.
Other methods of response being applied or considered and assistance being sought (e.g. OSR).
Local fisheries consideration (such as seasonal fisheries, advice given to fishermen).
Local wildlife considerations, e.g. whether migrant birds are present.
Tide, type and speed and time of HW/LW particularly.
Wind and weather (e.g. ‘Moderate breeze NW’ or ‘Overcast drizzle’).
State of Seas.

7.4.6 Department of Fisheries - Notification Following Use of Dispersant

The following information is required by FIG Department of Fisheries following the use of dispersant:

DEPT. of FISHERIES FAX NUMBER : 27265/4*   **SENT BY:**
Incident no.
Volume and type of oil
Location
Remedial action taken
Name and type of oil treatment product
Date of manufacture
Efficacy last tested (if applicable)
Comments on effectiveness
Report made by
Other remarks

* - If calling from outside the Falkland Islands, first dial: 00 500.

7.4.7 OSR Oil Spill Response Resources

OSR Oil Spill Response Equipment			
Load	**Principal Use**	**Equipment**	**Quantity**
OSR 2	Dispersant supply for ADDS pack.	Bulk Road Tanker loaded with 22,500 litres of dispersant (Slickgone NS)	1
OSR 3	Aerial Application System for Type 3 Dispersant.	ADDS Pack System (for installation into Lockheed 382-G)	1
OSR 4	At Sea Containment / Recovery of medium crude oils.	Weir Boom System	1
		Reserve Power Pack	1
		Fassi Crane	1
		VHF	1
		Radio Box	1
OSR 5	Shoreline Protection (standard supplement).	Sea Sentinel Boom 20 metres	16
		Sea Sentinel Boom 10 metres	10
		Shore Guardian Boom 20 metres	16
		Shore Guardian Boom 10 metres	16
		Air Fan and Water Pump box	3
		Komara 12K Skimmer	2
		Vacuum System	1
		Portable Buildings	2
		Fastanks	8
		Spate Pumps	3
		Decon + HR kit	1
OSR 6	At Sea Containment / Recovery of medium crude to medium fuel oils.	Ro-skim System (350 metres)	1
		Ro-skim Pump for tandem operation	1
		DS250 Skimmer System	1
		Oleophillic attachment for DS250	1
		Sea Sentinel Boom Extension (130 metres)	1
		Air Fan	1
		Upgrade Power Pack including air fan	1
		Deutz Power Pack	1
		GT185 skimmer	1
		Termite Weir Skimmers and Pumps	2
		Roto-drum Heavy Oil Skimmer	1
		50 T Lancer Barge	1
		Hose Reels	2
OSR 7	Typically for containment / recovery of medium to heavy crudes to medium fuel oils.	Egmopol Oil Recovery Barge	1

OSR Oil Spill Response Equipment			
Load	**Principal Use**	**Equipment**	**Quantity**
OSR 8	Shoreline Protection (standard supplement).	Sea Sentinel boom 20metres	24
		Shore Guardian boom 20 metres	6
		Anchors 30 kilogrammes	10
		Tripping Buoys (40)	1
		Air Fan & Water Pump box	1
		Chain Stillage	1
		Boom Support Stillage	1
		Stake box	1
		Generator & Lights	1
		Komara 12K Skimmer	2
		Powervac	1
		Peristaltic Pump	1
		Fastank	4
		All Terrain Vehicle (ATV)	1
OSR 9	Shoreline Protection Equipment (heavy oil supplement).	Sea Sentinel boom 20 metres	40
		Sea Sentinel boom 10 metres	20
		Shore Guardian boom 12 metres	20
		Shore Guardian boom 10 metres	10
		Anchors (10 x 30 kilogrammes)	6
		Tripping Buoys (40)	3
		Air Fan & Pump box	4
		Chain Stillage	3
		Boom Support Stillage	2
		Stake box	3
		Generator & Lights	1
		Komara 12K Skimmer	2
		Powervac	2
		Peristaltic Pump	1
		Fastank	6
		GT 185 Skimmer System	1
		Trimspeed Pressure Washer	1
OSR 10	Aerial Application System for Type 3 Dispersant.	NIMBUS Airborne Dispersant Delivery System	1

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8 Training & Exercises

8.1 Oil Spill Response Training

It is the Operator's intent to maintain the capability for a rapid and effective response to a spillage of oil during its offshore operations. Key offshore and onshore personnel responsible for managing the response to an oil spill will receive appropriate training prior to commencement of drilling operations. This will include rig personnel, supply vessel personnel, members of the OERT in Stanley, the AGR ERT in Aberdeen, the Diamond Offshore IST in Aberdeen and the Operator's CMT. This will facilitate a good understanding of oil spill equipment and strategies throughout the emergency response structure such that robust support can be provided and sound decisions can be made in the event of a spill.

Specific training involves familiarisation with this OSCP. The objective is that the personnel required to respond in the event of a spill fully understand their particular responsibilities, as well as be familiar with the OSCP as a whole.

The Operator will familiarise contractors on the content of this OSCP and their expected actions prior to the commencement of operations. This will be achieved via bridging documentation, pre-mobilisation meetings, drills and by pre-tour inductions for rig personnel.

8.2 Exercises & Drills

There will be regular exercises wherein the OSCP as a whole is tested for a Tier 1, Tier 2 or Tier 3 oil spill, to familiarise personnel with, particularly, the interfacing requirements between organisations and in co-ordination of the response as a whole.

The Operator will ensure that:

- A desktop exercise and communications test is conducted prior to spud to ensure that lines of communication are clear and that all contact details are verified as correct;
- All drilling rig crew take part in at least one environmental spill exercise;
- There is a pre-spud exercise for each drilling programme to test communications between the rig, AGR, Diamond Offshore, the Operator, Government Bodies, OSR, other principle contractors and relevant third parties;
- Offshore deployment of Tier 1 dispersant spraying equipment from the safety standby vessel is conducted prior to spud and monthly thereafter; and
- The oil spill response contractor can demonstrate that they have completed relevant equipment deployment exercises within the last five years.

Table 8.1 displays the minimum exercise requirements as stipulated by the UK Department of Energy and Climate Change (DECC). The Falkland Islands NOSCP states that the DECC Oil Spill Training Guidelines for the UK Offshore Oil Industry (April 2009) is a suitable programme approved by FIG. The Operator will ensure that these requirements are met as a minimum.

Table 8.1. Minimum Oil Pollution Incident Response Exercise Requirements (based on DECC UKCS Standards, April 2009)

Type of Exercise	Frequency	Aim
Offshore OSCP Exercise	1 per shift per year per location	The aim of this exercise is to ensure that offshore personnel are familiar with their OSCP and associated responsibilities. The scenario chosen must activate and test response in accordance with the OSCP.
Offshore Deployment of Tier 1 Dispersant Spraying Equipment (if identified for use under Tier 1 response)	Monthly	If included in the OSCP as part of a potential response strategy Tier 1 dispersant spraying equipment must be tested at monthly intervals or in accordance with manufacturers guidance if available. Note it is the spraying equipment which must be tested, NOT the dispersant.
Offshore Deployment of Tier 1 Oil Recovery Equipment (if identified for use under Tier 1 response)	1 Per Year	If included in the OSCP as part of a response strategy, Tier 1 oil recovery equipment must be tested and deployed annually.
Onshore ERC Installations and Procedures Associated with OSCP Response	1 Per Year	The aim of this exercise is to ensure that all personnel involved with pollution response are familiar with their OSCP and associated responsibilities. The scenario chosen must be realistic, leading to activation and therefore testing of the OSCP to at least a Tier 2 level. This must involve exercising the communication interfaces between onshore and offshore response teams and include any contracted response provider. This exercise may be planned in conjunction with and instigated by an offshore OSCP exercise. As a minimum this must be tested annually. If exercises are combined with a safety exercise, the scenario chosen must meet the above requirements.
Industry Deployment of Tier 2/3 Oil Spill Response Equipment (to test Tier 2/3 Contractors)	5 Yearly (takes place on the UKCS)	Operators must ensure that their Tier 2/3 oil response equipment and resources are tested and deployed every five years. It is recognised that many operators utilise the same response company and therefore each response company need only be tested once in every five years on behalf of each operator holding a contract with them. Results will be collated by the operator undertaking the exercise and feedback and learning will be shared with other operators contracted to the same response company. FIG must be made aware of exercises taking place and be provided with a copy of the final exercise report.

8.3 Recording of Exercises

A record of all exercises undertaken by the operator must be maintained at the location where the exercise was conducted, either onshore or offshore. Records should include the exercise scenario; aims of the exercise; lessons learnt and actions put in place in response to lessons learnt. Records must be retained for five years and be made available to relevant Offshore Environmental Inspectors during inspections or exercises.

9 Legal Framework

9.1 Regulatory Regime

The Falkland Islands are a dependent territory of the UK; with the key legislation based or adopted from United Kingdom Acts of Parliament or Statutory Instruments.

The principal regulations defining the requirements for Oil Spill Contingency Plans in the Falkland Islands are as shown in Table 9.1.

Table 9.1. Legislation Defining Requirements for Oil Spill Contingency Plans in the Falkland Islands

Legislation Relevant to Offshore Operations	Key Requirements / Relevance to Proposed Operations
Offshore Minerals Ordinance 1994	The licensing framework for offshore exploration and production. Regulates offshore installations and pipelines, offshore health and safety, oil pollution, liability for environmental damage, and abandonment. Production Licences are issued under this Ordinance. Imposes strict liability in respect of pollution caused by oil exploration activities. It is a standard condition of licences issued that oil operators must have an oil spill contingency plan in place. A further standard licence condition requires any licensee to give notice to the Falkland Islands Government (FIG) of any event causing escape or waste of oil.
Marine Environment Protection Ordinance 1995	Implements the conditions of the London Dumping Convention 1972 and prohibits, other than under license, the deposition or incineration of materials in Falkland Islands' waters. Is a system of licensing and licence offences with strict liability for certain loss or damage in relation to polluting incidents. The Deposits in the Sea (Exemptions) Order 1995, as approved under the Marine Environment Protection Ordinance, specifies categories of material exempt from requiring a licence for deposition. Includes sewage or domestic waste discharge from a vessel or platform, drill cuttings or muds under specific circumstances and the incineration of hydrocarbons.
Food and Environment Protection Act (FEPA) 1985	Part II of FEPA 1985 applies in the Falkland Islands by virtue of the Environment Protection (Overseas Territories) Order 1988 (As amended).
Petroleum Operations Notice No.8	FIG has introduced a range of petroleum operations notices (PONs). PON8 specifies reporting requirements in the event of an oil spill, guidance on the use of dispersants and provides contact numbers and reporting forms to use in case of oil pollution.

UK Statutory Instruments made under the Merchant Shipping Acts give effect to Falkland Islands obligations under MARPOL 73/78 (Annex IV of MARPOL 73/78 does not apply). MARPOL requires vessels to have Ship Board Oil Pollution Emergency Plans (SOPEPs).

The 1994 Offshore Minerals Ordinance imposes strict liability in respect of pollution caused by oil exploration or exploitation activities. It is a standard condition of licences issued that oil operators must have an oil spill contingency plan in place. A further standard licence condition requires any licencee to give notice to the Falkland Islands Government (FIG) of any event causing escape or waste of oil.

The use of dispersants by operators dealing with an oil pollution incident is controlled by the Food and Environment Protection Act 1985, Part II of which applies in the Falkland Islands by virtue of the Environment Protection (Overseas Territories) Order 1988.

The UK has ratified the Convention on Oil Pollution Preparedness, Response Co-operation (OPRC Convention), and has implemented its requirements in the UK through The Merchant Shipping (Oil Pollution Preparedness, Response Co-operation Convention)

Regulations 1998 (OPRC Regulations). These regulations require Oil Pollution Emergency Plans (OPEPs) to be in place for all oil and gas operations on the UK Continental Shelf (UKCS). FIG, however, has expressed a preference for the term ‘Oil Spill Contingency Plan’ (OSCP), and hence the term OSCP has been used in this plan.

Although the OPRC Convention has not been officially implemented by the Falkland Islands, there are a number of elements of the Convention that have been implemented. These elements include the establishment of the Falkland Islands Government National Oil Spill Contingency Plan (NOSCP), a national system for reporting oil spill incidents, an authority responsible for oil spills (the Department of Fisheries) and a stockpile of oil spill response equipment.

In light of the above implementation by FIG, this plan is therefore written in accordance with the OPRC Regulations, although these regulations do not strictly apply in Falkland Islands waters.

9.2 Statutory Authorities Roles & Responsibilities

Department of Mineral Resources

Regulates all petroleum exploration, development and production activities in the Falkland Islands.

Department of Fisheries

The Department of Fisheries is the FIG Lead Agency for national oil pollution planning and response on behalf of the Department of Mineral Resources, the regulator.

The Department of Fisheries:

- Maintains the National Oil Spill Contingency Plan (NOSCP);
- Acts as the National authority for receiving oil spill reports and;
- Co-ordinates the response to marine emergencies including oil spills.

Attorney General’s Chambers

The Attorney General’s Chambers provide advice on the details of the current legal framework regarding oil pollution.

Collector of Customs

The Collector of Customs is the Receiver of Wrecks and has duties which are laid out in the Major Incident Plan.

Environmental Planning Department

The Environmental Planning Department was formed in 1997 to provide a structure and framework for possible future developments on the Islands, paying particular attention to environmental sensitivities and their protection.

Departmental objectives include the mapping of environmentally sensitive areas, their status and vulnerability. This involves the collation of existing data and the identification of gaps which may need addressing through surveys. A review of existing environmental legislation is also intended.

Regarding oil spill planning and response, the Department is likely to play a significant role in:

- the provision of environmental data in support of that included in this plan, and;
- helping scope environmental surveys and monitoring, either as baseline or in response to a pollution incident to assess impact and follow recovery.

FIDF

The Falkland Islands Defence Force (FIDF) has the capability of calling on volunteers with access to overland transport and communications. There are also links with the military to allow requests for helicopters.

FIGAS

The Falkland Islands Government Air Service (FIGAS) has five Britten Norman Islander aircraft, two of which are equipped for prolonged flying over sea. These aircraft have a range of 8 hours at 120 knots, although these are normally limited to 6 hours. One of these aircraft is likely to be available at short notice to support spill surveillance and assessment, although it cannot be fully guaranteed that it will be available at any given time.

Fire Service

The Fire and Rescue Service has water pumping capability, although personnel may be unable to attend a spill outside Stanley because of their fire fighting commitment.

Public Works Department

The Public Works Department (PWD) will be able to supply limited personnel, transport and civil plant to support any shoreline operations. The personnel will have to be redeployed from other duties and therefore availability and mobilisation times will vary.

Royal Falkland Islands Police

The Police have a central role within the Emergency Services Major Incident Plan. For the purposes of pollution control, as co-ordinated by The Department of Fisheries, the Police would be able to assist with out of hours call-outs of other agencies.

The Agriculture Department

Possess knowledge of livestock coastal grazing areas and land ownership. Also employ veterinary expertise which may be useful in dealing with oiled wildlife. The department also has access to a small scale oiled animal and bird cleaning facility.

9.3 Other Support Agencies

BFSAI

The British Forces South Atlantic Islands (BFSAI) military maintains a significant presence in the Islands, including the operation of MPA. If the airport is needed for civilian purposes associated with an oil spill response then this should pose no difficulties. This includes access to and use of the airstrip and possible cargo handling support.

Further assistance may be available depending on the military's operational commitments. This could include use of personnel, their specialised pollution control equipment and tugs / other vessels.

Falklands Conservation

Falklands Conservation are a non profit making organisation part-funded by FIG; they have expertise and knowledge regarding environmental sensitivities. This includes information concerning habitats, marine mammals and seabirds.

Although not a FIG department they would be expected to work closely with any spill response effort though the provision of advice and information.

UK Maritime & Coastguard Agency, Counter-Pollution Unit (CPU)

MCA CPU is the UK's Lead Agency for shipping related marine oil spills and the Unit maintains the UK National Oil Pollution Emergency Plan. Advice may be available from

MCA CPU in the event of FIG resources becoming over-stretched during an oil spill response. However, resources of the MCA CPU are limited and it should be understood that their first concern is for UK waters. It is not considered that equipment support will be available from MCA CPU.

9.4 Interfaces with National Contingency Plans and Others

National Oil Spill Contingency Plan (NOSCP)

The National Oil Spill Contingency Plan (NOSCP) has been developed by the FIG Government and sets out the arrangements for dealing with spillage of oil in Falkland Islands waters. The plan involves a number of organisations from the Government and private industry. The NOSCP interfaces with Oil Operator's OSCP's as shown in Figure 1.1 in Section 1.2.

The Department of Fisheries is the organisation responsible for implementing the NOSCP. Within the framework of the NOSCP, the FIG marine Officer will activate the Incident Command Team (ICT) to oversee the spill response. The responsibility for oil spill clean-up rests with the Licence Operator.

The NOSCP should be used in conjunction with the **Falkland Islands Emergency Services Major Incident Plan**, which outlines actions to be taken in the event of incidents involving:

- Fire;
- Explosion;
- Threat to human life / casualties;
- Shipwreck / vessel abandonment.

Major incidents may require a co-ordinated response from Police, Fire Service, Medical Teams, Maritime Authorities, the Military and others. Pollution countermeasures are likely to be a lesser priority than life saving, fire fighting and salvage attempts.

Industry Plans

This OSCP interfaces with the following plans, as appropriate for the planned operations:

- Shipboard Oil Pollution Emergency Plan (SOPEP) for each vessel; and
- Bridging/interface documents between the Operator and its third party contractors.

The interaction of these plans in relation to potential oil spill size is shown in Figure 9.1.

Figure 9.1. Interaction of Contingency Plans

INCREASING SIZE OF SPILL AND POTENTIAL CONSEQUENCES →

Tier 1 Spill	Tier 2 Spill	Tier 3 Spill
Operator's OSCP in force from the time the rig is fixed/moored on location.		
Shipboard Oil Pollution Emergency Plan (SOPEP) carried by each vessel and in force prior to and following the time the rig is fixed/moored on location. Operator's Oil Spill Plan is in force for the duration of operations on location.		
National Oil Spill Contingency Plan (NOSCP) provides for the monitoring of all offshore oil spill incidents via the PON8 system.		

Note: an explanation of Spill Tier categories is provided in Section 6.2.

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10 North Falkland Basin Drilling Area Risk Assessment

This section identifies the type and size of oil spill that the Operator's oil spill response arrangements may have to cope with. It looks at the generic likelihood of spills that could occur from typical operations, gives an overview of the potential 'operational' and 'worst case' scenarios, the fate of the oils involved and the risk of this to the environment.

The Operator's oil spill response arrangements are based on this information, together with the statutory requirements prescribed by the UK Department of Energy and Climate Change (DECC).

The severity of effects from an oil spill are dependent on a very wide range of factors including:

- Volume of oil spilled;
- Physical and chemical nature of the oil;
- Location of spill and proximity of shoreline or other sensitivities;
- Weather and sea state conditions during and following the spill;
- Hydrographic conditions;
- Time of year;
- Time of day.

Given this variety of factors, accurate predictions of effects before a spill are difficult to make. However in spill contingency planning, consideration of environmental resources potentially affected by a spill in conjunction with the results of trajectory modelling allows the identification of likely response options and resource needs. Rapid access to information on the environmental conditions and features is essential in actual or simulated oil spill response.

10.1 Likelihood of an Oil Spill Occurring

The likelihood of an oil spill from a particular operation can be estimated from analysis of historic spills under similar conditions. As there is no data for the Falklands environment with regard to historic oil spills offshore, data is largely drawn from a report published by Oil and Gas UK '*Report on the Analysis of DECC UKCS Oil Spill Data for the period 1975-2005*.' The report uses historical DTI oil spill data (1975-1997), historical DTI PON1 (the equivalent of the Falklands PON8 Oil Spill Report Pro-forma) spreadsheets (1998-2005) and field information from the Brown Book, BERR/DECC websites and OPL Field Development Guide.

The likelihood of an oil spill occurring on the UKCS has increased over the period 1975 to 2005, as has the oil and gas activity. However, if the number of oil spills is normalised against the number of fields, the frequency of spills is seen to level off to approximately 1.5 spills per field (refer to Figure 10.1).

Figure 10.1. Number of Spills and Spill Amounts Normalised by the Number of Fields in Production (UKOOA, 2006)

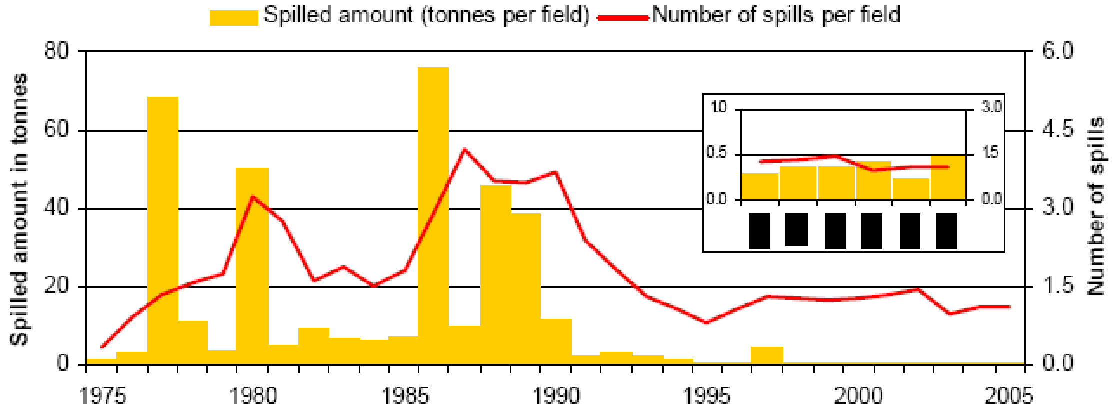
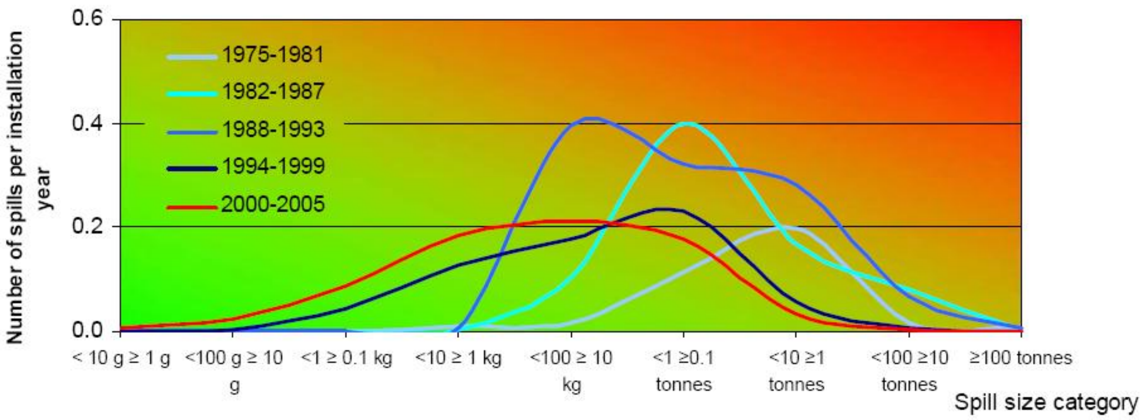


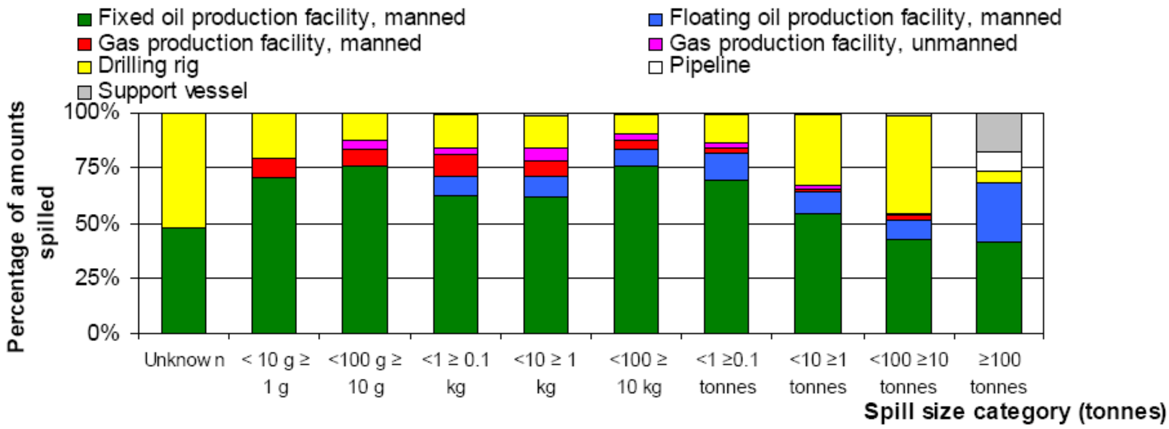
Figure 10.1 also indicates that the quantity of oil spilled has decreased greatly during the 1990s. The Oil and Gas UK report (*UKOOA, 2006*) suggests this may be due to improved environmental management. The decrease in spill volume in recent years on the UKCS is also highlighted by Figure 10.2, which shows that the distribution of spill sizes has shifted toward smaller volumes, with the most common spill size being between 0.1 tonnes and 1 tonne. There are also a significant number of spills between 0.0001 tonnes and 0.01 tonnes. This shift may be due to changes in reporting requirements; however it is reasonable to conclude from this data that spills of one tonne or less are the most likely.

Figure 10.2. Distribution of Spill Size and Likelihood (Normalised per Field) (UKOOA, 2006)



Large spills have become increasingly uncommon and Figure 10.2 indicates that this frequency has been close to zero in recent years. However, it can also be seen from Figure 10.3 that spills from drilling rigs make a significant contribution to those very large spills that do occur.

Figure 10.3. Distribution of Spill Size and Likelihood (Normalised per Topsides) (UKOOA, 2006)



Two scenarios that could result in a large spill from an exploration or appraisal well are:

- An incident, such as collision, resulting in loss of containment, or
- A loss of well control when drilling in a hydrocarbon bearing formation.

10.1.1 Vessel Collision

An incident, such as a collision, could potentially result in the entire inventory of hydrocarbons stored on the MODU potentially being released to the sea. To serve as an example, for MODUs in the North Sea between 1980 and 1997, a total loss accident frequency of 3.75 occurrences per 1,000 unit years was recorded (*WOAD, 1998*). For MODU's worldwide during the same period, a total loss accident frequency of 2.78 occurrences per 1,000 unit years was recorded (*WOAD, 1998*). Table 10.1 also presents worldwide release statistics for MODU's in terms of the type of release and the release size.

Table 10.1. Type and Size of Pollution Releases from MODU's Worldwide for the period 1980-1997 (World Offshore Accident Databank, 1998)

	Release Size						
Type of release	**Small (0-9 tonnes)**	**Minor (10-100 tonnes)**	**Significant (100-1,000 tonnes)**	**Large (1,000-10,000)**	**Very Large (>10,000)**	**Un-known**	**Total**
Crude oil	6	-	2	-	-	5	13
Oil and gas	9	-	1	2	5	13	30
Gas	43	-	3	2	1	60	109
Light oil	37	7	3	-	-	4	51
Chemicals	5	1	-	-	-	1	7
Other	8	1	-	-	-	-	9
Total	108	9	9	4	6	83	219

If a collision between vessels involved in the operations, or with a third party vessel, was to occur, the vessels' inventories of diesel could potentially be released to the sea. In practice it is most likely that any release of hydrocarbons would occur over a period of time. An immediate release could, however, occur in the unlikely event that all compartment/tanks containing hydrocarbons were instantaneously fractured in some way.

10.1.2 Uncontrolled Well Flow

Uncontrolled well flow can be caused by the formation pressures encountered being higher than the hydrostatic pressure exerted either by the drilling mud column or of the sea water. Typically this situation can be encountered in shallow gas pockets or in deeper over pressured formations. Over pressured gas can be exceptionally dangerous due to its expansion as it rises to surface, which can result in explosions and fires. Oil can also be over pressured, but liquid hydrocarbons expand far less than a gas as they rise to the surface. However, in an uncontrolled well flow situation, oil causes considerably more pollution.

Incidents such as the Macondo exploration well blow-out in the US Gulf of Mexico and the Montara Platform wellhead blow-out off the northern coast of Western Australia in 2009 have served as an unfortunate reminder to the global offshore oil and gas industry to the possibility of serious blow out situations occurring. However, it should be noted that despite these recent events, blow-outs are still extremely rare.

In response to the above two incidents, the International Association of Oil & Gas Producers (OGP) established the Global Industry Response Group (GIRG) to identify, learn from and apply the lessons of Macondo, Montara and similar well accidents (*OGP, 2011*). This joint industry review process incorporated three main teams, focusing on prevention, intervention and response. Of particular relevance is the output of the Well Engineering Design & Equipment/Operating Procedures Team, which focused specifically on incident prevention. Following the review process, the following general industry-wide recommendations were made on incident prevention:

- Creation of a new, permanent, OGP Wells Expert Committee;
- Introduction of a 3-tier review process;
- The promotion of human competency management systems to ensure individual staff and management teams always have the skills they need;
- The promotion of a culture that fosters adherence to standards and procedures;
- Recognition of existing internationally and nationally agreed standards as a baseline for industry improvements;
- New and improved technical and operational practices for the overall governance of well construction;
- Recommend to industry and regulators that a “two (independent and physical) barrier” policy is in place during the life of a well (during the drilling, completion, and abandonment phases of a well, BOP to be regarded as a barrier for the purposes of such a policy).

Despite their rarity and unlikely event of occurrence, very large spills resulting from blow-outs cannot be ruled out and as such, as a contingency for planning purposes, a worst case scenario for all wells is modelled, conservatively assumed to be uncontrolled open hole flow (blow-out) over a period of 10 days. The same scenario is also commonly run for a 48 hour period, and the results of the two (10 day and 48 hour models) compared.

The choice of a 10 day release is based on the recommendation of the UK Department of Energy and Climate Change (DECC) for the modelling of blow-out scenarios.

Worst case oil spill scenarios have been modelled and are included in Appendix A of this document.

In addition, the Operator spends considerable time and resources investigating the area of blow-out contingency. This contingency is discussed in detail in **Section 11.0**.

10.2 Possible Spill Scenarios

The potential spill scenarios are dictated by the oil and fuel inventories on the drilling rig and associated vessels and, once the pay zone has been penetrated, by the reservoir characteristics. Small spills can occur during the operation of the drilling rig for a number of reasons and the worst case scenarios are determined by both the total inventory of the rig and the reservoir characteristics. In practice, due to precautions such as training, operating procedures and engineered solutions, the majority of oil spills are small, with a low number of larger spills. The types of oil and typical cause of spill are summarised in Table 10.2 and the inventory of the drilling rig and reservoir characteristics are shown in Table 10.3.

