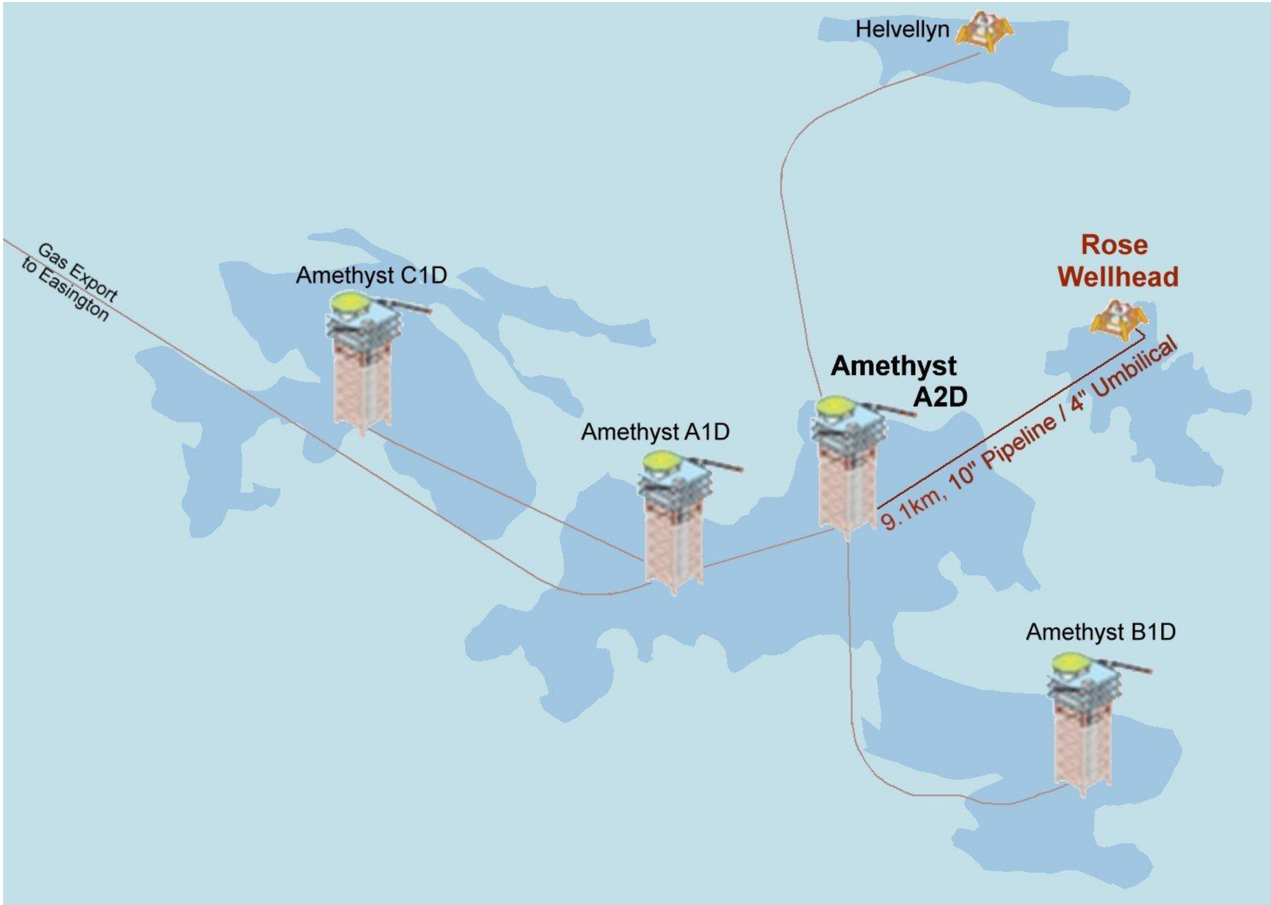
Rose Field Decommissioning Environmental Impact Assessment



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TERMS AND ABBREVIATIONS

ACRONYM	DESCRIPTION	ACRONYM	DESCRIPTION
ALARP	As low as is reasonably practicable	BMS	Business Management System
BODC	British Oceanographic Data Centre	BS	British Standards
CA	Comparative assessment	CEFAS	Centre for Environment, Fisheries and Aquaculture Science
Centrica	Centrica Energy Exploration and Production	CH_4	Methane
CO_2	Carbon dioxide	CoP	Cessation of Production
CSEMP	UK Clean Seas Environment Monitoring Programme	cSAC	Candidate Special Areas of Conservation
DECC	Department of Energy and Climate Change	Direct / Indirect impacts or emissions	Impacts or emission that are owned or controlled by Centrica / a consequence of the activities but are owned or controlled by an entity other than Centrica
DP	Decommissioning Programmes	DSV	Diving Support Vessel
EEC	European Economic Community	EC	European Commission
EMP	Environmental Management Plan	EIA	Environmental Impact Assessment
EN	European Norm	EMS	Environmental Management System
ERM	"Effects Range Medium" sediment concentrations threshold developed by the US Environmental Protection Agency below environmental impacts are anticipated to be significant	ERL	"Effects Range Low" sediment concentrations threshold developed by the US Environmental Protection Agency below environmental impacts are not anticipated
EU	European Union	ES	Environmental Statement
HSE	Health, Safety and Environment	GJ	Gigajoule
ISO	International Organization for Standardization	ICES	International Council for the Exploration of the Sea
Km	kilometre	JNCC	Joint Nature Conservation Committee
m/s	Metres per second	LAT	Lowest astronomical tide
MAT	Master Application Template	MARPOL	International Convention for the Prevention of Pollution from Ships
MCZ	Marine Conservation Zone	MCAA	Marine and Coastal Access Act
MOD	Ministry of Defence	MERMAN	Marine Environment Monitoring and Assessment National database
NGO	Non-Governmental Organisation	NFFO	National Federation of Fishermen's Organisations
NO_X	Nitrous oxides	NORM	Naturally Occurring Radioactive Material
OCNS	Offshore Chemical Notification Scheme	NUI	Normally Unattended Installation
OPEP	Oil Pollution Emergency Plan	OCR	Offshore Chemical Regulation

ACRONYM	DESCRIPTION	ACRONYM	DESCRIPTION
OSPAR	Oslo and Paris Convention	OPPC	Offshore Pollution Prevention and Control
PAH	Polycyclic aromatic hydrocarbon	P&A	Plugging and Abandonment
rMCZ	Recommended Marine Conservation Zone	QSE	Quality Safety Environment
SAC	Special Area of Conservation	ROVSV	Remotely Operated Vehicle Support Vessel
SOPEP	Shipboard Oil Pollution Emergency Plan	SAT	Subsidiary Application Template
SUTU	Subsea Umbilical Termination Unit	SPA	Special Protection Area
TOC	Total Organic Carbon	THC	Total Hydrocarbons
UCM	Unresolved Complex Mixture. The UCM fraction often represents the major component of hydrocarbons within hydrocarbon-polluted sediments	TOM	Total Organic Matter
UKCS	United Kingdom Continental Shelf	UK	United Kingdom
WFD	Waste Framework Directive	VOCs	Volatile organic compounds
		WHPS	Wellhead protection structure

1. NON-TECHNICAL SUMMARY

This summary outlines the findings of the Environmental Impact Assessment (EIA) conducted by Centrica Energy Exploration & Production (Centrica) for the decommissioning of the Rose gas field. The assessment concludes that the overall significance of the impacts from decommissioning is low.

The purpose of the report is to record and communicate the findings of the Environmental Impact Assessment, which assessed the potential for environmental impacts as a result of the decommissioning activities.

The EIA report has been prepared to support the following Decommissioning Programmes:

- The Rose installation (a wellhead protection structure); and,
- The associated pipeline and umbilical.

The Comparative Assessment (CA) and the EIA are supporting documents to the Decommissioning Programmes and will be submitted to the Department of Energy and Climate Change (DECC) for consideration under the regulatory approval process. A number of studies and surveys were undertaken to support the decommissioning and have been considered during the EIA, as appropriate.

The Rose field (block 47/15b), wholly owned and operated by Centrica Resources Ltd (CRL), is located in the southern North Sea. The field was discovered in 1998 and developed as a single subsea well (47/15b-6W) tied back to the Perenco operated Amethyst A2D platform via a 9km, 10" diameter pipeline (Figure 0-1). First gas occurred in 2004. The well is currently 'live' but not producing and is scheduled for pipeline isolation and plug and abandonment (P&A) as early as Q2 2015. The Rose field exploration well (47/15b-5) was previously plugged and abandoned and is therefore not considered in this document.

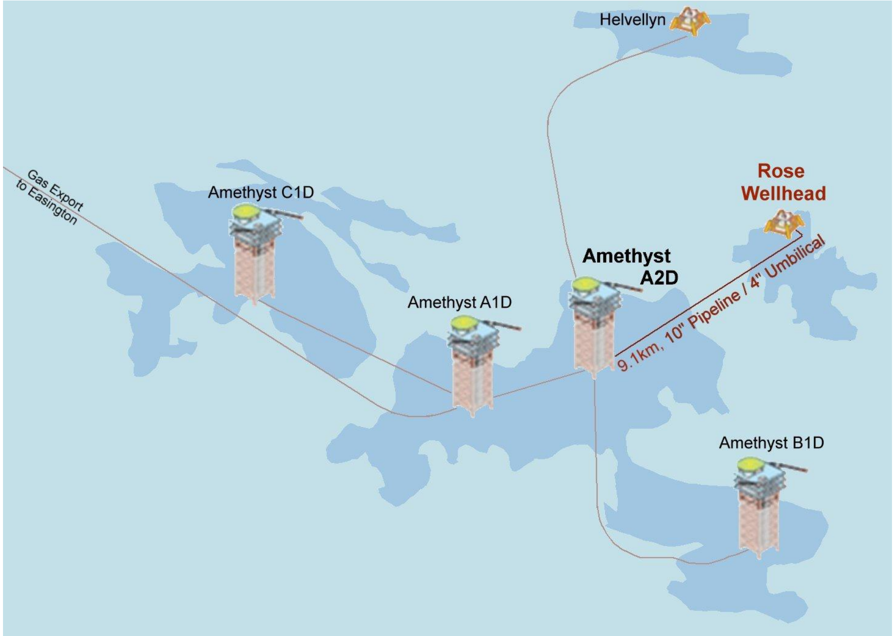


Figure 1.1: Rose field area

The Cessation of Production (CoP) document [1] for the Rose field was submitted to the DECC for approval in December 2014.

A summary of the Rose facilities is provided in Table 1-1 below.

Table 1-1: Summary of Rose subsea facilities for decommissioning

Sector of UKCS	Southern
Distance from English Coast	54km
Distance of Rose well from UK/Dutch median line	130km
Latitude/Longitude (WGS84 System)	53º 39.927' N and 0º 54.380 "E
License Block	Block 47/15b
License number	P776
Owner:	Centrica Resources Limited 100% equity owner
Cessation of production approval date	Q2 2015 (projected)
Scope of Decommissioning Programmes	• Partial removal of gas pipeline (10" x 9.0km). • Partial removal of the umbilical[1] (4" x 9.4km, multi-core) and its associated ballast wire (9.0km). • Complete removal of wellhead protection structure (WHPS). • Complete removal (where possible) of materials used to protect the pipeline and umbilical such as concrete mattresses (116 in total) and grout bags (approximately 200 in total, excluding emplaced rock).

[1] The umbilical carries hydraulic fluid, corrosion inhibitor and methanol in addition to the power and signals required for the control and operation of the wellhead and pipeline.

Regulatory context

Decommissioning of offshore oil and gas facilities on the UK Continental Shelf (UKCS) is governed by a range of legislation and guidance but falls principally under the Petroleum Act 1998 (as amended by the Energy Act 2008 [2]). The Petroleum Act sets out the requirements for a formal Decommissioning Programme, which must be approved by the DECC before decommissioning commences. The DECC Guidance Notes [3] require that the Decommissioning Programme is supported by an Environmental Impact Assessment, which considers the potential environmental impacts.

Environmental management

Centrica operate an environmental management system which is certified to the requirements of the international environmental management systems standard BS EN ISO 14001:2004 [4].

Decommissioning summary

The decommissioning activities are summarised in Table 1-2 below. Prior to decommissioning of the Rose field a range of preparatory activities will be completed. These will include cleaning of the contents of the gas pipeline and the umbilical.

Table 1-2: Summary of decommissioning activities

10" Pipeline PL1987	The gas pipeline will be decommissioned following a 'partial removal' approach, as it is sufficiently buried under the seabed with the exception of the ends and spool pieces, which will be recovered.	Approximately 9km of the pipeline will be left *in-situ*, where there is sufficient depth of cover. Sections of untrenched pipeline and pipeline with insufficient burial, of approximately 200m and 180m at the approaches to Rose wellhead and Amethyst A2D platform respectively (and including spool pieces) will be cut removed and returned to shore for recycling. The ends of the pipeline decommissioned *in-situ* will be excavated by water-jetting prior to cutting and allowed to backfill naturally. 18 areas of rock emplacement will remain *in-situ*. Five spool pieces with total length of approximately 90m at Rose wellhead and three spool pieces with total length of approximately 70m at Amethyst A2D will be disconnected, recovered and returned to shore for recycling. The pipeline riser and associated spool piece will remain with Amethyst A2D and be removed with the platform.
4" Umbilical (including ballast wire) PLU1988	The umbilical will be decommissioned following a 'partial removal' approach, as it is sufficiently buried under the seabed with the exception of the ends which will be recovered.	The umbilical will be disconnected from the Subsea Termination Unit (SUTU) at the Rose wellhead and cut approximately 150m away where it becomes buried. The cut section will be recovered. At the Amethyst A2D platform the umbilical will be cut at the base of the J-tube and at a second location approximately 170m away from the platform where it becomes buried. The 60m section of umbilical inside the J-tube will be recovered. Both sections of umbilical at Amethyst A2D will be recovered. Recovered sections will be returned to shore for recycling or disposal to landfill.
Wellhead Protection Structure (WHPS)	The structure will be completely recovered.	Sections of the WHPS will be removed by divers in order to disconnect the pipeline spool pieces and allow drilling rig access for later well plugging and abandonment activities.
Concrete mattresses and grout bags	Recovered from the wellhead end and at Amethyst A2D platform end. Four buried mattresses, at two midline locations, placed over the umbilical will be left *in-situ*.	The mattresses and grout bags will be removed from the Rose wellhead end and the Amethyst A2D platform end of the pipeline and umbilical by lifting to a vessel for onshore disposal.

Environmental setting and sensitivities

Water depth at the Rose wellhead is approximately 24m although water depth within the field ranges from 22m to 59m. The area is typical of the offshore regions of the southern North Sea, where hydrographical, meteorological, geological and biological characteristics are relatively uniform over large areas. Commercial users of the area are mainly associated with oil and gas exploration and development, shipping and fishing.

In 2001 the seabed sediments were surveyed as part of the development EIA and recorded as mega-rippled, mobile, shelly, fine to coarse sand, with varying quantities of gravel. A pre-decommissioning survey undertaken in 2012 revealed three main regions of distinct acoustic reflectivity that were characterised as: sandy gravel; gravelly sand; and, slightly gravelly sand. A transition area between gravelly sand and sandy gravel was also characterised, whilst in the west of the survey area within the 'Silver Pit', a slightly different reflectivity was observed and video imagery revealed that sandy gravel was more 'shelly' in nature than at other locations. The shallower water depths in this area of the southern North Sea allow hydrodynamic processes such as prevailing currents to cause changes over time to sediment composition and distribution on the seabed.

The ecosystem comprises a wide range of fauna from planktonic species through to molluscs, crustaceans, various fish species and larger marine mammals such as harbour porpoise and harbour and grey seals.

The 2001 survey also assessed the seabed suitability for herring spawning and concluded a mostly 'moderate suitability', although the pre-decommissioning survey indicated that herring, as well as sandeel, sprat, lemon sole and sole all spawn within the area. Fishing effort in the area is relatively low compared to other parts of the southern/central North Sea, focussing mainly on crustaceans. A range of seabird species are commonly observed. Many of these species may be sensitive to disturbance.

Impacts

Energy use and emissions to air

The principal energy use and associated atmospheric emissions will arise from fuel combustion for propulsion and power generation by the vessels required for the decommissioning programme. These emissions will include components that have the potential to contribute to global warming, acid rainfall, and dry deposition of particulate and photochemical pollution, or to impact upon local air and water quality. The impacts have been assessed as being short-term and of low significance.

Atmospheric emissions will be minimised by careful planning and optimisation of vessel schedules to ensure efficient operations. All equipment will be maintained for efficient operation and fuel consumption will be continuously monitored.

Underwater noise

Underwater noise has the potential to impact on fish and marine mammals. The subsea noise levels generated by the vessels and the pipeline cutting equipment to be used in the decommissioning programme are unlikely to result in physiological damage to species. The impacts have been assessed as being short-term and of low significance.

Activities such as underwater cutting and the use of dynamic positioning systems on vessels will be planned and closely controlled to minimise noise emissions.

Seabed disturbance

Activities being undertaken at or near the seabed have the potential for localised seabed disturbance. The activities which will lead to greatest disturbance of the seabed is the water-jetting of sediment and the lifting of sections of pipeline and umbilical. Once these activities are completed, it is expected that the seabed and its associated ecosystem will rapidly recover. The impacts have been assessed as being short-term and of low significance.

Activities will be planned and closely controlled to seabed disturbance..

Discharges to sea

Planned discharges to sea during the decommissioning programme include routine operational discharges from the vessels and releases of residual contamination from the pipeline and the umbilical when containment is broken.

Vessel discharges will be of short duration and within the normal scope of shipping activities. The prevailing hydrodynamic conditions are expected to ensure rapid dispersion. The impacts have been assessed as being short-term and of low significance.

The majority of discharges during pipeline disconnection and lifting will consist of residual levels of contamination only as the pipeline and umbilical will have been cleaned and flushed prior to decommissioning. The umbilical cores containing hydraulic fluid will not have been cleaned and their contents will be directly discharged to sea. The chemical has previously been permitted for discharge at the location and the volume discharged will be small. The discharge is expected to be rapidly dispersed under prevailing hydrodynamic conditions. The impacts have been assessed as being short-term and of low significance.

Releases to sea

Accidental events involving the release of polluting materials such as hydrocarbons or chemicals are unlikely to occur during the programme owing to the stringent control measures and operational procedures that are in place.

There remains the potential, however, for release to sea of a large quantity of diesel from the vessels. Although the likelihood of such an event is extremely low, the potential impact has been assessed. This was undertaken by reviewing the behaviour of a larger release that was modelled during the preparation of the Oil Pollution Emergency Plan for the Rose well location. This modelling is inherently conservative in relation to the credible worst case for the decommissioning programme and demonstrates that the acute impacts from a release of diesel is likely to be short-term. The significance has been assessed as low.

Emergency response measures are in place which will mitigate the impact of any accidental diesel spillage

Waste

The decommissioning programme will generate both hazardous and non-hazardous waste materials. Wastes will be segregated according to characteristics and their disposal routes will be determined according to the waste hierarchy, taking account of the potential for recycle or recovery for reuse. Landfill disposal of waste will only be used as a last resort.

Wastes may include concrete (mattresses and grout bags) and scrap metal (primarily steel). Naturally occurring radioactive material is not expected to be present. If contaminated items are identified, appropriate handling measures will be employed.

Waste management activities will be conducted in full compliance with all relevant legislation and regulatory controls, including shore side regulations for those wastes transferred ashore for treatment or disposal.

Socio-economic impacts

The potential impacts upon commercial activities, such as fisheries, oil and gas operations and shipping have been assessed.

Access to commercial fishing may be restricted whilst certain of the decommissioning activities are undertaken. Given the short duration and relatively small ‘footprint’ of the required activities, the impact has been assessed to be of low significance.

A series of surveys and assessments will be undertaken during and following decommissioning to ensure that the sections of the pipeline and umbilical that remain on the seabed are sufficiently buried or trenched such that they do not present a risk of snagging to other users of the sea. The impact of decommissioning infrastructure in this manner has been assessed to be of low significance.

The detailed timing and location of the decommissioning programme will be communicated to users of the sea to minimise the disruption.

There will be a beneficial impact associated with the short-term continuation of employment for vessel crews and at local ports and shore bases. This impact has been assessed to be of low significance given that the local economy is conditioned to the presence of the oil and industry.

Longer-term access to the seabed will be enhanced due to the removal of infrastructure. This impact has been assessed to be of low significance.

Conclusions

The impacts and risks associated with decommissioning activities have been assessed in the context of the environment within which the Rose field and facilities are situated.

A variety of procedural and technical controls and mitigations measures have been identified to reduce impacts to ‘as low as reasonably practicable’.

The Environmental Impact Assessment concludes that the overall significance of the impacts as a consequence of the decommissioning of the Rose field is ‘low’.

2. INTRODUCTION

This Environmental Impact Assessment (EIA) report is a supporting document to the Decommissioning Programmes required by the Department of Energy and Climate Change (DECC) for the decommissioning of the Rose installation (a wellhead protection structure) and its associated pipeline and umbilical. The term ‘Rose field and facilities’ is used herein to describe the Rose installation and pipeline and umbilical.

The EIA report presents the findings of the process undertaken by Centrica relating to the decommissioning of the Rose field and facilities. The original EIA [7] prepared for the Rose development has been used a reference.

2.1 Location of the Rose field and facilities

The Rose field is located in the southern North Sea in the United Kingdom Continental Shelf (UKCS) block 47/15b, (Figure 2.1), lying approximately 54km east of the English coastline and 130km from the UK/Netherlands median line.

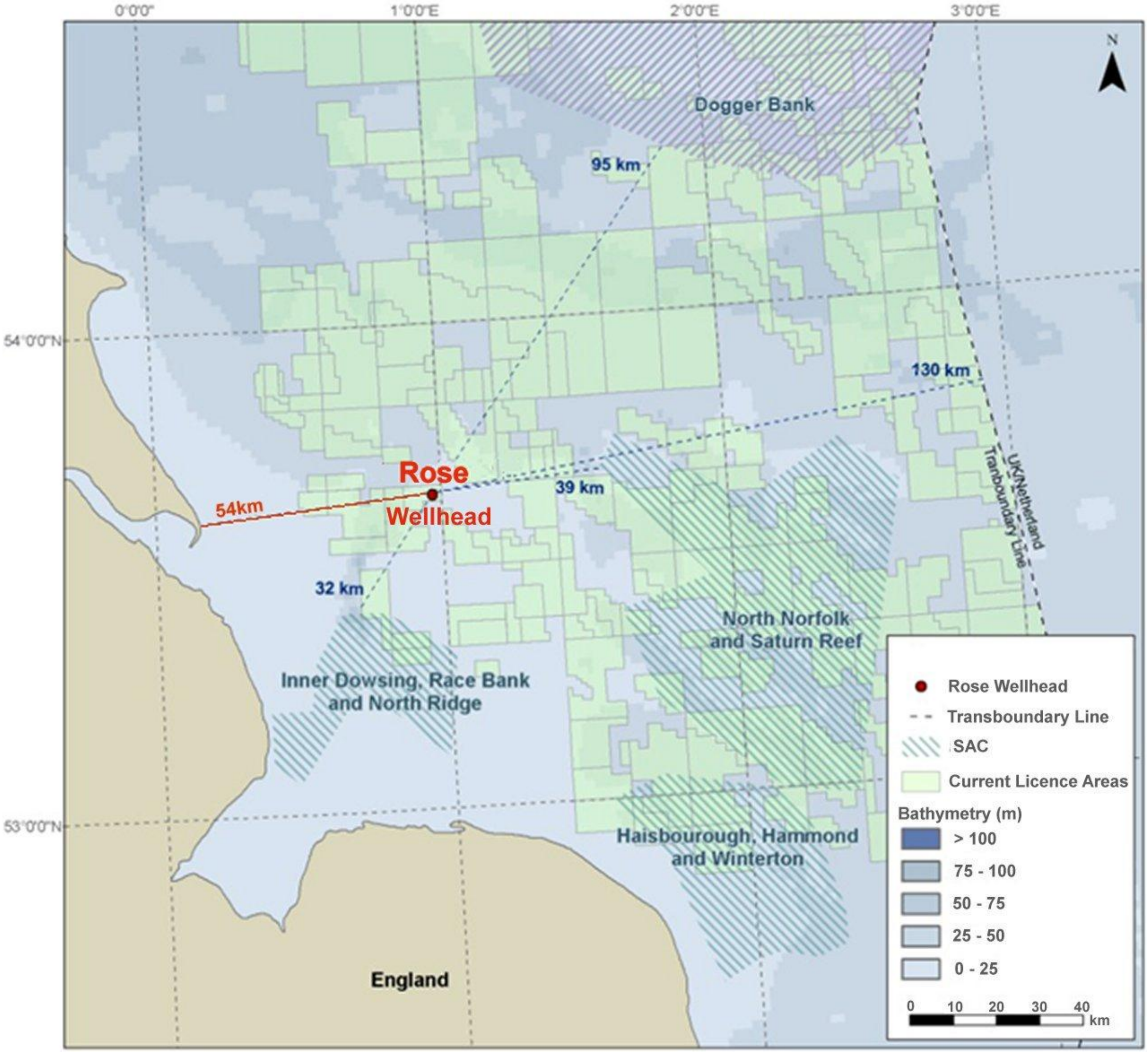


Figure 2.1 Location of Rose Field

2.2 Project background and purpose

The Rose field was discovered in 1998 by BG Group and Centrica. In 2002 Centrica bought out the 60% holding of BG Group and went on to develop the field with first gas occurring in 2004. The Rose field development (P776) is wholly owned by Centrica Resources Limited and comprises a single subsea production well (47/15b-6W) tied back to the Perenco (formerly BP) - operated Amethyst A2D platform, via a 10” diameter pipeline, approximately 9.0km in length (see Figure 1.2 for Rose field layout and facilities). No processing occurs on the Amethyst A2D platform, and production is comingled and exported to Dimlington via PL649. Both the Amethyst A2D platform and the Rose production well are located in water depths of approximately 24m. Water depth along the pipeline route varies between 22m and 59m (LAT).

The Rose well has not produced since 2010 and failed to restart in 2011 due to what was believed to be heavy liquid loading. The various engineering options and other opportunities examined by Centrica for extending production were deemed to be neither technically nor economically feasible. On this basis the likelihood of recovering additional reserves was considered minimal, hence the application for cessation of production and preparation for decommissioning.

The Rose production well is currently ‘live’ but not producing and is scheduled for pipeline isolation and plugging and abandonment (P&A) as early as Q2 2015.

The Rose field exploration well (47/15b-5) was previously subject to P&A in 2011.

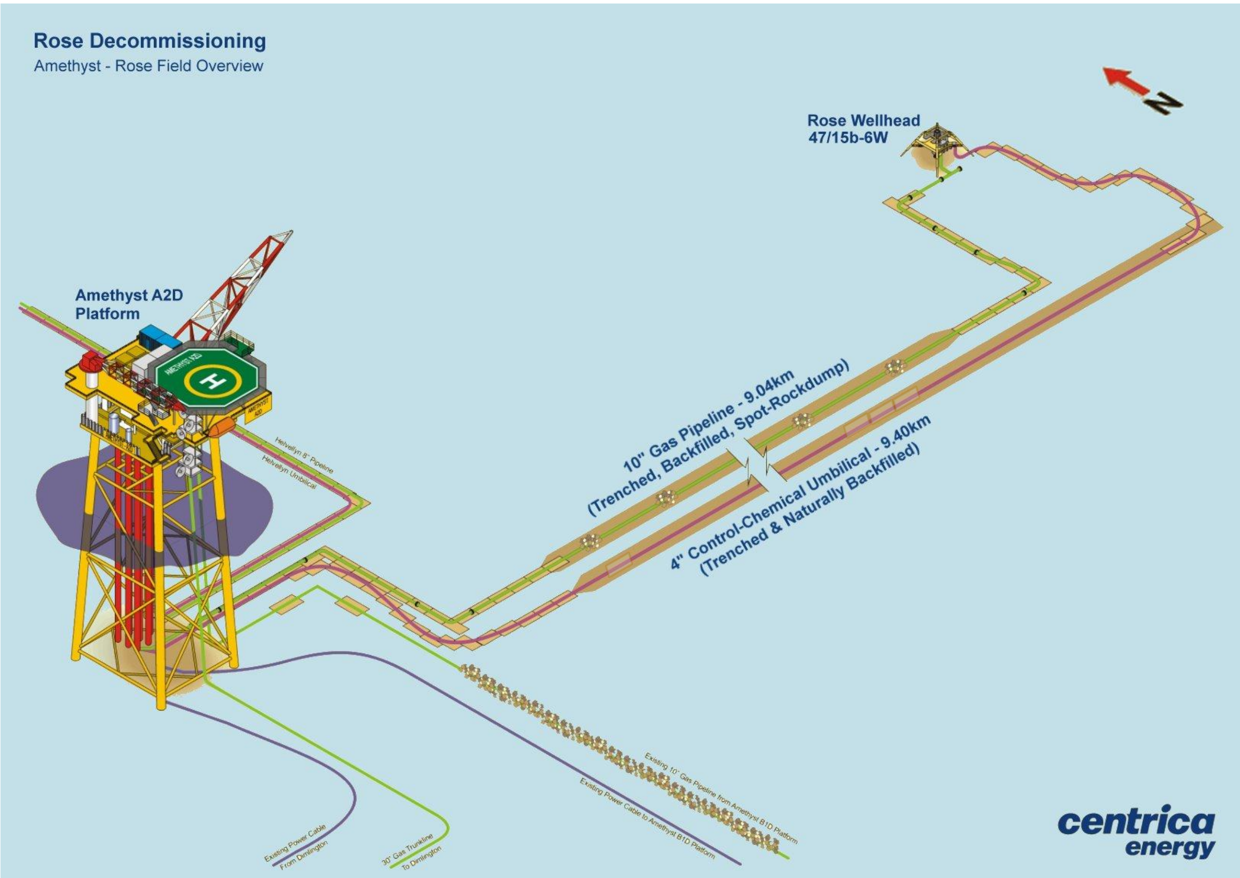


Figure 2.2: Rose field layout and facilities

2.3 Regulatory context

The relevant UK and international legislation is outlined below.

The UK international obligations on decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) Convention [8]. The OSPAR Decision 98/3 [9] sets out the UK's international obligations on the decommissioning of offshore installations. However, pipelines and umbilicals, such as PL1987 and PLU1988 at Rose are not included within the Decision.

The decommissioning of offshore oil and gas infrastructure (including pipelines) in the UKCS is principally governed by the Petroleum Act 1998 (as amended by the Energy Act 2008) [2]. The Petroleum Act sets out the requirements for a formal Decommissioning Programme, which must be approved by the DECC before the owners of an offshore installation or pipeline may proceed with decommissioning.

The DECC Guidance Notes [3] on the Decommissioning of Offshore Oil and Gas Installations and Pipelines advise that any Decommissioning Programme must be supported by an EIA. The Guidance goes on to state that the EIA should include an assessment of the following:

- All potential impacts on the marine environment including exposure of biota to contaminants; other biological impacts arising from physical effects; conflicts with the conservation of species and their habitats;
- All potential impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and impacts on the soil;
- Consumption of natural resources and energy associated with reuse and recycling;
- Interference with other legitimate uses of the sea and consequential impacts on the physical environment; and,
- Potential impacts on amenities, the activities of communities and on future uses of the environment.

The Marine and Coastal Access Act 2009 (MCAA) [10] states that an EIA is required for all licence applications relating to decommissioning activities. The MCAA licence application will be made at the time of decommissioning.

Other relevant legislation includes:

- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 [11];
- The Offshore Chemical Regulations 2002 [12];
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 [13];
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (requiring an OPEP) [14];
- The Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999 [15];
- Environmental Protection Act 1990 [16];
- Special Waste Regulations 1996 [17];
- Hazardous Waste (England and Wales) Regulations 2005 [18];

- Transfrontier Shipment of Waste Regulations 2007 [19]; and,
- Transfrontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008 [20].

As part of the requirements of the ISO 14001 certified Environmental Management System (EMS) [4], Centrica has identified all applicable legal and other requirements associated with the decommissioning activities.

2.4 Purpose of the Environmental Impact Assessment

As described in the DECC Guidance Notes [3], this EIA report has been produced following the EIA guidance for the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations (1999, as amended) [15]. This EIA report presents the findings of the process and has been prepared for submission as part of the planning and consents requirements. The purpose of the EIA is to understand and communicate the significant environmental impacts associated with the decommissioning and to identify the required control and mitigation measures.

The EIA and this report, assesses potential impacts in order to support the UK legislative requirements.

2.5 Stakeholder consultation

Stakeholder consultation is an important part of the decommissioning process. Informal responses received to date from stakeholders that are relevant to the EIA are shown in Table 1-1 and will be addressed as the project progresses.

Table 2-1: Summary of stakeholder comments

Stakeholder	Comment	Response
STATUTORY CONSULTATIONS		
NFFO	• Advice given was to commence discussions around 1 year before decommissioning. • Discussions with NFFO personnel.	• Discussed at regular meetings with no concerns raised to date. • A proposed way forward was agreed. • Discussions continue.
DECC	• The EIA report should cover the scope of the Decommissioning Programmes, not including well P&A.	• Included in this report.

2.5.1 Future consultation

The formal consultation will begin with the submission of the draft Decommissioning Programmes, supported by this EIA report, to the DECC. The consultation process at this stage will include the use of the Centrica internet website to make these documents publicly available. Hard copies will also be available in the Centrica Aberdeen office for inspection by members of the public.

2.6 Business Management System including environmental management

The management of the decommissioning activities is addressed within the Centrica EMS certified to the requirements of ISO 14001:2004. The EMS includes the procedures for environmental management in line with the Company's HSE policies and applicable legal requirements.

2.6.1 Environmental management

Centrica has a commitment to health, safety and security, as outlined below:

- The health, safety and security of our employees, customers and others who may be affected by our activities are a top priority. We believe that all work-related fatalities, injuries and illnesses can be prevented and we are committed to ensuring that all employees work in a safe and healthy way.
- The company's Business Management System (BMS), which describes those controls required to address Quality, Safety and Environmental (QSE) risks, is designed to meet business needs and to adopt a consistent approach to QSE management by satisfying the requirements of the recognised, applicable management systems standards, for environment, ISO 14001 Environmental management systems.

Centrica also has a commitment to the environment and details of this are outlined below:

- We are committed to understanding, managing and reducing the environmental impact of our activities. In particular we are committed to playing our part in the transition to low carbon energy, while ensuring the security of present and future energy supplies. We aim to achieve this by sourcing and producing energy from cleaner sources, reducing wasted energy and developing and deploying new technology.
- We aim to reduce the carbon intensity of our power generation by developing renewable energy sources. We are also committed to leading the consumer market for low carbon energy products and services, helping customers to reduce their energy usage.
- We recognise that our operations, together with the way we deliver products and services, can have a major impact on the environment. For example, in the way we produce and use energy, manage our local environment and its biodiversity, operate our fleet of vehicles and manage the waste we create. We will work with our employees and suppliers to reduce these impacts through innovation, technology and cultural change. In addition we will quantify, measure and communicate our environmental performance in a rigorous and clear manner.

2.6.2 Contractor management

Centrica will appoint a project management team to select and manage the operations of competent contractors. The team will ensure the decommissioning is executed safely, in accordance with Centrica Health and Safety principles and safeguard the environment in line with the environmental policy. Any change to the proposed decommissioning activities will be discussed with the DECC.

3. PROJECT DESCRIPTION

This section describes the Rose field and facilities that will be decommissioned and outlines the methodology that will be utilised. The process that was followed to identify the recommended decommissioning option is also presented.

3.1 Background

The Rose field was developed using a single subsea well producing gas via a 10” diameter, 9.042km long steel pipeline to the third party operated Amethyst A2D platform. The platform is classified as a Normally Unattended Installation (NUI) from which controls, hydraulic energy and chemicals are supplied to the wellhead, Xmas tree and pipeline via a 9.400km long umbilical. The steel pipeline riser and umbilical are located inside a 30” diameter caisson at the platform, with the umbilical being routed through the same caisson inside a steel tube with a 90 degree bend at its base (referred to as a J-tube).

Figure 2.2 shows the Rose field layout and Figure 3.1 below shows the battery limits of the pipeline system.

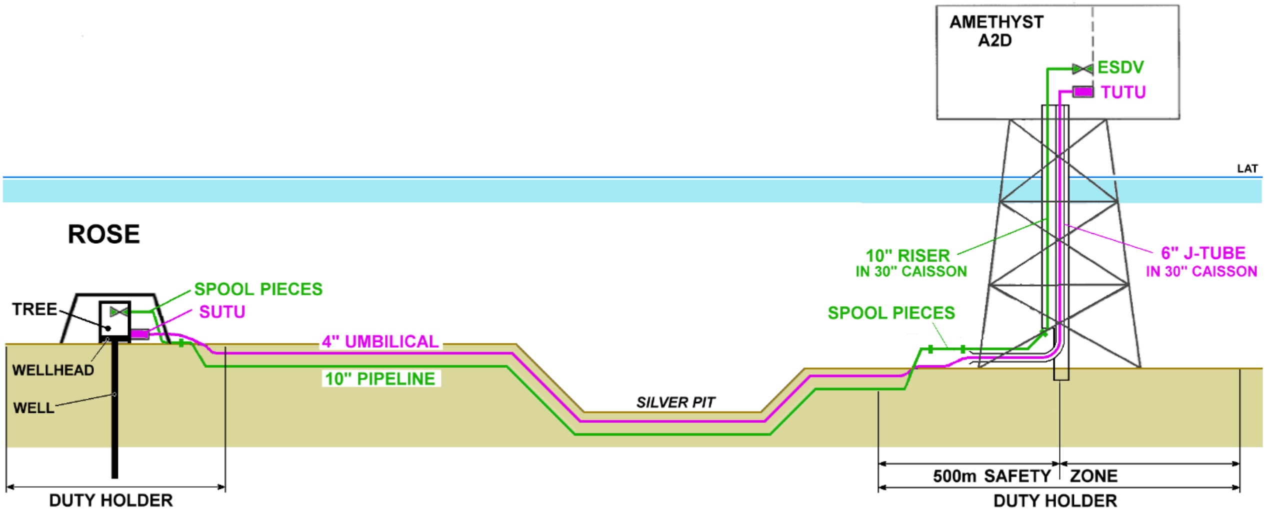


Figure 3.1: Rose pipeline system battery limits

The Rose well is located at the upstream end of the pipeline system and comprises the wellhead, Xmas tree, subsea umbilical termination unit (SUTU) and wellhead protection structure (WHPS). The WHPS is connected to the wellhead and positioned over the top of the Xmas tree. The WHPS is designed to be over-trawlable to minimise the snagging risk presented to commercial fishing and other third party users. The WHPS and Xmas tree are shown in Figure 3.2.

The Amethyst A2D platform will remain operational after the Rose facilities have been decommissioned. The caisson, riser, **J**-tube and topside facilities uniquely associated with Rose will be removed when the platform is decommissioned.

Figure 3.2: Rose wellhead protection structure and Xmas tree

3.1.1 10" gas pipeline (PL1987)

The 10" nominal bore carbon steel gas pipeline has a thin, three layer polypropylene outer coating which was applied to give protection from external corrosion. The pipeline was installed by a rigid pipe reel lay vessel and laid in a pre-cut trench. The trench was mechanically backfilled with seabed material, giving typically 1m or more of cover. Within the vicinity of the Rose wellhead, and within the Amethyst A2D platform 500m exclusion zone there are sections of approximately 180 - 200m in length, where the pipeline is not buried but covered with concrete mattresses and grout bags. There are also 18 midline sections where the buried pipeline is covered with emplaced rock. The purpose of the rock sections, which are typically 30 -40m in length, is to provide downforce at locations where the pipeline was susceptible to upheaval buckling while in service. There are no pipeline crossings.

The pipeline is connected to the Xmas tree by six rigid spool pieces, totalling approximately 90m in length. These comprise sections of straight pipe and horizontal and vertical bends that are designed to absorb pipeline end expansion and to facilitate fit-up and tie-in of the pipeline and Xmas tree.

The pipeline is connected to the riser at the Amethyst A2D platform by four rigid spool pieces totalling approximately 100m in length.

3.1.2 4" umbilical (PLU1988)

The 4" (96.5mm) diameter umbilical cross-section is shown in Figure 2-3. The umbilical was laid in a pre-cut trench that was left to backfill naturally with sediments. It comprises a composite flexible configuration of small diameter thermoplastic cores and polyethylene coated cables, the purpose of which is to provide the necessary controls, hydraulic energy and chemicals to operate the well and pipeline. In addition, the umbilical contains polyethylene filler elements and fibre tape, surrounded by layers of varying thicknesses of polyethylene and galvanised steel wire. The umbilical is attached to a steel ballast wire that provides additional weight to maintain its stability within the sediment in the trench. The steel ballast wire, which is made up of nine 1km long sections, runs the length of the buried umbilical. Umbilical elements which are on the surface or within the platform J-tube have no steel ballast wire attached.

The connection of the umbilical to the Rose Xmas tree is made at the SUTU, which is located within the WHPS.

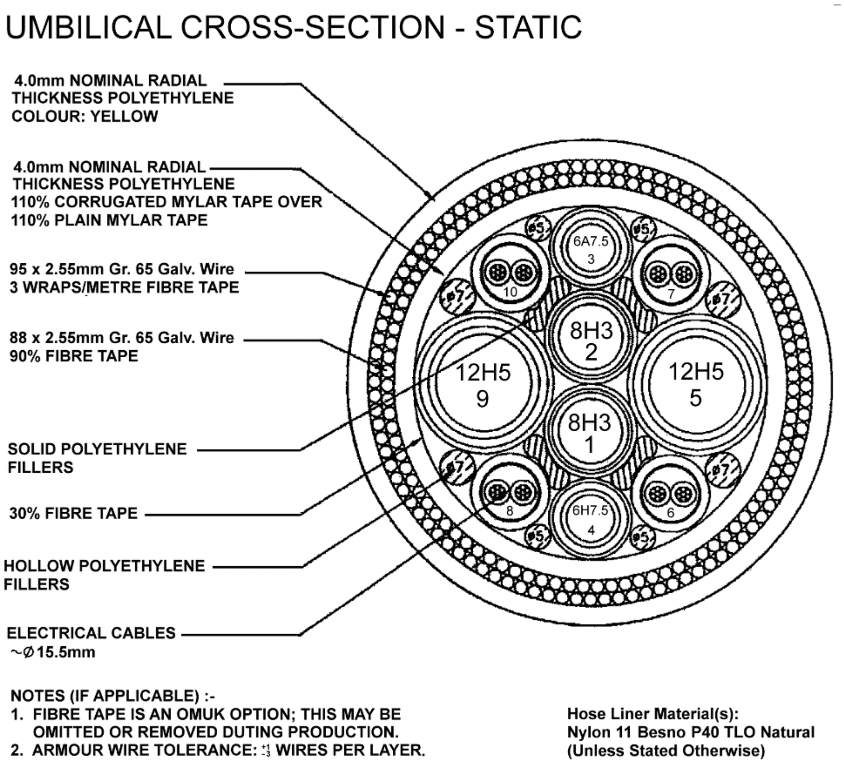


Figure 3.3: Rose umbilical cross section

The content of the umbilical cores and their approximate volumes at the time of decommissioning is shown in Table 3-1.

Table 3-1: Content of umbilical cores

Core No.	Core Description	Approximate Volume (m^3)	Content at decommissioning
1 & 2	Hydraulic Cores (2x)	2.4 (2 x 1.2)	Oceanic HW540 v2
3 & 4	Hydraulic Cores (2x)	1.4 (2 x 0.7)	Oceanic HW540 v2
5 & 9	Methanol/Corrosion Inhibitor Cores (2x)	5.4 (2 x 2.7)	Water with methanol/corrosion inhibitor residues
Others	Electrical/Signal	N/A	N/A

3.1.3 Emplaced rock, concrete mattresses and grout bags

As stated above, the pipeline has 18 median locations of emplaced rock, totalling approximately 5,547 tonnes distributed along the length of the pipeline.

The pipeline and umbilical are each protected with concrete mattresses at either end where they emerge from their trenches. There are 63 mattresses at the ends of the pipeline (30 at Rose, 33 at Amethyst A2D), and 49 mattresses at the ends of the umbilical (25 at Rose, 24 at Amethyst A2D). There are additional mattresses placed over the umbilical at two midline locations; one located 0.86km from the platform and a group of three located 5.70km further towards the Rose wellhead (shown schematically on the Rose field layout and facilities in Figure 2.2). The purpose of these additional mattresses, which have become buried since installation, is to mitigate areas of insufficient cover over the umbilical.

Grout bags (typically 25kg in weight) have been used to fill voids, as scour prevention, to provide improvements to protective cover to the exposed sections of pipeline and umbilical, and to ensure smooth transitions between the pipeline and the seabed. It is estimated that around 200 grout bags have been placed on the seabed (some will be located on top of one another). These are mostly under and adjacent to the spool pieces and tie-in points at the ends of the pipeline and umbilical.

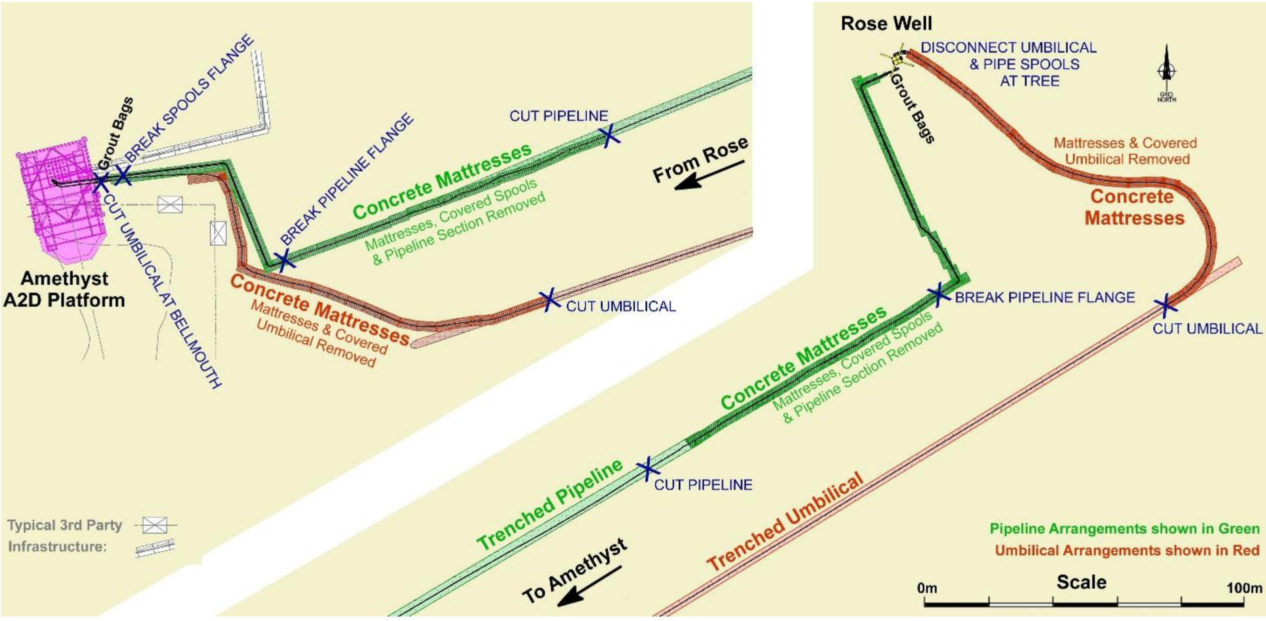


Figure 3.4: Pipeline and umbilical approaches showing mattress protection features and cut locations

3.1.4 Summary of facilities to be decommissioned

The following facilities and materials will be decommissioned:

- WHPS;
- Spool pieces;
- Pipeline;
- Umbilical, including ballast wire and SUTU; and,
- Concrete mattresses and grout bags.

The decommissioning (removal) of the Rose wellhead and Xmas tree is governed under the Offshore Installation and Wells (Design and Construction etc.) Regulations 1996 [21] and will be undertaken in accordance with the Oil and Gas UK guidelines for the suspension and abandonment of wells. These items will be decommissioned under a separate programme undertaken by a drilling rig and hence are not assessed in this document.