Although low toxicity oil based mud (LTOBM) is presented in Tables 10.2 and 10.3 as a risk element, it should be noted that the use of LTOBM is not planned for use by any of the Operators in the North Falkland Basin.

Table 10.2. Typical Initiating Events that can Result in Oil Spills – Drilling Phase

	Initiating Event
1	Reservoir blow-out before or after installation of BOP releasing reservoir hydrocarbons
2	Reservoir blow-out during well completion releasing reservoir hydrocarbons
3	Loss of diesel or fuel oil containment during transfer or due to leakage
4	Loss of lubricating oil containment during transfer or due to leakage
5	Loss of hydraulic oil containment during transfer or due to leakage
6	Loss of LTOBM, if carried/used on the drilling rig during transfer or due to leakage
7	Loss of hydraulic fluid from control equipment due to leakage

Table 10.3. 'Inventory of Oils' of a Typical Rig and Exploration Well

Type of Oil	Maximum Quantity	Comments
Diesel	Approx. 1,100 tonnes - semi-submersible rig.	Used as fuel on rig and/or support vessel
Lube oil & hydraulic oil	10 + 10 tonnes	Hydraulic oil volumes vary depending on work in progress, assumed here to be equal volume to lube oil. Hydraulic oil drums are commonly stored on deck.
Reservoir hydrocarbons	Based on maximum theoretical open hole flow rates.	Viscosity and behaviour estimates based on anticipated API.
LTOBM	100 tonnes	Mud containing an oil component, if carried on the rig or used in the field.

10.3 Spill Prevention & Mitigation

10.3.1 Policy & Training

It is the Operator's policy that operations will be conducted in such a manner as to minimise the risk of oil spillage and pollution.

Onshore efforts in operations planning are subjected to review to identify potential risks and to ensure that they are properly controlled. These include:

- Programme review meetings (involving all relevant contractors);
- Pre-spud and pre-job (drilling) meetings to review the final programme in detail; and

- Hazard and risk identification to test the programme for likelihood and severity of all identified risks.

The Operator will facilitate that appropriate oil spill response training is undertaken by key personnel (refer to Section 8.0). The Operator fully recognises that spills can and do occur and takes the following precautions to reduce the possibility of a spill occurring.

10.3.2 Well Kick

In the unlikely event that a well kick does occur the well would be shut in using the blow-out preventer (BOP). Training is carried out to ensure that the correct actions are taken on the rig in the event of a well kick and these will be in accordance with Diamond Offshore's Well Control Procedures or as otherwise specified in the Operator's bridging documents.

10.3.3 Hydrocarbon Spills

The five main sources of potential spills, from historical oil spill records are listed in Table 10.4 with the measures being taken by the Operator to minimise or eliminate the risks. These are discussed further in the sections below along with measures proposed by the Operator in the unlikely event that a spill does occur.

Table 10.4. Sources of Oil Spills and Control Measures Planned

Potential Source of Spill	Risk and Control Measures Taken
Oil based mud	Wells drilled entirely using WBM where practicable.
Unburnt hydrocarbons during testing	Wells would normally be tested using high efficiency burners with procedures in place to shut in well immediately if any problems are encountered.
Fuel or other utility fluids (e.g. diesel, lubricants)	Where practicable, re-fuelling will only commence during daylight 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 drilling rig.
Loss of rig (ship collision)	Safety stand-by vessel will monitor shipping activities and patrol the 500 metre safety exclusion zone. Notification of planned drilling programme with all relevant maritime and fishing authorities.
Loss of well control	Precautions to prevent loss of well control include analysis of existing shallow seismic and 3D seismic to identify shallow gas hazards, appropriate well design and engineering, well monitoring programme, blow-out preventer, well control training and emergency drills.

Re-fuelling and transfer of crude for well testing

The Operator will ensure that bunkering and crude transfer activities only commence during daylight hours where possible and in favourable weather conditions. Non-return valves will be installed on fuel transfer hoses and operations will be supervised at all times from the supply boat and the drilling rig. The Operator will ensure that the rig crew are trained and regularly hold exercises to contain and clean up deck spills and safely store contaminated material until their ultimate disposal onshore. Training records will be held on board the drilling rig.

Drop-out During Well Testing

If testing operations are conducted, a proven clean-up package and high efficiency green burners will be used. The flare will only be ignited during daylight hours. A station watcher(s) will monitor potential flare liquid drop out and raise the alarm should this occur. If liquid drop out is observed, flaring operations will be suspended. Surrounding sea areas will be monitored for presence of high numbers of seabirds.

Loss of Rig Inventory

The safety standby vessel will monitor approaching shipping by radar, patrol the 500 metre safety exclusion zone around the rig and warn off approaching vessels prior to them entering the safety exclusion zone. Notification of the presence and location of a drilling rig will be made to all the relevant maritime authorities in advance of the commencement of operations.

Loss of Well Control

Many precautions are taken to prevent a well blowout from occurring including shallow gas survey, well design and engineering, mud programme, well monitoring programme, blow-out preventers, and well control training and emergency drills. Consequently the probability of such an event occurring is extremely low.

10.4 Bow Tie Risk Analysis Diagrams

BowTie analysis is a qualitative risk assessment methodology that provides a way to effectively communicate complex risk scenarios in an easy to understand graphical format and shows the relationships between the causes of unwanted events and their potential escalation to losses and damage. BowTies can show the controls which prevent the Top Event from occurring in the first place specific to each Threat and also the recovery measures which are in place to limit the potential effects once the Top Event has been realised, specific to each credible Outcome.

The key benefits of adopting the BowTie approach to risk analysis are that it:

- Provides a powerful technique to comprehensively identify all of the risk events and promotes an understanding of their relationships with each other;
- Uses an easy to understand diagrammatical format to communicate the cause and effect relationships underlying more complex risk scenarios to a wide range of stakeholders;
- Helps to clearly demonstrate the level of control that exists over risks and therefore provides a way to identify weaknesses, gaps and opportunities for further risk reduction;
- Enables verification of and linking to the relevant sections of the management system that supports controls (incl. Safety Critical Elements and Safety Critical Activities);
- Increases workforce awareness of the risks associated with their facility and how these are being managed; and
- Uses the knowledge and expertise of the workforce who best understand the true operational state of controls and the Threats that exist.

The below BowTie analysis diagrams focus on environmental losses and damage resulting from possible oil spill scenarios for exploration drilling.

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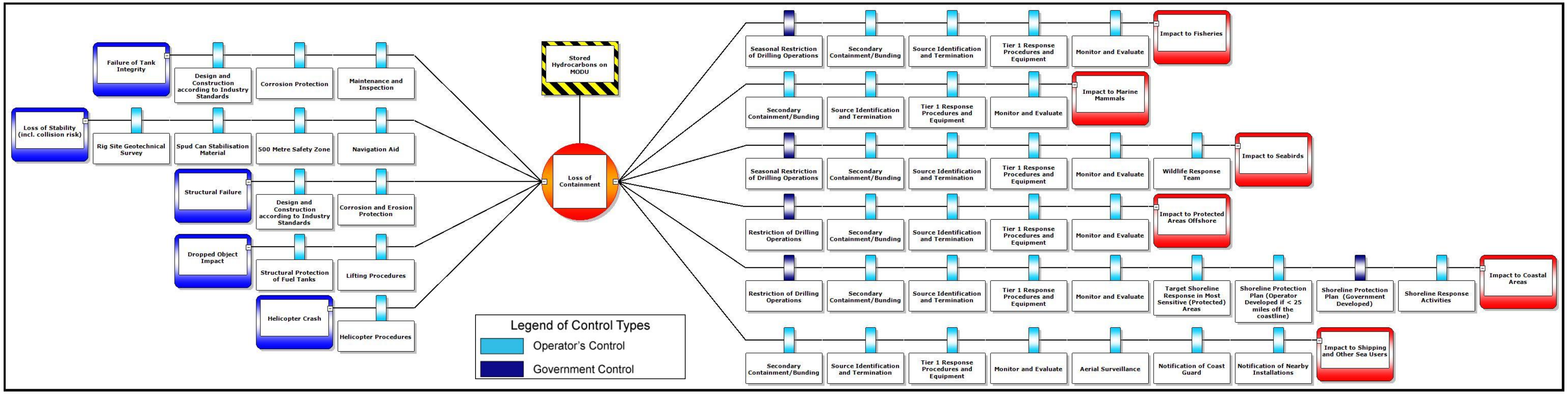
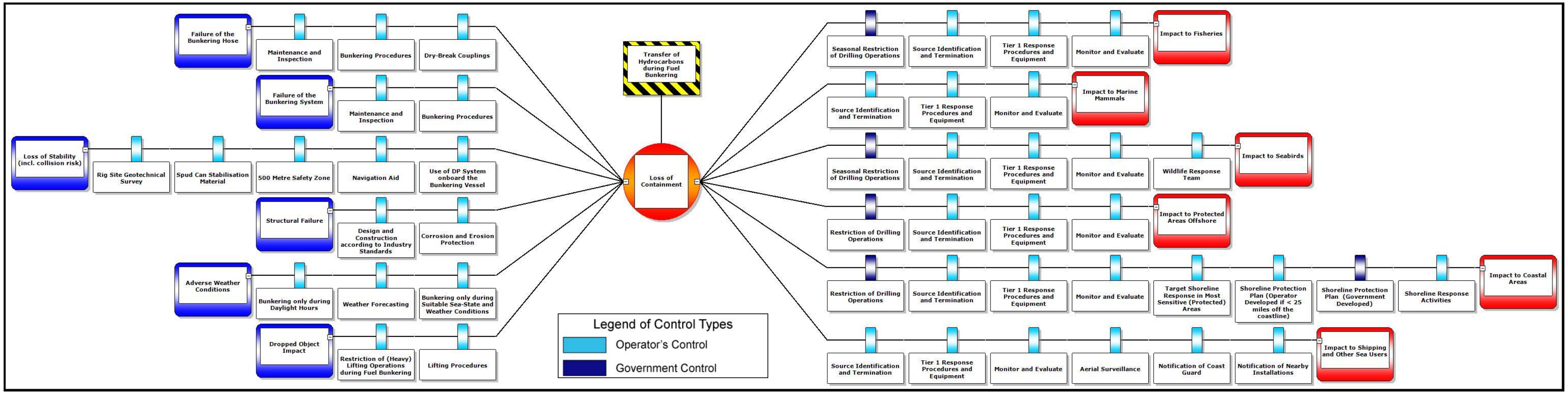
10.4.1 Stored Hydrocarbons on MODU



10.4.2 Transfer of Hydrocarbons during Fuel Bunkering



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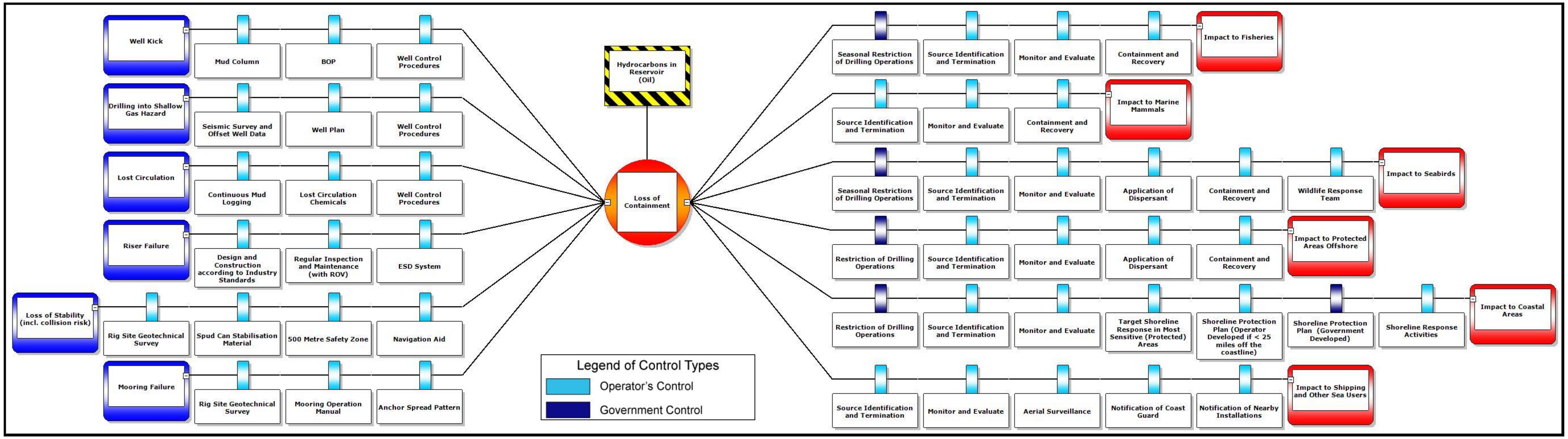
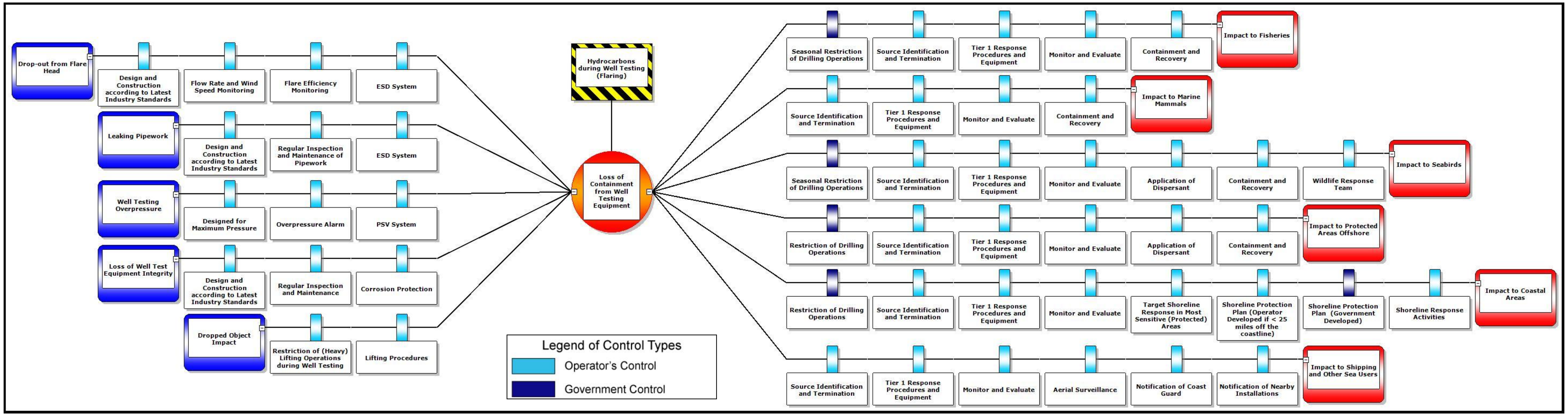
10.4.3 Hydrocarbons in Reservoir (Oil)



10.4.4 Hydrocarbons during Well Testing (Flaring)



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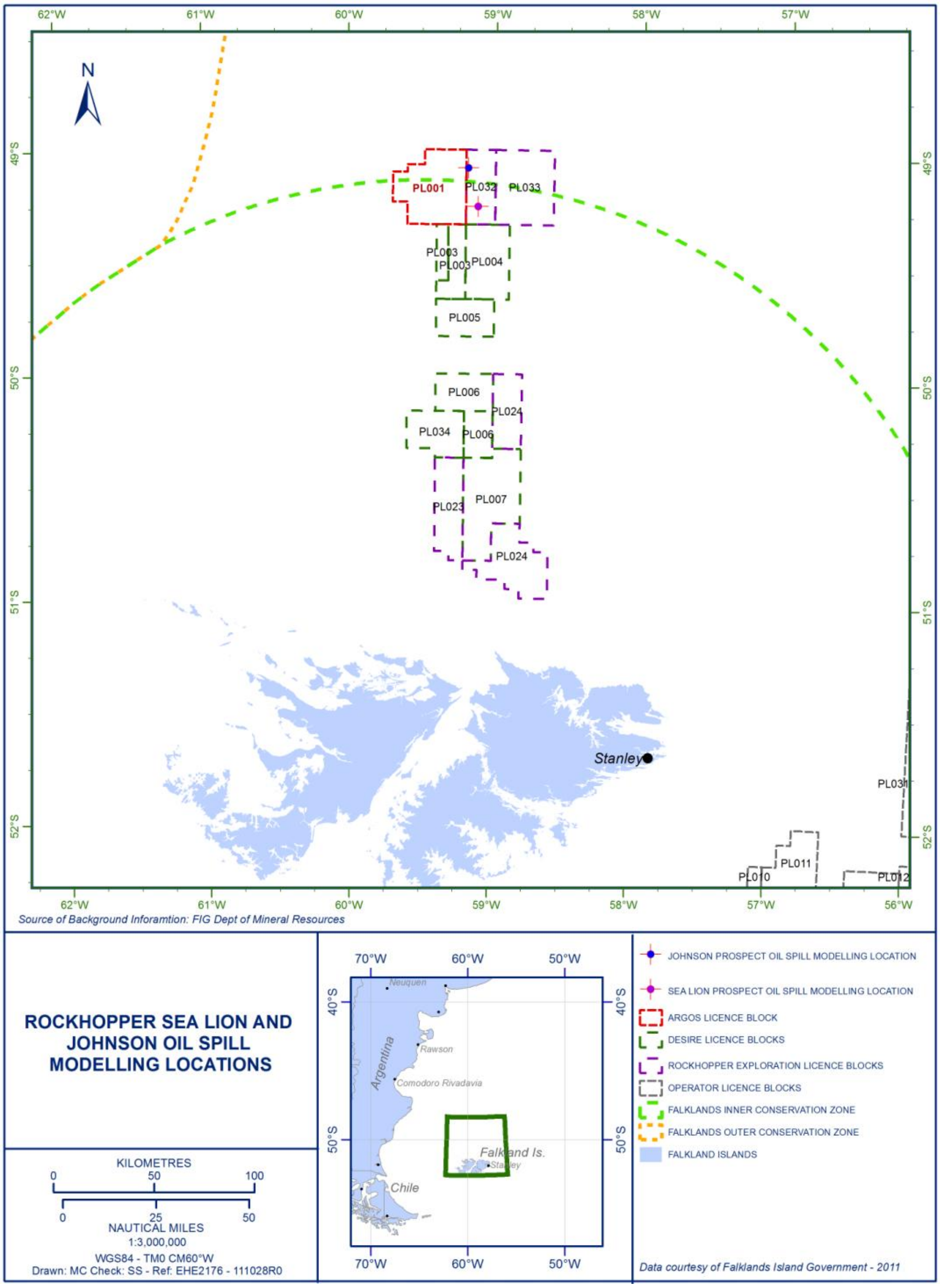
10.5 Generic Oil Spill Modelling for the North Falkland Basin Drilling Area

10.5.1 Introduction

In August 2011, Rockhopper Exploration plc commissioned an independent oil spill modelling study. The oil spill modelling was conducted using SINTEF's Oil Spill Contingency and Response (OSCAR) model (version 6.1).

The models were run at locations in both of Rockhopper's Sea Lion discovery and the Johnson prospect in PL032, as shown in Figure 10.4 below.

Figure 10.4. Rockhopper Sea Lion and Johnson Oil Spill Modelling Locations



The modelling study is briefly summarised in this Section. The modelling study report is provided in full in Appendix A of this document.

10.5.2 Justification of Modelling Software

The OSCAR model system has been developed to supply a tool for objective analysis of alternative spill response strategies. Key components of the system are:

- SINTEF's data-based oil weathering model;
- A three-dimensional oil trajectory and chemical fates model;
- An oil spill combat model, and;
- Exposure models for fish and ichthyoplankton, birds, and marine mammals.

The OSCAR model calculates and records the distribution in three physical dimensions plus time of a contaminant on the water surface, along shorelines, in the water column, and in the sediments. Oil and chemical databases supply chemical and toxicological parameters required by the model. Results of model simulations are stored at discrete time-steps in computer files, which are then available as input to one or more biological exposure models.

OSCAR employs surface spreading, advection, entrainment, emulsification, and volatilisation algorithms to determine transport and fate at the waters surface. In the water column, horizontal and vertical advection and dispersion of entrained and dissolved hydrocarbons are simulated by random walk procedures. Partitioning between particulate-adsorbed and dissolved states is calculated based on linear equilibrium theory. The contaminant fraction that is adsorbed to suspended particulate matter settles with the particles. Contaminants at the bottom are mixed into the underlying sediments, and may dissolve back into the water. Degradation in water and sediments is represented as a first order decay process.

10.5.3 Hydrocarbon Properties

Rockhopper also commissioned a hydrocarbon assay study to accurately identify the properties of the Sea Lion reservoir crude. The results from the assay identified the Sea Lion crude as having a high wax content (22%). To ensure the model was as accurate as possible, the properties of the Sea Lion hydrocarbon assay were used in the OSCAR model.

Due to the fact that this is the only significant oil discovery to date, the Sea Lion hydrocarbon assay data is considered suitable as representative of the likely characteristics of oil that may be discovered in other areas of the North Falkland basin. Although it is appreciated that the properties of crude oil differ between reservoirs, this data represents the only hydrocarbon assay data currently available from the area, and is thus considered fit for purpose in terms of oil spill modelling.

10.5.4 Modelling Parameters

To illustrate the potential fate and movement of oil in the marine environment following a blow-out event, several trajectory and stochastic (typical wind conditions) scenarios were modelled, for both oil and condensate from the proposed Sea Lion and Johnson well locations. For crude oil, these included various blowout scenarios of 182.5 days duration, under worst case 30 knot onshore and offshore wind conditions, and also using typical wind conditions obtained from the wind roses.

10.5.5 Metocean Conditions

Current data were obtained from the metocean screening report prepared by Fugro (2011). Current data was obtained from observations collected between July 1997 and July 1998. Wind data was obtained from observations collected between 1994 and 2010.

10.5.6 Modelling Outputs & Conclusions

The results of the Sea Lion modelling showed that none of the released hydrocarbons beached, either on the Falkland Islands or elsewhere. Due to the high wax content of the Sea Lion crude (22%), the oil remains on the sea surface for a significant period of time, spreading over a relatively large area to the north of the release location.

The Sea Lion crude does not appear to significantly accumulate in the sediments, which is likely to be as a result of the waxy nature of the oil in combination with the relatively deep water (450 metres).

The model predicts that for the worst case blowout flow rate, a significant percentage (ca. 25%) of the oil would evaporate over time, approximately 15% of the oil would be decayed (or broken down) in the water column and approximately 7% would remain on the sea surface (*Orbis Energy Limited, 2011*).

For the purposes of the study, it was assumed that the scenarios which were modelled are absolute worst case, in terms of both flow rate and duration. In reality, due to the high wax content (22%) of the Sea Lion crude, it is predicted that, in the case of a blow-out, as the oil rises and cools through the well tubing, it will begin to solidify and more significantly so when it comes into contact with the much cooler sea water. This solidification will begin to reduce the diameter of the well tubing, effectively sealing the release point over time. This expected decrease in flow rate is the reason why two flow rates were modelled. A commissioned flow rate modelling study conducted by Axis Well Technology (*Orbis Energy Limited, 2011*), supports the flow rates used in the model.

In addition to the solidification of the Sea Lion oil, it is also expected that the Sea Lion reservoir will not flow naturally from the well. Therefore, without additional pressure or pumping, the Sea Lion crude is unlikely to flow from the well (*Orbis Energy Limited, 2011*).

The modelling study report is provided in full in Appendix A of this document.

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11 Relief Well Contingency

11.1 Blowout Contingencies

If primary[3] and secondary[4] well control is lost and oil flows uncontrollably from the well to the sea surface (blowout), then a relief well may be required to relieve reservoir pressure and bring the well back under control. During a blowout, the drilling rig may also be damaged or otherwise rendered un-usable. Therefore, an additional suitable drilling rig may be required to conduct the relief well drilling operations. Any decisions relating to the drilling of relief wells will be taken by the Chief Executive Officer (CEO) of the Operating Oil Company with support advice being provided by the Operating Oil Company Drilling Manager and AGR, the Well Management Contractor.

A number of elements are required in order to provide an effective blowout contingency plan. These include surveyed relief well locations, relief well designs, relief well equipment, alternative rigs and access to well control specialist services and equipment. Each of these is discussed in the following sections and each of the North Falkland Basin Operators will include detailed information in the project Specific Appendix.

11.2 Relief Well Locations

Suitable locations on the seabed for potential relief wells will be identified by the Operator based on a well design profile that optimally intersects the reservoir which is blowing out. Prior to spudding the primary well a detailed Shallow Hazard Assessment will be conducted to determine hazard free locations from where a relief well could be drilled. Where possible at least two locations will be identified to provide multiple options in the event of an emergency incident.

Each relief well shallow hazard assessment will be modified/updated with the data obtained from the drilling of this interval on the primary well. Relief well locations will be selected to take account of the prevailing wind and current directions.

11.3 Relief Well Designs

Contingent relief well designs, based on the key design criteria of the primary well will be prepared prior to the commencement of drilling. In the eventuality that a relief well is required, this design would be reviewed and amended to incorporate the data obtained from the drilling of the primary well bore and to meet the specific requirements of intersecting this well bore. These amendments to the well design would occur during the period when the relief well drilling rig and specialist equipment are being mobilised to the site.

Any relief well would, most likely, have casing set just above the intersect point before drilling into the reservoir. A drill string would then be run with a retrievable packer which is set just above the casing shoe. The BOP's would be closed around the drill string prior to commencing the kill operations by pumping kill weight fluid at a high rate with the rig's mud pumps. The amount of time to kill the well will depend on the condition of the damaged well and the amount of exposed reservoir.

[3] Primary well control is achieved by keeping the well bore full of drilling fluid with a density that is greater than the formation pressures which are drilled. It is normal practice to operate with a minimum of 200 psi overbalance between the mud column hydrostatic and the estimated formation pressure.

[4] Secondary well control is provided by the Blowout Preventer (BOP) system and is required when primary control fails to prevent an influx of reservoir fluids into the well bore.

11.4 Relief Well Equipment

The North Falkland Basin Operators will have available in the Falklands a complete set of additional equipment, including casing and wellheads, which would allow the drilling of a relief well if required. There will also be a significant reserve of bulk mud and cement materials, as well as the necessary directional drilling equipment. Full details will be provided in the Project Specific Appendix.

11.5 Rigs for Relief Well Drilling

The water depths (<500 metres) and the environmental conditions encountered do not define the North Falkland Basin as a harsh environment for drilling units. In the event that an alternative unit was required for relief well drilling the Operator's would initially be looking for a suitably equipped semi-submersible that could be anchored at the relief well location. The 400 to 500 metre water depth is on the margins for a dynamically positioned (DP) vessel, but depending on the time of year and subject to simulation of the rig offset in the worst environmental conditions the use of a DP vessel should not be discounted.

The drilling market is dynamic and continually changing so it is difficult to predict where a suitable rig for drilling a relief well would be obtained. With assistance from both the Rig Owner (Diamond Offshore) and the Well Management Contractor (AGR) the Operator's will survey the market monthly in order to track rig movements and availability.

To mobilise a rig to the Falkland Islands from the North Sea would take between 60 and 90 days depending on the weather conditions. In addition a further period would be required to negotiate a contract for the rig and to inspect it for its suitability to carry out relief well operations. Overall, it is estimated that it would take between four and five months to get a rig on site and ready to start relief well operations.

It is also possible that a rig could become available from an area much closer to the Falkland Islands than the North Sea, however, the rigs suitability would have to be critically reviewed, especially with respect to its meeting the regulatory requirements.

11.6 Well Control Specialist Services & Equipment

The North Falkland Basin Operators have in place via their Well Management Contractor (AGR) a call off contract with Wild Well Control (WWC) for the provision of well control services. WWC specialise in drilling relief wells and controlling blowouts. For relief well drilling, WWC have available specialised drilling equipment such as magnetic ranging tools as well as expertise in planning and executing relief well operations.

The Operators also have in place a contract with Oil Spill Response (OSR) in the UK. OSR provide specialised oil spill services on a worldwide basis. The tiered response structure used by OSR and the resources which are available are detailed in Section 7.0 of this document.

11.7 Lessons from the Macondo & Montara Blowouts

The North Falkland Basin Operators have kept themselves fully informed on the investigations and reports relating to the two recent industry blowouts at the Macondo well in the US Gulf of Mexico and at the Montara platform in the Australian waters of the Timor Sea and where appropriate will take account of the recommendations in the Project Specific Appendix.

The capping devices presently being developed in response to the Macondo blowout are designed to interface with either the rigs Lower Marine Riser Package (LMRP) or the well head profile. It assumes in the event of a blowout that either can be accessed, since it is very likely that considerable quantities of debris would prevent immediate access in the event of a major incident.

With the normal reservoir pressure and the waxy crude which has been encountered to date in the North Falkland Basin the capping devices are not seen as the primary method

of controlling a blow out. The primary method of control would be to mobilise a replacement rig and drill a relief well.

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12 Fate & Effects of Spilt Oil in the Marine Environment

12.1 Fate of Spilt Oil

The International Tanker Owners Pollution Federation (ITOPF) has ranked oils according to their physical characteristics (API/SG) and likely spill behaviour:

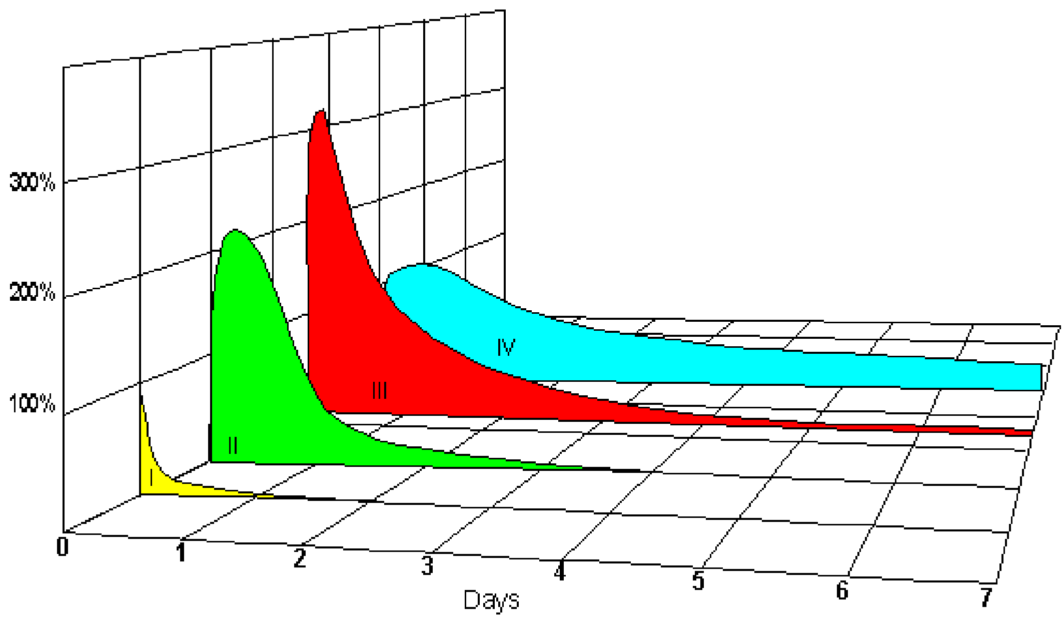
ITOPF Categories

Group I	SG <0.8	API >45	**Light**
Group II	SG 0.8-0.85	API 45-35	
Group III	SG 0.85-0.95	API 35-17.5	
Group IV	SG >0.95	API <17.5	**Heavy**

As an example, crude discovered to date in the North Falkland Basin is Group III oil under this classification (Rockhopper Sea Lion discovery). Diesel is a Group I oil. The expected removal rates of these oils from the sea surface are shown in Figure 12.1. Group 1 oils are rapidly removed and Group 2 oils first undergo emulsification before being relatively quickly removed from the sea surface. Group III and IV oils have a greater tendency to persist for longer in the marine environment due to their greater density.