All emplaced rock will be left *in-situ* and is not assessed further in this document.

3.2 Comparative Assessment

A Comparative Assessment (CA) [22] of pipeline and umbilical decommissioning options is a key supporting document of the Decommissioning Programmes submitted to the DECC. The options were assessed using the DECC Decommissioning Guidance Notes and Centrica Comparative Assessment guidelines. During the assessment process, evaluations were made principally on a qualitative basis using Centrica's established corporate risk assessment tables but also combined with deterministic values from the cost and energy use estimates which were normalised to provide a consistent measure against all Comparative Assessment evaluation criteria of:

- Safety
- Environmental
- Technical
- Societal
- Cost

The Comparative Assessment was undertaken with a focus on the decommissioning options for the 10" pipeline, the 4" umbilical and the midline mattresses on the umbilical (Table 3-2, Table 2-3 and Table 3-4 below). The options were assessed using the DECC Decommissioning Guidance Notes [3] and Centrica Comparative Assessment guidelines [23].

Table 3-2: Pipeline Comparative Assessment of options for decommissioning

Item	Option 1 Complete Removal	Option 2 Partial Removal
Buried pipeline	Remove. *Use pipe reel lay construction vessel to pull pipeline out through covered trench and onto reel using "reverse lay" technique. Return pipe to shore for cutting into transportable lengths and processing*	Leave *in situ.* No work
Exposed pipeline ends	Remove. *Recover with reel lay vessel as part of reverse lay process*	Cut and remove. *Use divers from DSV to unbolt buried pipeline from riser, excavate local areas to give access for cutting pipeline and allow seabed to backfill naturally. This may also involve local water jetting.*
6 spool pieces at Rose wellhead, and 3 spool pieces at Amethyst A2D platform	Remove. *Divers disconnect flanges and rig spools for lifting to Dive Support Vessel*	Remove. *As option 1.*
Single spool piece adjacent to rigid riser inside jacket at Amethyst A2D platform	Leave *in situ* with the Amethyst A2D platform for possible reuse (to be decommissioned in future)	Leave *in situ.* As option 1.

Table 3-3: Umbilical Comparative Assessment of options for decommissioning

Item	Option 1 Complete Removal	Option 2 Partial Removal (ends only)	Option 3 Partial Removal (rock emplacement)	Option 4 Partial Removal (3.5km removal)
Buried Umbilical	Remove. *Pull umbilical out through covered trench and onto a reel mounted on a vessel, possibly a reel lay vessel, but probably the Dive Support Vessel. Return umbilical to shore for cutting into transportable lengths / weights and processing*	Remove poorly buried or potentially unstable sections and leave acceptably buried sections *in situ*. Locate poorly buried sections, excavate extremities by local water jetting, cut, and connect to winch for recovering to deck of vessel	As option 2, but also place graded rock over areas with relatively shallow cover	As option 2 but remove additional length of umbilical 3.5km long measured from Amethyst A2D platform with relatively shallow cover within Silver Pit area
Umbilical ends within Amethyst A2D platform 500m exclusion zone	Remove. *Disconnect from TUTU on topsides, connect rigging to subsea end and pull section out from bottom of J tube to deck of DSV using winch*	Remove. *As option 1*	Remove. *As option 1*	Remove. *As option 1*
SUTU and umbilical ends at Rose wellhead	Remove. *As part of reverse reel process*	Remove with umbilical end section As "Complete Removal."	Cut and Remove	Cut and Remove

Table 3-4: Midline mattresses Comparative Assessment of options for decommissioning

Item	Option 1 Complete Removal	Option 2 Excavation and backfill with rock	Option 3 Leave *in situ*
Buried Midline Mattresses	Excavate local area and remove	Excavate local area and remove mattresses. Thereafter, backfill excavated area with graded rock	Leave *in situ*

The results of the assessment showed the risks and impacts of *all* pipeline and umbilical options to be broadly acceptable, although it could be argued that the technical and safety risks associated with complete removal of a pipeline or umbilical would be tolerable rather than be completely acceptable. This is primarily due to the limited experience of removing trenched and buried pipelines on the UKCS. From an environmental perspective lower risks and impacts will be incurred for the partial removal case than for any of the other decommissioning options.

The societal assessment showed that complete removal would be marginally beneficial because of continuation of employment due to extension of vessel use and onshore waste management activities. Although in the short-term, fishing activities might proportionately be disrupted as decommissioning activities increase.

Finally, the partial removal options would cost less to adopt than any of the other options.

Therefore, this Comparative Assessment recommends that the partial removal options be adopted for both the pipeline and umbilical. This means that after flushing and left full of seawater the majority of the pipeline and the umbilical will be left *in situ* with no disruption for the majority of their lengths. The pipeline and umbilical will cut below the seabed and the sections between the trench and the platform or Xmas tree will be removed.

The Comparative Assessment also recommends that the four umbilical midline mattresses will be left buried *in situ.*

Table 2-5 is a summary of the proposed Decommissioning Programmes, for consistency and to ensure that the EIA directly aligns this is as stated in the Decommissioning Programmes [24].

Table 3-5: Summary of Decommissioning Programmes

Selected Option	Reason for Selection	Proposed Decommissioning Solution
1. Topsides		
n/a		
2. Jacket(s)/Floating Facility (FPSO etc.)		
n/a		
3. Subsea Installation(s)		
Wellhead Protection Structure (WHPS) will be removed.	To remove all seabed structures and leave a clean seabed. To comply with OSPAR requirements.	WHPS will be removed from the seabed.
4. Pipeline, Flowline & Umbilical		
Pipeline will be flushed and left buried *in-situ*. Umbilical will be flushed and left buried *in-situ*.	The pipeline is sufficiently buried and stable, posing no hazard to marine users. The mattresses are not visible at their specified locations. This would suggest that the mattresses have become buried. Minimal seabed disturbance, lower energy usage, reduced risk to personnel engaged in the activity. The umbilical and its ballast wire are sufficiently buried and stable, posing no hazard to marine users. Minimal seabed disturbance, lower energy usage, less risk to personnel engaged in the activity.	The 10" NB pipeline, the 4" umbilical and its associated 36mm steel ballast wire will be left *in-situ* with the ends excavated locally to the cut location to ensure that the ends remain buried. Surveys indicate that both the pipeline and umbilical will remain buried with flooding. Degradation will occur over a long period within the seabed sediment, not expected to represent a hazard to other users of the sea. The four buried mattresses will be left *in-situ*; they are not expected to present a hazard to other users of the sea. The pipeline riser, J-tube and 30" caisson will remain with the A2D platform. Emplaced rock will remain *in-situ* on the pipeline.
5. Wells		
Well will be plugged and abandoned to comply with HSE "Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996" and in accordance with Oil & Gas UK Guidelines for the Suspension and Abandonment of Wells.	Meets the DECC and HSE regulatory requirements.	The Rose well will be plugged and abandoned using a drilling rig. A Master Application Template (MAT) and the supporting Subsidiary Application Template (SAT) will be submitted in support of activities carried out. A PON5 will also be submitted to the DECC for application to abandon the well.
6. Drill Cuttings		
No cuttings pile exists at Rose.	Cuttings are widely dispersed and fall below OSPAR 2006/5 thresholds.	n/a.
7. Interdependencies		
Mattresses (excluding the four mattresses midline on the umbilical to remain *in-situ*) and grout bags will be removed as part of the pipeline and umbilical removal activities		

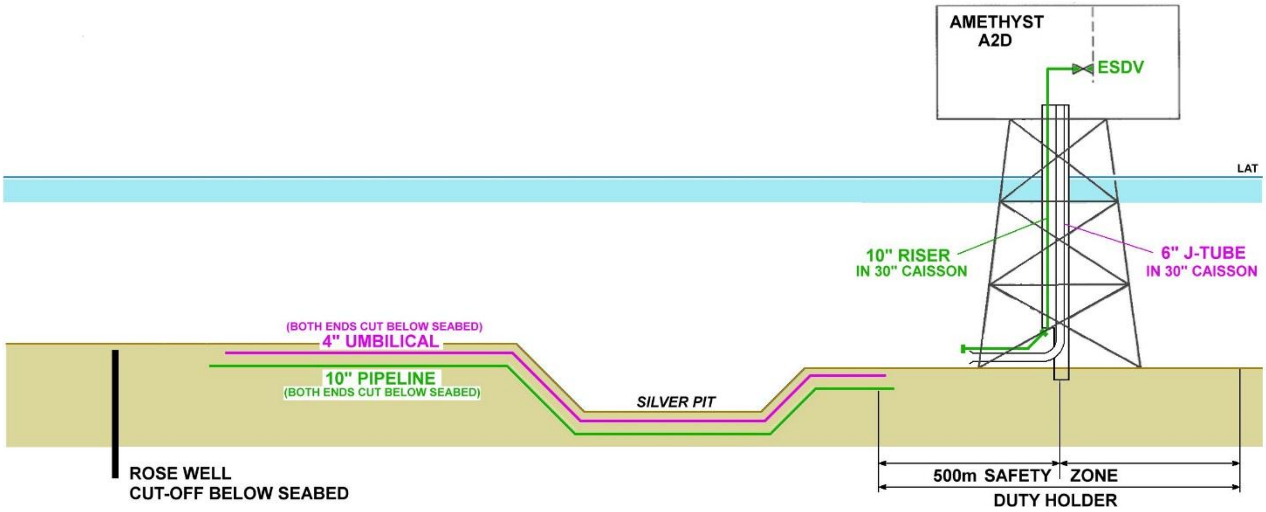
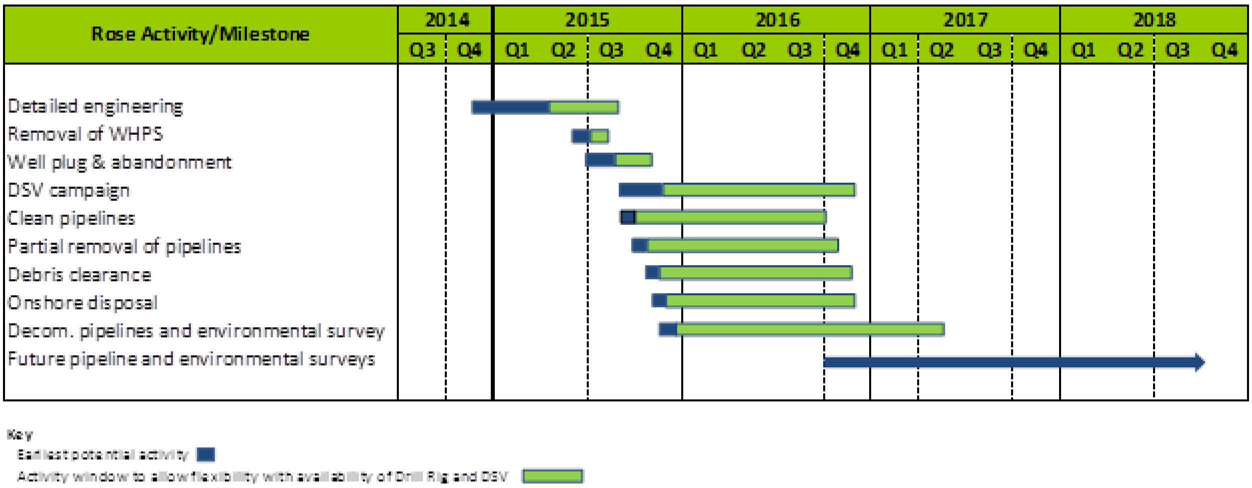


Figure 3-5: Recommended decommissioning approach

The decommissioning of Rose field and facilities is expected to progress in line with the dates set out in Figure 3.6.

Figure 3.6: Rose decommissioning schedule



3.3 Method and equipment

This section describes the methodology and equipment that will be used in decommissioning of the Rose field and facilities.

Offshore decommissioning activities will take place in three principal geographical areas, and under two principal operational modes, namely:

- At, and in the vicinity of, the Rose wellhead and the Amethyst A2D platform - vessel supported subsea operations predominantly in relation to removal and recovery of the WHPS, spool pieces, cut pipeline and umbilical sections, concrete mattresses, and grout bags.
- Along the length of the Rose wellhead to Amethyst platform pipeline/umbilical corridor - vessel operations predominantly in relation to surveying and monitoring.

3.3.1 Preparatory activities

Certain offshore activities will be undertaken in preparation for decommissioning and for completeness, these have been summarised below. They do not form part of the pipeline and umbilical Decommissioning Programme and their environmental impacts have not been assessed in this document.

- Isolation of the Rose Xmas tree from the Amethyst A2D platform (disconnection of the umbilical and gas jumper at the tree);
- Cleaning of the pipeline to remove remaining gas, liquids and loose solid deposits. The pipeline will first be pigged and then flushed, leaving it filled with inhibited seawater. Pigging waste and wash water will be returned to the Amethyst A2D platform for treatment and/or disposal. It will not be possible to clean the spool pieces at the Rose wellhead end in this manner; and,
- Cleaning of the umbilical cores that contain corrosion inhibitor and/or methanol. The cores will be flushed with potable water. Displaced chemicals and wash water will be returned to the Amethyst A2D platform for treatment and/or disposal.

3.3.2 Removal of the wellhead protection structure

The WHPS will be decommissioned in two stages. A DSV will initially be used to partially dismantle the WHPS in order to allow access for a drilling rig. The DSV will deploy a diver-operated cutting tool to remove its top and sides, which will be recovered to surface. The drilling rig will then deploy a tool to mechanically disconnect the remainder of the WHPS from the wellhead and to recover it to surface.

All component parts of the WHPS will be transported to the shore where, preferentially, they will be reconditioned for reuse. If this is not possible, constituent materials (predominantly steel) will be recycled.

3.3.3 Removal of pipeline and umbilical protection

- All 112 concrete mattresses and all grout bags (approximately 200) at the Rose wellhead and Amethyst A2D platform ends will, where technically feasible, be removed and recovered by a DSV to shore for reuse, recycling or disposal to landfill in accordance with the waste hierarchy principles. Given the relatively short duration that the mattresses and grout bags have been installed (ca. 13 years), it is assumed that (rather than single lifts) the concrete mattresses and grout bags will be able to be placed into purpose-built transport frames and debris baskets for temporary seabed placement.
- Trials will be undertaken to assess if these assumptions are correct in advance of the main DSV mobilisation. This will allow alternative arrangements to be planned should the above assumptions be incorrect.
- The four buried mattresses that have been placed over the umbilical at midline locations will be left *in-situ*. Emplaced rock protection will also be left *in-situ*.

3.3.4 'Partial removal' of the pipeline (including spool pieces)

All of the spool pieces at the Rose wellhead end of the pipeline and with one exception, all of the spool pieces at the Amethyst A2D platform end of the pipeline will be removed by DSV and recovered to the shore for recycling. The riser spool piece located under the Amethyst platform will not be removed. Spool pieces will either be unbolted, or cut into manageable lengths.

As stated in Section 2.1.1, the majority of the pipeline is trenched and sufficiently buried to a depth of at least 0.6m to top of pipe to present no expected threat to marine users [3]. This section of the pipeline will be subject to *in-situ* decommissioning.

The sections of the pipeline that make the transition from full burial to the seabed surface, and the sections of the pipeline that rest on the seabed are classed, respectively, as 'insufficiently buried' and 'not buried'. These sections of the pipeline will be removed by DSV and recovered to shore for recycling. The pipeline will be cut into approximate 20m lengths using a specialist diver-operated cutting tool before being cut further into smaller lengths suitable for road transport. Figure 3.4 shows the locations of the cuts. At the Amethyst A2D platform end, the pipeline will be unbolted where it enters the platform structure at the riser spool piece flange and the unduried or 'insufficiently' buried section will be cut, removed and recovered for recycling onshore. The riser will remain in place.

Access to the pipeline circumference may require the deployment of a water-jetting tool from the DSV to displace sediment. Water-jetting of the seabed may be required to gain access for cutting and/or unbolting of the spool pieces/pipeline and access for lifting. This will be undertaken using a specialist tool deployed by a DSV/ROVSV. The excavations containing the cut ends of the section that will be subject to *in-situ* decommissioning will be left to backfill naturally.

3.3.5 'Partial removal' of the umbilical

The umbilical will be disconnected from the SUTU at the Rose wellhead end and cut at the base of Amethyst A2D platform riser using a diver-operated cutting tool deployed from a DSV. The SUTU will be disconnected from the Xmas tree and recovered to surface by the DSV. The section of umbilical inside the J-tube will be removed and recovered by the DSV.

The majority of the umbilical is trenched and sufficiently lowered below sea level to a depth of at least 0.6m to top of pipe, while depth of backfill material lying over the umbilical varies along the route. This section of the umbilical (which is fitted with steel ballast wire) will be subject to *in-situ* decommissioning.

The sections of the umbilical that are 'insufficiently' buried (i.e. un-trenched or transitionally trenched) at both the wellhead and the Amethyst A2D platform will be cut by divers using a specialist tool, removed by DSV and recovered to shore for preferential recycling. If this is not possible, they will be disposed of to landfill.

Access to the umbilical circumference may require the deployment of a water-jetting tool from the DSV to displace sediment. No emplaced rock is present in the vicinity of the cut ends.

3.3.6 Vessels

A range of specialist and support vessel types (e.g. DSV, standby) will be required at various times, and for various durations, to undertake particular component activities of the offshore decommissioning programme. The performance characteristics including the fuel consumption of the generic vessel types required to execute the work programme are well understood. This has allowed, in conjunction with a consideration of the programme vessels' schedule, estimates of fuel consumption to be made.(Table 3-6 and Table 2-7).

Estimates of fuel use have been based on Institute of Petroleum Guidelines [25]. The durations given allow for transit to/from the Rose – Amethyst area as well as operations.

The vessel durations given are worst case estimates. Vessel use will continue to be optimised until decommissioning commences. Actual durations are likely to be lower (in alignment with commitments made in this EIA report).

While decommissioning of the pipeline and umbilical will be undertaken during the same campaign, vessel use has been presented separately to be consistent with Comparative Assessment and Decommissioning Programmes documentation.

Table 3-6: Vessel requirements for decommissioning of the pipeline

Vessel		Fuel usage (Tonnes)
Type	Duration (Days)	
DSV	31	558
Standby	31	24.8
ROVSV	7	126
Surveys	9	13.5

Table 3-7: Vessel requirements for decommissioning of the umbilical

Vessel		Fuel usage (Tonnes)
Type	Duration (Days)	
DSV	5.5	99
Standby	5.5	4.4
Survey	9	13.5

3.3.7 Decommissioning and post-decommissioning survey/monitoring programme

A seabed debris survey, a pipeline and umbilical 'as left' trenching/burial status survey, and a seabed 'over-trawlability' assessment will be undertaken at the conclusion of decommissioning activities.

Post-decommissioning assessments of the trenching/burial status of the pipeline and umbilical sections that were decommissioned *in-situ,* and of the environmental status of the seabed will also be undertaken. While the exact timing and extent of required 'legacy' monitoring will be agreed with the DECC, at least two such rounds will be undertaken. The estimates of survey vessel days used in Tables 2.6 and 2.7 are based upon this minimum requirement and allow for both vessel mobilisation and demobilisation. It should be noted however that legacy monitoring of decommissioned Rose field infrastructure will be undertaken in combination with other Centrica surveying requirements at the time in the southern North Sea and that actual required vessel days are likely to be lower.

3.3.8 Summary of principal planned decommissioning activities

Offshore

General (in support of all removal activities below):

- Use of specialist and support vessels.

Removal of the wellhead protection structure:

- Partial dismantling (by cutting) of the WHPS. Undertaken using a specialist tool deployed by a surface vessel;
- Removal and recovery (lifting) of part of the WHPS to the surface vessel;
- Mechanical disconnection of the remaining part of the WHPS from the wellhead. Undertaken by a drilling rig; and,
- Removal and recovery (lifting) of the remaining part of the WHPS to the drilling rig.

'Partial removal' of the pipeline (including spool pieces) and umbilical:

- Unbolting/cutting each spool piece located between the Rose wellhead and pipeline, and the Amethyst platform riser and pipeline. Unbolting of the SUTU from the Rose Xmas tree and its cutting at the base of the Amethyst riser. Unbolting will be undertaken by divers deployed from a surface vessel, cutting will be undertaken using specialist tool(s) deployed by a surface vessel;
- Water-jetting of the seabed to permit access for the unbolting/cutting and lifting of spool pieces, pipeline and umbilical. Undertaken using a specialist tool deployed by a surface vessel;
- Cutting of the pipeline and the umbilical. Undertaken using specialist tool(s) deployed by a surface vessel; and,
- Removal and recovery (lifting) of spool pieces, and cut sections of pipeline and umbilical to the surface vessel.

Removal of pipeline and umbilical protection:

- Removal and recovery (lifting) of concrete mattresses and grout bags to a surface vessel.

Execution of decommissioning and post-decommissioning survey/monitoring programme:

- Use of specialist vessels.

Onshore

Processing of recovered materials:

- The light processing (cleaning and cutting etc. but excluding recycling) of recovered materials at a shore base, in preparation for their reuse, recycling or disposal. Undertaken by a variety of plant and equipment.

4. ENVIRONMENTAL BASELINE

This section describes the environmental setting of the Rose field and the receptors, both within the field and the surrounding area, which may be affected by the proposed decommissioning activities described in Section 2. The Rose field and facilities are located in an area of the southern North Sea that is both environmentally sensitive (including and herring spawning) and close to busy shipping lanes. The information will be used to assess the level of impact that the proposed activities will have on the existing environment.

The Environmental Statement (ES) for the development of the Rose field was prepared in 2002 [7]. A series of environmental surveys were undertaken within the Rose field and in the surrounding area in 2001 to inform the ES. A pre-decommissioning environmental survey was undertaken in 2012 [5]. The results of this survey have been used to update, where necessary, the findings of the ES and to establish the environmental baseline for this assessment.

The pre-decommissioning survey was undertaken within the vicinity of the Rose wellhead (47/15b-6W) and along the length of the Rose to Amethyst A2D pipeline and umbilical corridor. The survey, undertaken in August 2012, collected geophysical and environmental data using a combination of single-beam and multi-beam bathymetry, sidescan sonar and environmental sampling. The environmental sampling locations, where habitat mapping, grab and video analysis were undertaken, were informed by the bathymetry and sidescan sonar data.

Four samples (3, 4, 9 & 10) were taken in a cruciform pattern approximately 250m from the Rose wellhead; four further samples (1, 2, 5 & 6) at 250m intervals both north-north-west and south-south-east along the main tidal axis; and four samples (12-15) along the Rose to Amethyst pipeline corridor at approximately 2km intervals. Two additional samples (8 & 11), 1km west and 1km east of the wellhead, were collected from areas of undisturbed sediment as reference sites. Sample 7 was also collected, as a reference site, 1.25km south-south-east of the wellhead. The two sampling sites (8 & 9) to the south-west of the wellhead were moved slightly north to allow 200m between the sampling sites and the pipeline. Two video only sites (16 & 17) were added on review of the sidescan sonar data, to target different habitats along the pipeline. The locations of all samples are presented in Figure 4.5.

Comparing the observations of the 2002 ES, which described the environment in the area surrounding the Rose prior to its development in 2001/2002, and the pre-decommissioning survey in 2012 allows consideration of the recovery of the environment from the disturbance associated with original development.

4.1 Physical and chemical environment

This section provides information on the physical and chemical characteristics of the environment at and around the Rose field. The physical environment in which the Rose field is located is typical of the southern North Sea region.

4.1.1 Bathymetry

The 2002 ES states that water depths in the immediate area of the well location are shallow, varying between 23m and 24m and that the well lies approximately 1,200m to the north of an area of sand waves. The tops of the largest of these sand waves are 16m below Lowest Astronomical Tide (LAT) [7].

The 2012 survey recorded the majority of the survey area within a depth range of 20m to 30m LAT, but down to a depth of 60m in the area known as Silver Pit, towards the Amethyst A2D platform end of the pipeline (Figure 4.1). These depths are typical of the wider region, with deeper water corresponding to shelf troughs, such as Silver Pit. Over the majority of the survey area, depth changes were gradual, between 21.9m and 31.4m. The shallowest depth recorded, 14.2m, was directly over the Rose wellhead, which was found to be 9m higher than the surrounding seabed (Figure 4.1) [5].

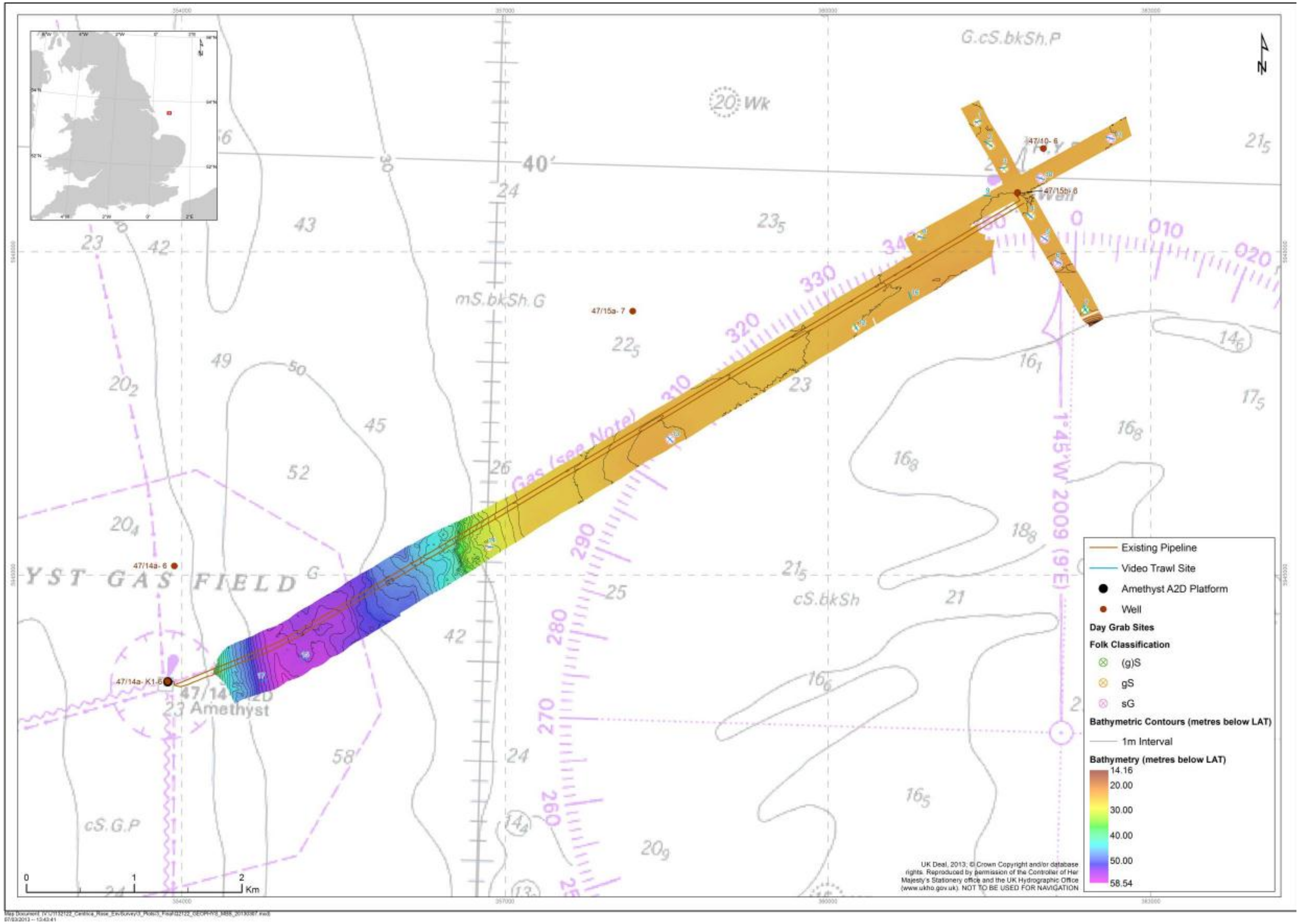


Figure 4.1: Bathymetry and shaded relief of bathymetry showing the location of The Silver Pit (deeper waters) [5]

4.1.2 Currents

The entire water mass surrounding the UK southern North Sea moves in a south-easterly direction following the contours of the English coast (Figure 4.2). The current then moves in a north-easterly direction as it approaches the Norfolk coast making up the general anticlockwise direction of water flow for the North Sea. The North Sea has a single outflow, which commences in the Skagerrak, formed from all the inflows from the Baltic and Norwegian coastal run off. This current is known as the Norwegian Coastal Current and leaves the North Sea at its north-eastern margin [26]. The general water circulation is shown in Figure 4.2 below.

The majority of the North Sea is influenced by meteorological factors, which have a key role in ecosystem structuring. However in the shallower southern North Sea, the strong tidal flows prevent stratification of the water column and the input of nutrients from riverine sources reduce the influence of seasonal climatic factors.

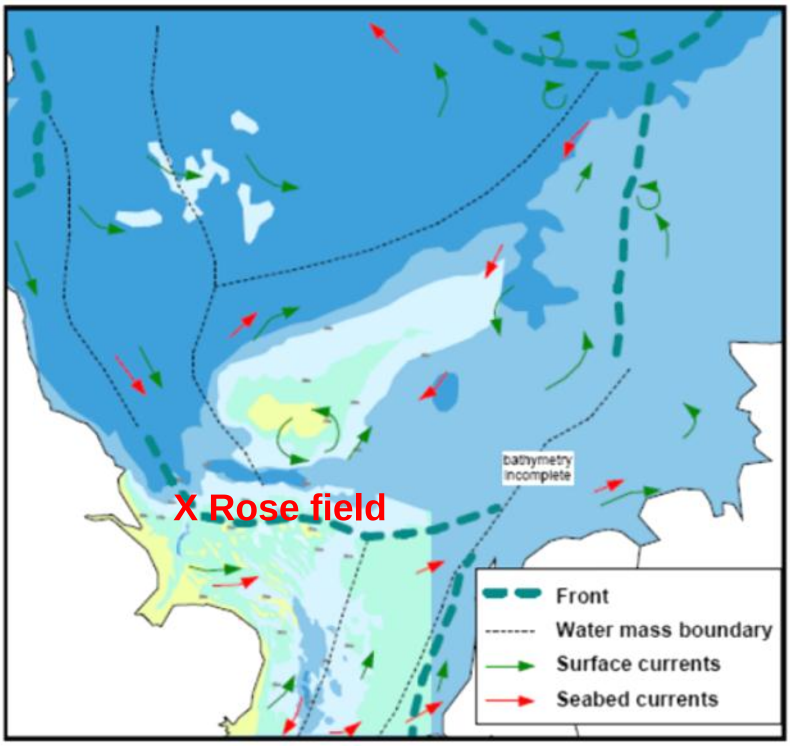


Figure 4.2: General water circulation [26]

The local current direction close to the Amethyst A2D location (taken from the Admiralty Chart for Flamborough Head to Blakeney Point) is predominantly north to south. Minimum and maximum tidal rates at spring tides range from 0.46m/s to 1.49m/s, whilst values for neap tide rates range from 0.15m/s to 0.82m/s. The spring and neap flood tides have the highest rate when compared with spring and neap ebb tide rates.

At the Rose wellhead location the tidal currents are influenced by the Outer Dowsing Channel and Shoal where current directions are more aligned in a north-north-west to south-south-east direction. Tidal rates at this location are likely to be lower than at the Amethyst A2D platform with typical ranges of 0.26m/s to 0.87m/s at spring tides and 0.15m/s to 0.46m/s at neap tides.

4.1.3 Meteorology

Wind speed and direction in the vicinity of the Rose field is seasonal but also highly variable, particularly during the spring. In summer, winds are light, averaging 9 - 10 knots and generally from the south-west. In autumn and winter, winds are stronger averaging 16 - 17 knots, although still typically from the south-west (Figure 3.3).

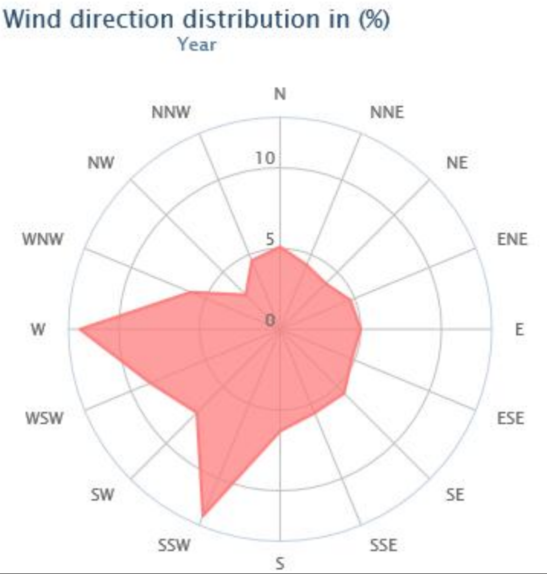


Figure 4.3: Mean wind direction distribution for the Humber Estuary platform. Source www.windfinder.com

4.1.4 Sea temperatures and salinity

The temperatures within the southern North Sea vary seasonally, ranging from 5˚C in the winter months up to 15˚C in the summer months. Salinity in the North Sea remains constant throughout the year at approximately 34‰.

As described in Section 3.1.2 above, the physical characteristics of the southern North Sea result in a well-mixed water column, preventing stratification. As a result, there is minimal difference between the temperature and salinity at the surface and that at the seabed.

4.1.5 Seabed characteristic, sediments and types

The nature of seabed sediments is an important factor in providing information to help assess the potential for resuspension and transport of sediments. It is also a determining factor in the flora and fauna present and for their suitability as spawning and nursery grounds.

The 2002 ES described the seabed sediments in the immediate vicinity of the Rose field as consisting of megarippled (aligned in an approximately east-west direction), mobile, shelly, fine to coarse sand, with varying quantities of gravel [7].

As part of the pre-decommissioning environmental survey [5], the pipeline/umbilical and surrounding areas were surveyed (Figure 4.4) and subsequently sampled at a number of locations (Figure 4.5). Three main regions of distinct acoustic reflectivity were identified in the low frequency data, these were characterised according to Folk [27] as: sandy gravel; gravelly sand; and slightly gravelly sand. A transition area between gravelly sand and sandy gravel was also characterised. Within the Silver Pit, in the west of the survey area, a slightly different reflectivity was observed. Video imagery revealed that here the sandy gravel was more shelly in nature than at other locations.

The main areas of sandy gravel were located in the central area and the far western end of the pipeline. Gravelly sand was characterised on the pipeline to the east of Silver Pit, a section towards the Rose wellhead end of the pipeline and to the south-east of the wellhead itself. A small patch of slightly gravelly sand was demarcated far south-east from the Rose wellhead. The areas to the north and west of the wellhead were predominantly transitional areas of gravelly sand and sandy gravel, as were the two patches on the pipeline. Figure 4.4 presents the seabed characterisation in the vicinity of the wellhead and along the length of the pipeline.

Variations of acoustic reflectivity in the data were used to identify seabed features. The main features observed were the wellhead, with the pipeline and umbilical clearly visible in the data, as well as the trenched pipeline and areas of emplaced rock. Boulders were frequently identified across the entire survey area. Regions of dunes were observed across the survey area, in general orientated approximately east to west, as observed in the 2002 ES. Cobbles and boulders were also visible throughout the data, but were not characterised as they were well dispersed across the area [5]. Table 4-1 presents the results of the analysis of the grab samples collected.

Table 4-1: Sediment characteristics. (Adapted from [5])

Site	Mean Particle Diameter (µm)	Mean Particle Diameter (Phi)	% Gravel (64000 – 2000 µm)	% Sand (<2000 – 63 µm)	% Mud (<63 µm)	Folk Class *	Total Organic Carbon (%)	Total Organic Matter (%)
1	751.4	0.4	15.1	84	0.9	gS	0.3	7.6
2	482.9	1.1	11.0	87.5	1.6	gS	0.4	9.4
3	652.8	0.6	18.8	80.4	0.9	gS	0.4	9.5
4	461.0	1.1	5.4	93.6	1.0	gS	0.4	7.7
5	904.6	0.1	30.3	69.1	0.7	sG	0.3	7.5
6	903.6	0.2	34.8	64.6	0.6	sG	0.2	7.2
7	406.3	1.3	1.0	98.1	0.9	(g)S	0.2	6.4
8	690.9	0.5	18.6	80.7	0.8	gS	0.3	7.8
10	956.2	0.1	38.7	60.7	0.6	sG	0.3	6.4
11	869.1	0.2	34.0	65.3	0.6	sG	0.2	6.1
12	515.3	1.0	10.4	88.5	1.1	gS	0.3	7.6
13	7986.5	3.0	65.8	33.1	1.1	sG	-	-
14	537.0	0.9	14.5	84.0	1.5	gS	0.5	8.4

gS = gravelly sand, sG = sandy gravel, (g)S = slightly gravelly sand

The results for Total Organic Carbon (TOC) and Total Organic Matter (TOM) are presented in Table 4-1 above. TOC concentrations are consistently low, between 0.2% and 0.5% with an average of 0.3% across all sites. These results are comparable to other values obtained from the southern North Sea, which recorded organic carbon values of between 0.02% and 0.51% ([29] as cited by [7]).TOM results varied between 6.1% (Site 11) and 9.5% (Site 3) with an average of 7.6%. These values were noted as being high in respect to the TOC and when compared to other values from the North Sea. Quality control procedures were checked from the sample collection to the laboratory analysis and no obvious sources for the high values were found [5].

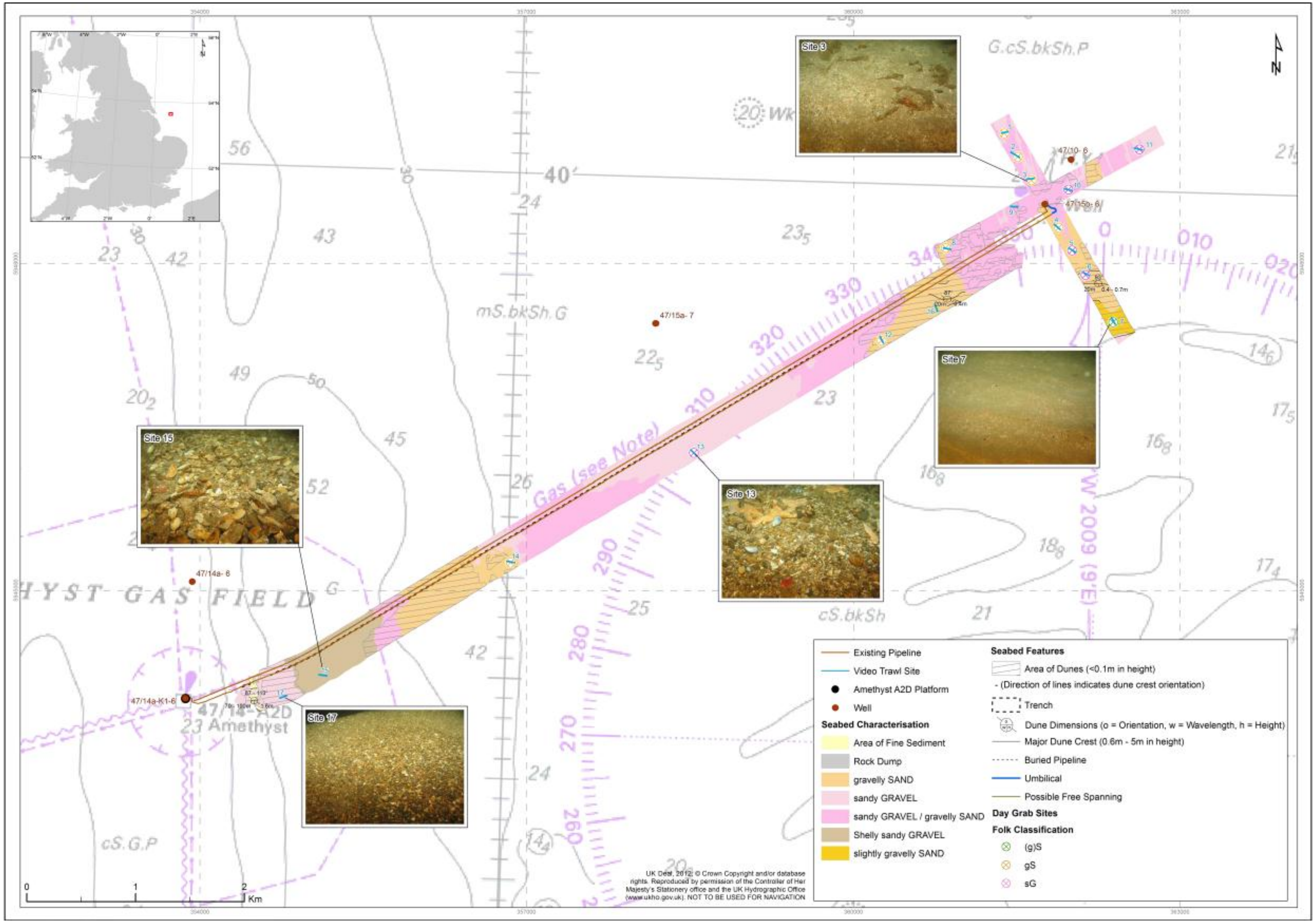


Figure 4.4: Seabed characterisation [5]

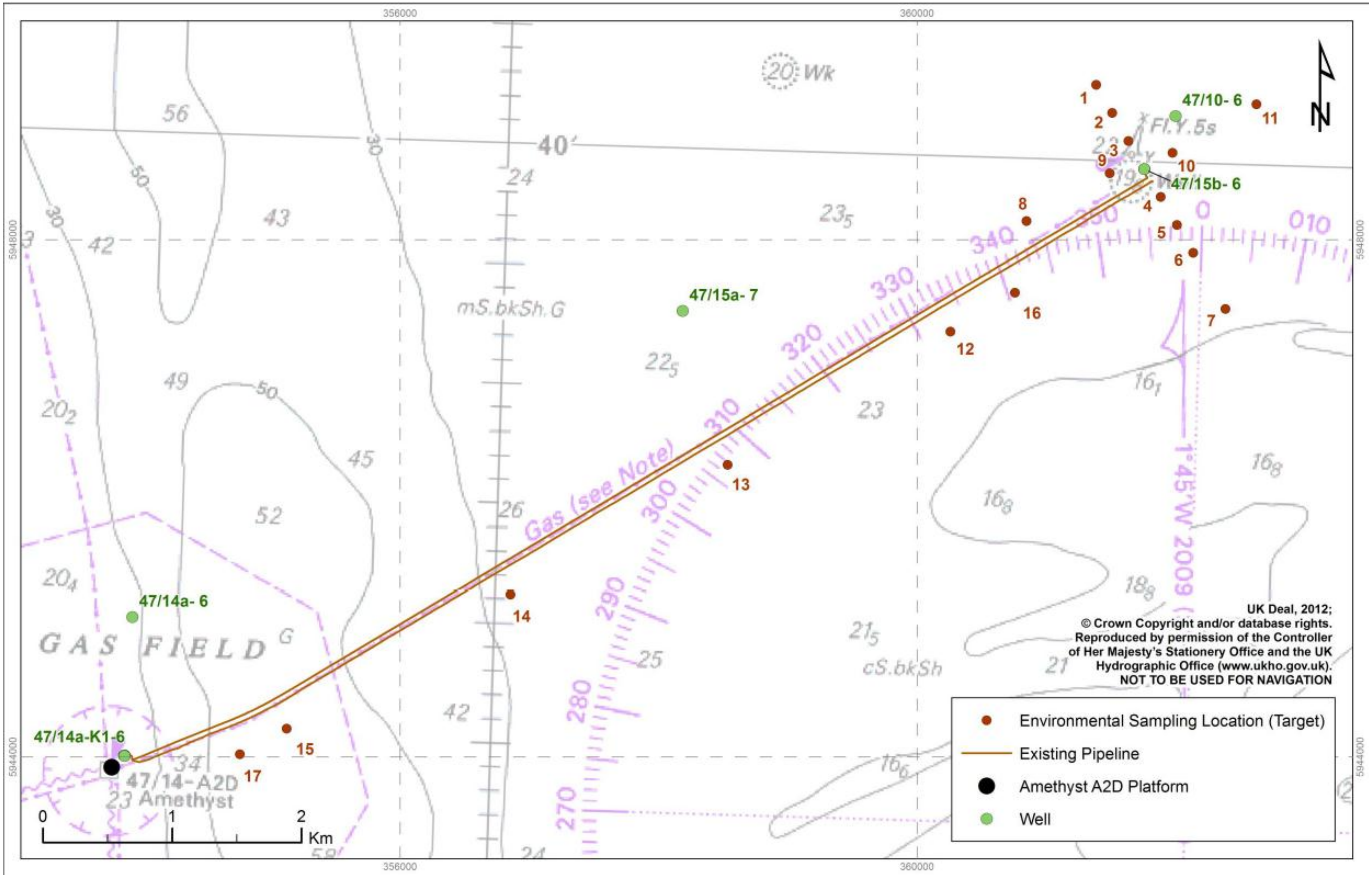


Figure 4.5: Subsea infrastructure features and sampling locations [5]

4.1.6 Seabed chemistry

For the purposes of this report, seabed chemistry is discussed as the composition of hydrocarbons and metals present within the sediments in and around the Rose field.

Hydrocarbon concentrations

The 2002 ES states that the hydrocarbon content of southern North Sea sediments had been surveyed previously and that levels of up to 3,000mg/kg were recorded near sites where oil based muds had been used whilst drilling gas wells. However subsequent analysis had indicated that the trend for hydrocarbons was downwards ([26] as cited by [7]).

Sediment hydrocarbon analysis results from the pre-decommissioning environmental survey are presented in Table 4-2 below. Total Hydrocarbons (THC) varied from 2.29mg/kg (Site 11) to 22.84mg/kg (Site 14) and averaged 10.65mg/kg across the entire survey area. Background hydrocarbon concentrations are generally higher in fine sediments (muds and silts) than in coarser sediments (sands and gravels) due to their greater surface area and adsorptive capacity ([29]] as cited by [5]). Site 14, which had the highest THC value, also had one of the highest (1.49%) mud (<63 µm) fraction of any of the sampled sites (Table 4-1).

All sites were significantly below the Centre for Environment, Fisheries and Aquaculture Science (Cefas) Action Level 1 (AL1 - in general, contaminant levels in material below Action Level 1 are of no concern and are unlikely to influence the licensing decision) of 100mg/kg for THC. The typical range for THC in offshore North Sea surface sediments is 17 – 120mg/kg ([29] as cited by [5]). This illustrates how low the concentrations of THC recorded from the samples taken from the survey area are [5]. Furthermore the results represent a significant reduction in recorded concentrations from those presented in the 2002 ES [7].

Studies by the Norwegian Oil Industry Association [30] and UKOOA (2002) [31] indicate that THC concentrations below 50mg/kg are unlikely to represent a significant environmental impact.

Table 4-2: Summary of sediment hydrocarbon analysis. (Adapted from [5])

Site	THC (mg/kg)	UCM	nC10- nC20	nC21- nC37	nC10- nC37	NPD
1	16.97	15	0.811	0.584	1.395	0.169
2	9.99	9	0.292	0.349	0.642	0.094
3	8.39	8	0.201	0.221	0.422	0.092
5	19.23	18	0.679	0.611	1.290	0.253
6	3.73	6	0.193	0.232	0.425	0.061
7	4.74	4	0.137	0.210	0.348	0.019
8	4.03	4	0.070	0.099	0.169	0.022
10	4.56	4	0.136	0.162	0.298	0.051
11	2.29	2	0.052	0.124	0.176	0.027
12	17.42	16	0.776	0.612	1.388	0.237
14	22.84	20	0.913	1.561	2.474	0.238

The Unresolved Complex Mixture (UCM), also shown within Table 4-2, can provide an indication of the origin of hydrocarbons in the sediment and the extent to which they are weathered. Four of the Sites 7, 8, 10 and 11 have low levels of UCM across the entire hydrocarbon range measured. The other sites (1 - 3, 5, 6, 12 & 14) show a consistent pattern of low level high weight UCM. Site 14 had the most distinguished trace, which is typical of background levels of hydrocarbons in areas where oil and gas exploration occurs ([32] as cited by [5]). Hydrocarbons in this weight range (nC_{21}-nC_{33}) commonly originate from terrestrial or vascular plant sources, or could represent the residue of highly weathered and degraded petrogenic material [33]. The relatively large UCM and high proportion to the individual n-alkanes indicates there has been a high degree of weathering of the hydrocarbons, suggesting they did not originate from any recent input as the lighter n-alkanes are lost first as a result of evaporation, dispersion, dilution and degradation.