Note: Oils only behave as per their given group at ambient temperatures above their pour points. At temperatures lower than pour point, they should be considered as Group IV.

Figure 12.1. The Rate of Removal of Oil from the Sea Surface According to Type (the volume of oil and oil-in-water emulsion remaining on the sea surface is shown as a percentage of the volume spilled) (ITOPF, 2002)



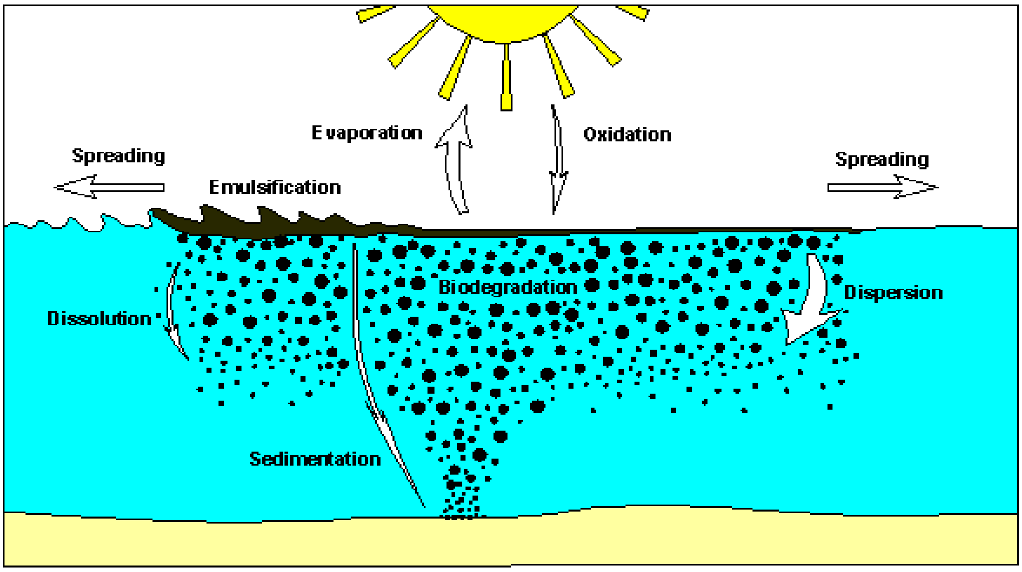
Oil, spilled offshore, will normally break up and be dissipated into the marine environment over time. This dissipation is a result of several chemical and physical processes that progressively alter the make-up of the oil from when it was spilled. The processes are collectively known as weathering.

Figure 12.2 illustrates the main weathering processes. Oils are termed persistent or non-persistent depending on how quickly an oil slick breaks up and dissipates. Light products

such as diesel and kerosene under most conditions, evaporate and dissipate quickly and naturally, and rarely need cleaning-up. In contrast, persistent oils, such as many crude oils, break up and dissipate more slowly and may require a clean-up response. Physical properties such as the density, viscosity, wax content and pour point of the oil all affect its behaviour.

As soon as oil is spilled, it starts to spread out over the sea surface, initially as a single slick. The speed at which this takes place depends largely on the viscosity of the oil. Fluid, low viscosity oils spread more quickly than those with a high viscosity. Normally, slicks quickly spread over the sea surface. Typically, spreading is not uniform with large variations in the thickness of the oil. After a few hours the slick will begin to break up and, because of wind and wave action, will form narrow bands or windrows in parallel to the wind direction. The rate at which the oil spreads is also determined by the prevailing conditions such as temperature, water currents, tidal streams and wind speeds.

Figure 12.2. Fate of Spilled Oil (ITOPF, 2002)



There are eight main oil weathering processes:

Evaporation – Lighter components of oil evaporate to the atmosphere. The amount of evaporation and the speed at which it occurs depend upon the volatility of the oil and the ambient temperature. Oil with a large percentage of light and volatile compounds will evaporate more than one predominantly composed of heavier compounds. For example, kerosene and diesel oils, tend to evaporate almost completely within hours to days while little evaporation occurs from a heavy fuel oil. In general, in temperate conditions, those components of the oil with a boiling point under 200ºC tend to evaporate within the first 24 hours. Evaporation can increase as the oil spreads, due to the increased surface area of the slick. Rough seas, high wind speeds and high temperatures tend to increase the rate of evaporation and thus the proportion of oil lost by this process.

Dispersion – Waves and turbulence at the sea surface can cause a slick to break up into fragments and droplets of varying sizes which become mixed into the upper levels of the water column. Some of the smaller droplets will remain suspended in the sea water while the larger ones will tend to rise back to the surface, where they may either coalesce with other droplets to reform a slick or spread out to form a thin film. Small droplets have a greater surface area which facilitates other natural processes such as dissolution, biodegradation and sedimentation. The speed at which an oil disperses is largely dependent upon the nature of the oil and the sea state, and occurs most quickly if the oil is light and of low viscosity and if the sea is very rough. A combination of these factors led to the complete dispersion of the oil (light Norwegian crude) spilled from the MV

BRAER at the Shetland Islands in 1993. The use of chemical dispersants can accelerate the process of dispersion.

Emulsification – An emulsion is formed when two liquids combine, with droplets of one becoming suspended in the other. In emulsification of crude oils, seawater droplets become suspended in the crude. This occurs as a result of physical mixing promoted by wave action. The emulsion thus formed is usually very viscous and more persistent than the original oil and is often referred to as chocolate mousse because of its appearance. The formation of these emulsions causes the volume of the slick to increase between three and four times and slows and delays the other processes which cause the oil to dissipate. Emulsions are not normally amenable to chemical dispersants. Oils with an asphaltene content greater than 0.5% tend to form stable emulsions which may persist for many months after the initial spill has occurred. Oils with a lower asphaltene content are less likely to form emulsions and more likely to disperse. Emulsions may separate back into oil and water again if heated by sunlight under calm conditions or when stranded on shorelines.

Dissolution – Some compounds in oil are water soluble and will dissolve into the surrounding water. The proportion dissolving depends on the composition and state of the oil, and occurs most quickly when the oil is finely dispersed in the water column. Components that are most soluble in seawater are the light aromatic hydrocarbons compounds such as benzene and naphthalene. However, these compounds are also those first to be lost through evaporation, a process which is 10-100 times faster than dissolution. In contrast to diesel, crude oil contains only small amounts of these compounds making dissolution one of the less important processes.

Oxidation – Oils react chemically with oxygen either breaking down into soluble products or forming persistent tars. This process is promoted by sunlight. This process is very slow and even in strong sunlight, thin films of oil break down at no more than 0.1% per day. The formation of tars can form an outer protective coating of heavy compounds that result in the increased persistence of the oil as a whole. Tarballs, such as found on shorelines, have a solid outer crust surrounding a softer, less weathered interior and are a typical example of this process.

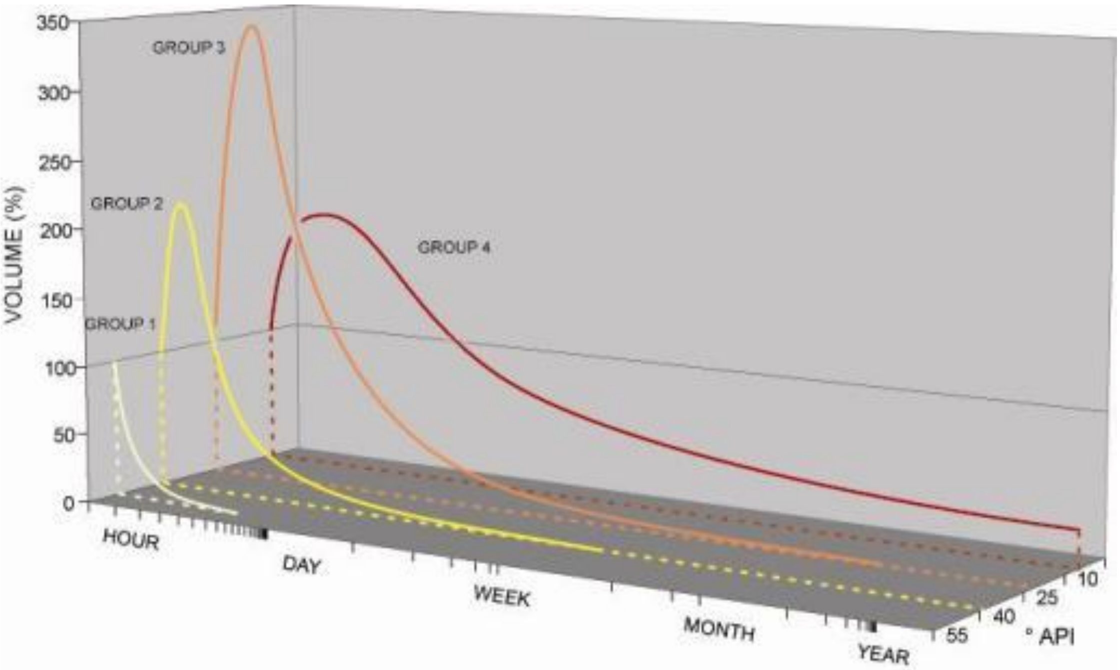
Sedimentation/Sinking – Seawater has a density of approximately 1.025 and very few types of crude are dense enough or weather sufficiently, so that their residues will sink in the sea. Sinking is usually caused by the adhesion of sediment particles or organic matter to the oil. In contrast to offshore, shallow waters are often laden with suspended solids providing favourable conditions for sedimentation. Oil stranded on sandy shorelines often becomes mixed with sand. If this mixture is then washed off the beach into the sea it is likely to sink. In addition, if the oil is burned after it has been spilled, the tarry residues may be sufficiently dense to sink.

Biodegradation – Sea water contains a range of micro-organisms that can partially or completely break down the oil to water soluble compounds (and eventually to carbon dioxide and water). Many types of hydrocarbon bacteria exist and each tends to degrade a particular group of compounds in crude oil. However, some compounds in oil are very resistant to attack and may not degrade. The main factors affecting the efficiency of biodegradation are the levels of nutrients in the water, temperature and the level of oxygen present. The creation of oil droplets, either by natural or chemical dispersion, increases the surface area of the oil thus increasing the area available for biodegradation to take place.

Combined processes – The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important early on in a spill whilst oxidation, sedimentation and biodegradation are more important later. To predict how different oils change over time whilst at sea, some simple models have been developed based on oil type. Oils have been classified into groups roughly according to their density. Generally, oils with a lower density will be less persistent. However, some apparently light oils can

behave more like heavy ones due to the presence of waxes. One model uses the half-life (the time needed for 50% of the oil to disappear from the sea surface) for a group of oils to describe the persistence and the time needed for the oil to dissipate (Figure 12.3). After six half-lives have passed, about 1% of the oil will remain. Weather and climatic conditions will alter the rates shown, e.g. in rough weather, a group 3 oil may dissipate in a timescale similar to a group 2 oil.

Figure 12.3. Volume of Oil and Water-in-Oil Emulsion Remaining on the Sea Surface, as a Percentage of the Original Volume Spilled (ITOPF, 2002)



12.2 Effect of Spilt Oil and Environmental Risk

12.2.1 Effect of Spilt Oil

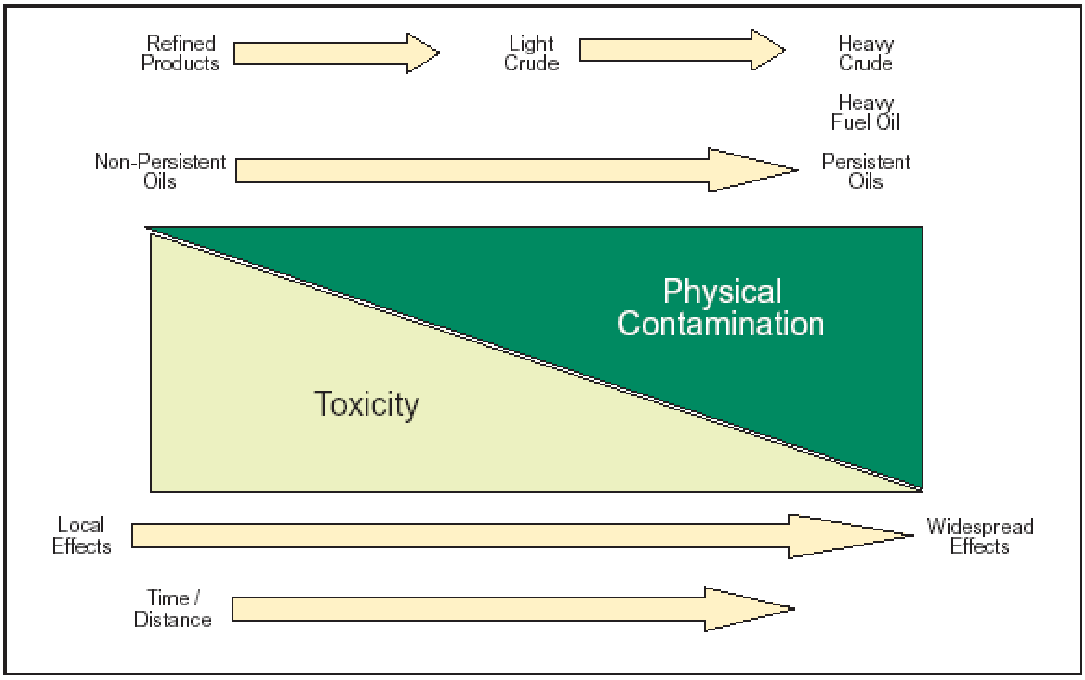
The risk to the environment is the result of the probability of a spill occurring multiplied by it's consequences. The larger the spill, the greater it's potential to cause damage. The closer the environmentally sensitive area is to the oil, the greater the potential for damage.

The effects of oil in the environment are related to the following:

- Toxicity; primarily the lighter more volatile fractions can kill or debilitate organisms;
- Physical effects; smothering of plants and animals, preventing photosynthesis and respiration and causing loss of insulation to animals with fur or feathers; and
- Tainting; whereby the flavour of fish meat can be tainted with an 'oily' taste for a period following an oil spill.

The type of oil and its effects on the environment over time are shown in Figure 12.4 below. From the point that oil is spilt at sea, its composition and location will change with time. The volume of the slick will tend to decrease rapidly due to weathering by the weathering agents. For a diesel or condensate spill the principal factor removing oil from the sea is evaporation. Light oils will spread rapidly on the sea surface and, until dispersion has taken place, will move with the surface water currents and the prevailing wind.

Figure 12.4. Illustration of the Effects of Oil (Dicks, 1992)



12.2.2 Environmental Risk

An environmental risk assessment is undertaken using a matrix, plotting the probability of a given size of oil spill against its potential consequences. Spills that pose an acceptable risk are unlikely to need any specific mitigation measures beyond good housekeeping and adherence to the Operator's Health Safety & Environmental (HSE) Management System (as appropriate). A risk that requires mitigation measures does so to both reduce the probability of a spill and the environmental impacts of such a spill. Non-acceptable risks highlight areas of greatest risk to the environment where efforts should be concentrated to reduce the probability of a spill occurring.

Guidelines have been established for the establishment of acceptance criteria for environmental risks posed by acute oil spills (*OLF 1994*).

According to OLF (1994), frequency of occurrence data may be used in place of probability data. Table 12.1 presents risk acceptance criteria as a matrix. Tables 12.2 and 12.3 define probability levels and consequence levels, respectively.

Table 12.1. Environmental Risk Acceptance Criteria Presented in a Matrix in Relation to Probability Levels and Consequence Levels (OLF, 1994)

PROBABILITY LEVELS					
5	B	C	D	D	D
4	B	B	C	D	D
3	A	B	B	C	D
2	A	A	B	B	C
1	A	A	B	B	B
	1	2	3	4	5

CONSEQUENCE LEVELS

A= Acceptable Risk, B= Acceptable risk, but measures ought to be implemented, C= Unacceptable risk unless risk reducing measures are in place, D= Unacceptable risk

Table 12.2. Probability Levels / Frequency of Occurrence (OLF, 1994)

Probability level	Frequency of Occurrence	Diesel spill levels
Level 1	0 – 0.0001 (Less than one incident per 10,000 years)	
Level 2	0.0001 – 0.01 (Incidents occur at a rate of one per 10,000 years to one per 100 years)	
Level 3	0.01 – 0.1 (Incidents occur at a rate of one per 100 years to one per 10 years)	Large Tier 2 and Tier 3
Level 4	0.1 – 1 (Incidents occur at a rate of one per 10 years to one per year)	Tier 1 and small Tier 2
Level 5	>1 (Incidents occur more often than once per year)	Small Tier 1 spillages

Table 12.3. Environmental Consequence Levels (OLF, 1994)

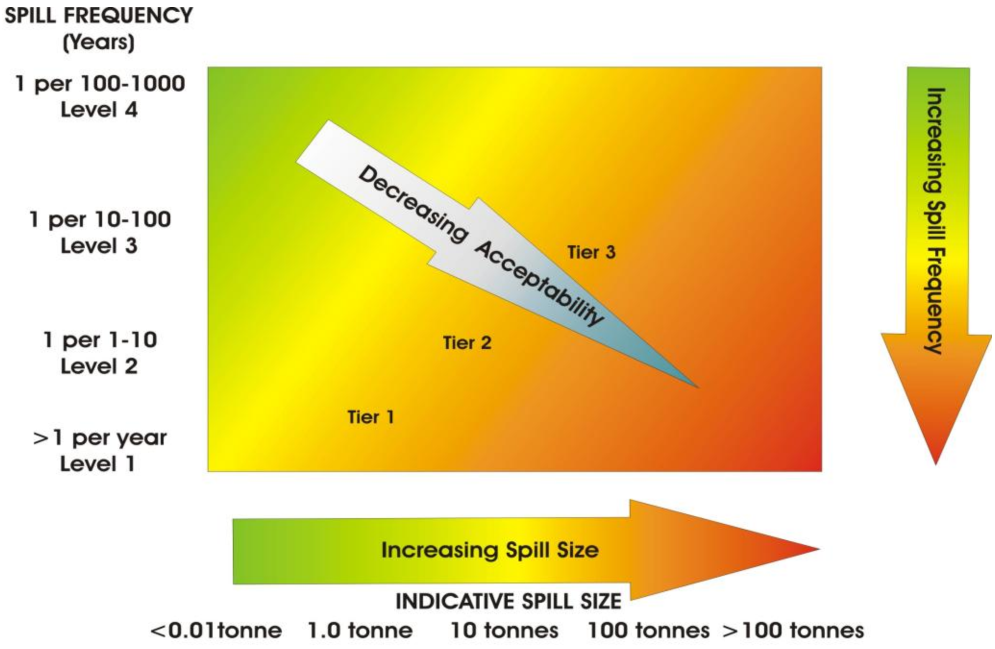
Consequence level	Category of environmental damage	Description of environmental damage
Level 1	Indemonstrable environmental damage	No demonstrable or measurable effect.
Level 2	Minor environmental damage	Few fish, birds and sea mammals affected; <1 kilometre of coastline affected.
Level 3	Moderate environmental damage	Some effect on fish, birds and sea mammals; restoration time <2 years; 1 to <10 kilometres of coastline affected.
Level 4	Significant environmental damage	Affects animal life which will threaten the multiplicity of fish, birds or sea mammals in the influence area; restoration time 2 - 5 years; 10 to <100 kilometres of coastline affected; affects areas of scientific interest.
Level 5	Serious environmental damage	Affects animal life which will threaten the multiplicity of fish, birds or sea mammals in the influence area; restoration time >5 years; >100 kilometres of coastline affected; significant effect on preservation areas.

12.2.3 Assessment of Environmental Risk and Risk Mitigation

Location and time to beaching can be estimated using slick trajectory analyses based on spill location and volume spilled. Utilising the OLF (1994) criteria, risk matrix methodology can be applied to give an assessment of overall environmental risk from a spill. The matrices are formed from a combination of probability of occurrence (plotted vertically down the matrix) and size of spill, equating to environmental consequence (plotted horizontally across the matrix) (Figure 12.5).

The overall frequency of spills is low, however small diesel spills have a relatively high frequency of occurrence compared to other oil spill scenarios and therefore plot into the high probability level in the matrix. However, as Tier 1 type spills, they will disperse rapidly and would normally result in minimal environmental damage. They therefore plot into the lowest matrices for environmental consequence. A diesel spill of >50 tonnes has a lower frequency of occurrence but still plots into the high level of occurrence. These situations will both be classified as 'acceptable risk' (refer to Figure 12.5) providing that the precautions are taken to minimise the risk of spills. Environmental effects are related to the presence of sensitive features at the time of the spill and are therefore likely to be limited to minor effects on small numbers of marine fauna such as seabirds and fish, present in the immediate vicinity of the spill.

Figure 12.5. Spill Size and Frequency versus Potential Effects



	ENVIRONMENTAL CONSEQUENCE				
Diesel/LTOBM Spill	Level 1	Level 1-2	Level 2-3	Level 3	Level 3-4
Light Crude Spill	Level 1	Level 2	Level 2-3	Level 3	Level 3-4

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13 Response Strategy Guidelines

This guide provides supporting information to personnel involved in planning and executing oil spill response for the Operator's offshore drilling operations. The document should be read and understood by all response organisation personnel.

This guide gives information on each type of response available in the event of a spill at sea and provides details on factors affecting selection and deployment of response.

The response strategy adopted will depend upon the spill details and the prevailing environmental conditions. The essential information required as a basis for decision making is:

- Size and status of the oil spill (e.g. controlled or uncontrolled);
- Location of the oil slick;
- Type of oil and its characteristics;
- Meteorological information, current and predicted weather and sea state;
- Authorities informed;
- Action taken; and
- Evidence gathered, e.g. samples and photographs.

More information will be required, as the situation develops, for example as a part of the monitoring process, a survey of the location of seabirds might be carried out to determine the advisability of using dispersants. Aerial surveillance and monitoring will also form an integral part of the response, for example in the case of a large oil spill where dispersant is being used.

13.1 Options Available

The main elements of response are outlined below:

- Monitor and Evaluate;
- Natural dispersion – maintain the spill under observation but with no active intervention;
- Chemical dispersion of the oil spill;
- Mechanical containment and recovery of the spilt oil; and
- Onshore clean-up.

13.2 Monitor & Evaluate

Under FIG Policy, Monitor and evaluate is the primary strategy for oil spills that pose no significant threat to the coastline or sensitive resources, as the normally high energy conditions offshore will naturally break up the oil spill. It is recognised that it is essential to monitor an oil spill until complete dispersion. Where surveillance from a vessel is insufficient, FIG will request that aerial surveillance is undertaken (*FIG NOSCP*).

All spilt oil must be kept under observation until it has completely dispersed. During rig operations, small spills close to the rig can be monitored by the safety stand-by vessel. However its primary role is to ensure the safety for the rig personnel, so it must stay close to the rig.

13.2.1 Aerial Surveillance

Oil that moves away from the rig, or where there is no surface support vessel available offshore, should be monitored from the air. Initial monitoring will be carried out using the crew change helicopter and FIGAS aircraft (if available).

Sustained aerial observation and observation during the hours of darkness should only be carried out using specialised, multi engine, fixed wing aircraft equipped for this role. The observer for the flight must be experienced and be able to correctly identify surface and dispersed oil on the sea from amongst other 'phenomena' that have a similar appearance.

The slick should be monitored at least twice daily until fully dispersed. The observations of the surveillance must be passed daily to the interested government bodies until the response is stood down. Normally this would be the Falklands Department of Mineral Resources and the Department of Fisheries.

Aerial surveillance is the method of choice for observation. Height allows visibility over a wide area and, combined with the high speed of aircraft, allows a large area to be covered and the 'big picture' to be seen. Aerial observation allows response units to be co-ordinated and directed to great effect and allows detection of environmental sensitivities in the path of the oil slick in 'real time'.

Aerial surveillance for tier three spills should be mobilised from OSR. Prior to the flight the observer and pilot must be briefed upon weather conditions, weather forecast, surface water currents and predicted position of the oil slick. A flight plan must be developed which will consist of a ladder search that will proceed across the expected track of the oil. The observer should be equipped with a suitable chart, already marked into grid sections and during the flight must communicate with the pilot to ensure that the aircraft's position at any time is known so that accurate references can be passed on. The search height will be determined by conditions on the day.

13.2.2 Guidelines for Detection, Investigation and Post flight Analysis/Evaluation for Oil Spill Volume Estimation

This section is based upon the internationally recognised Bonn Agreement Oil Appearance Code (BAOAC) 2003, used for oil spill volume estimation during aerial surveillance.

Detection

The main detection equipment is radar and / or visual look out. Most marine pollution aircraft have Side Looking Airborne Radar (SLAR).

After the initial detection where possible the aircrew should try to orientate the flight path so that all the oil passes down one side of the aircraft, parallel to the flight path, at a range of between 5 and 10 miles: this positioning optimises the radar performance and avoids the 'radar blind' area directly beneath the aircraft.

If time permits a 'radar' box should be flown around the slick at a range of between 5 and 10 miles. This ensures that at some stage the oil and sea will present the best aspect for data collection to the radar. The best SLAR image will normally be available when the surface wind is at 90^0 to the aircraft's flight path.

Investigation – Data Collection

Following the detection the slick should be thoroughly investigated using the vertical remote sensing instruments; IR, UV and Vertical Camera. The aircraft should be flown directly over the oil to enable the 'plan' view (the most accurate view) of the slick to be recorded.

The UV sensor may enable an accurate 'overall' area measurement. UV may also show the areas not covered with oil allowing the overall area measurement to be 'adjusted'. The vertical camera may provide area and appearance data of the oil. The IR data may give a 'relative' thickness of the slick, which can be used to supplement the UV, and Vertical Camera information.

It is suggested that the aircraft is flown 'up' the line of oil towards the 'polluter', ship or rig; this avoids the IR 'flaring out' because of the rapid increase in temperature associated with the vessel (engines) or installation (flare).

It is also suggested that the aircraft is flown at a height that allows as much of the slick as possible to fall within the field of view of the vertical sensors. In general terms it is understood that most IR sensors have a field of view of 1000 feet when the aircraft is at 1000 feet; so if the line of oil is considered to be 2000 feet wide to ensure that all the oil is scanned an aircraft height of 3000 feet is suggested. It may be necessary to 'map' large slicks.

Investigation – Visual Observation

Visual observation of the pollution and polluter provides essential information about the size, appearance and coverage of the slick that are used to calculate the initial estimate of volume. The visual form of an oil slick may also suggest the probable cause of pollution:

- A long thin slick of thin oil sheen suggests a possibly illegal discharge of oil from a ship. The cause is obvious if the ship is still discharging, as the slick will be connected to the ship, but the slick may persist for some time after discharge has stopped; it will subsequently be broken up and dispersed by wind and waves.
- A triangular slick with one side aligned with the wind and another aligned with the prevailing current suggests a sub-sea release, such as that from a sub-sea oil pipeline or oil slowly escaping from a sunken wreck.

Slicks seen some distance 'down current' of oil installations, particularly in calm weather, may be caused by re-surfacing of dispersed oil from permitted discharges of produced water. The observation can be influenced by several factors; cloud, sunlight, weather, sea, and angle of view, height, speed and local features. The observer should be aware of these factors and try to make adjustments for as many as possible.

It is suggested that the ideal height to view the oil will vary from aircraft to aircraft. For example an Islander with its low speed allows observation at a lower level than a Merlin with its higher speed. For an aircraft with a speed of around 150 knots a height of around 700 to 1000 feet is suggested.

It is recommended that the slick should be viewed from all sides by flying a racetrack pattern around the oil. The best position to view the oil is considered to be with the sun behind the observer and the observer looking at the object / subject from an angle of 40^0 to 45^0 to the perpendicular.

The oil appearances will tend to follow a pattern. The thinner oils (sheen, rainbow and metallic) will normally be observed at the edges of the thicker oils, discontinuous true colour and true colour. It would be unusual to observe thick oil without the associated thinner oils; however, this can occur if the oil has aged and / or weathered.

During the observation the aircrew should estimate the areas within the overall area that have a specific oil appearance. The Bonn Agreement Oil Appearance Code (BAOAC) is detailed below in 'Description of the Oil Appearance Codes'.

Investigation – Photography

Photographs of the oil slick and polluter are probably the most easily understood data for a non technical person. It is therefore essential to produce a complete set of pictures showing the required evidence.

The photographs can also confirm or amend the in flight visual observation during the post flight analysis. The ideal set of photographs will show an overall, long range, view of the pollution and the polluter and a series of detailed, close up, shots of the pollution and the polluter.

It is important, where possible, to show clear evidence of a connection between the polluter and the pollution, directly or indirectly, the camera data can provide this as can

the IR and UV data. The data should also show 'clean' water ahead of the vessel so that the ship's crew cannot claim that the pollution was already there and they were 'just' sailing through it.

Volume Estimation – Overall Area Measurement

Trials have shown that both overall area and specific oil appearance area coverage measurement is the main source of error in volume estimation. Therefore observers should take particular care during this part of the volume estimation process.

Estimating or measuring the overall area can be done in several ways:

- Visual estimation;
- Measurement of SLAR image; or
- Measurement of UV image.

Estimations of overall slick area based on visual observations are likely to be less accurate than estimates based on measurements made of remote sensing images.