The levels of all hydrocarbons recorded (petroleum and polycyclic aromatic) were within the range expected for the North Sea.

Metal concentrations

The heavy metal analysis results are shown in Table 4-3 below. With the exception of arsenic at all sites and chromium and nickel at Site 1 (approximately 500m north of the well location), all metal concentrations within the sediments were found to be below Cefas AL1 and the UK Clean Seas Environment Monitoring Programme (CSEMP) Effects Range Low (ERL) levels (*concentrations below the ERL rarely cause adverse effects in marine organisms*).

Arsenic was found to be above the CSEMP ERL value (8.2mg/kg) at all sites, but was below the CSEMP Effects Range Medium (ERM) (*concentrations below the ERM are unlikely to cause adverse effects in marine organisms*) value (70mg/kg) and the Cefas AL1 value (20mg/kg). A study by Whalley *et al.* [34] found that arsenic concentrations varied between <0.15mg/kg and 135mg/kg for areas including Dogger Bank, Western North Sea and the Humber Estuary. The Humber was found to have elevated arsenic levels, but when the results were normalised against iron they appear to have reduced significance. The current arsenic values (9 - 14mg/kg) are within the range recorded by [34] and, therefore, are not considered to be notably out of line for the area, or indicative of any contamination from oil and gas activities in the area.

Chromium levels at Site 1 (45.5mg/kg) were found to be above the Cefas AL1 (40mg/kg) but below the CSEMP ERL level (81mg/kg). The proposed revised Cefas Action Level for chromium is 50mg/kg, which would place the level found at Site 1 below the threshold level. Values between 10mg/kg and 127mg/kg were obtained from the site named “Off Humber/Wash”, a monitoring site, for which data is held within the Marine Environment Monitoring and Assessment National (MERMAN) database. The MERMAN database holds data from the CSEMP, previously known as the National Marine Monitoring Programme (NMMP) and the National Monitoring Plan (NMP). The values within this survey ranged between 8.0mg/kg and 45.5mg/kg, which fall within or below the levels found at the CSEMP monitoring site.

Nickel concentrations were all below Cefas AL1 (20mg/kg) and CSEMP ERL (21mg/kg) limits at all sites with the exception of Site 1 (23mg/kg), which was higher for both Cefas and CSEMP ERL limits. However the nickel concentration was below the CSEMP ERM (52mg/kg) AL2 values (200mg/kg). Previous data collected in the area, obtained from the Marine Environment Monitoring and Assessment National database, show the repeat monitoring site named “Off Humber/Wash” had values between 27mg/kg and 57mg/kg. The value recorded at Site 1 fell below this range.

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Table 4-3: Sediment metal concentrations [5]

Analyte		Aluminium	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Nickel	Lead	Vanadium	Zinc
Analysis method		HF-OES	HF-MS	HF-OES	HF-MS	HF-OES	HF-MS	HF-OES	Tot.MS	HF-OES	HF-MS	HF-OES	HF-OES
Guidance Levels (mg/kg)													
CSEMP ERL		-	8.2	-	1.2	81	34	-	0.15	21	47	-	150
CSEMP ERM		-	70	-	9.6	370	270	-	0.71	52	218	-	410
Cefas AL1		-	20	-	0.4	40	40	-	0.3	20	50	-	130
Cefas AL2		-	100	-	2	400	400	-	3	200	500	-	800
Recorded Values (mg/kg) *(Colour Coded to Match Highest Guidance Value they Exceed)*													
Site	1	28100	13.1	266	<0.1	45.5	16.7	30100	0.02	23	9.3	68	37
	4	12200	9.0	146	0.1	11.0	11.9	12200	0.01	7	8.6	22	15
	5	14700	11.2	180	<0.1	14.0	8.7	14900	0.01	12	10.6	25	19
	6	12000	10.5	482	<0.1	13.5	6.7	14900	<0.01	12	9.1	24	21
	7	9810	9.1	324	<0.1	8.0	6.6	9580	<0.01	7	7.3	16	10
	8	15300	13.3	277	<0.1	16.5	8.6	16800	<0.01	15	9.4	31	22
	10	24200	13.7	467	<0.1	25.5	12.3	28700	<0.01	19	9.7	52	32
	11	24900	14.2	241	<0.1	24.5	9.8	25100	<0.01	17	9.0	46	31
	12	12700	11.7	143	<0.1	13.0	4.6	14800	<0.01	11	9.6	27	18
	14	15300	12.7	204	<0.1	15.0	8.5	17500	<0.01	8	12.2	32	21
Summary Values (mg/kg)													
Min		9810	9.0	143	0.1	8.0	4.6	9580	0.01	7	7.3	16	10
Max		28100	14.2	482	0.1	45.5	16.7	30100	0.02	23	12.2	68	37
Mean		16921	11.9	273	0.1	18.7	9.4	18458	0.01	13	9.5	34	23
SD		6383	1.9	121	-	10.9	3.5	7031	0.01	5	1.3	16	8

4.2 Biological environment

4.2.1 Benthos

Benthos refers to the community of organisms which live in, on or near the seabed. As such the benthic community present are dependent upon available substrate and sediment composition as well as depth. For example, in fine and sandy sediments, benthic communities are typically dominated by infaunal species (those which live within the sediment). In general, differences in species composition are as a consequence of changes in sediment particle size [7].

The North Sea Benthos Survey of 1986, found that in the southern North Sea where the water is less than 30m deep and the seabed deposits coarse, the macrofauna is comprised of errant polychaetes i.e. *Nepthys caeca*, the heart urchin (*Echinocardium cordatum)* and the burrowing amphipod (*Urothoe poseidonis*) ([35] as cited by [7]). The meiobenthic fauna, particularly the copepods, was dominated by *Ectinosomatididae, Ameridae* and interstitial *Leptacidae*, albeit at low densities of 3 - 81 individuals $10cm^{-2}$ ([36] as cited by [7]).

The Marine Habitat Classification for Britain and Ireland [37], first published online in 2004 by Connor *et al,* allows users to categorise benthic communities as biotopes, based on a combination of the marine substrate and the marine flora and fauna present. As part of the pre-decommissioning survey, habitats recorded were classified to their lowest practical level in accordance with the 'Marine Habitat Classification [37]. Two biotopes were identified within the Rose field and vicinity (Figure 4.8).

The finer, sandy sediments within the survey area were classified as a circalittoral coarse sediment (SS.SCS.CCS) biotope complex and was found at Stations 7 and 16. The coarser well mixed gravelly sand areas with cobbles and small boulders within the survey area were classified as a F. *foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (SS.SMx.CMx.FluHyd) biotope complex and was found at Stations 1 - 6, 8 - 15 and 17 [5].

Descriptions of the observed biotopes, as well as the benthic species characteristic of these complexes are presented below.

Circalittoral Coarse Sediment (SS.SCS.CCS)

Connor *et al* [37] describe the circalittoral coarse sediment biotope complex as typically comprising coarse sands, gravel and shingle. The habitat, as with shallower coarse sediments, may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves.

The faunal community observed within this biotope complex during the survey was impoverished, with only the mobile crustacea Paguridae and Liocarcinus sp. (crabs) being recorded as frequent, along with Ammodytidae (sand lance). The bryozoan A. *diaphanum* and F. *follacea* were noted as rare.

Photographs of the biotope complex observed at these sites are presented in Figure 4.6.

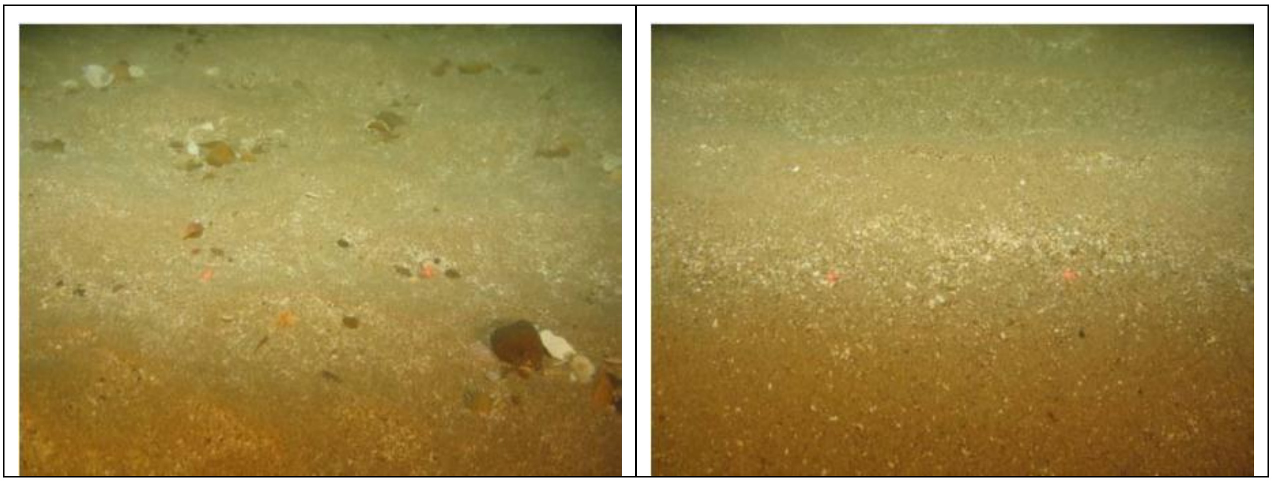

Figure 4.6: SS.SCS.CCS biotope complex observed at Site 7(L) & Site 16 (R)

***Flustra foliacea* and *Hydrallmania falcata* on tide-swept Circalittoral Mixed Sediment (SS.SMx.CMx.FluHyd)**

Connor *et al*. [37] describe the *F*. *foliacea* and *H. falcata* on tide-swept Circalittoral Mixed Sediment biotope complex as typically comprising medium to coarse sand with variable compositions of overlaying gravel and pebbles with the bryozoan *F*. *foliacea* and the hydroid *H*. *falcata* the characterising species.

Other hydroids such as *Sertularia argentea*, *Nemertesia antennina* and occasionally *Nemertesia ramosa*, occur where suitably stable hard substrata is found. The anemone *Urticina felina* and the soft coral A. *digitatum* may also characterise this biotope. Barnacles *Balanus crenatus* and tube worms *Pomatoceros triqueter* may be present, as well as the robust bryozoan *A*. *diaphanum* and the hydroid *Vesicularia spiniosa*.

The faunal community observed within this biotope complex during the survey was more abundant in comparison to the circalittoral coarse sediment biotope complex; fauna observed included the hydroids *F*. *foliacea* and *N*. *antennina*, anemones such as *Urticina* sp., the soft coral *Alcyonium digitatum* and the bryzoan A. *diaphanum*. In addition Cirripedia, Pomatoceros sp. *Vesicularia spinosa* and *Asterias rubens* were also observed.

Photographs of this biotope complex are presented in Figure 4.7.

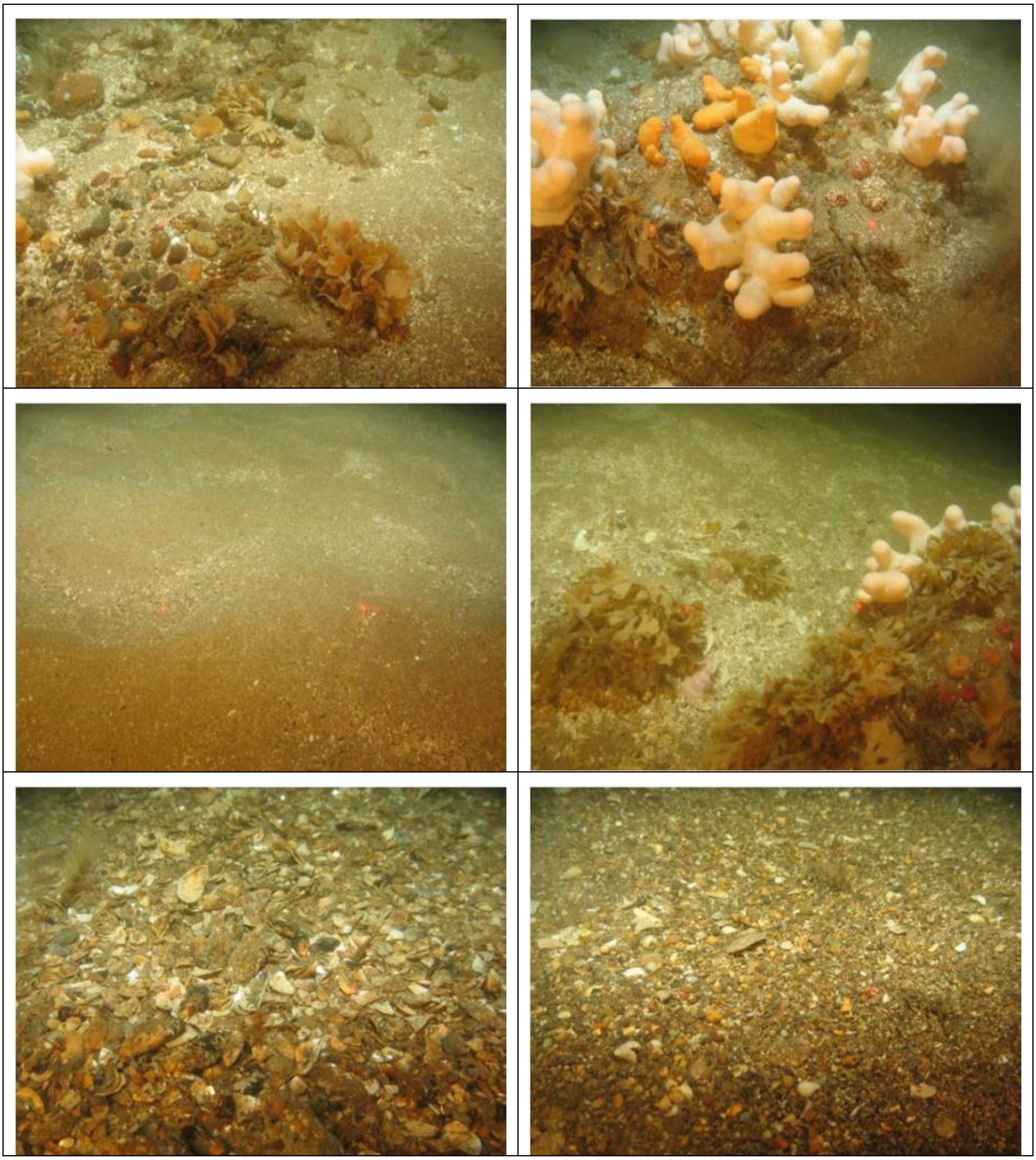

Figure 4.7: SS.SMx.CMx.FluHyd biotope complex observed at Site 2(TL), Site 4 (TR), Site 6 (ML), Site 12 (MR), Site 15 (BL) & Site 17 (BR)

Conspicuous species noted in the surface sediments of the grab samples during the decommissioning surveys included *Abietinaria abietina*, Plumulariidae, *Ophiura albida*, *Crepidula fornicata* and Mytilidae.

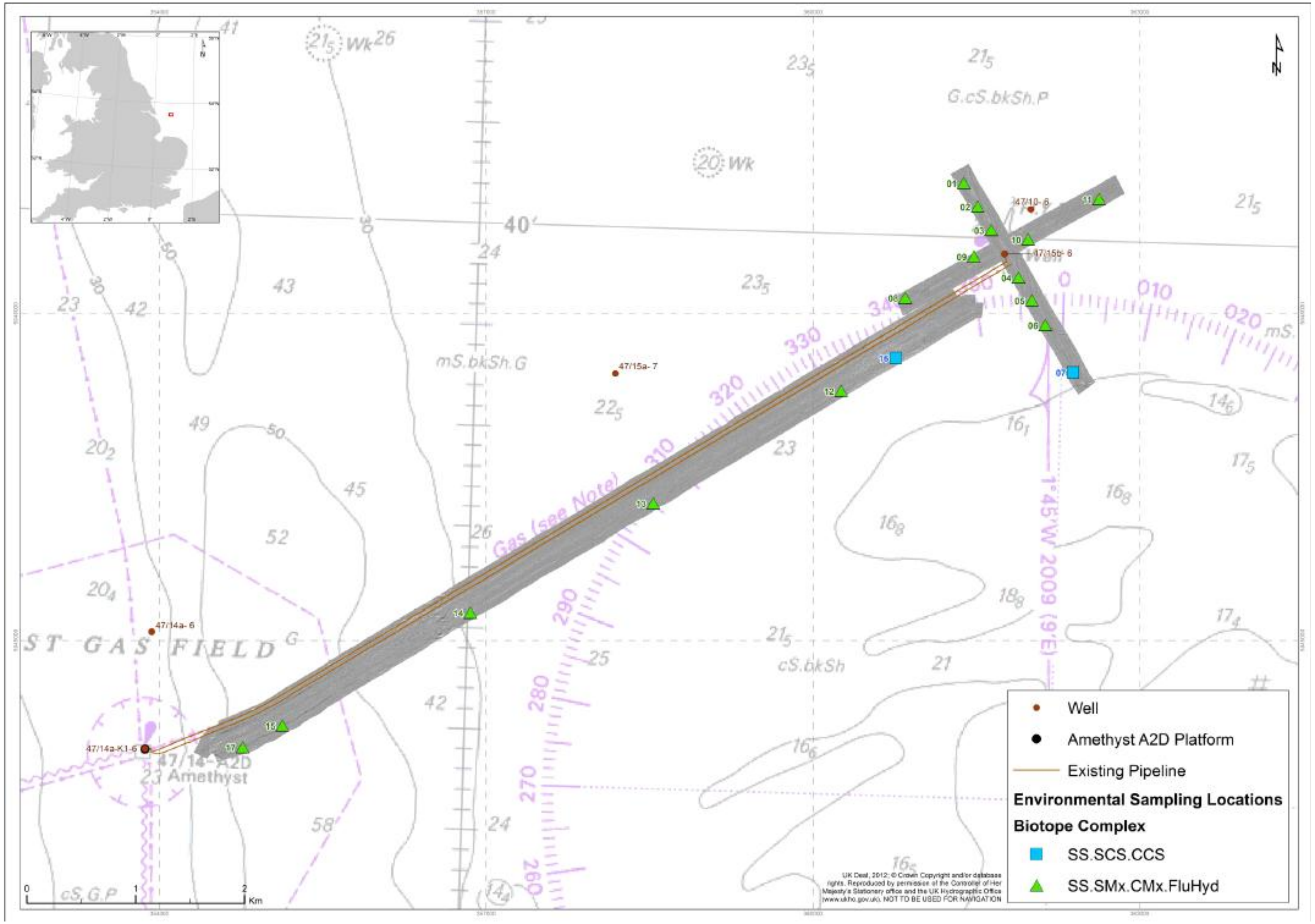

Figure 4.8: Biotopes identified based on video data surveyed within Rose field [5]

4.2.2 Plankton

Within the North Sea, planktonic assemblages are influenced mainly by vertical mixing and the availability of light and nutrients for growth [38]. During the winter months the rate of phytoplankton production decreases and increased concentrations of key nutrients i.e. phosphorus, ammonia, nitrogen and silicate, can be recorded as these are no longer used up during the production of phytoplankton. However, during the spring months, the rate of primary production increases significantly, coupled with a reduction in the available nutrients, which is subsequently followed in August by a smaller peak in abundance of phytoplankton [39]. These large phytoplankton blooms which occur in the North Sea during the spring and autumn support the majority of marine food chains in the area.

The North Sea phytoplankton community is dominated by the dinoflagellates *Ceratium fusus, Ceratium furca,* and *Ceratium tripos*. The population of diatoms is also significant and includes Chaetoceros (both the Hyalochaere and Phaeocerus sub-genus) [38]. Notably however, the abundance of these has been recorded as decreasing over time (from 1990 to 2000) and dinoflagellates are becoming more abundant due to the increased inflow into the North Sea [40].

The population of zooplankton is mainly composed of small *copepods,* predominantly *Para-psuedocalanus* sp, with echinoderm larvae being the second most abundant.

Planktonic organisms, primarily copepods, compose the main food resource for many commercial fish species ([35] as cited by [7]).

4.2.3 Finfish and shellfish

In general there is little interaction between fish and offshore oil and gas activities, although some species are known to congregate around offshore platforms and subsea infrastructure as they tend to provide habitat and shelter.

Many fish species are found in the North Sea and can be broadly classified according to their commercial use: pelagic (mid-water fish); demersal (near-bottom dwelling fish); and shellfish. Pelagic fish feed in the water column, primarily upon the zooplankton and demersal fish feed on or near the seabed. The most abundant, pelagic fish, form a fundamental part of the North Sea food web i.e. sandeel (pelagic), herring, sprat and mackerel. The fish present in the area of Rose are characteristic of those present in the southern North Sea. Further information regarding the fish species caught within the southern North Sea is provided in Section 4.3.6, which discusses commercial fisheries.

Spawning areas

Generally, spawning areas and nursery grounds are dynamic features of species' life history traits and thus are rarely fixed to the same location from year to year [41]. Broadly, commercially important species spawn in the spring between January and June. The exceptions to this are herring and sandeel which spawn in autumn and shellfish species such as lobster and edible crab which are generally winter spawners.

Coull *et al.* [42] indicate that the following species spawn within block 47/15 (Figure 4.9). Spawning times are given in brackets. Sandeels (Nov-Feb), plaice (Dec-Mar), sole (Mar-May), lemon sole (Apr-Sept), sprat (May-Aug) and herring (Aug-Oct).

The data have been subsequently supplemented by Ellis *et al* [43]. Ellis *et al* confirms the presence of ecologically important fish habitats. This includes spawning grounds for spurdog, herring, cod, whiting, sand eels, plaice and sole.

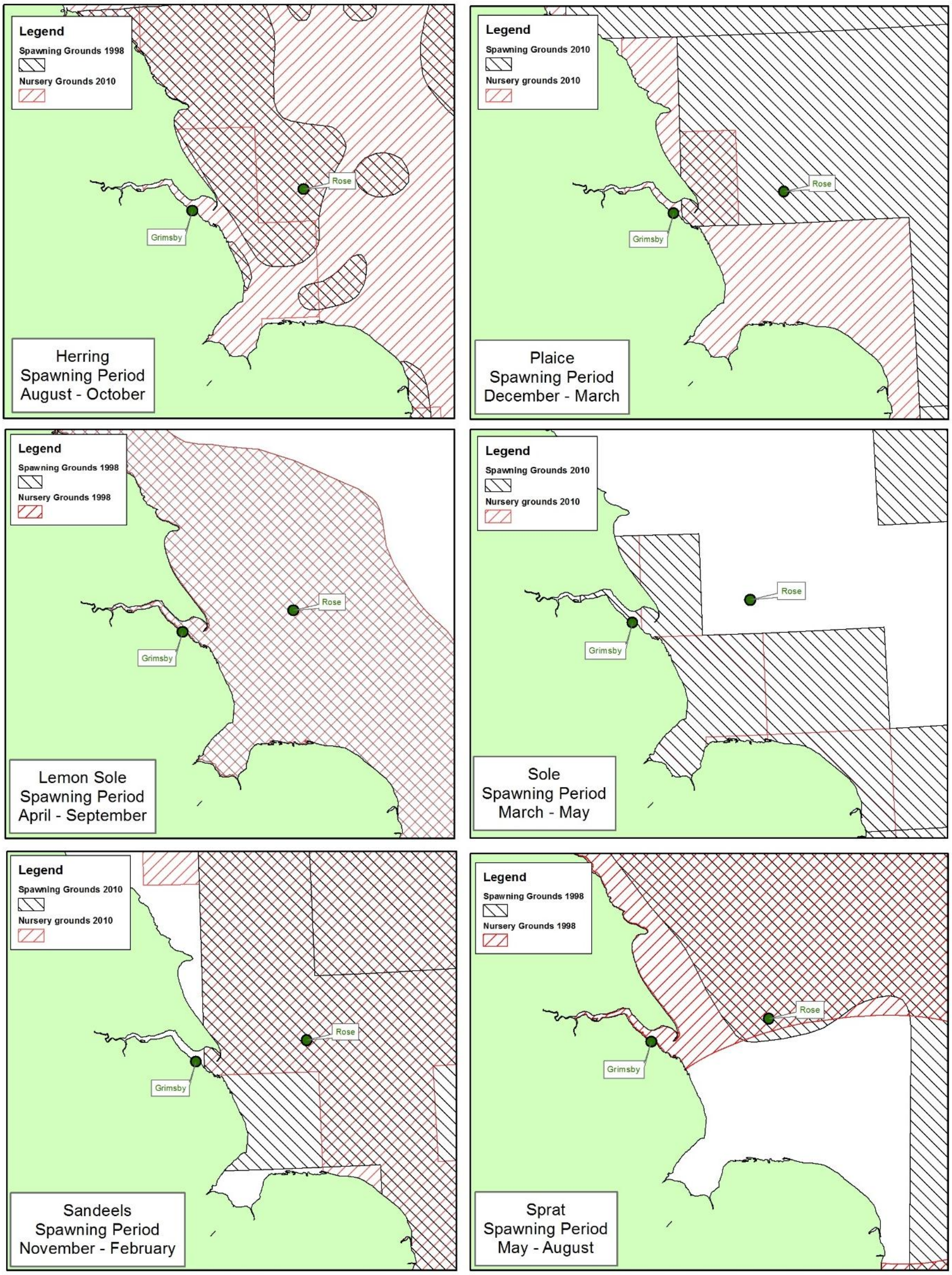

Figure 4.9: Identified spawning and nursery grounds in the area of the Rose Field [7]

Note: 2010 data is not available for all species. In these cases the most up to data available has been used.

Herring spawning

Most of the fish species spawn over wide areas of the North Sea, however herring have particular spawning requirements which makes the species particularly susceptible to impacts from anthropogenic activities. Herring require raised areas of gravel, elevated above the surrounding seabed, free of silt and irrigated by good water circulation. These areas of gravel are limited in number and extent and it is important that those that do exist remain viable spawning grounds. If such an area is identified particular restrictions apply e.g. for seismic survey, drilling and pipeline hydrotest discharge, that may not be carried out within one mile of them at spawning time (Aug – Oct).

The 2002 ES [7] concluded that no area suitable for herring spawning was identified within 1 mile of the well location. However the survey work at that time was incomplete and there remained an additional area to survey in 2002/2003 to complete the coverage. Herring spawning potential was reassessed as part of the most recent surveys undertaken in 2012 [3].

As described in Section 3.1.5, numerous ripples/dunes were present within the survey area having elevated thin sections of the seabed and therefore potentially meeting the criteria 'elevated above surrounding seabed'. Upon further investigation these were also shown to be composed of mixed sediments, a potentially suitable substrate for herring spawning grounds. Areas of elevated seabed were present at the majority of sites, including those around the wellhead; with only four sites (11, 13, 14 and 15) not having elevated areas. Sites 7 and 16 had a small gravel fraction which was observed in the troughs of the sediment features rather than the elevated sections. This was taken into consideration when classifying the herring spawning potential at these sites.

Particle size data showed fine sediments were <1.6% (Table 4-1) from all stations, with all stations therefore meeting the requirement of <2% fine material. Station 7 comprised mainly medium sand with negligible (1%) coarse sediments. Station 16 had a similar sediment composition to Site 7 with only a very small gravel component noted. These stations were classified as having low herring spawning potential. In the North Sea, herring require stable coarse sand and/or gravel substrates to successfully spawn, therefore, the medium sand habitat observed at these sites were considered unsuitable for herring spawning ([43] as cited by [5]).

As Figure 4.10 illustrates 'moderate' potential spawning habitat was identified around the Rose wellhead at sites 1-6 and 8-10. In addition, two more discrete patches on the pipeline at Site 12, near the eastern end and Site 17 at the western end were also classified as having 'moderate' potential spawning habitat for herring. The assessment of 'moderate' for Site 17 is conservative and reflective of the absence of sufficient data for this location. All eleven of these sites fulfilled the gravel, elevation and <2% fines criteria where sufficient data were available but were classified as poorly or very poorly sorted therefore could not be rated as having a 'high' spawning potential. A further section, west of Site 14, on the pipeline was also categorised as having 'moderate' potential as spawning habitat.

A small patch furthest south-east of the Rose wellhead, within which Site 7 was located, had a 'low-moderate' spawning potential classification whilst another small area around Site 11, furthest east, was categorised as habitat with 'low' spawning potential for herring (Figure 4.10).

The majority of the pipeline was also classified as comprising 'low' potential spawning habitat for herring (Figure 4.10). Sites 13 - 15 met only two of the criteria in Table 4-4 having gravel present and <2% fines. Similarly Site 16 was also within the area of 'low' potential on the pipeline but with only very small quantities of gravel in the troughs seen.

Table 4-4 below summarises the herring spawning potential of all the surveyed sites in the vicinity of the Rose – Amethyst area.

Table 4-4: Herring spawning potential (adapted from [5])

Station	Adjacent Infrastructure	Elevated	<2% Fine Sediments	Sorting Classification	Spawning Potential
1	-	Yes	Yes	Poorly Sorted	Moderate
2	Wellhead	Yes	Yes	Poorly Sorted	Moderate
3	Wellhead	Yes	Yes	Poorly Sorted	Moderate
4	Wellhead	Yes	Yes	Poorly Sorted	Moderate
5	Wellhead	Yes	Yes	Very Poorly Sorted	Moderate
6	-	Yes	Yes	Very Poorly Sorted	Moderate
7	-	Yes	Yes	Moderately Well Sorted	Low - Moderate
8	Pipeline/Umbilical	Yes	Yes	Poorly Sorted	Moderate
9	Wellhead	Yes	-	-	Moderate
10	Wellhead	Yes	Yes	Very Poorly Sorted	Moderate
11	-	No	Yes	Poorly Sorted	Low
12	Pipeline/Umbilical	Yes	Yes	Poorly Sorted	Moderate
13	Pipeline/Umbilical	No	Yes	Very Poorly Sorted	Low
14	Pipeline/Umbilical	No	Yes	Poorly Sorted	Low
15	Pipeline/Umbilical	No	-	-	Low
16	Pipeline/Umbilical	Yes	-	-	Low
17	Closest sample to A2D	Yes	-	-	Moderate

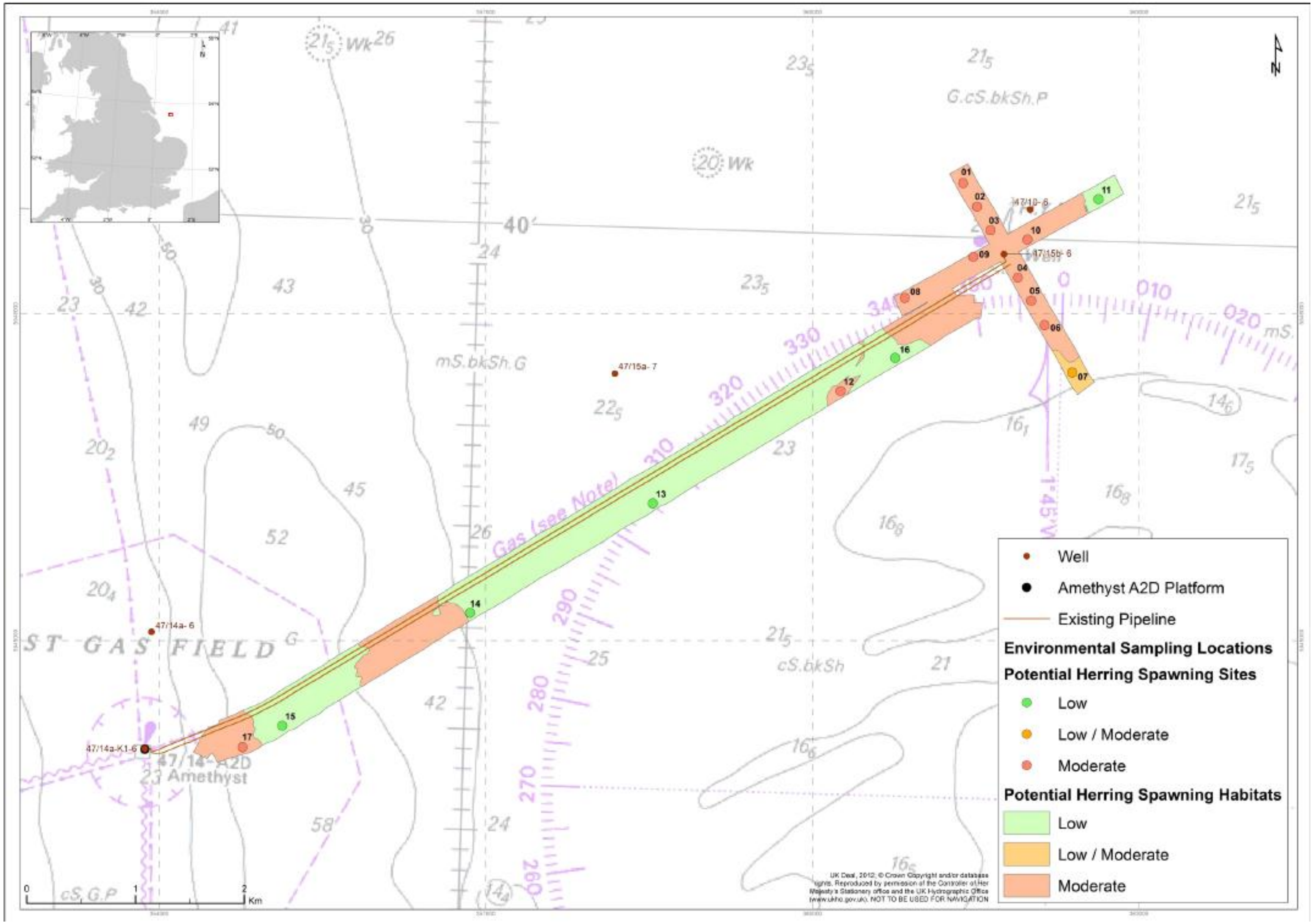

Figure 4.10: Potential herring spawning habitat [5]

Nursery grounds

Nursery grounds are generally defined as areas which have a higher density of juveniles, reduced rates of predation and faster growth rates than other habitats. This therefore results in areas providing a greater relative contribution of recruitment by juveniles to adult populations of commercially important species [44]. Nursery ground locations are dependent on a number of factors including the reproductive mode of the species, and the location and extent of spawning grounds. As the location of spawning grounds are often subject to change year on year this is also reflected in the location of nursery grounds.

Whiting, lemon sole, and sandeel are known to use the waters of Block47/15 as a nursery area in the period immediately following spawning (Figure 3.9) [42]. This has subsequently been confirmed by Ellis *et al* [43] which identifies the area to be a spawning ground for herring, sandeels, plaice and sole. The widespread commercial fishery for crab, lobster and whelks in the region indicates that these species must also breed here.

As both spawning areas and nursery grounds are subject to annual change, data collected on the location of these sites generally covers a wide area. Therefore grounds identified in the vicinity of the Rose field are not unique, but represent a small proportion of available grounds around the UK and are not definitive fixed areas for spawning and nursery grounds of identified species.

4.2.4 Seabirds

The offshore waters of the southern North Sea are visited by several seabird species mainly for feeding purposes. Among the species using the waters in the vicinity of block 47/15 fulmars (*Fulmarus glacialis*) are present in highest numbers in the southern North Sea during the early and late breeding seasons, leading to peak densities in September. Species using the waters in the vicinity of the Rose field are most notably species of auk (Alcidae) including guillemot and razorbill. These birds spend the majority of the time on the surface of the sea. Increased numbers of gannets (*Morus bassanus*), occur in November and December when dispersion from breeding sites is at a maximum. Kittiwakes (*Rissa tridactyla*) are widely distributed throughout the year. Lesser black-backed gulls (*Larus fuscus*) are mainly present during summer, whilst in contrast guillemot (*Uria aalge*) numbers are present in greatest numbers during winter months. In addition, substantial numbers of terns (*Sterna hirundo*) migrate northwards through the offshore North Sea in April and May, with return passage from July to September [44].

Seabird vulnerability to surface pollution varies throughout the year with peaks in late summer after breeding when the birds disperse into the North Sea, and during the winter months with the arrival of over-wintering birds. The JNCC ranks seabird vulnerabilities on a four point scale (1 is the highest vulnerability and 4 the lowest). This index takes account of seabird breeding and population recovery rates, the numbers of birds present, the time spent at sea and dependence on the sea, in order to assess the vulnerability of seabirds to oil pollution. Seabird vulnerabilities in Block 47/15 and the surrounding blocks are lowest during the breeding months of May to July and highest, with rating of 1, in August, November and December (Table 4-5).

Table 4-5: JNCC seabird vulnerabilities [45]

Block	J	F	M	A	M	J	J	A	S	O	N	D	All
47/9	2	1	2	4	3	3	2	1	1	2	1	1	1
47/10	1	1	2	2	2	3	2	1	1	2	1	1	1
47/14	4	2	4	4	4	4	3	1	2	3	1	1	2
47/15	4	2	3	2	3	4	3	1	2	2	1	1	2
47/19	4	2	4	4	4	4	3	1	2	3	1	1	2
47/20	4	2	3	2	3	4	3	1	2	2	1	1	2
48/6	1	1	2	2	2	4	4	1	2	2	1	2	2

Key: High Sensitivity = 1, Low Sensitivity = 4.

Much of the North Sea and its surrounding coastline are designated as internationally important breeding and feeding habitats for birds. These designations are discussed in more detail below.

4.2.5 Protected sites

Special Areas of Conservation

There are currently 108 Special Areas of Conservation (SACs) with marine components, covering 7.6% of the UK sea area. Of these, 88 SACs are completely within inshore waters, 16 are completely within offshore waters and there are four sites which are within both inshore and offshore waters. In addition there are three Annex I marine habitats (*Sandbanks which are slightly covered by seawater all the time, reefs, and submarine structures made by leaking gases*) and four Annex II species *grey seal, common seal, bottlenose dolphin and harbour porpoise*) present in UK waters for which the European Commission has stated additional SACs must be designated. A number of candidate SACs (cSACs) have been put forward and are in the latter stages of the designation process.

As is evident from Figure 4.11, there are a number of SACs and cSACs in proximity to the Rose field. At the time of the 2002 ES there were no formally recognised marine components to SACs or cSACs. However, a survey was undertaken of the area surrounding the Rose wellhead to identify any areas containing the Habitats Directive Annex I habitat of '*Sandbanks which are slightly covered by sea water all the time*' [7]. It was concluded that whilst sand waves do occur in the region, the well location was selected to be sufficiently distant from these areas and the nearest sand bank was located over 1,200 metres to the south. The water depth at the location of the well was 24m [7].

The pre-decommissioning survey undertaken in 2012 also concluded that although, dunes were observed and cobbles collected in the grab samples, no evidence in the acoustic, video or grab data collected from this survey indicated the presence of any species or habitats of conservation importance under the Offshore Marine Conservation [46] [5].

Special Protection Areas

Special Protection Areas (SPAs) are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species. There are a total of 270 SPAs designated in the UK. Three of these sites are within the vicinity of the Rose field (Figure 4.11) and have been discussed further below (Table 3.6).

Marine Conservation Zones

The Marine and Coastal Access Act 2009 [10] allows for the creation of Marine Conservation Zones (MCZs) anywhere in English and Welsh territorial and UK offshore waters. The purpose of MCZs is to protect a range of nationally important marine wildlife, habitats, geology and geomorphology, they will exist alongside European marine sites to form an ecologically coherent network of marine protected areas. From the original list of recommended sites, 27 MCZs were designated in English waters in 2013. It should be noted that none of the recommended MCZs listed in Table 3.6 are currently designated. However this is an ongoing process with further rMCZs expected to be designated over coming years.

The Holderness Inshore rMCZ is currently being consulted on for designation in the first tranche of 2015. Figure 4.11 shows the designated areas, (SACs, cSACs, SPAs and rMCZs) in the vicinity of the Rose field. describes the key designated sites in the immediate vicinity of the Rose field in further detail and lists the priority features for which the sites are designated.

As Figure 4.11 shows, a number of recommended MCZs are located in close proximity to the Rose field. The Rose pipeline and umbilical run through both the Holderness Offshore and Silver Pit rMCZs (cut out from Figure 3.11). Site 15 was located within the Silver Pit and Site 17 on the slope from the Silver Pit up to the Amethyst A2D platform.

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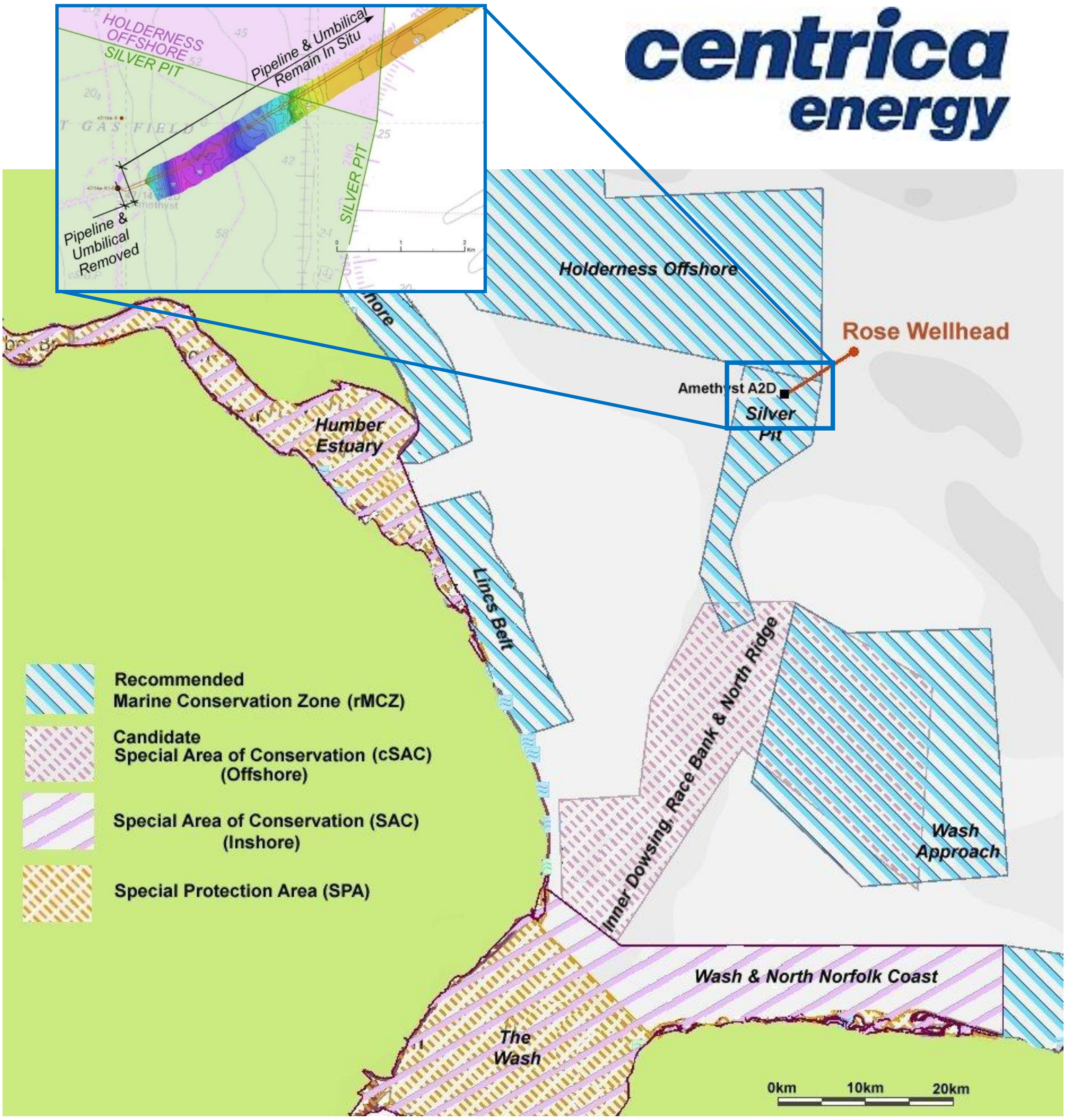


Figure 4.11: Location of protected sites in the vicinity of the Rose field

Table 4-6: Protected areas in the vicinity of the Rose field.

<table>
<tr><th>Protected Area (name and designation)</th><th>Approximate distance from Rose (km)</th><th>Primary features for which the site is designated / recommended.</th></tr>
<tr><td>Inner Dowsing, Race Bank and North Ridge (cSAC)</td><td>31</td><td>Qualifying features: Annex I Habitats –
Sandbanks slightly covered by seawater all the time; and
Sabellaria spinulosa reefs.
The area encompasses a wide range of sandbank types (banks bordering channels, linear relict banks, sinusoidal banks with distinctive 'comb-like' subsidiary banks) and biogenic reefs of the worm Sabellaria spinulosa. Shallow sandbanks can be vegetated with eel grass beds or maerl and animals that live on sandbanks include worms, crabs, starfish, sandeels and flatfish such as plaice and sole. The presence of sandeels in particular also makes sandbanks a rich feeding ground for other wildlife such as seabirds, seals and porpoises.</td></tr>
<tr><td>North Norfolk Sandbanks and Saturn Reef (cSAC)</td><td>43</td><td>Qualifying features: Annex I Habitats –
Sandbanks slightly covered by seawater all the time; and
Sabellaria spinulosa reefs.
The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters [47]. They are subject to a range of current strengths that are strongest on the banks closest to shore and reduce offshore [48]. The outer banks are the best example of open sea, tidal sandbanks in a moderate current strength in UK waters. Sandwaves are present, being best developed on the inner banks; the outer banks having small or no sandwaves associated with them [48]. The banks support communities of invertebrates which are typical of sandy sediments in the southern North Sea such as polychaete worms, isopods, crabs and starfish.