If possible, the whole slick should be visible in one image for ease of area measurement. Area calculations using accurate measurements of SLAR images will be more appropriate for large oil slicks, while measurements of UV images will be more suitable for smaller slicks.

Most modern SLAR systems incorporate electronic measuring devices; areas can be measured by drawing a polygon around the detected slick. It is recommended that these devices be used where at all possible as they will provide the most accurate measurement within the confines of the aircraft during flight. Alternatively the overall length and width can be measured electronically and the overall coverage estimated visually.

It should be remembered that because of the resolution of the SLAR (generally 20 metres) small areas of less than 20 metres NOT covered with oil but within the overall area would not show on the SLAR. However, oil patches of less than 20 metres will show up as patches of 20 metres.

The recommended procedure for visual observation is to estimate the length and width of the slick by making time and speed calculations. This forms an imaginary rectangle that encloses the slick. The coverage of the oil slick (expressed as a percentage or proportion) within this imaginary rectangle is then used to calculate the overall area of the slick. Inevitable inaccuracies in dimension estimates and estimated coverage within these dimensions can give rise to high levels of error in area estimation.

Oil slicks frequently contain 'holes' of clear water within the main body of the slick, especially near the trailing edge of the slick. The proportion of the overall area that is covered by oil of any thickness needs to be estimated. For compact slicks, this proportion may be high at around 90% or more, but for more diffuse oil slicks a much lower proportion of the overall area will be covered in oil. More accurate assessments of overall slick area can be made by a more thorough analysis of the SLAR or UV images. The visual and SLAR overall area calculations should be 'adjusted' to take into account the 'holes' (areas) of clear water within the main body of the slick.

Volume Estimation – Specific Appearance Area Coverage Measurement

The 'adjusted' overall area covered with oil should be sub-divided into areas that relate to a specific oil appearance. This can be achieved using the recorded data from the vertical sensors and the noted visual observations.

This part of the volume estimation is mainly subjective so great care should be taken in the allocation of coverage to appearance, particularly the appearances that relate to higher thicknesses (discontinuous true colour and true colour). The vertical camera data (if available in flight) and the visual observations should be compared with the IR data, which will give an indication of the thickest part of the slick.

It is generally considered that 90% of the oil will be contained within 10% of the overall slick (normally the leading edge (up wind side) of the slick).

Thermal IR images give an indication of the relative thickness of oil layers within a slick. Relatively thin oil layers appear to be cooler than the sea and relatively thick oil layers appear to be warmer than the sea in an IR image. There is no absolute correlation between oil layer thickness and IR image because of the variable heating and cooling effects caused by sun, clouds and air temperature.

The presence of any area within the slick as warm in an IR image indicates that relative thick oil (Code 4 or 5 in the BAOAC) is present. Since these areas may only be small, but will contain a very high proportion of oil volume compared to the much thinner areas, their presence should be correlated with visual appearance in the BAOAC assessment.

Post Flight Analysis

The aim of post-flight analysis / evaluation is to provide a more accurate estimate of spilled oil volume than can be made within the confines of the aircraft during flight. It is based on measured oil slick areas and the estimated oil layer thickness in various parts of the oil slick. It involves integrating the information from several different sources in a systematic way.

Electronic methods or the use of grid overlays should be used to obtain accurate measurements of overall slick area from the recorded images. Where several images have been obtained during a period of time, the area should be calculated for each one.

The next stage in post-flight analysis is to calculate oil coverage within the overall area estimated from visual observation or measured from the remote sensing images.

The photographs and Bonn Agreement Pollution Observation Log should be re-examined and the proportions of slick area of different BAOAC codes should be re-calculated. Any assessment of the appearance of different areas of oil within a slick will be somewhat subjective. Nevertheless, the BAOAC provides a standard classification system to allow at least semi-quantitative thickness (and subsequently, volume) estimation, particularly at lower oil thickness (Codes 1 to 3).

It is particularly important that areas of any thick oil (Codes 4 or 5 in the BAOAC) – if present – be confirmed as accurate or correlated with the thicker areas shown on the IR image, since these will have a very large influence on estimated volumes.

The final stage of post flight analysis is to calculate the estimated volume by totalling the volume contributions of the different areas of the slick.

Volume estimations made by analysis of different sensors and methods should be compared. Similarly, volume estimates made from data obtained at different times should be compared to ensure that it is consistent; spilled oil volume would not normally change over a short time, so very different estimates obtained only a few minutes apart will be a signal of problems.

Oil Volume Estimate Usage

Using the BAOAC to estimate oil volume gives a maximum and minimum quantity (Table B.1). It is suggested that in general terms the maximum quantity should be used together with other essential information such as location to determine any required response action. It is suggested that the minimum volume estimate should be used for legal purposes.

The appearances described cannot be related to one thickness; they are optic effects (codes 1 – 3) or true colours (codes 4 – 5) that appear over a range of layer thickness. There is no sharp delineation between the different codes; one effect becomes more diffuse as the other strengthens. A certain degree of subjective interpretation is necessary when using the code *and any choice for a specific thickness within the layer interval MUST be explained on the Bonn Agreement Pollution Observation Log*.

Description of the Oil Appearance Codes

The oil appearance codes are described below and summarised in Table 13.1.

Code 1 – Sheen (< 0.3 µm thickness)

The very thin films of oil reflect the incoming light slightly better than the surrounding water and can therefore be observed as a silvery or grey sheen. All oils in these thin layers can be observed due to this effect and not the oil colour itself. Oil films below approximately 0.04 µm thickness are invisible. In poor viewing conditions even thicker films may not be observed. Above a certain height or angle of view the observed film may disappear.

Code 2 – Rainbow (0.3 µm – 5.0 µm thickness)

Rainbow oil appearance represents a range of colours, yellow, pink, purple, green, blue, and red, copper, orange; this is caused by an optical effect and is independent of oil type. Depending on angle of view and layer thickness, the distinctive colours will be diffuse or very bright.

Oil films with thicknesses near the wavelength of different coloured light, 0.2 µm – 1.5 µm (blue: 400nm or 0.4 µm, through to red: 700nm or 0.7 µm) exhibit the most distinct rainbow effect. This effect will occur up to a layer thickness of 5.0 µm. Bad light conditions may cause the colours to appear duller. A level layer of oil in the rainbow region will show different colours through the slick because of the change in angle of view. Therefore if rainbow is present, a range of colours will be visible.

Code 3 – Metallic (5.0µm – 50 µm thickness)

The appearance of the oil in this region cannot be described as a general colour and is oil type dependent. Although a range of colours can be observed, blue, purple, red and green, the apparent colour is not caused by interference of light or by the true colour of the oil. The colours will not be similar to ‘rainbow’. Where a range of colours can be observed within a rainbow area, metallic will appear as a quite homogeneous colour that can be blue, brown, purple or another colour. The ‘metallic’ appearance is the common factor and has been identified as a mirror effect, dependent on light and sky conditions. For example blue can be observed in blue-sky conditions.

Code 4 – Discontinuous True Colours (50 µm – 200 µm)

For oil slicks thicker than 50 µm the true colour will gradually dominate the colour that is observed. Brown oils will appear brown, black oils will appear black. The broken nature of the colour, due to thinner areas within the slick, is described as discontinuous. This is caused by the spreading behaviour under the effects of wind and current.

‘Discontinuous’ should not be mistaken for ‘coverage’. Discontinuous implies true colour variations and not non-polluted areas.

Code 5 – True Colours (>200 µm)

The true colour of the specific oil is the dominant effect in this category. A more homogenous colour can be observed with no discontinuity as described in Code 4.

This category is strongly oil type dependent and colours may be more diffuse in overcast conditions.

Table 13.1. Thickness Band for Allocation Appearance

Code	Appearance	Approximate Thickness (μm)		Litres per km^2
		Minimum	Maximum	
1	Sheen (silver/grey)	0.04	0.3	40 – 300
2	Rainbow	0.3	5.0	300 – 5000
3	Metallic	5.0	50	5000 – 50,000
4	Discontinuous true colours	50	200	50,000 – 200,000
5	Continuous True Colour	200	> 200	200,000 - > 200,000

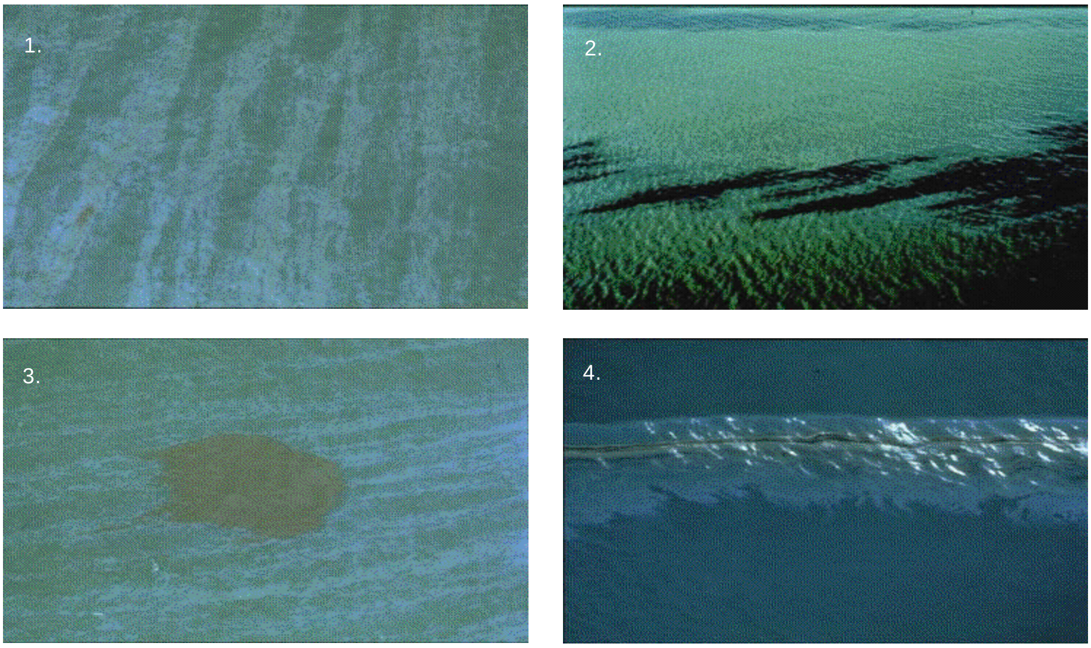
Source- the Bonn Agreement – Agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances 1983 (updated January 2004).

13.2.3 Determination of Volume of an Oil Slick

The amount of oil spilt should be estimated. If the source of the spill is known, then it may be possible to have a measure of the spill volume, depending upon the source characteristics (e.g. size of tank, volume of pipeline, etc.). If this is not possible then a rough estimate of the volume of oil in a slick may be judged by its size and appearance.

The oil, once positively identified, should be described and quantified. This is done by determining the area covered by the whole slick and by estimating the different thicknesses of oil from its colour and the area covered by each (refer to Figure 13.1 and Table 13.1).

Figure 13.1. Appearance of Oil: 1. Silvery Sheen, 2. Black Oil, 3. and 4. Brown Emulsion



The area covered by the slick is estimated from the time taken to travel over it at a given (ground) speed and the area of each colour in the slick estimated as a percentage cover.

Volume Estimation Procedure - Worked Example

1. Overall Area Measurement

SLAR Polygon

Overall Area from SLAR Data 12 km^2

Length and Width (SLAR Image or Time and Distance)

Length – 12 km x Width – 2 km (Imaginary Rectangle)

Area Covered (within Imaginary Rectangle) – 50%

Overall Area 12 x 2 x 50% 12 km^2

2. Overall Area Covered With Oil Calculation

Percentage of Overall Area Covered With Oil 90%

Using UV Imagery and Visual Observation

Overall Area Covered With Oil – 12 km^2 x 90% 10.8 km^2

3. Appearance Coverage Allocation

Appearance Code 1 (Sheen)	50%
Appearance Code 2 (Rainbow)	30%
Appearance Code 3 (Metallic)	15%
Appearance Code 5 (True Colour)	5%

4. Thickness Band for Allocated Appearance

Sheen	0.04 µm – 0.3 µm
Rainbow	0.3 µm – 5.0µm
Metallic	5.0 µm – 50 µm
True Colour	More than 200 µm

5. Minimum Volume Calculation

Overall Area x Area Covered with Specific Appearance x Minimum Thickness

Appearance 1 (Sheen)

10.8 km^2 x 50% x 0.04 µm = 0.216 m^3

Appearance 2 (Rainbow)

10.8 km^2 x 30% x 0.3 µm = 0.972 m^3

Appearance 3 (Metallic)

10.8 km^3 x 15% x 5.0 µm = 8.10 m^3

Appearance 5 (True Colour)

10.8 km^2 x 5% x 200 µm = 108.0 m^3

Minimum Volume = 0.216 + 0.972 + 8.10 + 108.0 = 117.288 m^3

6. Maximum Volume Calculation

Overall Area x Area Covered with Specific Appearance x Maximum Thickness

Appearance 1 (Sheen)

10.8 km^2 x 50% x 0.3 µm = 1.62 m^3

Appearance 2 (Rainbow)

10.8 km^2 x 30% x 5 µm = 2.7 m^3

Appearance 3 (Metallic)

10.8 km^3 x 15% x 50 µm = 81.0 m^3

Appearance 5 (True Colour)

10.8 km^2 x 5% x (more than) > 200 µm = > 108.0 m^3

Maximum Volume = 1.62 + 2.7 + 81.0 + > 108 = > 193.32 m^3

Typical Conversions		
1 tonne = 7.45 bbls	1 bbl = 42 US gallons	1 m^3 = 0.85 tonnes

13.2.4 Prediction of Oil Spill Trajectory

Oil spill movement can be modelled to predict the movement and fate of spilt oil and to 'monitor' the slick when not under direct observation. This can be done by the Operators's oil spill contractor (OSR) using the OSIS and/or the Oil Map models.

For this purpose, the following **essential information** is required;

- The date and time of the spill;
- The type of oil;
- Amount of oil;
- Spill location (latitude and longitude);
- Current and forecast weather;
- Air and water temperature (if available) and;
- Location of environmental sensitivities.

The models contain the relevant tidal data and a database of the characteristics of different oils. The output from the model will be a map showing the location of the slick at any desired time and data about the oil indicating the rate of oil dispersion and oil viscosity. This can also indicate the likelihood of the oil being amenable to chemical dispersion.

Predicting Slick Movement Manually

Slick movement can be predicted manually to provide a rough guide to possible direction and speed of slick movement, which may assist in developing an appropriate response strategy. It should not be considered a substitute for visual monitoring of slick movement throughout the oil spill response in the field.

The oil slick will move at approximately 3 percent of the wind speed and 100 percent of the current speed. Estimating slick movement and direction may be done manually by vector addition using an estimate of current speed and wind speed as indicated in the diagram and explained in the worked example.

Requirements

A protractor, a rule, a sheet of graph paper, appropriate Admiralty chart.

Data:

- Wind speed and wind direction;
- Current speed and direction (use Admiralty Chart);
- Latitude and longitude of the spill location (use project co-ordinates provided in the summary sheet).

Construction of a Vector Diagram

Use the same units and scale for the X axis (horizontal) and Y axis (vertical).

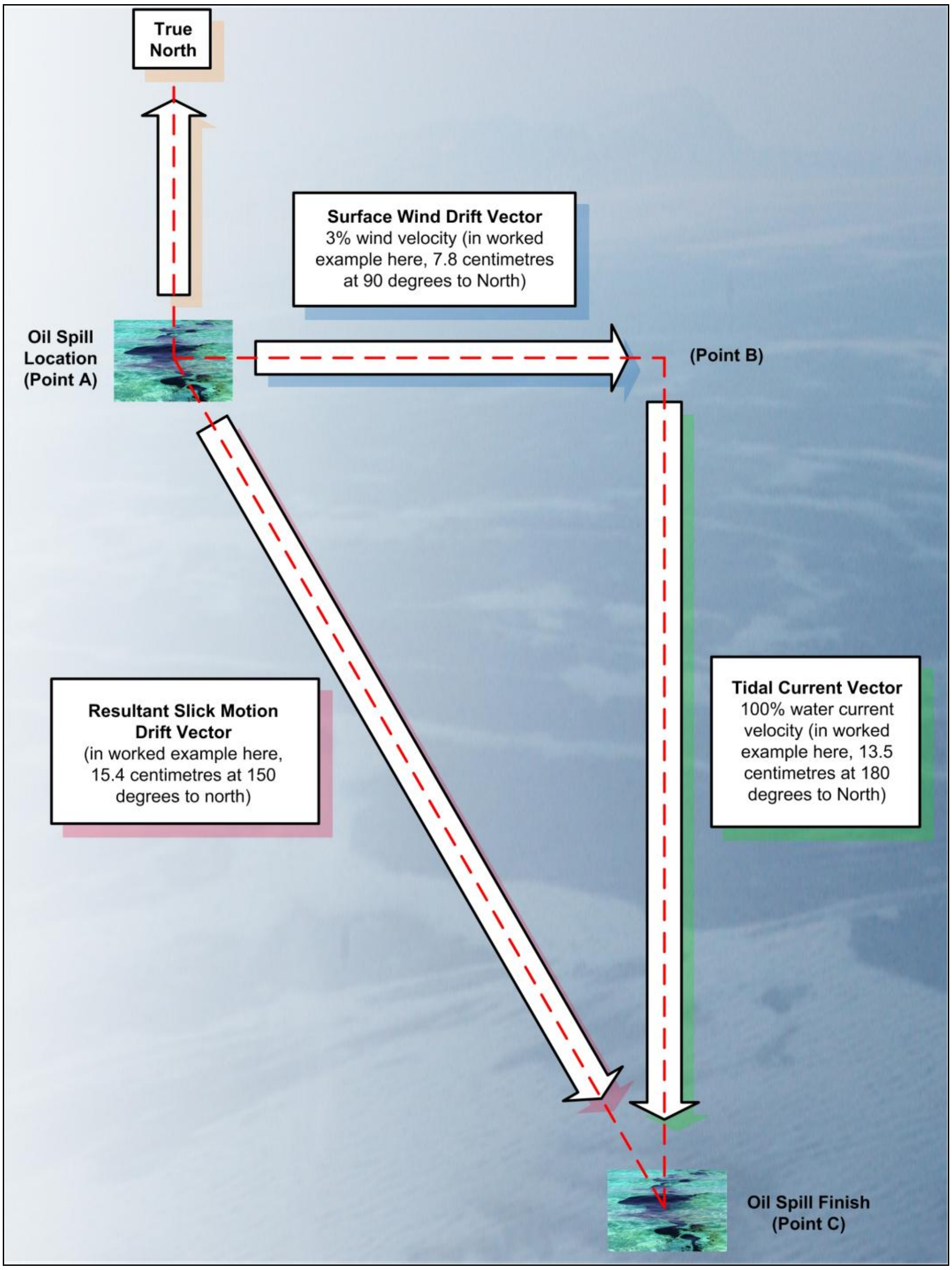
Units can be knots or kilometres per hour (1 knot = 1.85 kilometres per hour).

Suggested scale: 1 centimetre to 1 knot for high wind speeds or 10 centimetres to 1 knot for lower wind speeds (less than 20 knot).

- Plot the spill location on the graph paper (point A).

- On one axis, draw a line from A in the direction of the wind to represent the distance travelled by the slick in 1 hour at 3 percent of the wind speed (multiply the speed by 0.03 to give 3 percent of the wind speed) to point B. This is the Surface Wind Drift Vector.
- On the other axis draw a line from point B, the end of the Surface Wind Drift Vector in the direction of the current to represent the distance travelled by the slick in 1 hour at 100 percent of the current speed to point C. This is the Tidal Current Vector.
- Draw a line from A to where it intersects the Tidal Current Vector (point C). This is the Resultant Slick Motion Drift Vector.
- The length of the Resultant Slick Motion Drift Vector provides a value for the speed at which the slick is moving (or the distance moved in 1 hour). The angle of this line with the vertical axis of the graph, representing true north, (measured using the protractor) indicates the direction in which the slick is travelling. Figure 13.2 illustrates the construction of a simple vector diagram.

Figure 13.2. Movement of Spilt Oil at Sea



Plotting Slick Movement on an Admiralty Chart

The progressive movement of the oil slick should be plotted upon a chart.

- Mark the co-ordinates of the drilling rig on the chart.
- Convert the distance moved in one hour (obtained from the Resultant Slick Motion Drift Vector) to the same scale as the Admiralty chart.
- Draw a line (to scale) from the marked rig location at an angle equivalent to the direction of slick movement. Note the resultant co-ordinates of the slick, these represent the predicted position of the slick after one hour.
- A 24 hour prediction can be achieved by repeating steps 1 and 2 above for each hour, using the co-ordinates for the slick location as the starting point for the next iteration. The direction of the tidal current will need to be adjusted for each iteration.

Example

The wind speed is 30 knots and is blowing from the West.

A West wind blows from 270 degrees

The slick moves towards 270 degrees – 180 degrees = 90 degrees

30 knots = 30 x 1.85 kilometres per hour

= 55.5 kilometres per hour

Adjusted for 3 percent of the wind speed = 55.5 x 0.03

= 1.7 kilometres per hour

On a scale of 1 centimetre to 1 kilometre per hour plotted for a 1 hour period:

1 centimetre represents 1 kilometre.

1 x 1.7 = 1.7 centimetre represents 1.7 kilometres

The Surface Wind Drift Vector is drawn as a 1.7 centimetre line at an angle of 90 to the vertical axis.

The current speed is 3 knots and is flowing to the South.

A southerly current moves towards 180 degrees

3 knots = 3 x 1.85 kilometres per hour

= 5.6 kilometres per hour

On a scale of 1 centimetre to 1 kilometre per hour, plotted for a 1 hour period:

1 centimetre represents 1 kilometre.

1 x 5.6 = 5.6 centimetre represents 5.6 kilometres.

The Tidal Current Vector is drawn from the end of the Surface Wind Drift Vector as a 5.6 centimetres line at an angle of 180 degrees to the vertical axis.

From a vector diagram of the above:

The length of the Resultant Slick Motion Drift Vector = 6.0 centimetres and is at angle of 166 degrees to the vertical axis.

Therefore it is predicted that in 1 hour the slick will move 6.0 kilometres in a South South-East direction (towards 166 degrees).

The Admiralty chart has a scale of 1:200,000.

1 centimetre on the chart represents 200,000 centimetres = 2 kilometres.

The line drawn on the chart will be 1 centimetre x (6.0 kilometres / 2 kilometres) = 3.0 centimetres at an angle of 166 degrees.

13.2.5 Sampling of Spilt Oil

Where there is doubt in the source of spill, confusion of the identity of the responsible party, or if there appears to be more than one spill; FIG will request that samples are taken (*FIG NOSCP*). The oil samples should then be sent for lab testing and analysis in order to find the likely source of the oil.

The OIM should request the Master of the safety standby vessel to collect a sample of the oil using the oil spill sampling kit provided.

Advice on the collection and handling of oil samples is given in the NOSCP and summarised below. More information on sampling can be sought from the STOp4/2001 Notice that can be found on the MCA web site: http://www.dft.gov.uk/mca/stop4_01.pdf.

Sampling Location

Sample locations should be recorded using grid reference (e.g. latitude / longitude), including maps, sketches and photographs as appropriate. The date and time of sampling should also be noted.

Sample Collection

At sea The simplest sampler is a narrow mouth bottle which can be used to skim the surface of the oil. After the bottle is closed, it can be inverted and the closure opened slightly to drain excess water. The oil can then be decanted into to a clean bottle if necessary.

On shore Oil deposited on rocks or other impervious materials should be scraped off and placed directly into the sample container. Oil adhering to seaweed, wood, sand, plastic, sand or other debris should be dealt with by placing the complete specimen comprising oil and support material into the sample container where practical.

Sample Quantities

An oil sample should be as large as is reasonably practical. The minimum amounts needed for full chemical analysis are as follows. Note that small quantities may still have value as limited analyses may still be possible:

Fresh oils	100 ml. (4 fl. oz.)
Weathered oil, particularly water-in-oil emulsion (‘chocolate mousse’)	500 ml. (20 fl. oz.)
Tarry materials from beaches	50 g. (2 oz.)

Three samples should be taken:

Sample 1 Sent to certified laboratories for appropriate chemical analyses

Sample 2 Given to FIG if requested

Sample 3 Retained in storage for reference

Labelling & Storage

Oil samples should be stored in glass jars and refrigerated at less than 5°C in the dark. Metal and plastic containers should be avoided as these may interfere with subsequent analyses. Metal sampling tools containing nickel or vanadium should also be avoided. The top should be sealed with a signed adhesive label to prevent tampering.

13.3 Natural Dispersion

This is the **'default' response,** appropriate for the possible oil spills identified for the Operator's North Falkland Basin operations. If the oil slick does not immediately threaten any sensitivity or resource and prediction methods show that the oil will disperse by itself, then the valid response strategy is to monitor the oil slick until it disperses naturally. The future movement and behaviour of the oil should be predicted, as far as possible, using weather forecasts and computer modelling (available from OSR), until it has completely dispersed. Oil on the sea should be monitored by direct observation.

13.3.1 Weathering

As soon as oil is spilt to the sea, it is subject to a number of weathering processes which act simultaneously. Their relative importance varies with the properties of the oil and the prevailing environmental conditions. Its ultimate fate is to be biodegraded/oxidised, chiefly into carbon dioxide and water. The weathering agents are spreading, evaporation, dissolution, dispersion, emulsification, sedimentation, photo-oxidation and bio-degradation (Figure 13.3). For diesel and condensate the most important of these are **spreading** on the sea surface, **evaporation** and **dispersion**. The main weathering processes are summarised in Table .

Figure 13.3. Fate of Oil Spilt at Sea

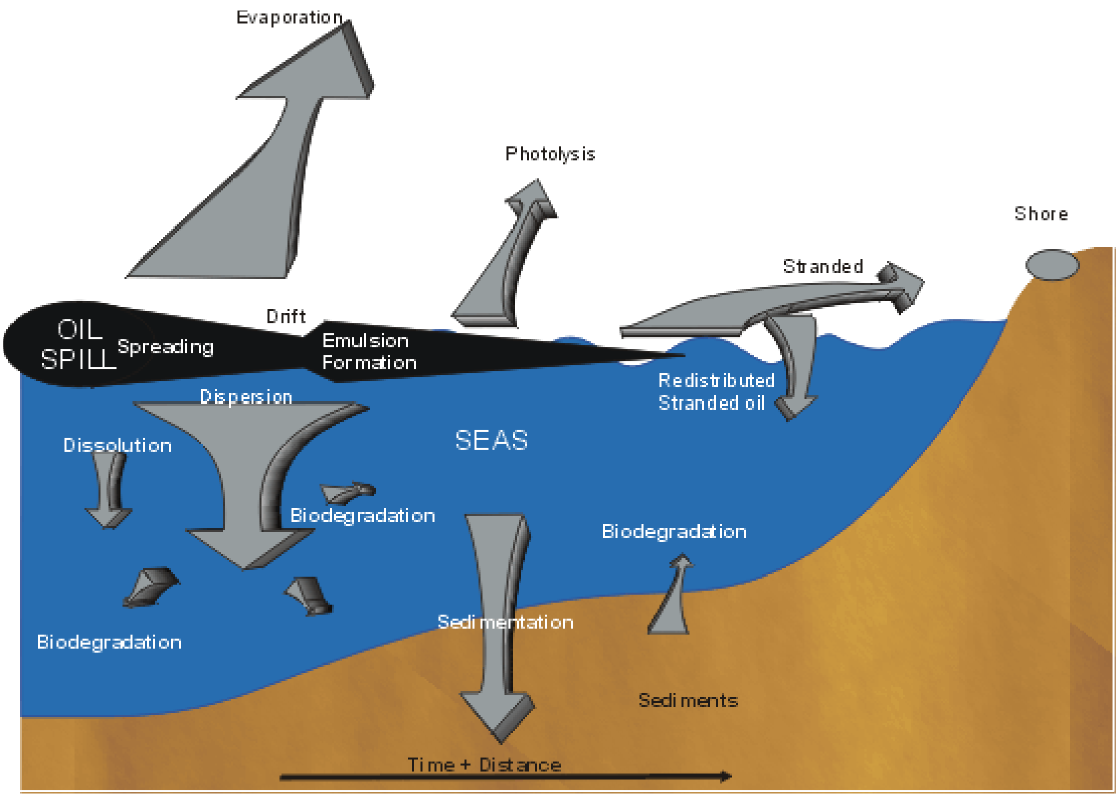


Table 13.2. Fate of Spilt Oil in the Marine Environment

Weathering Agent	Description	Rate and contribution to slick removal	DIESEL	CRUDE
Spreading	Oil will tend to spread out on the surface of the water. The rate and degree to which it does will depend upon the viscosity of the oil and the surface tension between the oil and the water. The higher the temperature, the lower the viscosity and the greater the degree and speed of spreading. Under the influence of wind the oil will become unevenly distributed. It will tend to break up into patches or ribbons, thickest in the leading edge and thinnest at the trailing edge.	Rapid cover of large areas.	Very rapid spreading	Rapid spreading
Evaporation	Evaporation will remove the more volatile molecules from the surface of the oil slick into the atmosphere. It will act fastest when there is a large surface area of oil exposed to the air and will increase with temperature. It will be more predominant when the proportion of lighter to heavier molecules in the oil is high and the energy in the sea and atmosphere is high (rough conditions).	Rapid, particularly for lighter oils. It may account for 10 – 75% of removal of oil from the sea surface depending upon the initial type.	Major means of removal	Initially dominant means of removal
Dissolution	The soluble elements of the oil (the lighter molecules) will preferentially be removed from the slick into the water column and they will subsequently be diluted by dispersion. Aided by high energy in the sea.	Active soon after a spill occurs, but overall it is a relatively minor pathway.	Can be important	Can be important
Dispersion	The oil layer on the surface of the sea is broken into small droplets which then disperse into the water column. The rate at which this occurs and the degree to which it occurs will depend upon the composition of the oil. Aided by high energy in the sea.	An important process for removing oil from the surface and facilitating bio-degradation. Most important for the less viscous oils.	Important	Important
Photolysis	Light energy acting upon oil breaks chemical bonds in the hydrocarbon chains and allows it to slowly oxidise. Aided by high levels of irradiation.	Negligible over the short term in high northern latitudes however important in the long term and lower latitudes.	Important	Important
Bio-degradation	Biodegradation is the ultimate means of removal of free oil from the environment. Aided by ample nutrient supply, dispersion of oil, moderate temperatures, high energy environment.	Minor importance in the short term but very important in the long term.	Not important	Important in long term
Drift	Drift of the oil slick is facilitated by wind, waves and surface water currents.	Important in distributing oil and moving it into or out of sensitive areas.	Can be important	Important

Diesel is a low viscosity distillate fuel made from light gas oil. Typically it has a density of 0.846 kilogrammes per litre. It contains a high proportion of light ends and so evaporation will play an important part in the removal of the oil from the surface of the sea. Spill evaporation rate will depend on the volume and rate of spill. LTOBM, if present, contains oil which would behave in a similar manner to diesel on the surface.

Crude (e.g. 25° API), accompanied by associated gas comprises the reservoir fluids; this is an ITOPF Group III crude which is persistent.

Lube and hydraulic oils are refined products. They have no light ends and behave as viscous oil. Evaporation will be limited and spreading relatively slow however they are dispersed rapidly by natural wave action. Aviation fuel is a refined distillate hydrocarbon fuel and more volatile than diesel. It will evaporate quickly.

13.4 Chemical Dispersant Application

Chemical dispersants are applied as a spray to floating oil to speed up the break-up of surface oil slicks into small droplets that disperse into the water column. As per FIG policy, where the FIG application criteria are met and approval from the Department of Fisheries is given, dispersant application is a primary response strategy offshore the Falkland Islands.

The amenability of the oil to dispersion should be tested by shaking a sample of oil and water in a container with the appropriate a mount of dispersant. Dispersant treatment should only be considered if the oil sample is effectively dispersed.

13.4.1 Dispersant Use Guidelines

The UK Marine Management Organisation (MMO) and the Marine Scotland - Marine Laboratory (MS-ML) have issued the following guidance on their use (*Annex 4 PON1 Guidance, 22nd March 2011*). Although these are UK agencies, their general advice is still applicable to the Falklands Offshore environment.

In addition, it has been stated by FIG that the list of approved dispersants for use on the UKCS will also apply to the Falklands i.e. dispersants permitted for use on the UKCS will be permitted by FIG for use offshore.

Shallow Water

The FIG application criteria as set out in the NOSCP relate to water depth and minimum distance from shore. The FIG application criteria are described below in Table 13.3.

Table 13.3. FIG Offshore Dispersant Application Criteria (FIG NOSCP)

Amount of Pollution to be Dispersed	Minimum Water Depth (metres)	Minimum Distance from Shore (nautical miles)
Up to 10 tonnes of oil	5	0.5
Up to 100 tonnes of oil	10	1
Up[to 1,000 tonnes of oil	15	2.5
Over 1,000 tonnes of oil	FIG would consult with technical experts	

Clearly, for offshore exploration operations, the criteria set out in Table 13.3 would be met in all cases.

In UK law, **government approval must be received before such products are used in shallow water.** The only exception is *force majeure* circumstances where it is necessary to use dispersants to protect the installation, vessels, or personnel who are at risk from the release.

Although this law does not strictly apply to the Falkland Islands, **it is advised that the Department of Fisheries is informed and consulted prior to the use of dispersant offshore**.

Deep Water (i.e. at least 1 nautical mile outwards from the 20 metre contour)

The UK DECC PON1 Guidelines state that:

"*It is the policy of the Licensing Authorities that they should be consulted in advance on all proposals to use oil dispersants except in circumstances where a release poses an immediate threat to human health or the safety of an installation*".

The appropriate Licensing Authorities therefore request to be consulted before dispersants are used, unless there are *force majeure* circumstances.

Following the UKs example therefore, the **Falklands Department of Fisheries should be consulted before dispersants are used, unless there are *force majeure* circumstances**.

According to FIG policy on the use of dispersant, as per the NOSCP, where the application criteria are met and approval from the Fisheries Department is given, dispersant application is a primary response strategy. The application criteria are set out in Table 13.4 below.

Table 13.4. FIG dispersant application criteria (NOSCP)

Amount of pollution to be dispersed	Minimum water depth (metres)	Minimum distance from shore (nautical miles)
Up to 10 tonnes of oil	5	0.5
Up to 100 tonnes of oil	10	1.0
Up to 1,000 tonnes of oil	15	2.5
Over 1,000 tonnes of oil	FIG would consult with technical experts	

Spills of Gasoline, Kerosene and Diesel

The general view of the UK Government Authorities is that chemical dispersants should **not** be used on released gas oil or diesel fuel, for two reasons. Firstly, the natural processes of evaporation and dispersion will usually rapidly remove these oils from the sea surface without the need for chemical treatment. Secondly, chemical dispersion of these light oils will result in unnecessary increased concentrations of toxic components within the upper water column.

Sometimes it is suggested that chemical dispersion of diesel, which is observed not to be dispersing naturally, might be necessary in order to protect seabirds. It is agreed that this may be an appropriate response, but, as always, it is a question of balancing one environmental outcome against another. Many spawning species have pelagic eggs and/or larvae which are vulnerable to oil which is chemically dispersed into the water column. Inevitably, they would become exposed to higher oil concentrations if dispersants were used than would be the case if the oil had been allowed to disperse naturally.

In the unlikely event that any spilled diesel oil does not disperse naturally, chemical dispersion can be considered, but this should only take place with the agreement of the relevant regulatory authorities (Department of Fisheries). They will seek to respond to any request to use dispersants within an hour at the most, and will consult with their own scientific advisors and the relevant Nature Conservation Agencies before making a decision. This will ensure that any decision on the use of dispersant is based on the most up-to-date information on both spawning fish populations and seabirds, thereby minimising any environmental impact.

Further advice on all aspects of oil dispersant use is set out in the UK Marine Management Organisation (MMO) Publication "*The Approval and Use of Oil Dispersants in the UK (PB3180)*" available on the MMO website:

http://www.marinemanagement.org.uk/protecting/pollution/documents/approval_approved_products.pdf.

13.4.2 Dispersant Mechanics

Once in the form of small droplets, the surface area of oil open to attack by biodegrading agents is vastly increased. Dispersants work as wetting agents whose molecules are part hydrophilic and part oleophilic. On amenable oils (of viscosity of less than 2,000 centistokes or so) this has the effect of reducing the surface tension in the oil and makes it more amenable to breaking up into small droplets. The hydrophilic nature of the molecules makes the oil droplets more likely to disperse in to the water column and less likely to float. The lowering of the surface tension in the oil also makes it less likely that the oil will form an emulsion with water. In its turn this can reduce the time that oil will take to naturally disperse and can therefore reduce the threat to the environment.

In order to function, the dispersant must be delivered onto the surface of the oil and the oil must then be subjected to a degree of natural or artificial agitation, to break the oil film up. Dispersants must be delivered onto the surface of the oil as droplets, which will mix with the oil for long enough for them to take effect. This can be achieved from surface vessels equipped with a dispersant application system, or by an aerial delivery system, helicopter or by aeroplane. Specialist equipment for this function is commercially available for hire or direct purchase.

To function effectively the dispersant must be applied to the oil in the correct ratio of dispersant to oil. Normally the ratio used is 1:20, that is one volume of dispersant to twenty volumes of oil. However, in practice the ratio chosen will depend upon the technical details of the dispersant being used (see manufacturer's recommendations), the amount and type of oil to be dispersed and its state of weathering. For example, during the Sea Empress incident in the UK in 1996, following close monitoring of the response and its effectiveness, it emerged that the dispersant was effectively dispersing the oil at a ratio of 1:60. This high rate efficacy demonstrates the benefits that can accrue with a combination of favourable environmental conditions and a well conducted operation.

The key points for effective dispersant use are:

- Using dispersant upon an oil on which it is effective;
- Treating freshly spilt, un-weathered oil;
- Accurate targeting of the oil slicks for treatment; and
- Optimal wind speed and sea-state for enhanced dispersion of oil.

Dispersed oil in the water column increases the amount of oil, in droplets, in the first few metres below the sea surface. Sometimes this is visible as a characteristic plume spreading from the surface downwards. Studies have shown that despite the absence of the visible plume there may still be elevated oil concentrations below the surface following the use of dispersants, indicating that they are working. The toxic exposure of marine organisms to this oil has been demonstrated to have an effect at a concentration of more than 10 parts per million of dispersed oil with an exposure time of between two to four hours. Where rapid dilution of the dispersed oil is not possible then dispersant should not be used, for example in sheltered bays and shallow water. In open water, dilution normally ensures that this toxic concentration is rarely exceeded for any significant length of time.

The relatively high toxicity of dispersed diesel in the water column means that there is no net environmental benefit to be achieved by the use of chemical dispersant upon it. Chemical dispersant would therefore only be used on diesel if life or the installation was threatened. Dispersant use is therefore subject to certain limitations imposed by the nature of the oil to be dispersed, the delivery system and the weather conditions (Table 13.5).

Table 13.5. Limiting Factors for Dispersant Application

Constraint	Limits	Reference
Visibility (for aircraft delivery)	daylight hours (visibility > 5 nm)	IOE 1991, MPCU personal communication
Wind speed	Beaufort Force 4-5 (22 – 33 knots)	CONCAWE 1988, IP 1987, Mackay *et al.* 1986, IOE 1991
Wave height	0.5-2.5 m	Kvam 1986, IOE 1991
Oil viscosity	<2000 mPa	CONCAWE 1988, IP 1987, MPCU personal communication

The amenability of the oil to dispersion should be tested by shaking a sample of oil and seawater in a container with the appropriate amount of dispersant. Dispersant treatment should only be considered if the oil sample is effectively dispersed.

13.4.3 Field Testing Dispersability of Spilled Oil by the Standby Vessel

If dispersant is held on the standby vessel, the installation may be requested to instruct the standby vessel to conduct the following dispersability test described in Table 13.6. This test determines the effectiveness of dispersant on the spilt oil. Note: Government agencies may also require a dispersability test prior to giving approval for dispersant use.

Table 13.6. Bottle Test

Bottle Test – On Stand-By Vessel – Conduct ASAP	
Step	**Action**
1	¾ fill a screw top jar with seawater.
2	Add a 25 ml sample of the spilt oil (collected using the slick sampling procedure).
3	Add 2 or 3 drops (ca. 1 ml) of dispersant from the stock (in the spilled oil sampling kit) onto the surface.
4	Screw on the lid and shake the jar.
5	If the oil remains mixed throughout the seawater and does not rise again to the surface, the slick should be amenable to dispersant spraying.
6	Log result, time and operator and relay the result to the OIM who will report the result to the Emergency Response Team.

13.5 Containment & Recovery

Mechanical Containment and Recovery is not generally considered to be a practical response to offshore oil spills in the North Falkland Basin. However, as per FIG policy, containment and recovery is a primary response strategy for inshore waters, where feasible.

Mechanical containment and recovery is made up of a chain of operations consisting of:

- Containment with some form of boom;
- Mechanical recovery with a skimming device or adsorbent;
- Temporary storage and transport of recovered oil; and
- Treatment, disposal or use of recovered oil.

Mechanical containment of oils involves containing all or part of the oil slick by deploying a boom from the response craft. The boom will form a barrier containing the oil floating on the surface of the water against the tendency of oil to spread and to drift. The boom must be attached at each end to a vessel or anchored. There are a variety of different booms available for use in different circumstances, each being designed, as far as possible, to overcome the problems associated with a particular environment.

The physical factors limiting the use of booms (Table 13.7) are that they cannot be deployed when wind and sea conditions are too rough and they cannot be held against a water current of more than 0.7 metres per second. The physical barrier of the boom will fail to hold oil if waves are too high, allowing oil to escape over the top or by entrainment if the current is too strong, allowing oil to escape beneath.

OSRL have been consulted on the use of booms in the Falklands offshore environment and have assessed that the weather conditions (mainly significant wave height) are too severe to deploy booms for approximately 75% of the time based on annual weather statistics. Therefore, containment and recovery methods are not considered a practical response to offshore oil spills.

Offshore recovery typically requires two or more vessels to which are attached the ends of the boom to hold it stationary or tow it into the wind in either a U or J configuration. The oil is recovered using a skimmer deployed by a third vessel, or by the vessel at the 'base of the J', where the oil will tend to accumulate at its thickest. There are a variety of

different types and models of skimmers, each of which will function best in a certain set of conditions (Table 13.8). The recovered oil, normally mixed with some water, is then pumped to some form of tank for storage and transport.

The oil must then be transported to shore for final use or disposal. To prevent a recurrence of the pollution the storage location must be robust enough to allow transport ashore for disposal. There are a variety of temporary storage systems available, pillow tanks, or tankers. These must be appropriately rated for the job in hand and must be used within their limitations. Tankers used for storing oil must be rated according to Merchant Shipping notes M1663.

In practice, the amount of oil which is generally recovered at sea through containment and recovery operations is only a small percentage of the amount spilled. This is due to the great physical difficulties of carrying out a difficult operation in an uncontrolled environment and due to the limits of the containment and the recovery systems. Acknowledging this, any oil that can be recovered, will reduce the potential for the oil slick to cause damage to the environment and is therefore useful.

Table 13.7. Physical Limitations of Booms for Oil Containment

Constraint	Limits	Reference
Visibility	Daylight hours	IOE, 1991
Wave Height	< 2.0 metres (conservatively)	IOE, 1991, Schulze, 1993; BMES/OSR Personal communication
Water Current	Daylight hours < 0.7m/s (1.35 kts) normal to the boom	CONCAWE, 1981; Schulze, 1993; OSR Personal communication

Table 13.8. Physical Limitations of Skimmers

Skimmer	Type of Oil	Capacity	Weather	Observations
Disc skimmers	All kinds of oil, poor efficiency in emulsions	10-400m^3/h collect 10-60% water with the oil	Claimed up to Beaufort Force 4-5 (1-3 metre waves)	Installed on board ship or a floating unit, best used with booms
Band skimmers	Work in non viscous oils	10-300m^3/h 10-50% water with the oil	Efficient in calm water, low efficiency in waves	Tow speed is 1-2 knots max. The band can suffer from tearing with the presence of solids and too high towing speed
Vortex skimmers	All oils except viscous oil and emulsion	10-700m^3/h 20-60% of water is recovered	Used with waves up to 1.5 metres	Must be towed by ship or fixed to the boats hull. To be efficient the apparatus must be towed at 1-8 knots.
Skimming barrier	All oils except highly viscous emulsions	100-2,700m^3/day	Efficiency reduces with waves >0.5 metres	Must be towed at speed sufficient to ensure adequate thickness of oil reaches pump

13.6 Shoreline Protection & Cleanup

FIG Policy on Shoreline Protection and Cleanup stipulates to prioritise the most sensitive areas according to their Environmental Sensitivity Index (ESI) that have suitable access and where there is presence of wildlife that may be at risk of oiling. Also, areas where there is heavy contamination and floating oil should be prioritised to limit further oil mobilisation and contamination (*FIG NOSCP*).

If oil reaches the Falklands coastline, the principal factors to consider during an onshore clean-up operation are:

- Environmental sensitivity of the coastline;
- The length of contaminated coastline;
- The volume of oil to be cleaned up;

- The access route to the areas to be cleaned;
- Good communications and planning;
- A suitable clean-up method for each length of coast; and
- Temporary storage of contaminated materials and liquid oil.

Shorelines have varying degrees of vulnerability to oil spills and the clean-up techniques must be selected accordingly.

Where clean-up or coastal protection is recommended, the following options are available:

- Booms to protect specific areas or to contain oil;
- Skimmers to remove oil from the water near the shore;
- Cold/hot water hoses to wash down beaches;
- Dispersant treatment of beached oil at low tide (only with FIG approval);
- Bioremediation in situ (only with FIG approval);
- Physical removal of oil and contaminated debris; or
- Natural degradation of oil.

The clean-up option should be chosen in relation to shore type (Table 13.9). Advice should be sought from experts and conservation agencies. Environmental sensitivities may vary throughout the year and change accordingly. Particular attention needs to be paid to these together with the organisation of beach cleanup teams, temporary storage of oil and debris and access routes to shore. Consideration should also be given to the following:

- The areas where the oil should be left to disperse naturally and monitored (high-energy shorelines);
- The areas or conditions under which the oil should be dispersed;
- The areas where the spill should be recovered mechanically;
- The areas which should be given priority for protection by booms; and
- The location of temporary storage pits and treatment areas for oiled debris and oily water.

In practice, any inshore clean-up operations will be conducted in close consultation with FIG, to ensure that existing priorities can be met and an effective clean-up operation executed.

Table 13.9. Vulnerability Indices for Various Shoreline Types (1 indicates lowest vulnerability and 10 indicates highest vulnerability)

Vulnerability Index	Shoreline type	Comments
1	Exposed rocky shores	Wave reflection keeps most of the oil offshore. High energy wave environment. No cleaning necessary.
2	Eroding wave cut platforms	Wave swept. High energy wave environment. Most oil removed by natural processes within weeks.
3	Fine grained sand beaches	Oil does not usually penetrate far into the sediment, facilitating mechanical removal if necessary. Oil may persist for several months. High/Medium energy wave environment.
4	Coarse grained sand beaches	Oil may sink or may be buried rapidly, making cleanup difficult. High/Medium energy wave environment. Under moderate to high energy (> sea state 4 or 5) conditions the oil will be removed naturally within months from most of the beach face.
5	Exposed compacted tidal flats	Most oil will not adhere to or penetrate into the compacted tidal flat. Medium energy wave environment. Clean-up usually unnecessary – recommend leaving oil to disperse naturally.
6	Mixed sand and gravel	Oil may undergo rapid penetration and burial; under moderate to low energy conditions. Medium/Low energy wave environment. Oil may persist for years.
7	Gravel beaches	As for 6. A solid asphalt pavement may form under heavy oil accumulations.
8	Sheltered rocky coast	Areas of reduced wave action; oil may persist for many years. Low energy wave environment. These areas should receive priority protection by using booms or oil-adsorbent materials.
9	Sheltered tidal flat	Areas of low wave energy and high biological productivity; oil may persist for many years. Low energy wave environment. Clean-up is not recommended unless oil accumulation is very heavy, due to causing more environmental damage by entering the site. These areas should receive priority protection by using booms or oil-adsorbent materials.
10	Salt marsh	Most productive of aquatic environments; oil may persist for many years. Low energy wave environment. These areas should receive priority protection by using booms or oil-adsorbent materials. Seek advice from appropriate conservation organisations.

The majority of the Falklands coastline is remote and relatively inaccessible, which will make any shoreline cleanup operations difficult. **Therefore, the primary response strategy should be to disperse oil offshore before it has a chance to reach the coastline**.

13.7 Oiled Wildlife Response

Members of OSR have access to an emergency oiled wildlife response and preparedness service, coordinated by the Sea Alarm Foundation.

Sea Alarm is a non-governmental organisation working to improve global preparedness for and response to oiled wildlife incidents. An OSR member can contact Sea Alarm via the OSR Duty Manager.

13.7.1 Oiled Wildlife Response Aims

The principle aim of oiled wildlife response is to mitigate the effects of oil on wildlife (seabirds, marine mammals and sea turtles). Sea Alarm works in conjunction with its

international network to lead or support all elements of an oiled wildlife response in cooperation with local authorities, experts and response groups. This may include:

- Initial wildlife response assessment and response planning;
- Mobilisation of oiled wildlife response equipment (from Oil Spill Response or other);
- Hazing operations (techniques to deter wildlife away from oiled areas);
- Search and collection of oiled wildlife (alive and dead) on the beach or coastline;
- Setup of temporary rehabilitation facilities and/or transformation of existing rescue centres to handle large numbers of oiled animals;
- Transport of oiled wildlife to a forward holding centre or rehabilitation facility;
- Triage of animals for either long term rehabilitation or euthanasia;
- Cleaning and rehabilitation;
- Euthanasia of wildlife as appropriate and authorised by regulators;
- Monitoring and release;
- Scientific wildlife impact assessment; and
- Liaising and working with key representatives of the international compensation regimes (e.g. ITOPF, P&I Clubs, IOPC Fund) to maximise the probability of cost reimbursement.

13.7.2 Sea Alarm Mobilisation

In the event that Sea Alarm is mobilised, Sea Alarm will:

- Work closely with the client to determine the appropriate level of wildlife response and resource needs;
- Depending on the severity of the incident, Sea Alarm can provide distant expert advice and coach local responders remotely (via phone/email – Level 1 response), mobilise an assessment team of 2-4 people to visit the site to determine which assistance is needed and at what scale (Level 2 response) and/or mobilise an appropriate team of responders that works on site to assist the local response (Level 3 response);
- On the basis of information available Sea Alarm would identify available wildlife response organisations and experts and propose a response team and a plan to the client;
- Sign contracts, both with the Client and back-to-back with its team of wildlife responders (latter via subcontracts). All responders would have Professional Indemnity and travel insurance, via their own organisations or Sea Alarm;
- After contract signature, coordinate the mobilisation of the international wildlife response team;
- Together with Oil Spill Response, co-ordinate mobilisation of stocks of oiled wildlife response equipment from Oil Spill Response bases, plus 1 Oil Spill Response Specialist to be responsible for use and maintenance on site;
- Co-ordinate activities of the international wildlife response team on site and ensure the optimal integration of these activities into the overall oil spill response;
- Coordinate downscaling, demobilisation and debriefing towards the end of the response assistance, and completing documentation, reporting and financial administration.

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Appendix A – Rockhopper Exploration plc Sea Lion & Johnson Prospect OPEP Modelling Report

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Rockhopper Exploration Plc

Sea Lion & Johnson Prospect OPEP Modelling Report




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Table of Contents

1 Introduction

Rockhopper Exploration PLC (herby referred to as Rockhopper) has commissioned Orbis Energy Limited (Orbis) to undertake an oil spill modelling study, for use in an Oil Pollution Emergency Plan (OPEP), for their upcoming drilling campaigns (Sea Lion and Johnson Prospect), offshore of the Falkland Islands.

The oil spill modelling has been conducted using SINTEF's Oil Spill Contingency and Response (OSCAR) model (version 6.1).

To illustrate the potential fate and movement of the oil in the marine environment following a blow-out event, several trajectory and stochastic scenarios have been modelled for both oil (Sea Lion) and condensate (Johnson) hydrocarbons (in addition to rig fuel inventory modelling).

The modelling scenario runs reflect the current requirements for a UK OPEP, under the following regulations:

- Offshore Petroleum Activities (Oil Pollution Prevention and Control) (Amendment) Regulations 2011;
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (OPRC Regulations); and
- The Offshore Installation (Emergency Pollution Control) Regulations 2002 (EPC Regulations).

The Falklands Islands Government (FIG) has adopted the UK legislation on oil spill preparation.

The blow-out modelling scenarios have taken into account a range of open hole flow rates (i.e. the amount of oil released from the well per day) and durations (i.e. the time taken for the oil to cease flowing on the assumption that the well has been capped or brought under control).

Rockhopper has also commissioned a hydrocarbon assay study to accurately identify the properties of the Sea Lion crude. The results from the assay identified the Sea Lion crude as having a high wax content (22%). To ensure the modelling is as accurate as possible, the properties of the Sea Lion hydrocarbon assay have been used in the OSCAR model (refer to Table 2.2).

This report summarises the results of the modelling study.

2 Sea Lion Modelling Scenarios Data

2.1 The Sea Lion Area of Interest

The Sea Lion area of interest is located in Licence Block PL032 (Falklands Block 14/10) of the North Falklands Basin, immediately to the north of the Falkland Islands. The nearest landfall to the area is Cape Dolphin on East Falkland, approximately 220 kilometres due south. The nearest international boundary is the Falklands Inner Conservation Zone (FICZ) and Falklands Outer Conservation Zone (FOCZ) boundary, which lies approximately 110 kilometres to the west. The Sea Lion well specifics are shown in Table 2.1.

Table 2.1: Sea Lion Project Specifics

Parameter	Data
Well Name	Sea Lion
Well Type	Exploration / Appraisal
Falklands Block	14/10
Well Management Company	AGR

Parameter	Data
Drilling Rig	Ocean Guardian Semi-Submersible Drilling Rig
Drilling Rig Fuel Inventory (diesel)	1,108 tonnes
Hydrocarbons Expected	Oil
Support Vessel	UOS Endeavour and Enterprise

2.2 Modelling Parameters

The parameters entered into the OSCAR model (version 6.1) for the Sea Lion modeling scenarios are detailed in Table 2.2.

Table 2.2: Parameters entered into the OSCAR model for the Sea Lion Modelling

Parameter	Data Used for the Sea Lion Modelling
Release Location	
Latitude and Longitude Co-ordinates	049° 15’ 18” S; 059° 06' 55" W
Water Depth	451 metres
Nearest Landfall	220 kilometres (Falkland Islands)
Hydrocarbon Release Point	Surface Release (as per UK OPEP Requirements)
Drilling Rig	
Rig Name and Type	Ocean Guardian (semi-submersible)
Fuel Type	Diesel
Fuel Capacity (tonnes)	1,108
Hydrocarbon Characteristics (data taken from a hydrocarbon assay conducted on the Sea Lion crude by Intertek in 2011)	
Modelled Hydrocarbon	Sea Lion Crude
API	29.2 (medium crude with a high wax content)
Pour Point (˚)	30 degrees centigrade
Density at 15˚C	0.88
Wax Content	22% by weight
Asphaltenes	0.10% No significant quantities found After PPD testing, OilPlus found a residue that was not soluble in hexane, which is sometimes indicative of asphaltenes. Further testing showed that these were "insoluble" waxes rather than asphaltenes. It is possible that there could still be asphaltenes in Sea Lion crude, but we need higher quality PVT samples.
Metocean Data	
Current Data	Falklands specific current data (collected between July 1997 –

Parameter	Data Used for the Sea Lion Modelling
	July 1998) (*Fugro, 2011*) (refer to Appendix A)
Wind Data	Data from Falklands specific wind data collected between 1994 – 2010 (*Fugro, 2011*) (refer to Appendix A)
Water Temperature	10 degrees Centigrade
Air Temperature	10 degrees Centigrade

2.3 Modelling Scenarios

Table 2.3 summaries the Sea Lion scenarios that have been modeled for use in the OPEP. Both trajectory (single point wind, blowing in one direction) and stochastic (typical wind) simulations have been run to model the fate of oil, following a hydrocarbon release.

Table 2.3: The Sea Lion Modelling Scenarios

Hydrocarbon Release Scenario	Hydrocarbon Type	Released Volume (tonnes)	Duration (days)	Total Volume Released (tonnes)	Modelling Type and Wind
Loss of Rig Fuel Inventory					
Loss of Rig Fuel Inventory	Diesel	**1,108**	Zero (instantaneous release)	**1,108**	Trajectory 30 knot Offshore wind
Loss of Rig Fuel Inventory	Diesel	**1,108**	Zero (instantaneous release)	**1,108**	Trajectory 30 knot Onshore wind
Loss of Well Control (Blow-Out)					
Scenario 1 - Worst Case Flow Rate[3]	Sea Lion Crude	**577 per day (4,127 barrels[1])**	182.5[2]	**105,302.5**	Trajectory 30 knot Offshore wind
Scenario 1 - Worst Case Flow Rate[3]	Sea Lion Crude	**577 per day (4,127 barrels[1])**	182.5[2]	**105,302.5**	Trajectory 30 knot Onshore wind
Scenario 1 - Worst Case Flow Rate[3]	Sea Lion Crude	**577 per day (4,127 barrels[1])**	182.5[2]	**105,302.5**	Typical Conditions (Stochastic)
Scenario 2 – Best Case Flow Rate[3]	Sea Lion Crude	**47.4 per day (339 barrels[1])**	182.5[2]	**8,650.5**	Trajectory 30 knot Offshore wind
Scenario 2 – Best Case Flow Rate[3]	Sea Lion Crude	**47.4 per day (339 barrels[1])**	182.5[2]	**8,650.5**	Trajectory 30 knot Onshore wind
Scenario 2 – Best Case Flow Rate[3]	Sea Lion Crude	**47.4 per day (339 barrels[1])**	182.5[2]	**8,650.5**	Typical Conditions (Stochastic)

[1] A density of 0.88 was used for converting the Sea Lion Reservoir hydrocarbons from barrels to tonnes (taken from the Sea Lion Hydrocarbon Analysis Assay – *Intertek, 2011*)

[2] This would be the worst case duration estimated to source another drilling rig and drill a relief well. In reality, Rockhopper expect this release duration to be much shorter

[3] There will be an expected decrease in flow rate during any blow-out event; therefore two flow rates have been modelled. A commissioned flow rate modelling study conducted by Axis Well Technology (Axis, 2011), supports these flow rates.

2.4 Hydrocarbon Release Point

All modeling scenarios have been run using a surface release of hydrocarbons from the drilling rig. A surface release meets the requirements of OPEP modeling specified by the UKCS OPCR regulations, and by extension the Falkland Islands, Government.

3 Johnson Prospect Modelling Scenarios Data

3.1 The Johnson Prospect Area of Interest

The Johnson Prospect area of interest is located in Licence Block PL032 (Falklands Block 14/10) of the North Falklands Basin, immediately to the north of the Falkland Islands. The nearest landfall to the area is Cape Dolphin on East Falkland, approximately 240 kilometres due south. The nearest international boundary is the Falklands Inner Conservation Zone (FICZ) and Falklands Outer Conservation Zone (FOCZ) boundary, which lies approximately 110 kilometres to the west. The Johnson Prospect well specifics are shown in Table 3.1.

Table 3.1: Johnson Prospect Project Specifics

Parameter	Data
Well Name	Johnson Prospect
Well Type	Exploration
Falklands Block	14/10
Well Management Company	AGR
Drilling Rig	Ocean Guardian Semi-Submersible Drilling Rig
Drilling Rig Fuel Inventory (diesel)	1,108 tonnes
Hydrocarbons Expected	Gas (with some condensate)
Support Vessel	UOS Endeavour and Enterprise

3.2 Modelling Parameters

The parameters entered into the OSCAR model (version 6.1) for the Johnson Prospect modeling are detailed in Table 3.2.

Table 3.2: Parameters entered into the OSCAR model for the Johnson Prospect Modelling

Parameter	Data Used for the Johnson Prospect Modelling
Release Location	
Latitude and Longitude Co-ordinates	049° 05’ 00” S; 059° 11' 00" W

Parameter	Data Used for the Johnson Prospect Modelling
Water Depth	450 metres
Nearest Landfall	240 kilometres (Falkland Islands)
Hydrocarbon Release Point	Surface Release (as per UK OPEP Requirements)
Hydrocarbon Characteristics	
Modelled Hydrocarbon	Lavrans (47.9˚ API Condensate)
Metocean Data	
Current Data	Falklands specific current data (collected between July 1997 – July 1998) (*Fugro, 2011*) (refer to Appendix A)
Wind Data	Data from Falklands specific wind data collected between 1994 – 2010 (*Fugro, 2011*) (refer to Appendix A)
Water Temperature	10 degrees Centigrade
Air Temperature	10 degrees Centigrade

3.3 Modelling Scenarios

Table 3.3 summaries the Johnson Prospect modeling scenarios that have been modeled for use in the OPEP. Both trajectory (single point wind, blowing in one direction) and stochastic (typical wind) simulations have been run to model the fate of oil, following a hydrocarbon release.