The Saturn Sabellaria spinulosa biogenic reef, first discovered in 2002, consists of thousands of fragile sand-tubes made by ross worms (polychaetes) which have consolidated together to create a solid structure rising above the seabed. In 2003, the Saturn reef covered an area approximately 750m by 500m just to the south of Swarte Bank, varying in density over this area [49].</td></tr>
<tr><td>Humber Estuary

(SAC)</td><td>51</td><td>Qualifying features: Annex I Habitats –
Estuaries;
Atlantic salt meadows
Mudflats and sandflats not covered by seawater at low tide; and
Sandbanks slightly covered by seawater all the time
The Humber is the second largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. It is a muddy, macro-tidal estuary, fed by the Rivers Ouse, Trent and Hull, Ancholme and Graveney. Suspended sediment concentrations are high, and are derived from a variety of sources, including marine sediments and eroding boulder clay along the Holderness coast. This is the northernmost of the English east coast estuaries whose structure and function is intimately linked with soft eroding shorelines. Habitats within the Humber Estuary include Atlantic salt meadows and a range of sand dune types in the outer estuary, together with subtidal sandbanks (see description above), extensive intertidal mudflats, glasswort beds and coastal lagoons.</td></tr>
<tr><td>Humber Estuary SPA</td><td>51</td><td>Qualifying features: Annex I EC Birds Directive –
Botaurus stellaris : Recurvirostra avosetta; Limosa lapponica:</td></tr>
</table>

Protected Area (name and designation)	Approximate distance from Rose (km)	Primary features for which the site is designated / recommended.
		• *Pluvialis apricaria; Circus aeruginosus; Sterna albifrons* • *Breeding and wintering area* The Botarus stellaris and the Recurvirostra avosetta among other species of birds regularly use the Humber coastal plain estuary for breeding, accounting for 10.5% and 8.6% of the UK's population respectively. The Circus aeruginosus and the Sterna albifrons also use this area for breeding. The lagoons, salt marshes, sand dunes and beaches, mud and sand flats, form a habitat used during winter by Limosa lapponica and Pluvialis apricaria specimens, together with the Botaurus stellaris; Circus cyaneus; and the Recurvirostra avosetta in minor numbers. Regularly occurring migratory species that use the area for wintering and breeding include the Calidris alpina alpine (Northern Siberia / Europe / Western Africa); Calidris canutus (North-eastern Canada / Greenland / Iceland / Northwestern Europe); Limosa limosa islandica (Iceland); Tadorna tadorna (North-western Europe), and the Tringa tetanus (Eastern Atlantic) (www.jncc.defra.gov.uk [50]).
The Wash SPA	70	Qualifying features: Annex I EC Birds Directive – • *Sterna albifrons; Sterna hirundo; Cygnus columbianus bewickii,* • *Limosa lapponica; Anas Penelope; Branta bernicla bernicla* • *Calidris canutus; Limosa limosa islandica* • *Breeding and wintering area* The Wash is a large sea inlet with mud and sand flats that hosts birds of the species *Sterna albifrons* (Eastern Atlantic) and *Sterna hirundo* (Northern /Eastern Europe) during breeding season, and the *Cygnus columbianus bewickii,* and *Limosa lapponica* during winter. This marine area is also used by migratory species that come from Western Siberia such as the *Anas Penelope* and the *Branta bernicla bernicla;* the *Anser brachyrhynchus* from Eastern Greenland and Iceland; and by *Arenaria interpres* and *Anas acuta* specimens from different parts of the Palearctic zone. Around 54% of the *Calidris canutus* and 11% of the *Limosa limosa islandica* UK's population commonly use this site for wintering [50].
North Norfolk Coast (SPA)	70	Qualifying features: Annex I EC Birds Directive – • *Sterna albifrons; Sterna hirundo; Cygnus columbianus bewickii,* • *Limosa lapponica; Anas Penelope; Branta bernicla bernicla* • *Calidris canutus; Limosa limosa islandica* • *Breeding and wintering area* The Wash is a large sea inlet with mud and sand flats that hosts birds of the species *Sterna albifrons* (Eastern Atlantic) and *Sterna hirundo* (Northern /Eastern Europe) during breeding season, and the *Cygnus columbianus bewickii,* and *Limosa lapponica* during winter. This marine area is also used by migratory species that come from Western Siberia such as the *Anas Penelope* and the *Branta bernicla bernicla;* the *Anser brachyrhynchus* from Eastern Greenland and Iceland; and by *Arenaria interpres* and *Anas acuta* specimens from different parts of the Palearctic zone. Around 54% of the *Calidris canutus* and 11% of the

Protected Area (name and designation)	Approximate distance from Rose (km)	Primary features for which the site is designated / recommended.
		Limosa limosa islandica UK's population commonly use this site for wintering [50].
Holderness Offshore (rMCZ)	0	The seafloor consists of mixed and coarse sediment interspersed with small cobbles and ross worm reef, creating a mosaic of habitats for attaching and burrowing creatures. This area is significant for crustaceans, including edible crabs and common lobster. To the south of the site is the Inner Silver Pit, a deep canyon with sloping walls covered in a living turf of brittlestars. Harbour porpoises and grey and harbour seals are regularly seen here foraging for food (www.wildlifetrusts.org [51]).
Silver Pit (rMCZ)	0	The seafloor consists of mixed sediments and ross worm reef which in addition to blue mussel beds supports an abundance of marine wildlife, including brittlestars, sea squirts, hydroids, buried polychaete worms and bivalve molluscs. The deepest areas are carpeted in common and serpent's table brittlestars. Lemon and dover sole, sprat, whiting, cod, plaice and herring all spawn here and attract feeding white-beaked dolphins, minke whales and harbour porpoises [51].
Wash Approach (rMCZ)	31	This diverse seabed consists of sandbanks (including the Race Bank, North Ridge and Dungeon Shoal Banks), interspersed with cobbles, ribbons of coarse sand, gravel and ross worm reef. Carpets of bryozoans, sea squirts, hydroids, sponges and anemones cover the sand and gravel, with squat lobsters and crabs present. Harbour porpoises, grey and harbour seals feed here all year round alongside abundant numbers of seabirds. The diverse waters also support many species of fish, including sandeels, Dover and lemon sole, whiting, thornback rays, sea scorpions, dragonet and weaver fish.
Lincs Belt (rMCZ)	45	Characterised by coarse and mixed sediment, sand, peat and clay. Patches of Ross Worm and subtidal chalk are also found here. At its deepest the site reaches 10 m. Life found on both the seabed and in the water column is extremely rich and characterised by brown shrimps, bristleworms and dense mats of hydroids and bryozoans such as hornwrack. Important spawning and nursery grounds are found here for fish such as sprat, lesser pipefish, lemon sole, plaice and herring. It is also home to a key UK grey seal breeding ground, which annually sees 1,300 pups born, and a nationally important colony of little terns.
Holderness Inshore (rMCZ)	45	The seafloor here boasts a wealth of diversity, including habitats of cobbles, mixed sediment, sand and chalk, alongside patches of peat and clay. This mosaic supports a dense coverage of hydroid and bryozoan turf, sponges and ross worm reef as well as many fish, including tope and smoothhound. Over 8 different types of crabs have been seen at Holderness Inshore as well as the purple bloody Henry starfish and common sunstars. Harbour porpoises and minke whales are often spotted from the shore passing through this area.

4.2.6 Marine mammals

Marine mammals can be subdivided into four recognised groups; cetaceans (whales, dolphins and porpoises), pinnipeds (seals, sea lions and walruses), sirenians (manatees and dugongs) and fissipeds (polar bears and species of sea otter). Sirenians and fissipeds are not present in UK waters.

Five species of cetacean are present throughout the year or are recorded annually as seasonal visitors to the wider southern North Sea in varying numbers. These are minke whale (*Balaenoptera acutorostrata*), harbour porpoise (*Phocoena phocoena*), white-beaked dolphin (*Lagenorhynchus albirostris*), the white-sided dolphin (*Lagenorhynchus acutus*) and killer whale (*Orcinus orca*) ([52] as cited by [53]).

Two species of pinniped are resident in UK waters, the grey seal (*Halichoerus grypus*) and the harbour or common seal (*Phoca vitulina*), and both occur regularly over large parts of the southern North Sea. Both species breed in the UK, with harbour seals pupping in June and July and grey seals pupping between October and December.

The harbour seal is one of the most widespread pinniped species and is found in all coastal waters around the North Sea. Animals around the UK belong to a European sub-species (*P. vitulina vitulina*), approximately 33% of the world population of this sub-species occurs in the UK. Pupping occurs on land from June to July, while the moult is centred around August and extends into September. Therefore, from June to September harbour seals are ashore more often than at other times of the year.

Grey seals are found across the North Atlantic Ocean and in the Baltic Sea. Approximately half of the world's population occurs in the northeast Atlantic (including the Baltic Sea); with approximately 40% of these animals occurring in the UK [54]. It is estimated that approximately 70,000 seals are associated with breeding colonies in the North Sea with over 90% of the UK population breeding in Scotland [54]. Most of the grey seal population will be on land for several weeks from October to December during the pupping and breeding season, and again in February and March during the annual moult. Densities at sea are likely to be lower during this period than at other times of the year [54].

Seals are widespread throughout coastal waters surrounding breeding colonies and haul-out sites. Their distribution at sea is constrained by the need to return periodically to land [54]. Harbour seals are not normally recorded more than 60km from shore meaning the location of Rose is likely to be near the limit of their range.

All the species described above are recorded as observed within the nearby rMCZs, namely the Holderness Offshore and Silver Pit areas (The presence of harbour porpoises and grey seals is also reported within the Inner Dowsing, Race Bank and North Ridge cSAC (Table 3-6).

However, data indicates that harbour porpoise is the only marine mammal occurring in the southern North Sea in the vicinity of Rose in recordable densities (Table 4-7). White-beaked dolphin sightings drop off sharply south of the Humber estuary. Atlantic white-sided dolphins are the only other species to have been sighted in extremely low numbers in the southern North Sea in general [55].

This information is also supported by shipboard data presented by the SCANS-II project [56], which shows harbour porpoise as the most predominant species in the vicinity of the Rose field, although common dolphin, white-beaked dolphins and white-sided dolphins have been sighted in the area of Rose field. The times of year these species have been observed in the area are shown in Table 4-7 [55].

Harbour porpoise, grey seals and harbour seals are all listed under Annex II of the European Habitats Directive (92/43EEC) [57] and are therefore European Protected Species and it is an offense to intentionally disturb, injure or kill species, or to undertake activities which could potentially harm species allocated with protection under the Offshore Marine Conservation (Natural Habitats &c) Regulations [58] without the necessary license.

Table 4-7: Cetaceans recorded in the vicinity of Rose

Species	J	F	M	A	M	J	J	A	S	O	N	D
Harbour porpoise												
Common dolphin												
White-beaked dolphin												
White-sided dolphin												

4.3 Socio-economic environment

4.3.1 Other oil and gas facilities

As described in Section 1, the Rose wellhead is connected to the Amethyst A2D platform via a 10” pipeline and 4” umbilical. The Amethyst A2D platform is one of four platforms in the Amethyst field and is connected to the A1D, B1D and C1D platforms, as well as to the Helvellyn wellhead. The table below gives approximate distances from the Amethyst A2D platform to adjacent platforms.

Table 4-8: Adjacent oil and gas infrastructure to the Amethyst A2D platform

Platform	Approximate distance (km)
Amethyst A1D	4.6
Amethyst B1D	8.9
Amethyst C1D	12.8

4.3.2 Shipping

The density of shipping traffic within the southern North Sea is relatively high, due to the presence of a number of large international ports within the region, including, amongst others, the UK ports of:

- Hull (a commercial and passenger port, with roll on/roll off ferry services to Zeebrugge and Rotterdam);
- Immingham (a commercial container port on the Humber);
- Grimsby (particularly important for commercial fishing landings); and
- Great Yarmouth (a supply/fabrication base for the offshore oil and gas industry and a roll on/roll off ferry service to the Netherlands).

A shipping collision risk assessment was undertaken at the time of the 2002 ES using the COAST database for shipping routes that passed within 10nm (18.53km) of the Rose wellhead location. 118 routes were identified and grouped into 27 ‘common routes’ with an annual shipping traffic of 18,682 vessels equivalent to 51 per day [7]. An updated shipping collision risk assessment will be produced in support of well P&A and will be used to inform planning.

4.3.3 Wind farms

There are a number of wind farm licensed areas and wind farm projects under development in the vicinity of the Rose field. Figure 4.12 shows the location of the nearest wind farm license areas with the closest wind farm being approximately 15km south of the Rose – Amethyst location [59].

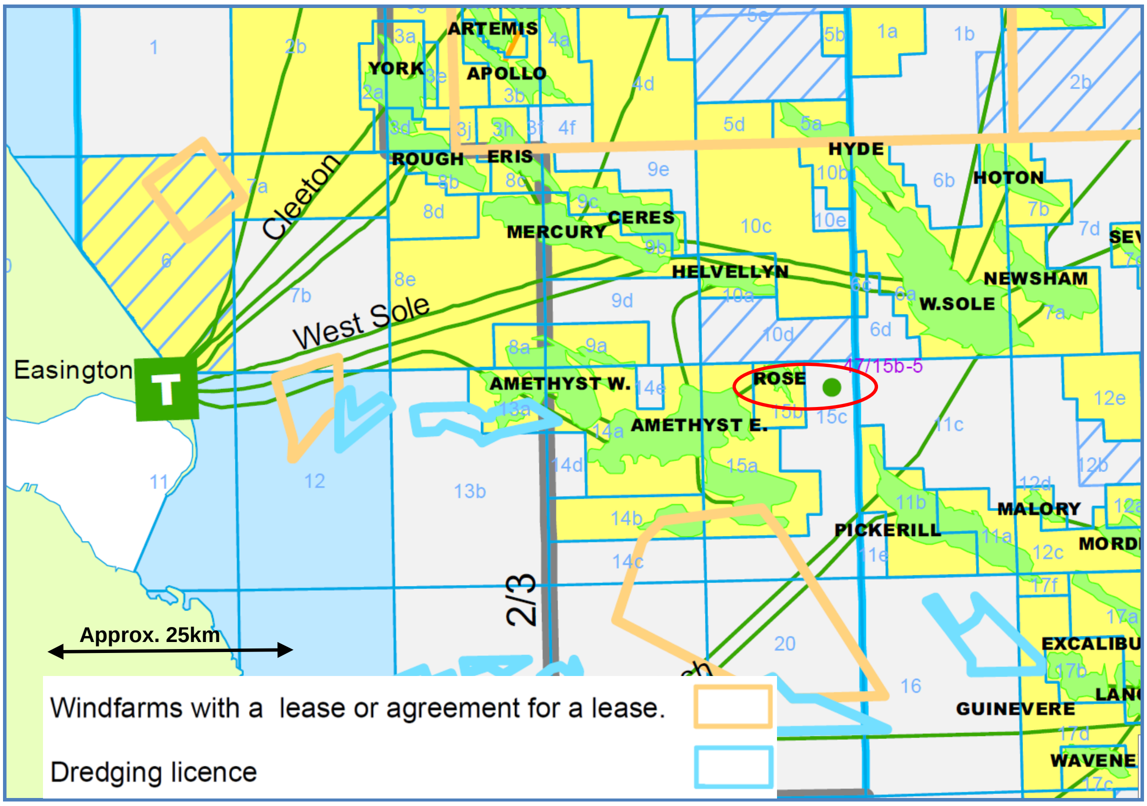


Figure 4.12: Location of wind farm and aggregate extraction licenses

4.3.4 Aggregate extraction

There are several licenced aggregate areas within 40km to the west, south and east of the Rose field [60]. Figure 4.12 shows the location of the closest aggregate extraction license areas in relation to the Rose – Amethyst area [60]. The closest aggregate extraction site is approximately 30km west.

4.3.5 Ministry of Defence (MOD)

There are known to be military firing practice ranges on the coast to the north and south of the Humber Estuary. Details will be confirmed with the MOD prior to decommissioning activities.

4.3.6 Commercial fishing industry

The International Council for the Exploration of the Sea (ICES) divided the North Sea into a number of sea areas, each of which is sub-divided into rectangles. ICES statistical rectangles are the smallest unit used in the collection and collation of fisheries statistics (landings/catch data) from vessel logbook data (except for UK vessels <10m vessels targeting shellfish, which are subject to a separate catch return system). Rose lies within ICES statistical rectangle 36F0 which lies just within ICES sea Area IVb (also more commonly known as the Central North Sea).

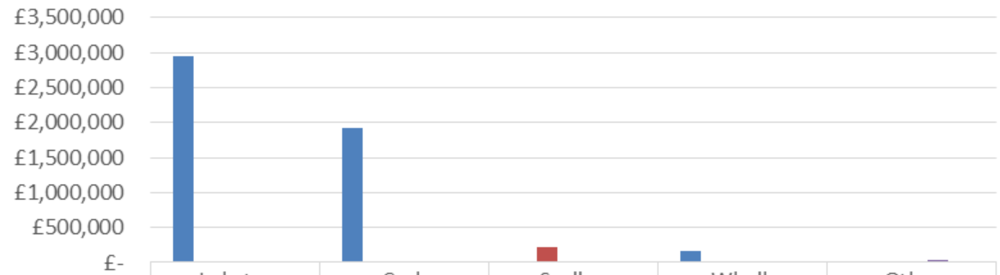
The Central North Sea is an important area for commercial fisheries by UK vessels with a total value of landings for demersal species in 2013 of £34,528,000, £2,156,000 for pelagic species and £45,924,000 for all shellfish species [61]. Historically fishing in the region around the Humber concentrated on trawling for plaice, sole, whiting, cod and other whitefish, as well as Norway lobsters (*Nephrops*). However over recent years, this has decreased and there has been a large increase in potting for crab, lobster and whelk and dredging for scallops which is reflected in the landings data (Table 4-9) [61].

The quantity of the UK landings from vessels both under and over 10m for ICES rectangle 36F0 as well as the wider IVb sea area are illustrated in Table 4-9 below. The table shows that ICES rectangle 36F0 provides a relatively small contribution (<8%) to the total landings of all species in the area IVb area.

Table 4-9: Total landings by UK fishing fleet in 36F0 compared with total Area IVb [61]

Year	Total Landings by UK Fishing Fleet (£)		
	Area IVb Total	36F0	% of landings of IVb
2010	£74, 477,000	£4,273,710	6%
2011	£90,319,000	£4,659,109	5%
2012	£90,933,000	£5,853,180	6%
2013	£82,609,000	£6,529,001	8%

As can be seen from Figure 4.13 the majority of landings from ICES rectangle 36F0 are crustaceans (lobster and crab) from pots and traps, totalling an annual average of approximately £4.8M which constitutes 91% of landings in ICES rectangle 36F0 (Figure 4.13).



	Lobster	Crab	Scallop	Whelk	Other
Pots and traps	£2,941,351	£1,927,322	£0	£161,053	£4,994
Dredge	£10	£-	£222,328	£-	£87
Demersal trawl/seine	£283	£4	£-	£-	£19,997
Beam Trawl	£50	£3	£-	£3	£27,238
Other	£1,443	£139	£-	£1,828	£11,789

Figure 4.13: Average annual landing values of key species for period 2010 - 2013 36F0 [61]

As demonstrated in Figure 4.13 above and supported by Table 4-10 below, in the period 2010 – 2013, UK fishing effort in the region of the Rose wellhead was predominantly focused on the use of pots and traps, with more than 86% of the fishing effort employing this gear (Table 4-10).

Table 4-10: Fishing effort by gear type in the region of the Rose wellhead* [61]

Year	Total effort (days)	Number of days and % of total effort		
		Pots & Traps	Dredge	Other
2010	1,908	1,742 (91%)	Disclosive Data (2%)	137 (7%)
2011	1,704	1,565 (92%)	Disclosive Data	Disclosive Data
2012	2,046	1,749 (86%)	203 (10%)	82 (4%)
2013	2,088	2,059 (99%)	Disclosive Data (0.6%)	10 (0.4%)

* Data are based on reported landings from ICES rectangles within which more than five UK vessels measuring over 10m were active. In those ICES rectangles where <5 vessels were active the information is considered disclosive and is therefore not available.

UK landings data for the key species in 36F0 for the period 2010 - 2013 shows that the most important period in terms of landing values for lobster and edible crab is between July and November, with an annual average peak value of £578,013 for lobsters in August and a peak of £271,319 in October for edible crab. Figure 4.14 reiterates the importance of crustaceans and molluscs to the commercial fishing industry in the vicinity of the Rose field.

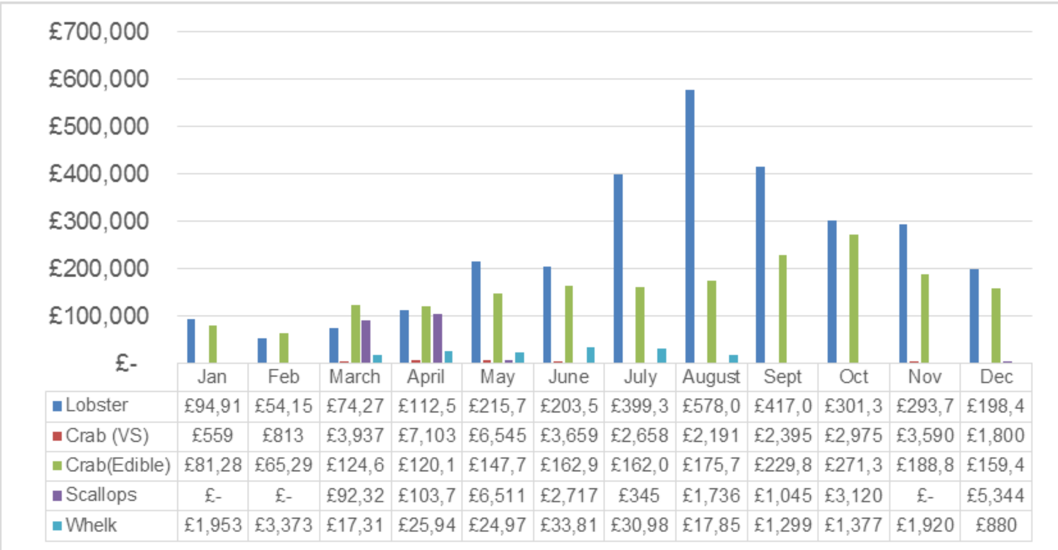


Figure 4.14: Annual landing values for key species in 36F0

In addition to the significant shellfish fishery, a number of demersal species are also taken from the area, the most valuable of which are cod, haddock, thornback ray, and bass (Table 4-11). Other species landed include lemon sole, sole, whiting, dab, turbot and plaice.

Table 4-11: Average values of the top 4 landed demersal species in 36F0

Species	Average Value (£)
Cod	£12,758
Bass	£3,233
Haddock	£2,076
Thornback Ray	£8,419

Demersal species comprise approximately 2% of the total value of landings from 36F0 (Figure 4.14). In the period 2010 - 2013 the combined landed weight of all demersal species was 90.2 tonnes, with a total value of £164,331, significantly less than that of the shell fish landed.

Pelagic species (e.g. mackerel and herring) comprise a very small portion of the value of the total recorded landings averaging 0.40%. In the period 2010 - 2013 the combined landed weight of pelagic species was 1.44 tonnes with a value of £329.69, significantly less than both the shellfish and the demersal fish landed.

Whilst the importance of the central North Sea (sea area IVb) and rectangle 36F0 to UK commercial fisheries is discussed above. It should also be noted that the North Sea is an important fishery for other EU registered vessels. In 2013 approximately 58,000 tonnes of fish were landed into the UK by foreign vessels. The vessels were predominantly registered in France and Demark, and the majority of species landed were demersal or pelagic fish [61].

4.4 Summary of environmental sensitivities

Table 4-12 summarises the environmental sensitivities in the vicinity of Rose.

Table 4-12: Key environmental sensitivities[1]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Habitats Directive: Annex I Habitats Surveys did not identify habitats which would be categorised under the EC Habitats Directive as being of conservation significance. Protected sites (SACs, cSACs & rMCZs) exist in the vicinity of the Rose field. Some of them have Annex I habitats as qualifying features.											
Habitats Directive: Annex II Species Surveys did not identify any species which would be categorised under the EC Habitats Directive. However, harbour porpoises, harbour/common seals and grey seals are all reported as being present in the vicinity of the Rose field and are all listed under Annex II of the habitats directive. Only harbour porpoise are reported to be present in any recordable density.											
Benthic Fauna Benthic communities, sensitive to disturbance and easily damaged/destroyed, are present within the vicinity of the Rose field. The protected sites (SAC, cSACs, SPAs & rMCZs) in the vicinity of the Rose field have been proposed in part due to their sensitive benthic habitats. However, benthic communities in the Rose field are not unique and are similar to those found in the surrounding southern North Sea.											
Plankton During summer there is a smaller peak in abundance of phytoplankton. However during the winter months the rate of phytoplankton production decreases due to increased ionic concentrations.											
Fish The Rose field and the surrounding area are spawning grounds for a number of species, including herring, lemon sole, sole, sandeel and sprat, and a nursery ground for whiting, lemon sole and sandeel. Specific spawning months overlap and while fish species sensitivities are not fully comparable they should be considered highly sensitive throughout the year, due to overlapping sensitive periods. Herring in particular spawn between August – October.											
Marine Mammals Harbour porpoises, harbour/common seals and grey seals are all reported as being present in the vicinity of the Rose field. Only harbour porpoise are reported to be present in any recordable density. Data indicates that harbour porpoise numbers are at their lowest July – September.											
Seabirds Seabird vulnerability to surface pollution varies throughout the year with peaks in late summer after breeding when the birds disperse into the North Sea, and during the winter months with the arrival of over-wintering birds. Seabird vulnerabilities in Block 47/15 and the surrounding blocks are lowest during the breeding months of May to July and highest in August, November and December.											

[1] Note: Sensitivities as listed in the above Table are not comparable with each other as they are indicative of the varying levels of sensitivity throughout the year, but not equal in sensitivity.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fisheries Fishing effort in vicinity of the Rose field is focused around shellfish species, making use of pots and traps. Fishing activity is at its highest during the summer months with static gear being mostly employed. Some fishing takes place throughout the year.											
Shipping Twenty seven shipping routes have been identified passing within 10km of the well location.											