Table 3.3: The Johnson Prospect Modelling Scenarios

Hydrocarbon Release Scenario	Hydrocarbon Type	Released Volume (tonnes)	Duration (days)	Total Volume Released (tonnes)	Modelling Type and Wind
Loss of Rig Fuel Inventory					
Loss of Rig Fuel Inventory	Diesel	**1,108**	Zero (instantaneous release)	**1,108**	Trajectory 30 knot Offshore wind
Loss of Rig Fuel Inventory	Diesel	**1,108**	Zero (instantaneous release)	**1,108**	Trajectory 30 knot Onshore wind
Loss of Well Control (Blow-Out)					
Scenario 1 - Worst Case Duration (6 months)	Condensate	**465 per day (3,750 barrels[1])**	182.5[2]	**84,862.5**	Trajectory 30 knot Offshore wind
Scenario 1 - Worst Case Duration (6 months)	Condensate	**465 per day (3,750 barrels[1])**	182.5[2]	**84,862.5**	Trajectory 30 knot Onshore wind
Scenario 1 - Worst Case Duration (6	Condensate	**465 per day (3,750 barrels[1])**	182.5[2]	**84,862.5**	Typical Conditions (Stochastic)

months)					
Scenario 2 – Best Case Duration (3 months)	Condensate	**465 per day (3,750 barrels[1])**	91.25[2]	**42,431**	Trajectory 30 knot Offshore wind
Scenario 2 – Best Case Duration (3 months)	Condensate	**465 per day (3,750 barrels[1])**	91.25[2]	**42,431**	Trajectory 30 knot Onshore wind
Scenario 2 – Best Case Duration (3 months)	Condensate	**465 per day (3,750 barrels[1])**	91.25[2]	**42,431**	Typical Conditions (Stochastic)

[1] A density of 0.78 was used for converting the Johnson Prospect condensate from barrels to tonnes.

[2] The worst case duration of an uncontrolled Blow-Out is 6 months, which is the time estimated to source another drilling rig and drill a relief well. In reality, Rockhopper expect that the duration within which the well will be under control will be much shorter and therefore a 3 month duration has also been modeled.

3.4 Hydrocarbon Release Point

All modeling scenarios have been run using a surface release of hydrocarbons from the drilling rig. A surface release meets the requirements of OPEP modeling specified by the UKCS OPCR regulations, and by extension the Falkland Islands, Government.

4 Modelling Results

4.1 Sea Lion Modelling Results

4.1.1 Overview

Table 4.1 provides an overview summary of the Sea Lion modeling results, which are discussed in detail below. It is predicted that any oil released from the Sea Lion Area of interest will spread out to the north and east, with a generalized movement of the oil to the north, in line with sea currents in this region (*Fugro, 2011*). None of the scenarios modelled resulted in hydrocarbons being beached on the coastline of the Falkland Islands.

Table 4.1: Results of the Sea Lion Modelling

Hydrocarbon	Scenario	Model	Released Volume per day (tonnes)	Duration of spill (days)	Total Volume Released (tonnes)	Section and Figure Number	Summary of the Fate of Oil
Diesel	-	Trajectory 30 knot Onshore wind Modelled for 30 days	1,108	Zero (instantaneous)	1,108	Section 4.1.2 Figure 4.1	The diesel did not beach The diesel is no longer significant on the sea surface after approximately 75 hours The diesel plume moves in a north easterly direction, away from the rig and the Falkland Islands
	-	Trajectory 30 knot Offshore wind Modelled for 30 days	1,108	Zero (instantaneous)	1,108	Section 4.1.2 Figure 4.2	The diesel did not beach The diesel is no longer significant on the sea surface after approximately 86 hours The diesel plume moves in a westerly direction, away from the rig and the Falkland Islands
Sea Lion Crude	1 - Worst Case – Blow-Out Flow rate	Trajectory 30 knot Onshore wind	577	182.5	105,302.5	Section 4.1.3 Figure 4.3	The oil did not beach The oil plume moves in north-easterly direction, away from the rig and the Falkland Islands
	1 - Worst Case – Blow-Out Flow rate	Trajectory 30 knot Offshore wind	577	182.5	105,302.5	Section 4.1.3 Figure 4.4	The oil did not beach The oil plume moves in northerly direction, away from the rig and the Falkland Islands

Hydrocarbon	Scenario	Model	Released Volume per day (tonnes)	Duration of spill (days)	Total Volume Released (tonnes)	Section and Figure Number	Summary of the Fate of Oil
	1 - Worst Case – Blow-Out Flow rate	Stochastic	577	182.5	105,302.5	Section 4.1.3 Figures 4.5 a and b	The oil did not beach The spill plume headed in a north-easterly direction with a 50-100% probability that the oil would be present within 500 km of the release point
	2 – Best Case – Blow-Out Flow rate	Trajectory 30 knot Onshore wind	47.4	182.5	8,650.5	Section 4.1.3 Figure 4.6	The oil did not beach The oil plume moves in north-easterly direction, away from the rig and the Falkland Islands
	2 – Best Case – Blow-Out Flow rate	Trajectory 30 knot Offshore wind	47.4	182.5	8,650.5	Section 4.1.3 Figure 4.7	The oil did not beach The oil plume moves in northerly direction, away from the rig and the Falkland Islands
	2 – Best Case – Blow-Out Flow rate	Stochastic	47.4	182.5	8,650.5	Section 4.1.3 Figures 4.8 a and b	The oil did not beach The spill plume headed in a north-easterly direction with a 50-100% probability that the oil would be present within 450 km of the release point

4.1.2 Loss of Rig Fuel Inventory

Trajectory Modelling Results (under worst case conditions)

Figure 4.1 below, displays the surface concentration of diesel (in parts per billion (ppb)) and the dissolved oil particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) onshore wind.

It can be seen that the diesel moves in a north easterly direction, away from the drilling rig and the Falkland Islands. After 75 hours, the diesel is no longer significant on the sea surface, with the furthest presence of surface oil from the release location being approximately 50 kilometres to the northeast.

After a 30 day duration, the 1,108 tonnes of diesel is broken down into the following:

- Sea Surface – Zero;
- Evaporated – 427.90 tonnes;
- Submerged – 58.44 tonnes;
- Decayed – 621.60 tonnes.

The maximum size of the diesel slick was calculated to be 15.5 square kilometres. Due to the lightness of the diesel, the model demonstrates that it will not persist on the sea surface past 75 hours.

Figure 4.1: Trajectory model run (under worst case 30 knot onshore wind) of an instantaneous 1,108 tonne diesel spill. Figure illustrates surface concentration (ppb) and the dissolved oil particles. Image taken at 10 days and 9 hours into the model

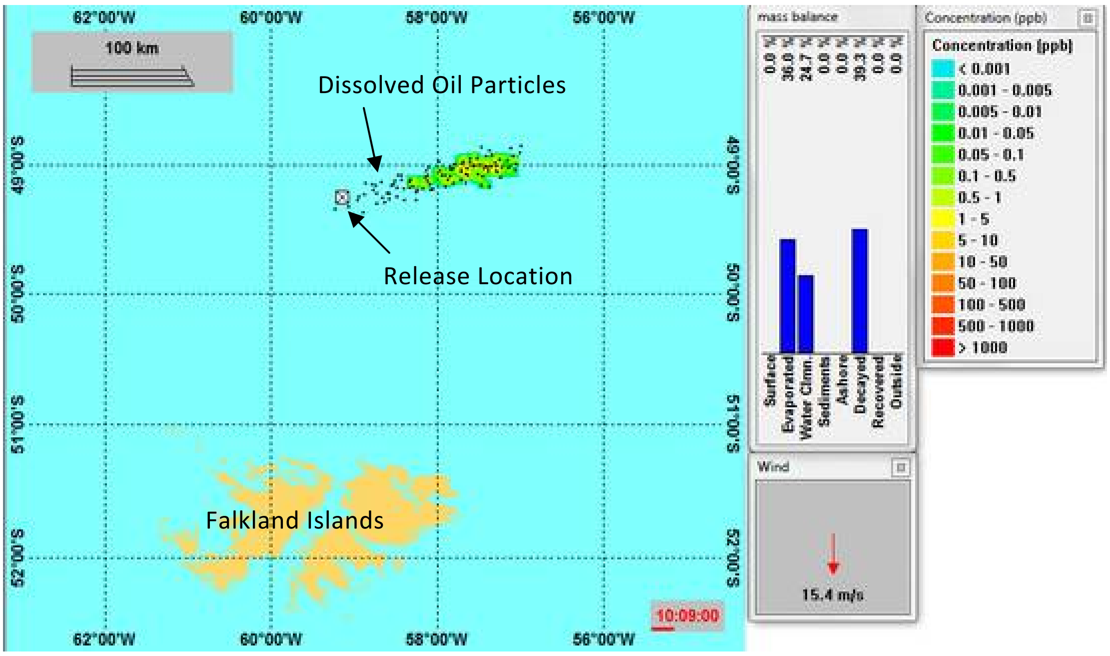


Figure 4.2 below, displays the surface concentration of diesel (in parts per billion (ppb)) and the dissolved oil particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) offshore wind.

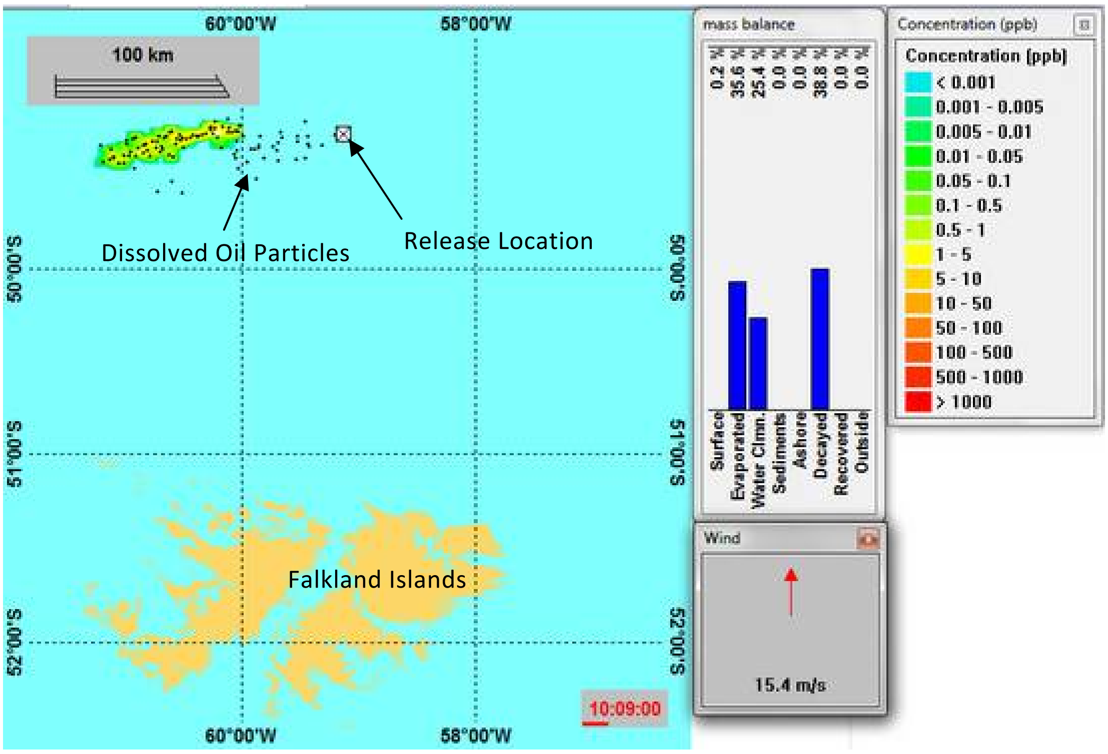
It can be seen that the diesel moves in a westerly direction, away from the drilling rig and the Falkland Islands. After 86 hours, the diesel is no longer significant on the sea surface, with the furthest presence of surface oil from the release location being approximately 65 kilometres to the west.

After a 30 day duration, the 1,108 tonnes of diesel is broken down into the following:

- Sea Surface – Zero;
- Evaporated – 428.70 tonnes;
- Submerged – 63.96 tonnes;
- Decayed – 614.50 tonnes.

The maximum size of the diesel slick was calculated to be 10.51 square kilometres. Due to the lightness of the diesel, the model demonstrates that it will not persist on the sea surface past 86 hours.

Figure 4.2: Trajectory model run (under worst case 30 knot offshore wind) of an instantaneous 1,108 tonne diesel spill. Figure illustrates surface concentration (ppb) and the dissolved oil particles. Image taken at 10 days and 9 hours into the model



4.1.3 Crude Oil Spill (Blow-Out)

Scenario 1 – Worst Case Flow Rate (577 tonnes per day for 6 months)

Trajectory Model Run Results (under worst case wind conditions)

Figure 4.3 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved oil particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) onshore wind.

It can be seen that the oil moves in a north north-easterly direction, away from the drilling rig and the Falkland Islands. After 182.5 days, the furthest presence of surface oil from the release location is over 1,000 kilometres to the north northeast.

After a 182.5 day duration, the 105,302.5 tonnes of oil is broken down into the following:

- Sea Surface – 7,035;
- Evaporated – 27,070 tonnes;
- Submerged – 4,199 tonnes;
- Decayed – 17,780 tonnes;

- Outside the modelling area (with the fate of the oil expected to be the same as above breakdown) – 49,510 tonnes.

The maximum size of the oil slick was calculated to be 7,501 square kilometres. Due to the high wax content of the oil, the model demonstrates that the Sea Lion crude will persist longer on the sea surface, when compared to a lighter / lower wax content oil. However, this will also make it easier to collect and contain.

Figure 4.3: Trajectory model run (under worst case 30 knot onshore wind) of a 577 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released - 105,302.5 tonnes). Figure illustrates surface coverage as a percentage and the dissolved oil particles. Image taken at 15 days and 6 hours into the model

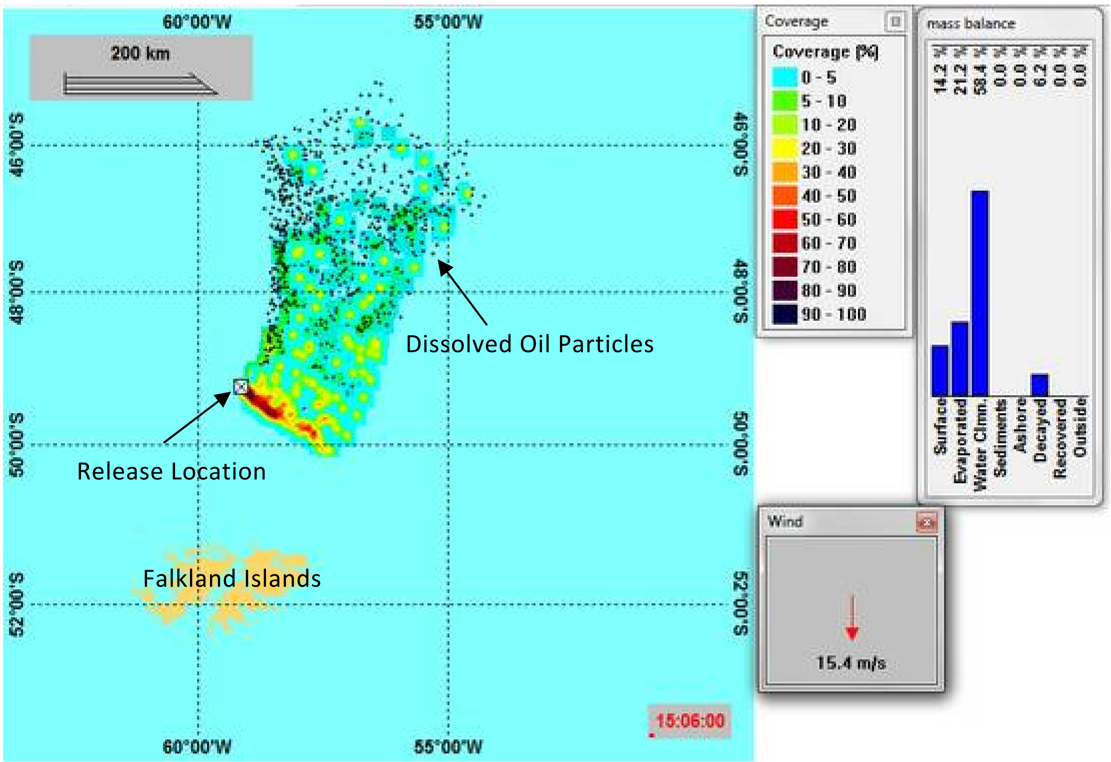


Figure 4.4 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved oil particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) offshore wind.

It can be seen that the oil moves in a northerly direction, away from the drilling rig and the Falkland Islands. After 182.5 days, the furthest presence of surface oil from the release location is approximately 750 kilometres to the north.

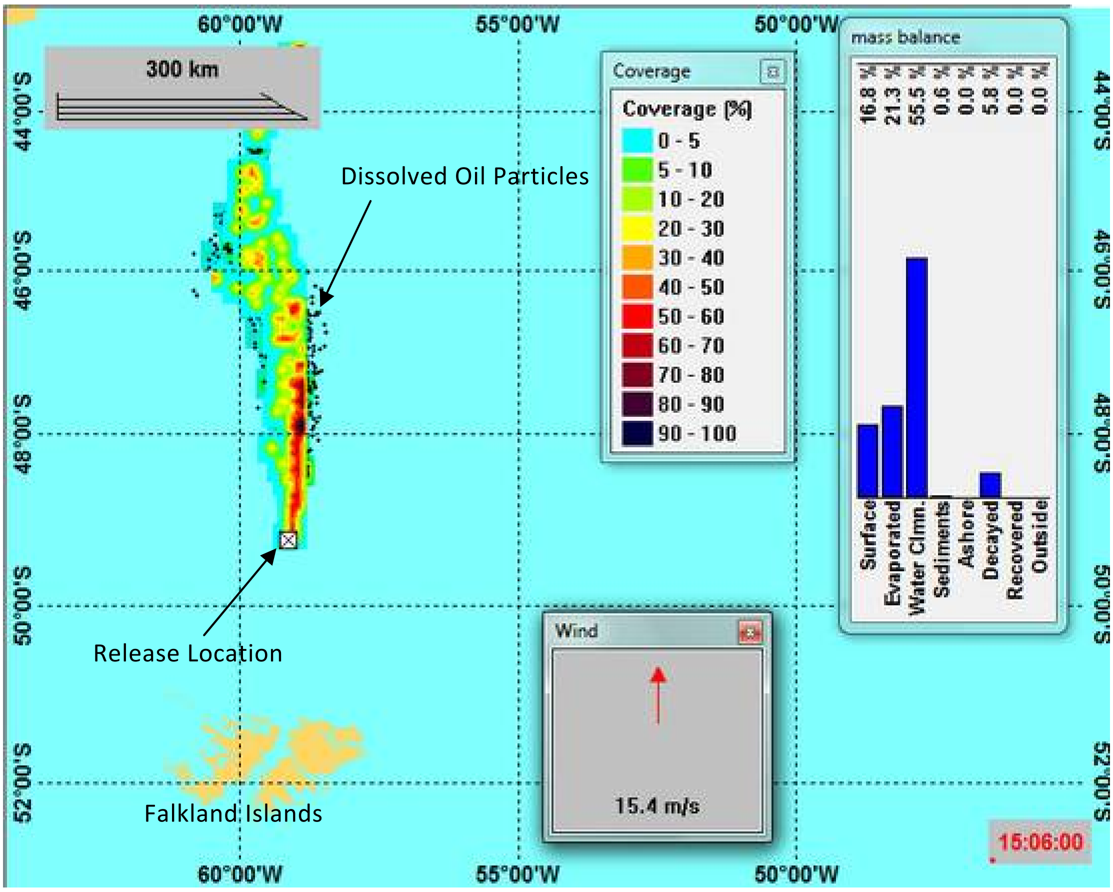
After a 182.5 day duration, the 105,302.5 tonnes of oil is broken down into the following:

- Sea Surface – 5,230 tonnes;
- Evaporated – 26,530 tonnes;
- Submerged – 3,331 tonnes;
- Sediment – 8,705 tonnes;
- Decayed – 16,820 tonnes;
- Outside the modelling area (with the fate of the oil expected to be the same as above breakdown) – 44,980 tonnes.

The maximum size of the oil slick was calculated to be 4,241 square kilometres. Due to the high wax content of the oil, the model demonstrates that the Sea Lion crude will persist longer on the

sea surface, when compared to a lighter / lower wax content oil. However, this will also make it easier to collect and contain.

Figure 4.4: Trajectory model run (under worst case 30 knot offshore wind) of a 577 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released - 105,302.5 tonnes). Figure illustrates surface coverage as a percentage and the dissolved oil particles. Image taken at 15 days and 6 hours into the model



Stochastic Modelling Results (under typical weather conditions)

Figure 4.5a displays the percentage probability of the released hydrocarbons being present. The majority of the released hydrocarbons (50-100% probability) are found within 500 kilometres of the release point, with a movement of the oil north northeast away from the release point and the Falkland Islands.

Figure 4.5b displays the last time with surface oil exposure, in days. As the model demonstrates, the high waxy content of the Sea Lion oil leads to a high exposure time of the Sea Lion Crude on the sea surface, the majority of which persists for 14-20 days in duration.

Figure 4.5a: Stochastic modelling (under typical wind and current conditions) of a 577 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released - 105,302.5 tonnes). Figure shows surface probability as a percentage

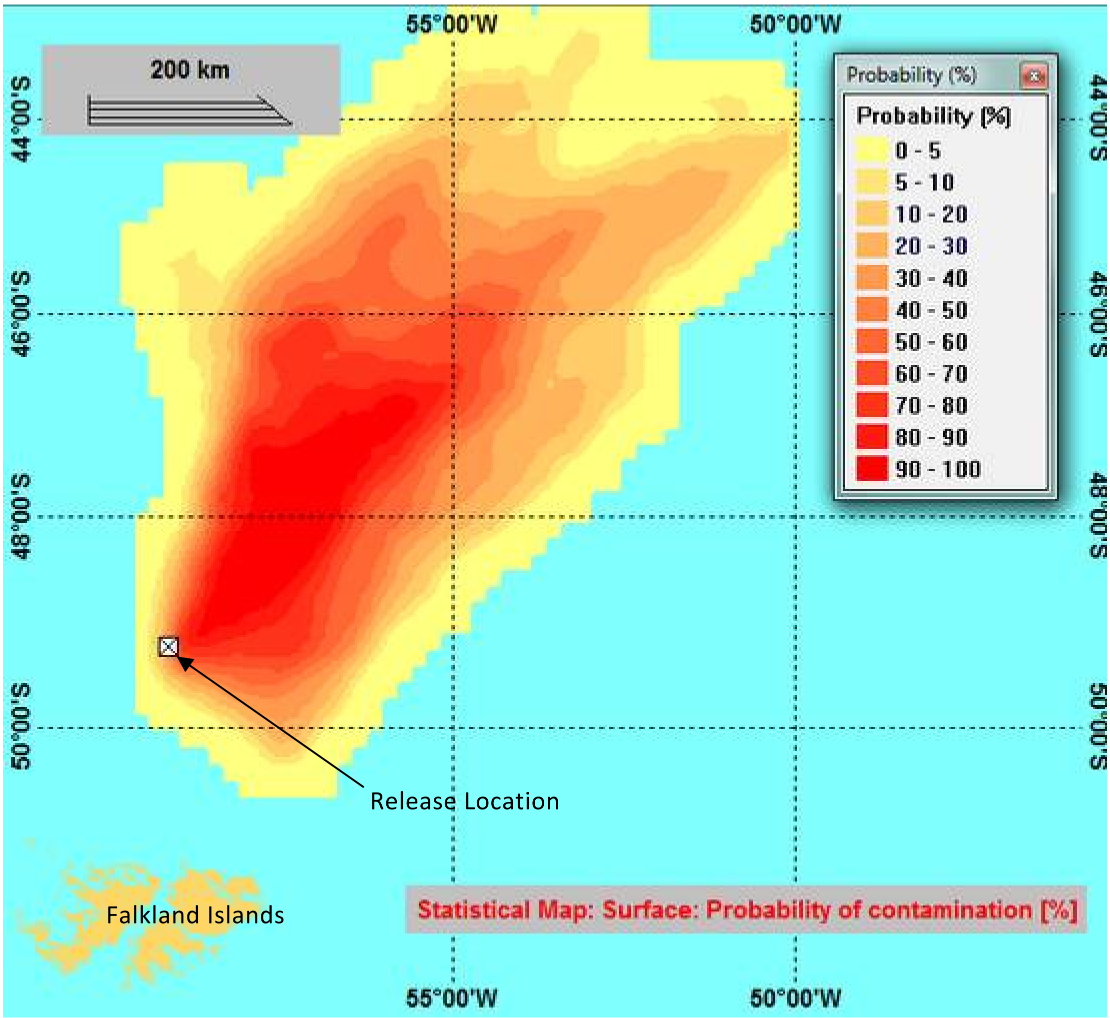
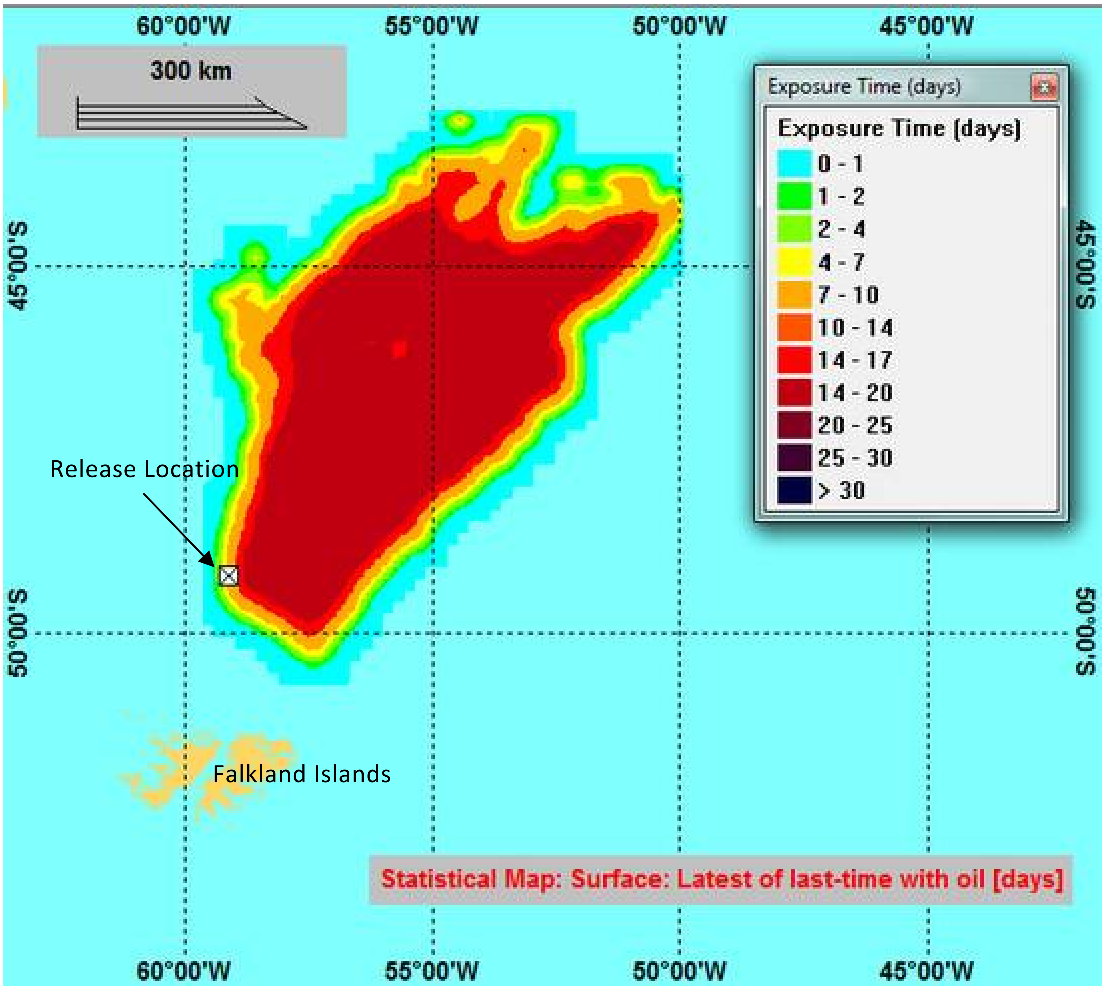


Figure 4.5b: Stochastic modelling (under typical wind and current conditions) of a 577 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released - 105,302.5 tonnes). Figure shows last time with surface oil exposure in days



Scenario 2 – Best Case Flow Rate (47.4 tonnes per day)

Trajectory Model Run Results (under worst case wind conditions)

Figure 4.6 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved oil particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) onshore wind.

It can be seen that the oil moves in a north north-easterly direction, away from the drilling rig and the Falkland Islands. After 182.5 days, the furthest presence of surface oil from the release location is approximately 600 kilometres to the north.

After a 182.5 day duration, the 8,650.5 tonnes of oil is broken down into the following:

- Sea Surface – 380 tonnes;
- Evaporated – 2,359 tonnes;
- Submerged – 446 tonnes;
- Sediment – Zero;
- Decayed – 1,365 tonnes;
- Outside the modelling area (with the fate of the oil expected to be the same as above breakdown) – 4,123 tonnes.

The maximum size of the oil slick was calculated to be 642 square kilometres. Due to the high wax content of the oil, the model demonstrates that the Sea Lion crude will persist longer on the sea surface, when compared to a lighter / lower wax content oil. However, this will also make it easier to collect and contain.

Figure 4.6: Trajectory model run (under worst case 30 knot onshore wind) of a 47.4 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released – 8,650.5 tonnes). Figure illustrates surface coverage as a percentage and the dissolved oil particles. Image taken at 15 days and 6 hours into the model

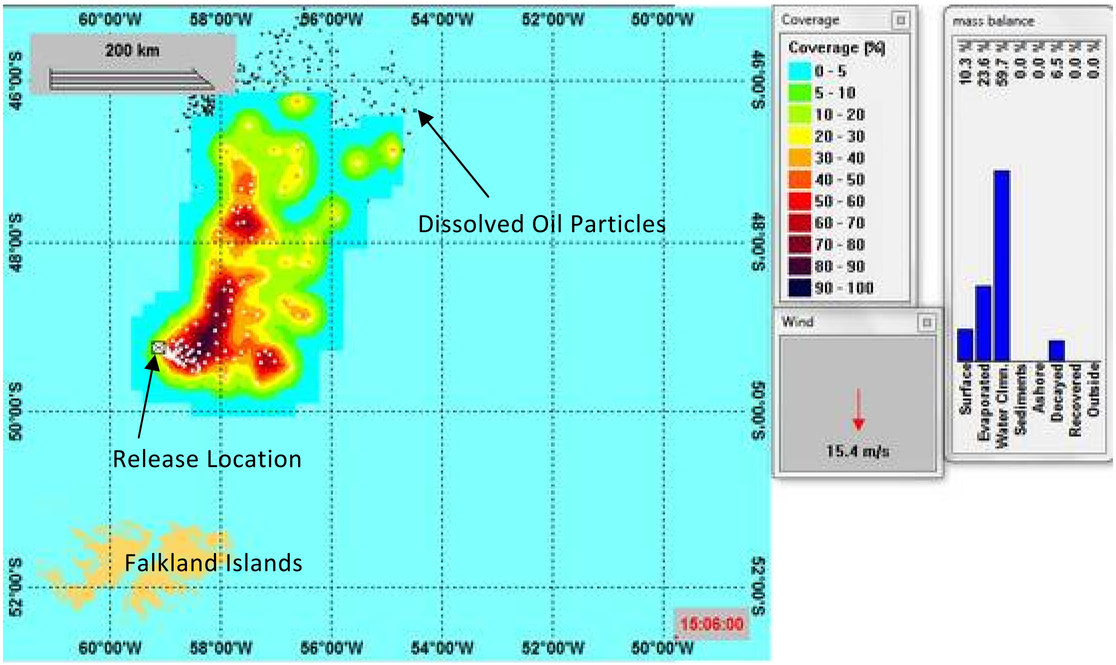


Figure 4.7 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved oil particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) offshore wind.

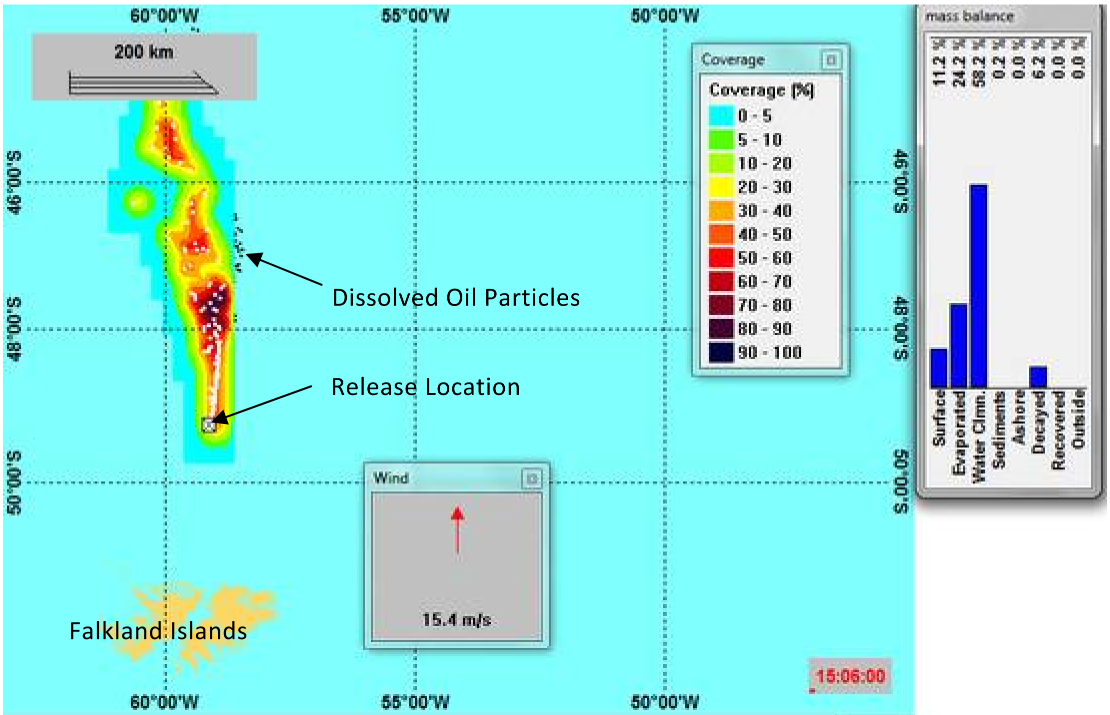
It can be seen that the oil moves in a northerly direction, away from the drilling rig and the Falkland Islands. After 182.5 days, the furthest presence of surface oil from the release location is approximately 750 kilometres to the north.

After a 182.5 day duration, the 8,650.5 tonnes of oil is broken down into the following:

- Sea Surface – 335 tonnes;
- Evaporated – 2,336 tonnes;
- Submerged – 397 tonnes;
- Sediment – 972 tonnes;
- Decayed – = 1,467 tonnes;
- Outside the modelling area (with the fate of the oil expected to be the same as above breakdown) – 3,166 tonnes.

The maximum size of the oil slick was calculated to be 420 square kilometres. Due to the high wax content of the oil, the model demonstrates that the Sea Lion crude will persist longer on the sea surface, when compared to a lighter / lower wax content oil. However, this will also make it easier to collect and contain.

Figure 4.7: Trajectory model run (under worst case 30 knot offshore wind) of a 47.4 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released – 8,650.5 tonnes). Figure illustrates surface coverage as a percentage and the dissolved oil particles. Image taken at 15 days and 6 hours into the model



Stochastic Modelling Results (under typical weather conditions)

Figure 4.8a displays the percentage probability of the released hydrocarbons being present. The majority of the released hydrocarbons (50-100% probability) are found within 450 kilometres of the release point, with a movement of the oil north northeast away from the release point and the Falkland Islands.

Figure 4.8b displays the last time with surface oil exposure, in days. As the model demonstrates, the high waxy content of the Sea Lion oil leads to a high exposure time of the Sea Lion Crude on the sea surface, the majority of which persists for 14-20 days in duration.

These results are similar to the higher flow rate modelling, showing that the Sea Lion crude will behave in the environment in a similar manner, regardless of the amount of Sea Lion hydrocarbon released.

Figure 4.8a: Stochastic modelling (under typical wind and current conditions) of a 47.4 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released - 8,650.5 tonnes). Figure shows surface probability as a percentage

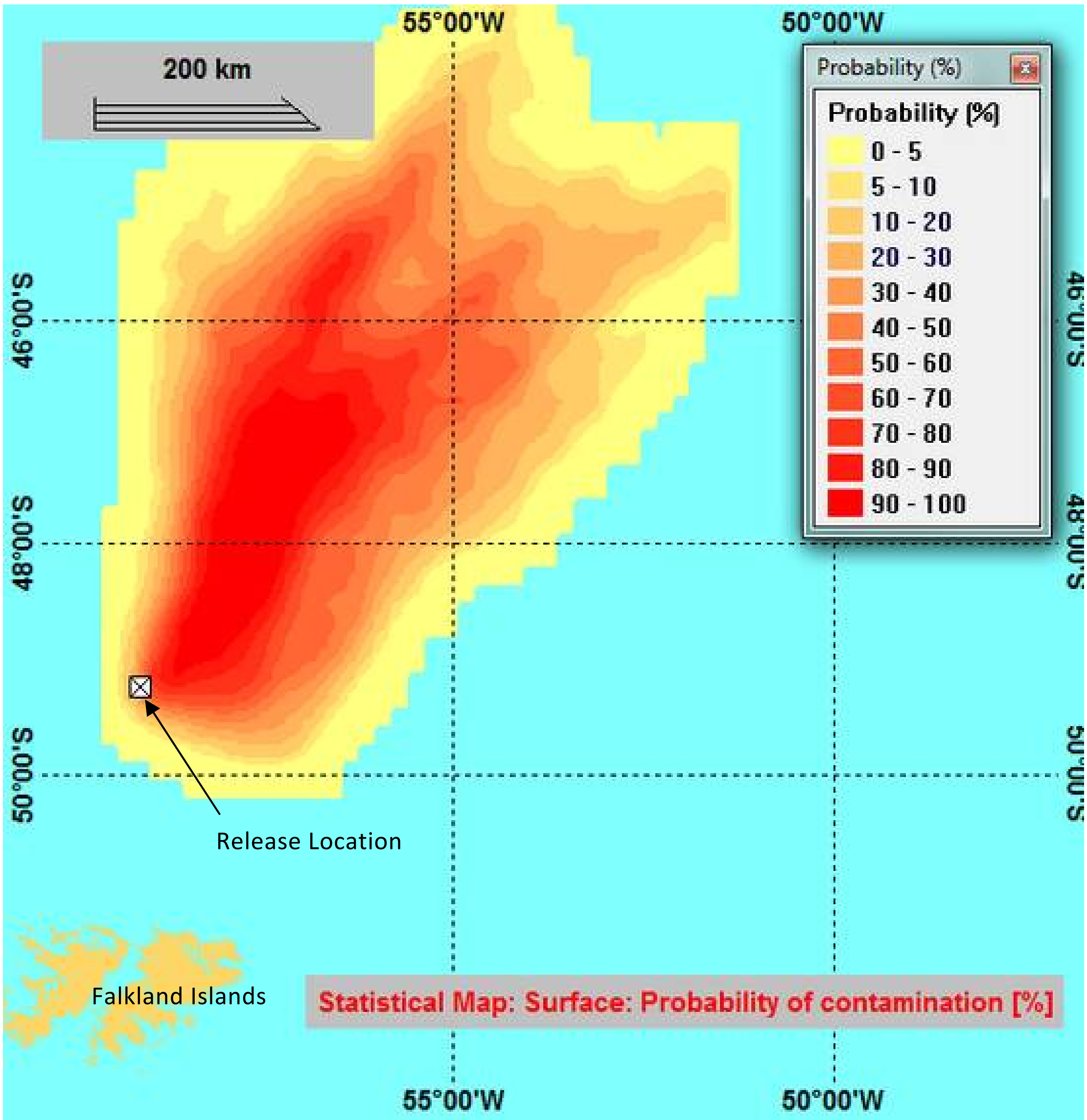
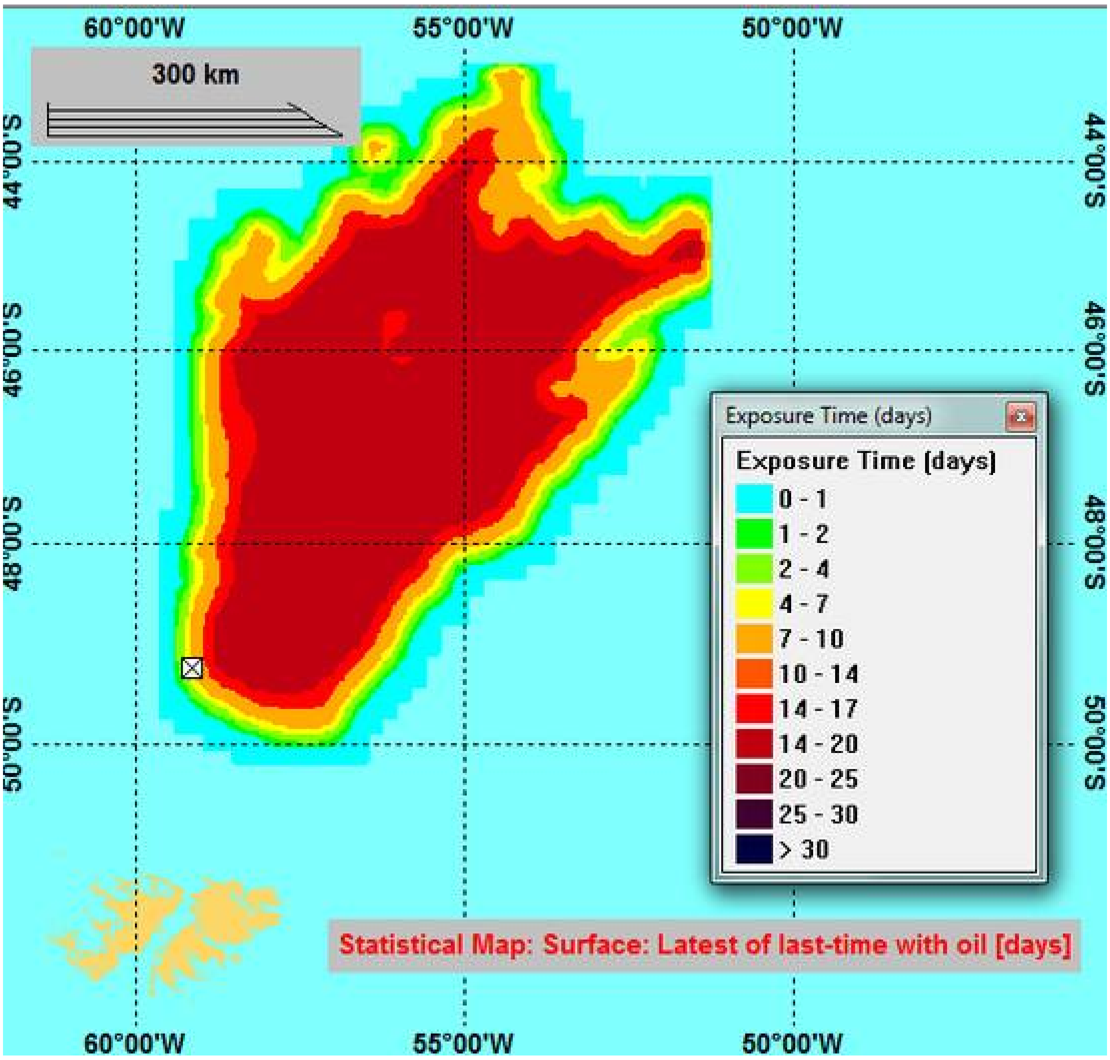


Figure 4.8b: Stochastic modelling (under typical wind and current conditions) of a 47.4 tonnes per day Blow-Out flowing for 182.5 days duration (total crude released - 8,650.5 tonnes). Figure shows last time with surface oil exposure in days



4.2 Johnson Prospect Modelling Results

4.2.1 Overview

Table 4.2 provides an overview summary of the Johnson modeling results, which are discussed in detail below.

The drilling rig used on the Johnson Prospect will be the same as that used to drill the Sea Lion wells and therefore the diesel inventory will remain the same (1,108 tonnes). Due to the close proximity of the Johnson Prospect to the Sea Lion well, and the fact that the diesel spill scenarios did not beach, it was considered that the diesel modeling was not required to be re-run for the Johnson Prospect.

It is predicted that any oil released from the Johnson Prospect Area of Interest will spread out to the north and east, with a generalized movement of the oil to the north, in line with sea currents in this region (*Fugro, 2011*). None of the scenarios resulted in condensate being beached on the coastline of the Falkland Islands.

Table 4.2: Results of the Johnson Prospect Modelling

Hydrocarbon	Scenario	Model	Released Volume per day (tonnes)	Duration (days)	Total Volume Released (tonnes)	Section and Figure Number	Fate of Oil
Johnson Prospect Condensate	1 - Worst Case Duration	Trajectory 30 knot Onshore wind	465	182.5	84,862.5	Section 4.2.3 Figure 4.9	The condensate did not beach The spill plume headed in a northerly direction, however it did not remain on the surface for long
	1 - Worst Case Duration	Trajectory 30 knot Offshore wind	465	182.5	84,862.5	Section 4.2.3 Figure 4.10	The condensate did not beach The spill plume headed in a northerly direction, however it did not remain on the surface for long
	1 - Worst Case Duration	Stochastic	465	182.5	84,862.5	Section 4.2.3 Figures 4.11 a and b	The condensate did not beach The spill plume headed in a northerly direction with a 70-100% probability that the oil would be present within 275 km of the release point
	2 – Best Case Duration	Trajectory 30 knot Offshore wind	465	91.25	42,431	Section 4.2.3 Figure 4.12	The condensate did not beach The spill plume headed in a northerly direction, however it did not remain on the surface for long

Hydrocarbon	Scenario	Model	Released Volume per day (tonnes)	Duration (days)	Total Volume Released (tonnes)	Section and Figure Number	Fate of Oil
	2 – Best Case Duration	Trajectory 30 knot Onshore wind	465	91.25	42,431	Section 4.2.3 Figure 4.13	The condensate did not beach The spill plume headed in a northerly direction, however it did not remain on the surface for long
	2 – Best Case Duration	Stochastic	465	91.25	42,431	Section 4.2.3 Figures 4.14 a and b	The condensate did not beach The spill plume headed in a northerly direction with a 70-100% probability that the oil would be present within 250 km of the release point

4.2.2 Rig Diesel Spill

Trajectory Modelling Results (under worst case conditions)

Due to the close proximity of the two locations and the use of the same drilling rig, diesel modelling was not required to be re-run for the John Prospect. Therefore, please refer to section 4.1.2 for the rig inventory results.

4.2.3 Condensate Spill (Blow-Out)

Scenario 1 – Worst Case Duration (6 months)

Trajectory Model Run Results (under worst case wind conditions)

Figure 4.9 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved condensate particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) onshore wind.

It can be seen that the oil moves in a north north-easterly direction, away from the drilling rig and the Falkland Islands. However, due to the lightness of the condensate, it does not persist on the sea surface for very long. After 182.5 days, the furthest presence of surface oil from the release location is approximately 250 kilometres to the north.

After a 182.5 day duration, the 84,862.5 tonnes of condensate is broken down into the following:

- Sea Surface – 429 tonnes;
- Evaporated – 25,930 tonnes;
- Submerged – 2,684 tonnes;
- Sediment – Zero;
- Decayed – 55,820 tonnes.

The maximum size of the condensate slick was calculated to be 956 square kilometres. Due to the lightness of the condensate, the model demonstrates that the Johnson Prospect condensate will not persist very long in the environment, as it will either evaporate or decay in a timely manner.

Figure 4.9: Trajectory model run (under worst case 30 knot onshore wind) of a 465 tonnes per day Blow-Out flowing for 182.5 days duration (total condensate released – 84,862.5 tonnes). Figure illustrates surface coverage as a percentage and the dissolved condensate particles. Image taken at 15 days and 6 hours into the model

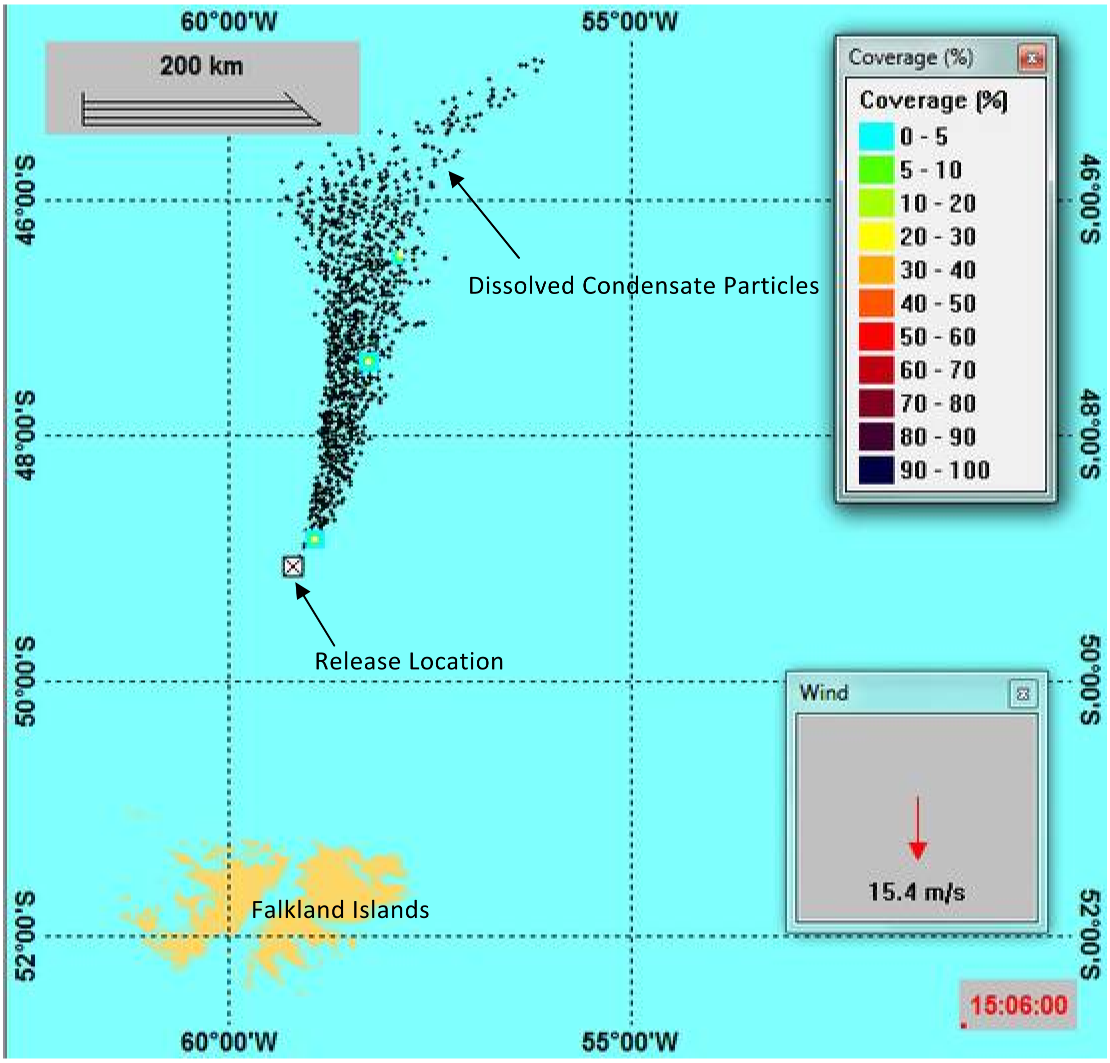


Figure 4.10 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved condensate particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) offshore wind.

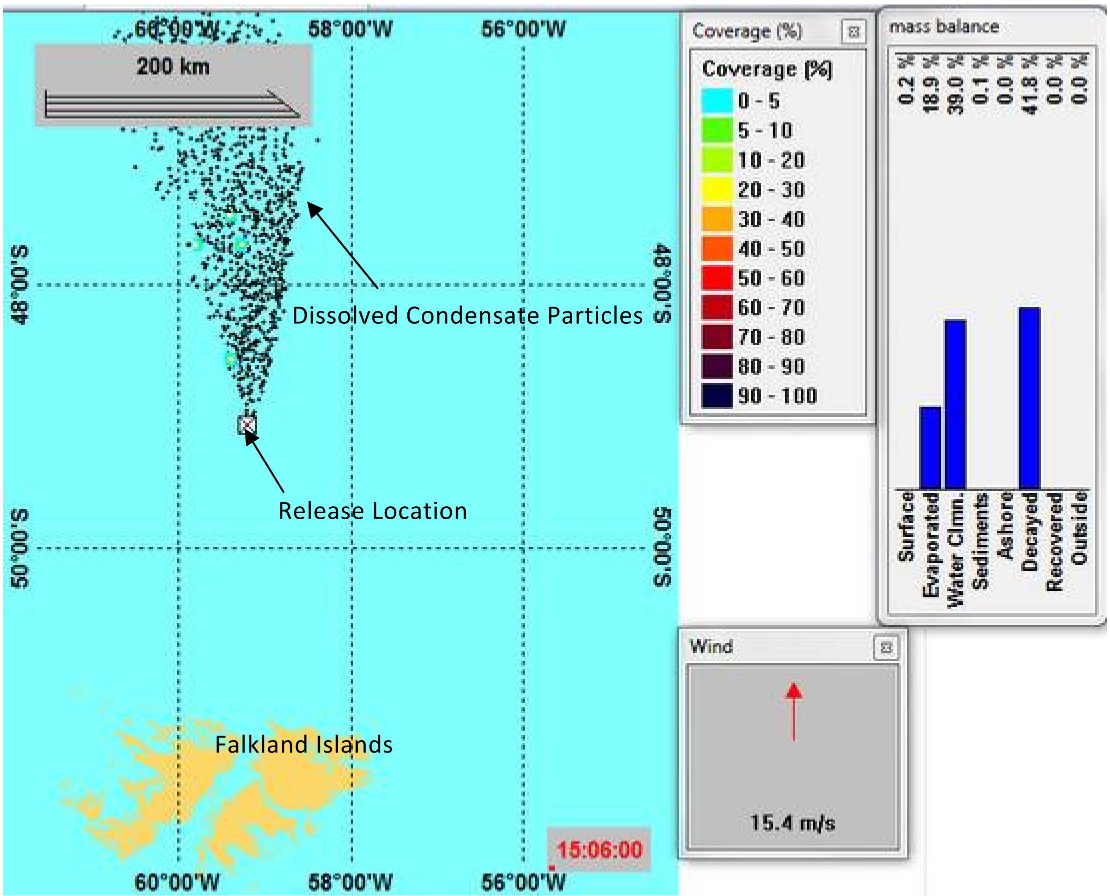
It can be seen that the oil moves in a north north-easterly direction, away from the drilling rig and the Falkland Islands. However, due to the lightness of the condensate, it does not persist on the sea surface for very long. After 182.5 days, the furthest presence of surface oil from the release location is approximately 275 kilometres to the north.

After a 182.5 day duration, the 84,862.5 tonnes of condensate is broken down into the following:

- Sea Surface – 46.74 tonnes;
- Evaporated – 16,860 tonnes;
- Submerged – 2,823 tonnes;
- Sediment – 5,680 tonnes;
- Decayed – 59,453 tonnes.

The maximum size of the condensate slick was calculated to be 843 square kilometres. Due to the lightness of the condensate, the model demonstrates that the Johnson Prospect condensate will not persist very long in the environment, as it will either evaporate or decay in a timely manner.

Figure 4.10: Trajectory model run (under worst case 30 knot offshore wind) of a 465 tonnes per day Blow-Out flowing for 182.5 days duration (total condensate released – 84,862.5 tonnes). Figure illustrates surface coverage as a percentage and the dissolved condensate particles. Image taken at 15 days and 6 hours into the model



Stochastic Modelling Results (under typical weather conditions)

Figure 4.11a displays the percentage probability of the released hydrocarbons being present. The majority of the released hydrocarbons (70-100% probability) are found within 275 kilometres of the release point, with a movement of the condensate north away from the release point and the Falkland Islands.

Figure 4.11b displays the last time with surface oil exposure, in days. As the model demonstrates, the majority of the condensate persists for 4-10 days in duration.

Figure 4.11a: Stochastic modelling (under typical wind and current conditions) of a 465 tonnes per day Blow-Out flowing for 182.5 days duration (total condensate released – 84,862.5 tonnes). Figure shows surface probability as a percentage

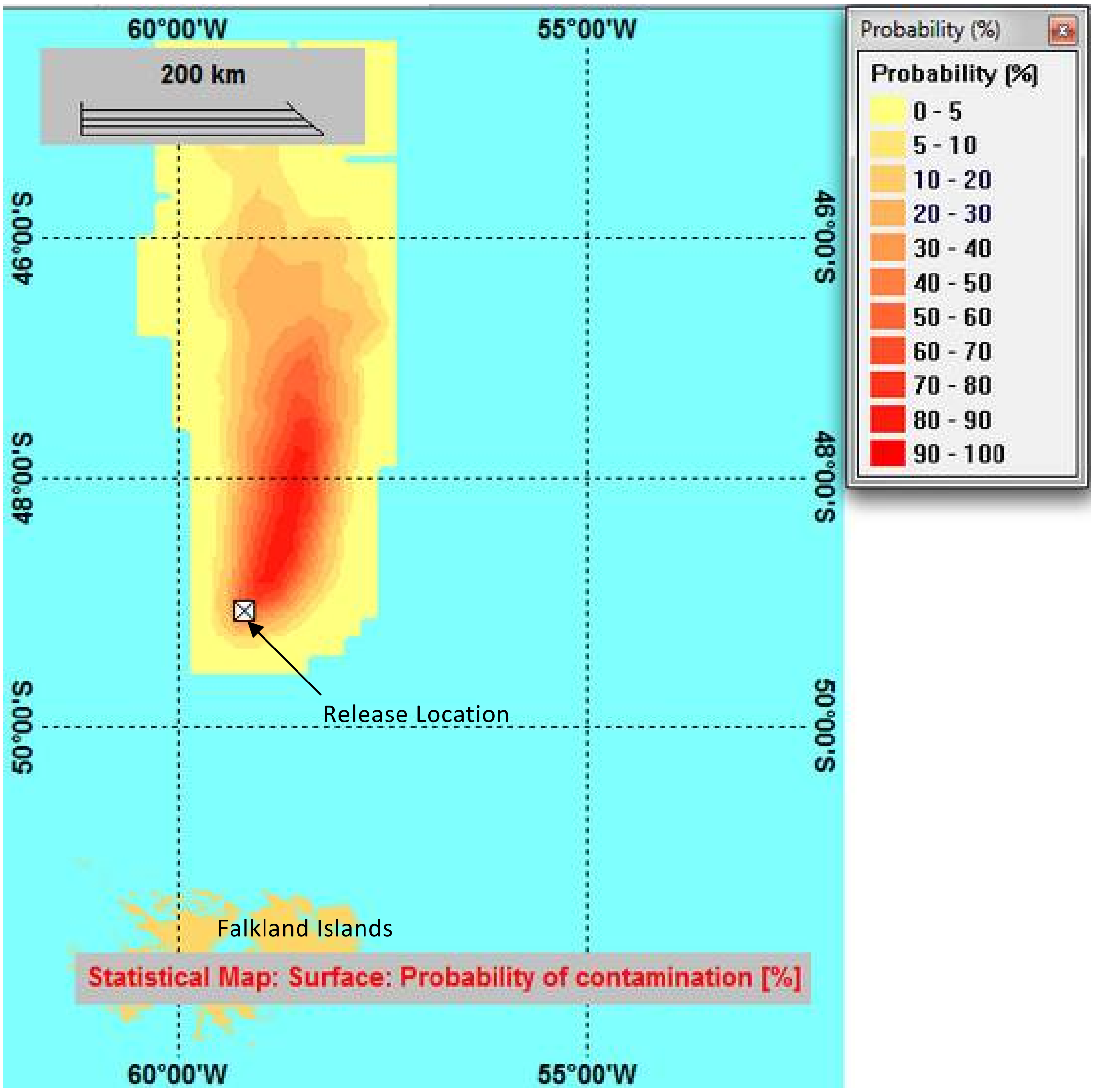
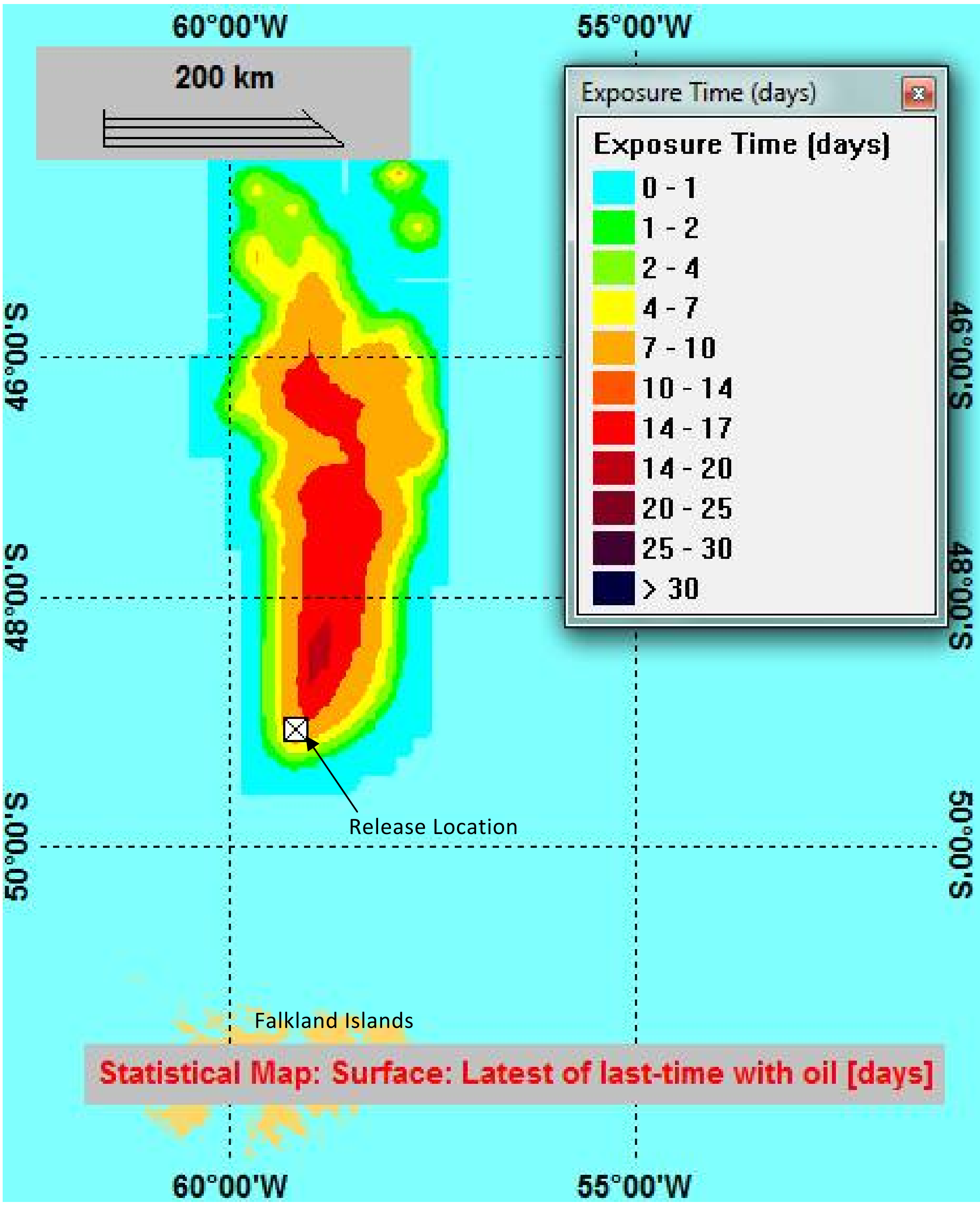


Figure 4.11b: Stochastic modelling (under typical wind and current conditions) of a 465 tonnes per day Blow-Out flowing for 182.5 days duration (total condensate released – 84,862.5 tonnes). Figure shows surface last time with oil exposure in days



Scenario 2 – Best Case Duration (3 months)

Trajectory Model Run Results (under worst case wind conditions)

Figure 4.12 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved condensate particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) onshore wind.

It can be seen that the oil moves in a northerly direction, away from the drilling rig and the Falkland Islands. However, due to the lightness of the condensate, it does not persist on the sea surface for very long. After 91.25 days, the furthest presence of surface oil from the release location is approximately 250 kilometres to the north.

After a 91.25 day duration, the 42,431 tonnes of condensate is broken down into the following:

- Sea Surface – Zero;
- Evaporated – 7,842 tonnes;
- Submerged – 2,080 tonnes;
- Sediment – Zero;
- Decayed – 32,509 tonnes.

The maximum size of the condensate slick was calculated to be 21 square kilometres. Due to the lightness of the condensate, the model demonstrates that the Johnson Prospect condensate will not persist very long in the environment, as it will either evaporate or decay in a timely manner.

Figure 4.12: Trajectory model run (under worst case 30 knot onshore wind) of a 465 tonnes per day Blow-Out flowing for 91.25 days duration (total condensate released – 42,431 tonnes). Figure illustrates surface coverage as a percentage and the dissolved condensate particles. Image taken at 15 days and 6 hours into the model

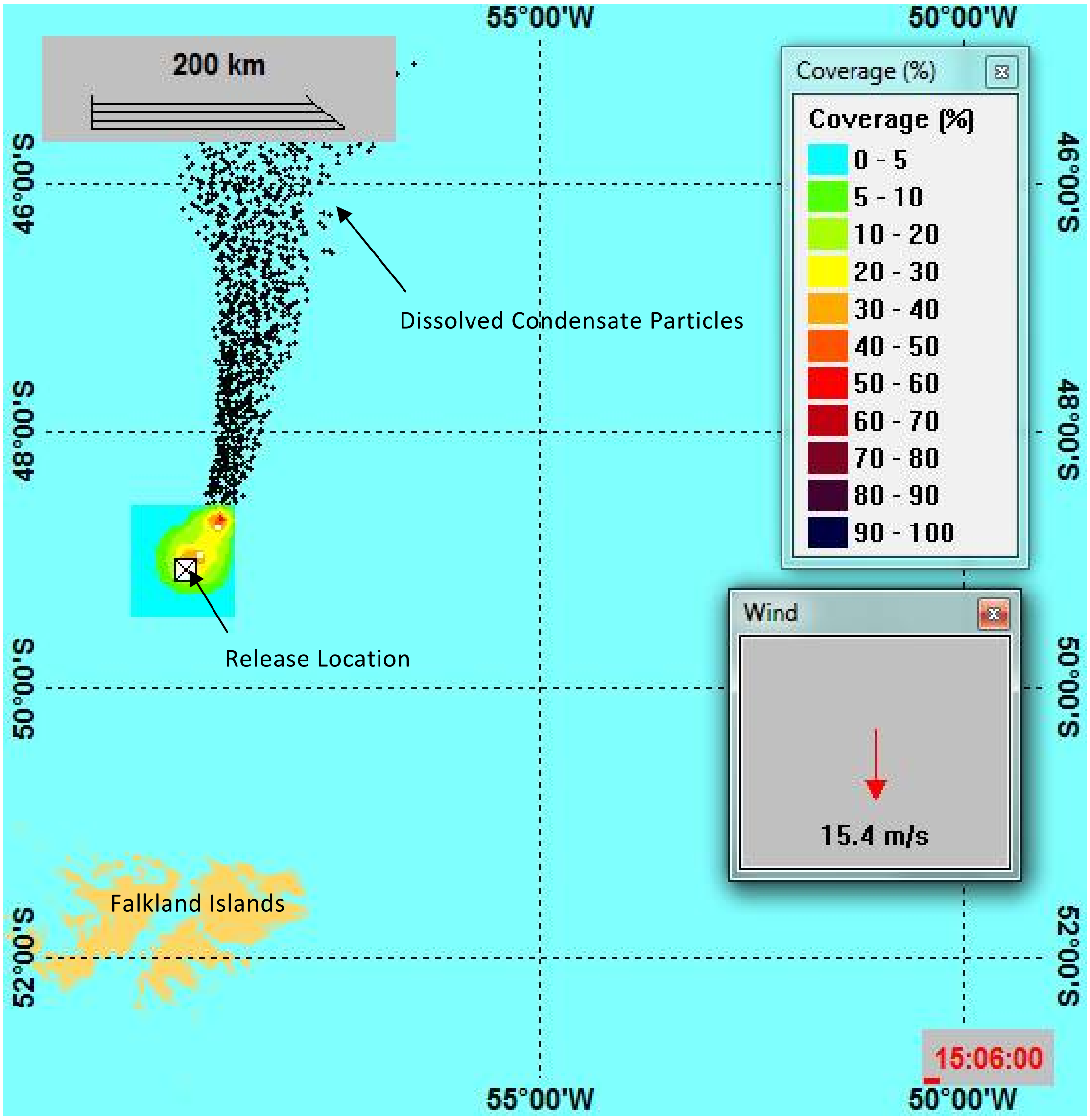


Figure 4.13 below, displays the surface coverage of hydrocarbons (as a percentage) and the dissolved condensate particles, resulting from a trajectory model run scenario using a 30 knot (15.4 m/s) offshore wind.

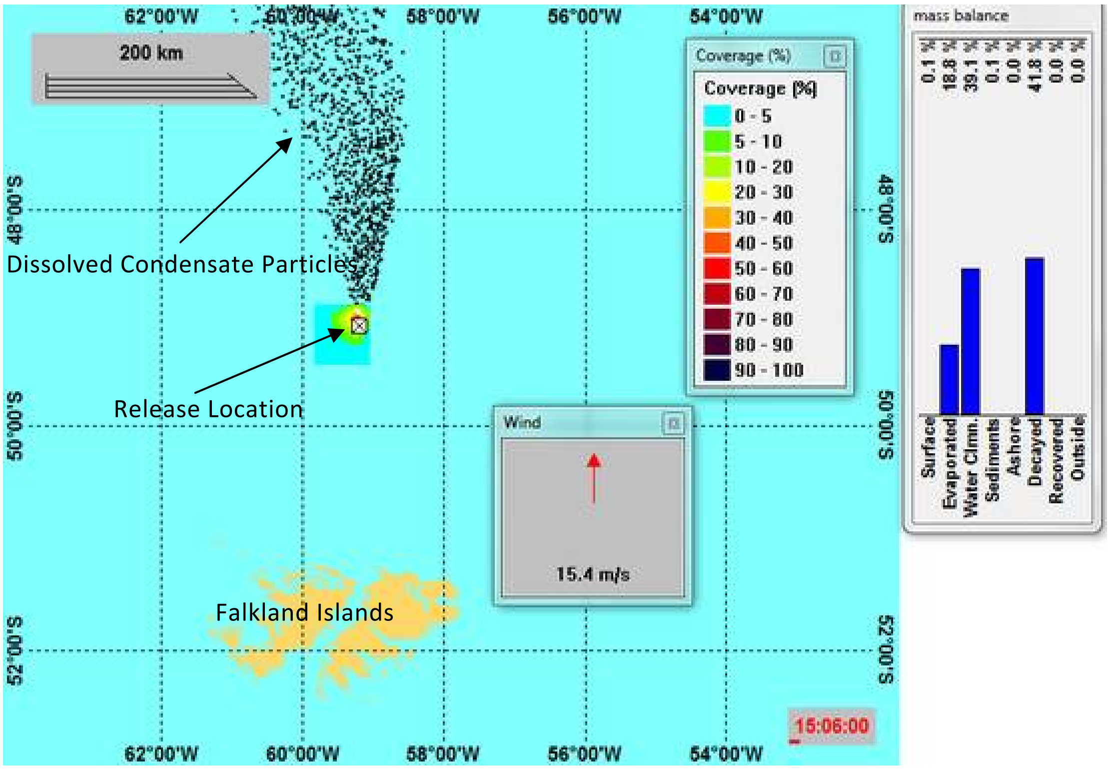
It can be seen that the oil moves in a northerly direction, away from the drilling rig and the Falkland Islands. However, due to the lightness of the condensate, it does not persist on the sea surface for very long. After 91.25 days, the furthest presence of surface oil from the release location is approximately 255 kilometres to the north.

After a 91.25 day duration, the 42,431 tonnes of condensate is broken down into the following:

- Sea Surface – Zero;
- Evaporated – 8,386 tonnes;
- Submerged – 1,701 tonnes;
- Sediment – 3,163 tonnes;
- Decayed – 29,208 tonnes.

The maximum size of the condensate slick was calculated to be 16 square kilometres. Due to the lightness of the condensate, the model demonstrates that the Johnson Prospect condensate will not persist very long in the environment, as it will either evaporate or decay in a timely manner.

Figure 4.13: Trajectory model run (under worst case 30 knot offshore wind) of a 465 tonnes per day Blow-Out flowing for 91.25 days duration (total condensate released – 42,431 tonnes). Figure illustrates surface coverage as a percentage and the dissolved condensate particles. Image taken at 15 days and 6 hours into the model



Stochastic Modelling Results (under typical weather conditions)

Figure 4.14a displays the percentage probability of the released hydrocarbons being present. The majority of the released hydrocarbons (70-100% probability) are found within 250 kilometres of the release point, with a movement of the oil north northeast away from the release point and the Falkland Islands.

Figure 4.14b displays the last time with surface oil exposure, in days. As the model demonstrates, the majority of the condensate persists for 7-14 days in duration.

Figure 4.14a: Stochastic modelling (under typical wind and current conditions) of a 465 tonnes per day Blow-Out flowing for 91.25 days duration (total condensate released – 42,431 tonnes). Figure shows surface probability as a percentage

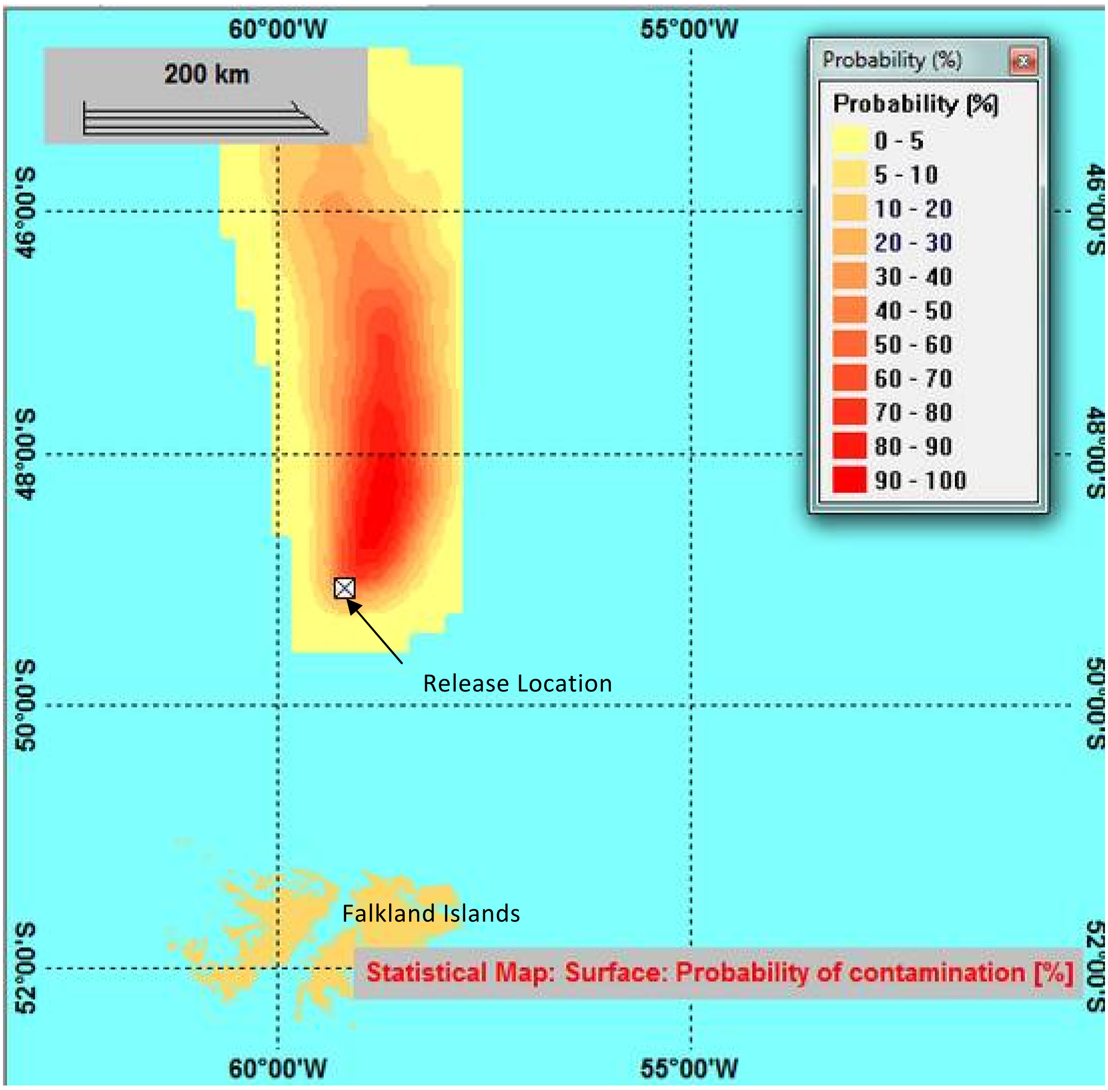
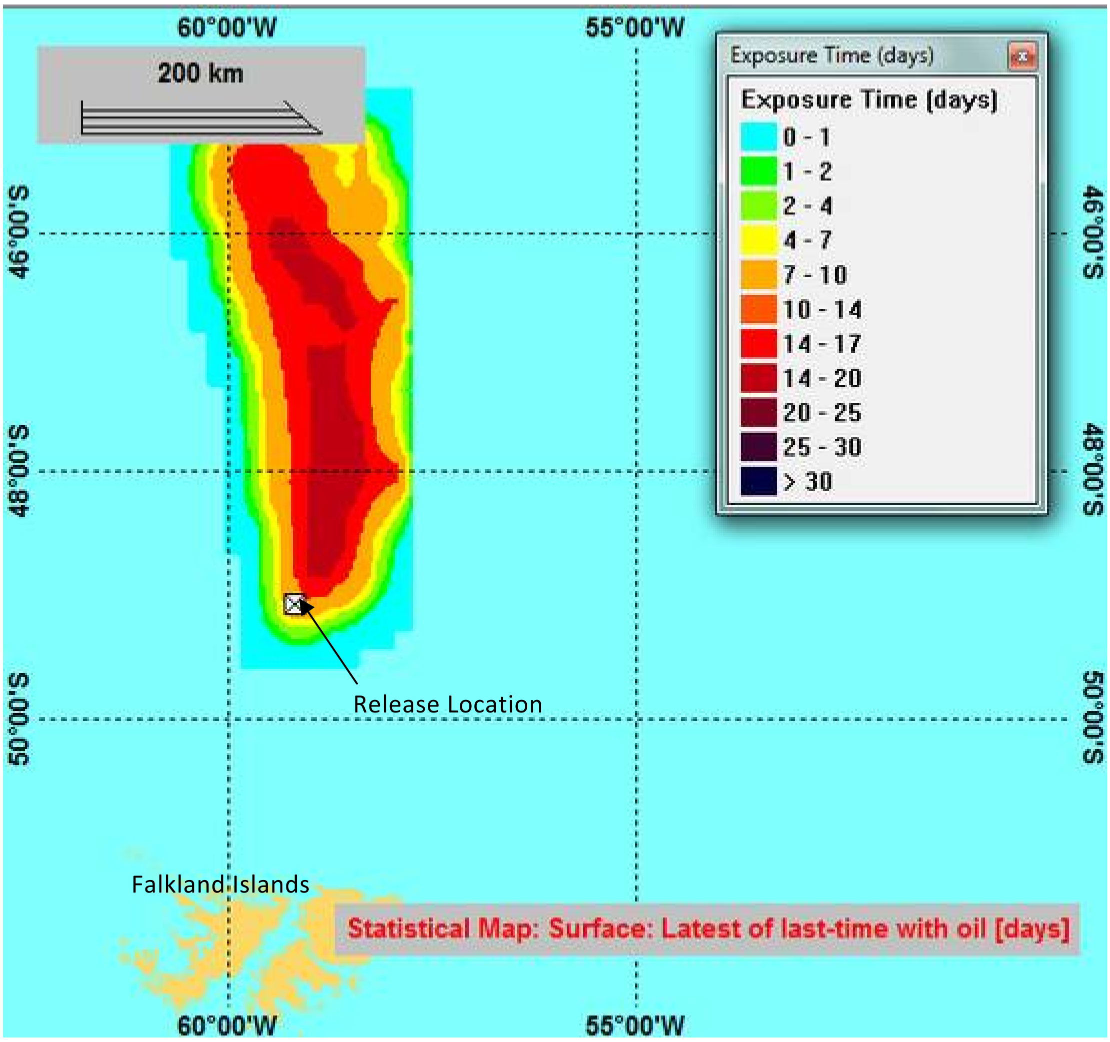


Figure 4.14b: Stochastic modelling (under typical wind and current conditions) of a 465 tonnes per day Blow-Out flowing for 91.25 days duration (total condensate released – 42,431 tonnes). Figure shows surface last time with oil exposure in days



5 Conclusions

5.1 Rig Inventory (Diesel) Modelling

The results from the rig inventory (diesel) modelling show that modelled with either an offshore or onshore worst case wind (30 knot) the diesel will not persist on the sea surface for any great length of time.

After 30 days duration for either scenario there was no diesel on the sea surface. The spilt diesel had either evaporated or decayed in an almost identical ratio (50/50), with a small amount being submerged.

5.2 Sea Lion Modelling

The results of the Sea Lion modelling show that none of the released hydrocarbons beached, either on the Falkland Islands or elsewhere. Due to the high wax content of the Sea Lion crude (22%), the oil remains on the sea surface for some time, spreading over a relatively large area to the north of the release location.

The Sea Lion crude does not appear to significantly accumulate in the sediments, which is likely to be as a result of the waxy nature of the oil in combination with the relatively deep water depth (450 metres).

The model predicts that for the worst case flow rate, a significant percentage (ca. 25%) of the oil would evaporate over time, approximately 15% of the oil would be decayed (or broken down) in the water column and approximately 7% remains on the sea surface.

For the purposes of this study, it has been assumed that the scenarios which have been modelled are a very worst case, in terms of both flow rate and durations. In reality, due to the high waxy content (22%) of the Sea Lion crude it is predicted that, in the case of a blow-out, the well tubing would simply start to solidify once in contact with the seawater. This solidification (caused by the crude coming in contact with the much cooler sea water), will begin to reduce the diameter of the well tubing, effectively sealing the release point, over time. This expected decrease in flow rate is the reason why two flow rates have been modelled in this report. A commissioned flow rate modelling study conducted by Axis Well Technology (*Axis, 2011*), supports these flow rates.

In addition to the solidification of the Sea Lion oil, it is also expected that the Sea Lion reservoir will not flow naturally from the well. Therefore, without additional pressure or pumping, the Sea Lion crude is unlikely to flow from the well (*Rockhopper, 2011*).

5.3 Johnson Prospect Modelling

The results of the Johnson Prospect modelling show that none of the released condensate beached, either on the Falkland Islands or elsewhere. Due to the lightness of the condensate, the hydrocarbons do not persist for long on the sea surface. The general movement of the condensate is to the north of the release point.

The Johnson Prospect condensate does not appear to significantly accumulate in the sediments, which is likely to be as a result of the lightness of the hydrocarbon, which would mainly be either evaporate or be decayed.

The model predicts that for the worst case duration (6 months of flow), a significant percentage (ca. 65-70%) of the condensate would decay in the water column, whereas 19-30% of the oil would evaporate and 0.05 - 0.5% remains on the sea surface.

6 References

Axis (2011). Rockhopper Sea Lion Blowout Calculations

Fugro (2011). SEA LION METOCEAN CONCEPT SCREENING. Report Number: C50814/6577/R1. Issue Date: 19 May 2011

Intertek (2011). Laboratory Test Report No. 11-004065-0-ABDN.

Rockhopper (2011). Wax Build-Up Calculations.

Appendix A – Falkland Wind and Current Data (*Fugro, 2011*)

All-Year

10min Wind Speed at 10m (m/s)	N	NE	E	SE	S	SW	W	NW	Total %	Exceed %
Total	13.02	3.09	1.72	2.06	5.58	21.40	28.32	24.79	100.00	
22–24						0.01	<0.01		0.02	0.02
20–22	<0.01				<0.01	0.01	0.03	<0.01	0.06	0.08
18–20				<0.01	0.03	0.16	0.10	<0.01	0.30	0.38
16–18	0.10	0.01	0.01	<0.01	0.08	0.43	0.46	0.15	1.24	1.62
14–16	0.56	0.06	0.01	0.06	0.23	1.42	1.38	0.79	4.52	6.13
12–14	1.68	0.15	0.06	0.11	0.43	3.08	3.04	2.45	11.01	17.14
10–12	2.71	0.23	0.13	0.20	0.72	4.28	5.44	4.91	18.62	35.76
8–10	3.19	0.50	0.27	0.31	1.12	4.57	6.73	6.86	23.55	59.31
6–8	2.51	0.85	0.40	0.50	1.12	3.88	5.88	5.14	20.29	79.60
4–6	1.54	0.84	0.53	0.55	0.98	2.63	4.01	3.34	14.43	94.02
2–4	0.67	0.40	0.25	0.27	0.79	0.82	1.17	1.07	5.42	99.44
0–2	0.08	0.05	0.06	0.04	0.09	0.10	0.08	0.07	0.56	

10min Wind Direction at 10m (°T From)

All-Year

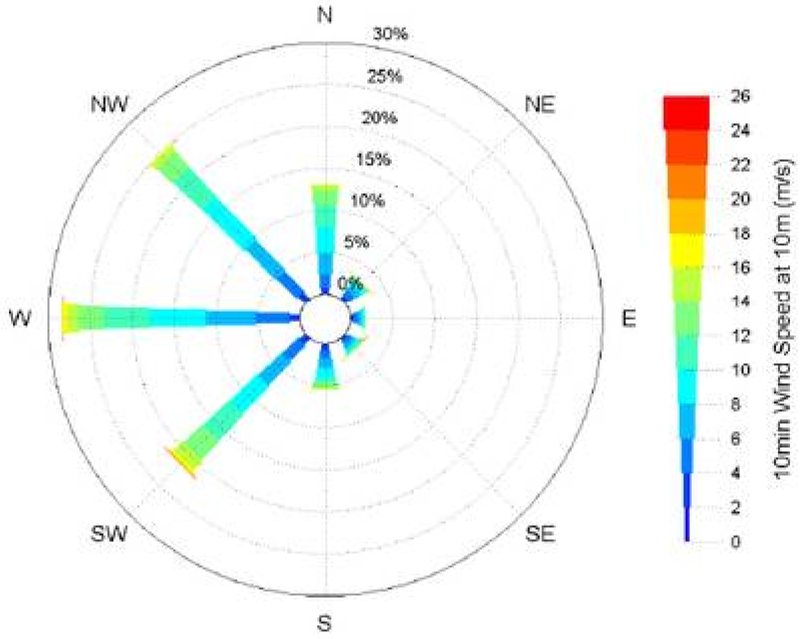


Figure B.1.1: Mean Wind Speed and Direction – All-Year

All-Year

Current Speed at 12m (m/s)	N	NE	E	SE	S	SW	W	NW	Total %	Exceed %
Total	17.06	16.17	6.85	3.18	4.58	15.92	21.91	14.33	100.00	
> 0.9	<0.01								<0.01	
0.8 – 0.9	<0.01	0.01	<0.01			<0.01	<0.01	<0.01	0.03	0.04
0.7 – 0.8	0.03	0.06	<0.01			0.03	0.04	<0.01	0.18	0.21
0.6 – 0.7	0.17	0.24	0.06	0.01	<0.01	0.21	0.27	0.11	1.08	1.29
0.5 – 0.6	0.60	0.68	0.17	0.02	0.03	0.83	1.18	0.44	3.96	5.25
0.4 – 0.5	1.77	1.84	0.44	0.07	0.25	1.86	2.71	1.16	10.11	15.36
0.3 – 0.4	4.06	4.00	1.00	0.26	0.54	3.54	5.37	2.97	21.74	37.10
0.2 – 0.3	5.17	4.79	1.86	0.71	1.17	4.98	6.47	4.50	29.65	66.75
0.1 – 0.2	4.00	3.43	2.32	1.32	1.77	3.43	4.64	3.85	24.75	91.50
0.0 – 0.1	1.25	1.12	1.00	0.78	0.82	1.03	1.23	1.28	8.50	

Current Direction at 12m (°T Towards)

All-Year

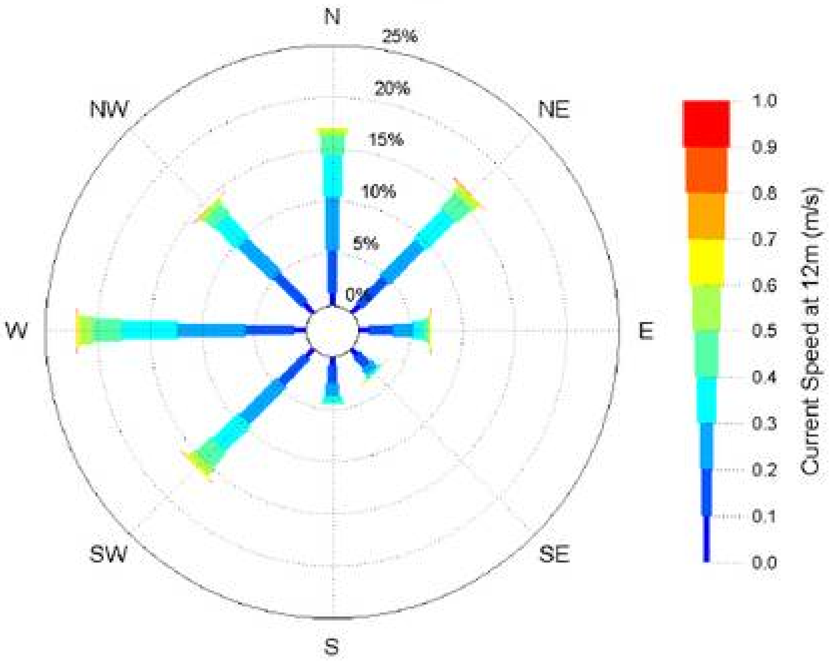


Figure B.3.1: Surface Current Speed and Direction – All-Year

Appendix B – Operator Project Specific Appendix

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