	Very high sensitivity		Low sensitivity
	High sensitivity		Not surveyed / No data available
	Moderate sensitivity		

5. EIA METHODOLOGY

5.1 Overview

The EIA process identifies the environmental impacts of a project from activities (both planned activities and unplanned events) and aims to prevent, reduce and offset any adverse impacts identified. Planned activities and unplanned events likely to affect the environment (aspects) or other users of the environment are first identified, then assessed to define the level of impact they could cause. Where necessary, project specific control and / or mitigation measures in addition to the industry standard, legislative and prescriptive controls and mitigation measures are identified in order to reduce any impacts to as low as reasonably practicable (ALARP) in line with the philosophy of the Centrica Environmental Policy.

5.2 Impacts from planned activities

The environmental impact assessment matrix is used to assess the planned impacts before and after control/mitigation measures. The controls and mitigations then form the basis for the Environmental Management Plan (EMP) thereby providing a systematic approach to controlling the impacts on, and interactions with, the environment.

5.2.1 Duration/frequency

A consideration of both the duration and frequency of each aspect (impact causing activity) allows a numerical score of between one and five to be awarded (Table 5-1).

Table 5-1: Duration / frequency of an aspect

Planned aspect	Category
One to many years Long term continuous	5
One month to a year Short term continuous or intermittent over a long duration	4
One week to a month Short term intermittent	3
One day to a week One off over a few weeks	2

Planned aspect	Category
Less than a day One off over a day	1

5.2.2 Consequence/severity

The consequence/severity of each aspect is also rated on a scale of one to five as shown in Table 5-2. Where consequence/severity appears to fall within two categories, the higher category should be selected to provide a worst case for the purposes of the assessment.

Table 5-2: Consequence / severity of an environmental aspect

Level	Definition
Catastrophic (5)	Change in ecosystem (land, air or water) leading to long-term (greater than 10 years) damage and impact on associated species with poor potential for recovery to the area or species. The thresholds for impact on species / features / environmental area are: • 2 hectares of more littoral or sub-littoral zone or coastal benthic community, or the benthic community of any fish spawning area; • 100ha or more of the open sea benthic community; • 10% of wide spread habitat area or population; • 5% of a protected area; • 1% of a protected species population impacted (not limited to mortality); for threatened or rare species appropriate statutory conservation organisations should be contacted to discuss the appropriate threshold; • soil, groundwater or aquifer contamination that would be regarded as contaminated by relevant authorities; • changes in air or water quality that would exceed relevant / applicable air quality standards. • Damage to an area of archaeological importance or nationally registered building such that there would be a loss of importance / de-registering if no remedial / restorative work is undertaken. • Long term substantial loss of private users or public finance (e.g. long term loss of fishing grounds).
Major (4)	Change in ecosystem (land, air or water) leading to medium-term (greater than 2 years) damage and impact on associated species with recovery likely between 2 and 10 years to the area or species. The thresholds for impact on species / feature / environmental area are: • 2 hectares or more of littoral or sub-littoral zone or coastal benthic community, or the benthic community of any fish spawning area; • 100ha or more of the open sea benthic community; • 10% of wide spread habitat area or population; • 5% of a protected area; • 1% of a protected species population impacted (not limited to mortality); for threatened or rare species appropriate statutory conservation organisations should be contacted to discuss the appropriate threshold. • soil, groundwater or aquifer contamination that would be regarded a contaminated by relevant authorities; • changes in air or water quality that would exceed relevant/applicable air quality

Level	Definition
	standards; • Damage to an area of archaeological importance or a nationally registered building such that there would be a loss of integrity, not leading to de-registering / categorisation with a requirement for remedial / restorative work to be undertaken; and • Medium term, substantial loss or long term, minor loss of private users or public finance (e.g. medium term loss of fishing grounds).
Severe (3)	Change in ecosystem (land, air or water) leading to short-term damage and impact on associated species with recovery anticipated within 2 years to an area or species; The thresholds for impact on species / feature / environmental area are: • Damage to an area of archaeological importance or nationally registered building with a requirement for minor remedial / restorative work to be undertaken; and • Possible short or medium term minor loss to private users or public finances (e.g. short term loss of fishing grounds).
Moderate (2)	Change is within scope of existing variability but potentially detectable.
Minor (1)	Effects are unlikely to be noticed or detectable.

5.2.3 Combining duration/frequency and consequence/severity to establish significance of impact

The overall environmental impact posed by each aspect is assessed using the combination of the consequence/severity and duration/frequency scores in Table 5-3 to provide an indication of the significance of the impact associated with the aspect. There are three possible impact significance ratings corresponding to the coloured squares as shown in Table 5-3.

Table 5-3: Significance of environmental impact

		Duration / frequency				
		1	2	3	4	5
Consequence / Severity	5	High	High	High	High	High
	4	Medium	High	High	High	High
	3	Low	Medium	Medium	Medium	Medium
	2	Low	Low	Low	Medium	Medium
	1	Low	Low	Low	Low	Low

Table 5-4: Environmental impact acceptance criteria

Significance	Acceptability	Action required
High	Impacts are intolerable in this region	Controls and measures to reduce impact to ALARP (at least a medium) must be identified, documented, approved and implemented. The aspect should be reassessed once control measures have been identified.
Medium	Impacts are tolerable	Controls and measures to reduce impact to ALARP must be identified, documented, approved and implemented. The aspect should be reassessed once control measures have been identified.
Low	Impacts are broadly acceptable	Controls measures are subject to continuous improvement

5.3 Impacts from unplanned events

As for Centrica's impact assessment matrix, the Centrica risk assessment matrix for assessing the risk and severity of impact from unplanned events is a 5x5 Boston square. However rather than considering the duration/frequency of an event, the risk assessment matrix considers the likelihood of an event occurring and its impact to determine the risk.

5.3.1 Likelihood

A consideration of the likelihood of each aspect (impact causing activity) allows a numerical score of between one and five to be awarded (Table 5-5).

Table 5-5: Likelihood of an unplanned activity / event occurring

Descriptor	Description	Category
Very Likely	Almost inevitable that an event would result	5
Likely	Not certain to happen but an additional factor may result in an event	4
Possible	Could happen when additional factors are present but otherwise unlikely to occur	3
Unlikely	A rare combination of factors would be required for an event to occur	2
Very Unlikely	An almost inconceivable combination of factors would be required for an event to occur	1

5.3.2 Severity/consequence

The severity of each aspect resulting from an unplanned activity / event is also rated on a scale of one to five as shown in Table 5-5. Where the severity / consequence appears to fall within two categories, the higher category is selected to provide a worst case for the purposes of the assessment.

5.3.3 Combining likelihood and severity to establish risk from the unplanned event

The overall environmental risk posed by each aspect is assessed using the combination of the severity/consequence and probability/likelihood scores to provide an indication of the significance of the impact of the risk associated with the aspect (Table 5-6). There are three possible risk ratings corresponding to the coloured squares as shown in Table 5-7.

Table 5-6: Centrica Energy upstream HSE risk assessment matrix

		Likelihood				
		1	2	3	4	5
Severity / consequence	5	Medium	Medium	High	High	High
	4	Low	Medium	Medium	High	High
	3	Low	Low	Medium	Medium	High
	2	Low	Low	Low	Medium	High
	1	Low	Low	Low	Low	Medium

Table 5-7: Risk acceptance criteria

Risk Level	Acceptability	Action Required
High	HSE risks are intolerable at this level	Controls and measures to reduce impact to ALARP must be identified, documented, approved and implemented by the responsible L4 or higher leader.
Medium	Risks are tolerable and managed to ALARP	Controls and measures to reduce impact to ALARP must be identified, documented, approved and implemented by the responsible leader.
Low	Risks are broadly acceptable	Controls are subject to continuous improvement through implementation of the HSEQ MS and in light of changes such as technology improvements.

5.4 Assessment of impacts, risks and control measures

Using the information provided in Section 3 and Section 4 and the criteria set out above an Environmental Management Workshop was held which includes the identification of the aspects and assessment of the environmental impact and risk of the aspects.

Those environmental aspects that are:

- subject to regulatory control;
- were found to pose a moderate or high risk to the environment; or
- were recognised during the consultation phase as areas of public concern

are further assessed and described in Section 6.

6. ENVIRONMENTAL IMPACT ASSESSMENT

An Environmental Assessment and Management Workshop was held on the 24th September 2014. The scope of the decommissioning programme assessed included: preparation of the facilities for decommissioning; subsea infrastructure removal; general project activities; and legacy issues and requirements.

The EIA worksheet tables resulting from the workshop are presented in Appendix A.

This section examines the environmental impact of the following aspects of the decommissioning programme:

- Energy use and atmospheric emissions;
- Underwater noise;
- Seabed disturbance;
- Discharges and releases to sea;
- Large hydrocarbon releases and oil spill response; and,
- Waste.

The socio-economic impacts of the decommissioning programme is addressed separately at the end of this section.

6.1 Energy use and atmospheric emissions

This section identifies the various offshore and onshore energy requirements connected with the decommissioning programme. It then estimates the quantity and assesses the impact of the associated atmospheric emissions.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed in the context of the sensitivity of, and the dispersive capacity of, the receiving environment.

The Energy Institute’s (formerly the Institute of Petroleum) Emissions Estimate Guidelines for decommissioning [25] have been used to inform this assessment. They advise that:

- A materials inventory for each structure to be decommissioned must be created;
- All activities associated with the decommissioning programmes should be identified; and,
- A calculation of direct and indirect energy use and the associated atmospheric emissions from the various activities should be undertaken using suitable conversion factors.

6.1.1 Sources

The decommissioning programme’s direct and indirect energy requirements will result in the emission of a range of gaseous combustion products including, primarily, carbon dioxide (CO_2), and also smaller quantities of methane (CH_4), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and volatile organic compounds (VOCs).

The principal planned activities of the decommissioning programme, including their location and estimated duration, are described in Section 2. Of these, the use of specialist and support vessels has been identified as the only offshore activity that will have a substantive direct energy requirement, and therefore the only activity warranting additional assessment.

The onshore transport and light processing (e.g. cleaning and cutting, but excluding recycling) of recovered materials (primarily steel) will require the use of a variety of vehicles, plant and equipment at a shore base. Given that these emissions are estimated to be of an order of magnitude less that the primary offshore source described above, an assessment of the energy use from these activities has not been undertaken. It is considered that they have no material significance.

Under the Energy Institute's guidance, the significant indirect energy use associated with the following activities has also been accounted for:

- Offshore *in situ* decommissioning: the replacement energy that would be indirectly required in the manufacture of 'lost' materials; and,
- Onshore recycling: the energy that would be indirectly used in recycling recovered materials.

Offshore

Specialist and support vessels:

The energy (fuel) required by these vessels to provide propulsion and dynamic station-keeping, and ancillary services (e.g. electrical power, winching) will account for the majority of the decommissioning programme's atmospheric emissions.

While contracts securing the services of named vessels have not yet been established, the performance characteristics (including the fuel consumption) of the generic vessel types required to execute the work programme are well understood. This has allowed, in conjunction with a consideration of the vessels' work programme schedule, estimates of atmospheric emissions to be made. Refer to Table 6-1 & Table 6-2.

Onshore

Replacement energy of 'lost' material:

An estimate of the indirect, replacement energy that would be required to manufacture a quantity of steel equivalent to that contained within the pipeline and umbilical sections that will be decommissioned in-situ has been undertaken. Refer to Refer to Table 6-1 & Table 6-2.

Recycling:

An estimate of the indirect energy that would be required to recycle the recovered steel has been undertaken. It should be noted that the atmospheric emissions resulting from this energy use would occur at a location(s) remote from the Rose field and its facilities. Refer to Refer to Table 6-1 & Table 6-2.

It is considered that the in-situ decommissioning of materials or the recycling of recovered materials other than steel will not be undertaken on a scale that would be materially significant to this assessment.

Whilst onshore manufacturing (replacement) and recycling activities will consume energy, they will typically only generate indirect emissions (related to power or heat generation).

Table 6-1: Estimated energy use & atmospheric emissions for partial removal of pipeline

Decommissioning Aspect	Vessel type		Energy (GJ)	Emissions (tonnes)			
	type	Days		CO_2	NO_x	SO_2	CH_4
Direct							
Vessel Type	DSV	31	24,050	1,785	33	1.9	0.19
	Standby	31	1,069	79	1	0.1	0.01
	ROVSV	7	5,431	403	7	0.4	0.04
	Survey	9	582	43	1	0.1	0.01
Total			**31,132**	**2,310**	**42**	**2.5**	**0.25**
Indirect							
Replacement of steel left *in-situ*	890 tonnes		22,247	1,652.7	122.8	9.1	0.7
Recycling of recovered steel	38 tonnes		344	25.6	1.9	0.2	0
Total			**22,591**	**1,678.3**	**124.7**	**9.3**	**0.7**

Table 6-2: Estimated energy use & atmospheric emissions for partial removal of umbilical

Decommissioning Aspect	Vessel type		Energy (GJ)	Emissions (Tonnes)			
	Type	Days		CO_2	NO_x	SO_2	CH_4
Direct							
Vessel Type	DSV	5.5	4,268	317	5.9	0.3	0.03
	Standby	5.5	190	14	0.2	0.1	0.01
	Survey	9	581	43	1.0	0.1	0.01
Total			**5,039**	**374**	**7.1**	**0.5**	**0.05**
Indirect							
Replacement of steel left *in situ*	138 tonnes		3,464	257.3	4.7	0.3	0.03
Recycling of recovered steel	3 tonnes		25.1	1.9	0.06	0	0
Total			**3,489.1**	**259.2**	**4.76**	**0.3**	**0.03**

6.1.2 Impacts and receptors

Offshore

As demonstrated by the tables above, the principal energy consumption and atmospheric emissions will arise from the use of specialist and support vessels conducting offshore activities. This direct energy consumption accounts for approximately 60% of the total energy consumption and associated atmospheric emissions resulting from, or attributable to, the decommissioning programme.

The impact of NO_x, SO_2 and VOC in the atmosphere is the formation of photochemical pollution in the presence of sunlight, comprising mainly low level ozone, but by-products may include nitric acid, sulphuric acid and nitrate-based particulate. The formation of acid and particulate may lead to a contribution to acid rainfall and the dry deposition of particulate.

If such deposition occurs at sea, it is possible that the substances will dissolve in sea water. The ultimate fate of emitted pollutants can often be difficult to predict owing to the dependence on weather (especially wind), which may be highly variable and may lead to wide variations in pollutant fate over quite short timescales.

In general, environmental conditions offshore will lead to rapid dispersion and dilution of atmospheric emissions. The Rose field and facilities are located approximately 54km from the nearest UK coastline and offshore weather conditions and prevailing south westerly winds will mean that impacts to air and water quality will be localised and short-term. The significance of impacts from atmospheric emissions to either sea water quality or air quality has therefore been assessed as **low.**

Section 3.2 describes the biological environment and Table 4-12 the key environmental sensitivities in and around the Rose field. There are spawning and nursery grounds and the potential for both marine mammals and seabirds to be present throughout the year. Given the relatively short duration of these activities and the low impact on air and water quality (assessed above), the significance of the impact on biological receptors has been assessed as **low**.

CO_2 emissions contribute to greenhouse gas emissions and global warming impacts. The total direct and indirect estimated CO_2 emissions produced as part of the decommissioning activities (2,310+1,678+374+259) = 4,622 tonnes) in relation to the total CO_2 produced annually in the North Sea and ports (20,671,000 tonnes) [63] is 0.02%. On this basis, the significance of the impact of CO_2 emissions has been assessed as **low**.

Onshore

The indirect energy required by the programme (for replacement of 'lost' steel and for recycling of recovered steel) has been estimated as approximately 40% of the total direct and indirect energy use required by the decommissioning programme. This equates to some (1,678+259) = 1,937 tonnes of CO_2. To put these emissions into context, approximately 445,000 tonnes of CO_{2e} were emitted from industry in Scotland in 2012 [62]. Indirect CO_2 emissions attributable to the decommissioning programme represent approximately 0.43% of this value.

Power or heat generation for primary or secondary smelting, and the associated emissions, is permitted under the Environmental Permitting regime (England) and the Pollution Prevention and Control regime (Scotland). The impact of emissions will have had to have been assessed as 'acceptable' for these permits to have been approved.

6.1.3 Transboundary and cumulative impacts

The Rose field is located approximately 130km west-south-west of the UK/Netherlands median line. The transboundary impact of the direct atmospheric emissions arising from the decommissioning activities has been assessed to be of **low** significance owing to the anticipated rapid dispersion and dilution of emissions that will occur under prevailing meteorological conditions, and over distance.

In comparison with the current levels of shipping traffic present in the vicinity of the Rose field (approximately 50 vessels per day within 10nm) direct emissions from the decommissioning activities represent a very small increment only. The significance of cumulative impacts on receptors from atmospheric emissions resulting from the decommissioning activities has therefore been assessed as **low**.

6.1.4 Control and mitigation measures

In accordance with Centrica's routine environmental management of vessels, the following measures will be adopted to optimise energy consumption and reduce the impacts from atmospheric emissions to 'as low as reasonably practicable':

- Prior to mobilisation, vessels will be audited to ensure that their management system appropriately addresses maintenance of both generator and engine efficiency in line with manufacturer's specifications;
- Fuel used for mobilised vessels will be monitored and comply with MARPOL [64] requirements, in particular with regard to low sulphur content;
- Decommissioning activities will be planned to minimise vessel use (e.g. optimisation of vessel schedules);
- Fuel consumption will be minimised by operational practices and power management systems for engines, generators and any other combustion plant (as required under the contract with the subcontractor); and,
- Planned, preventative maintenance systems will be required for all vessels to ensure that all equipment (combustion and mechanical/electrical) is maintained at peak operating efficiency for minimum overall fuel usage (as required under the contract with the subcontractor).

6.1.5 Conclusion

The principal energy use and associated atmospheric emissions associated with the Rose field decommissioning programme concerns the use of vessels. The emissions from them will have components with the potential to contribute to global warming and acid rainfall, to deposit dry particulate, or to cause impacts on local air quality.

The total energy requirement of the decommissioning programme is estimated to be 62,251GJ of which the direct energy use (related to vessel use) is estimated to be 36,171GJ and the indirect energy use (attributable to materials replacement and recycling) is estimated to be 26,080GJ.

The direct atmospheric emissions generated by the decommissioning have the potential to impact both local and regional air quality. The prevailing offshore meteorological conditions in the Rose area are expected however to rapidly dilute and disperse airborne contaminants.

The direct and indirect CO_2 emissions generated by the decommissioning represent approximately 0.02% of the total CO_2 produced annually in the North Sea and ports. On this basis it is concluded that they do not make a substantive contribution to global warming potential.

Standard mitigation measures to optimise energy usage by vessels will include operational practices and power management systems for engines, generators and any other combustion plant and planned preventative maintenance systems for all equipment for peak operational efficiency.

In summary, due to the localised and relatively short duration of activities, and with the identified control and mitigation measures in place, the overall significance of the impact of energy use and associated atmospheric emissions arising from the decommissioning of the Rose field is considered to be **low.**

6.2 Underwater noise

This section identifies, and then assesses the impact of the various surface and subsea sources of underwater noise resulting from the decommissioning programme.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed with regard to the sensitivity of known receptors in the receiving environment.

6.2.1 Sources

The principal planned activities of the decommissioning programme, including their location and estimated duration, are described in Section 2. Of these, the use of specialist and support vessels, and the use of water-jetting and cutting tools have been identified as having the potential to generate noise at levels warranting additional assessment.

There are a number of natural sources, including the sea itself, that generate background underwater noise, including waves, wind and rain and the noise generated naturally by the moving underwater environment, including that by marine mammals. In addition there are various anthropogenic sources of background noise, such as vessel movements associated with shipping and fishing, offshore wind and sonar associated with defence, fishing and hydrocarbons exploration. The characteristics of the noise produced vary with the type of activity. In general, sound can be characterised with reference to the frequency at which it is emitted (measured in hertz, Hz) and the strength or intensity of the sound (measured in decibels, dB). Sound levels in the marine environment diminish with distance from source by dispersion in three dimensions and absorption by the water [65]. Sound can be described as continuous noise, where there are no sudden rises or falls in pressure or impulsive noise.

Surface

Specialist and support vessels:

The operation of vessels will account for the majority of surface-generated noise. The following categories of vessel noise have been identified:

- Propeller noise;
- Flow noise: the action of water passing the hull (and dependent upon speed);
- The use of thrusters for dynamic station-keeping; and,
- Machine noise: the operation of engines, generators, winches etc.

The intensity and frequency of sound produced by vessels is related to vessel size and operating status. Larger vessels typically produce lower frequency sounds. In general, vessels produce noise over the range 100Hz to 10kHz, with strongest energy over the range 200Hz to 2kHz. Broadband source levels for these activities rarely exceed about 190dB re1μPam, even for a vessel using dynamic positioning, and are typically much lower [66 & 67].

Subsea

Cutting and water-jetting tools:

Specialist tools, separately deployed from surface vessel(s) will be used for water-jetting sediments and for cutting the WHPS, spool pieces, and pipeline and umbilical sections. Operation of these tools will account for the majority of the subsea noise generated at, or close to the seabed.

The precise specification and detailed performance characteristics of the water-jetting and cutting tools are not yet known. Furthermore, the literature contains little general information with respect to their expected noise generation. However, peak source intensities of 148 to 180dB re 1μPa are reported for a range of diver-operated tools including cutters, with most energy in the frequency range 200 to 1,000Hz [68].

The use of both underwater cutting tools and water-jetting tools is likely to be intermittent and of short duration.

6.2.2 Impacts and receptors

Surface

Sound is important for numerous species of marine organisms, with fish and in particular marine mammals having developed a range of complex mechanisms for both the emission and detection of sound [69]. Cetaceans (a sub set of marine mammals including whales, dolphins and porpoises) use sound for navigation, communication and prey detection. Thus anthropogenic underwater noise has the potential to impact on marine mammals [69] [70]. Underwater noise may cause animals to become displaced from activities, potentially interrupting feeding, resting and/or migration. This may impact body condition and reproductive success of individuals and ultimately the health of a population [69] [70]. Feeding may also be affected indirectly if noise disturbs prey species [69] [70].

Fish:

Very few studies have investigated the effects of anthropogenic sound on fish behaviour and little is known about the long-term effects or the cumulative effects of sound exposure on fish. The effects of underwater sound on fish vary according to the species in question and whether they are loud or when they are less intense but continuous. The exposure to intense sound is therefore brief, where sound is localized, since it passes by the fish quickly. Longer lasting sounds however, such as shipping can extend over a large region and cannot be as easily avoided by fish [71].

The lowest level of sound that a fish (or any other organism) can detect is known as the threshold of detection. All fish are able to detect sounds within the frequency range of the most widely occurring anthropogenic sounds [72]. Studies have shown how different fish species can react to different sound frequency ranges. Most fish species hear sounds from below 50Hz up to 500 - 1500Hz. A small number of species can detect sounds over 3kHz, but this is very rare and only very few species can detect sounds over 100kHz.

Behavioural responses of fish to underwater noise may include swimming away from the sound source, in an attempt to relieve the effects of the sound. The animal could also freeze and stay in place, leaving it exposed to considerable damage. When the fish swims away, the effects could be minimal or substantial. It may lead to a fish swimming away from an important feeding ground, which is a considerable change in behaviour. The fish might also swim away from an area where it would generally reproduce. If feeding and reproduction continues to be impeded, this could lead to long term effects. If the increased background noise level prevents fish from hearing biologically relevant sounds, this could lead to the effect of masking. As a result, a fish might be prevented from hearing for example, the sound of prey in the water [72].

There is very little data available for the sound thresholds which will result in behavioural and/or physiological impacts to fish. However, the studies undertaken, which focused on only a few species, found that the most significant impacts, sometimes mortality, resulted from prolonged exposure (1 - 5hrs) to noise generated by activities such as underwater pile driving and the use of seismic equipment which produce low frequency sounds.

The level of sound generated by the vessels associated with the decommissioning activities is highly unlikely to result in physiological damage to fish. Given the relatively high shipping activity in the area, fish behaviour will be habituated to general vessel noise. Noise generated by vessel thrusters when starting is likely to elicit a startle response in fish in the immediate vicinity.

Given the localised nature and relatively short duration of activities, the significance of the behavioural impact discussed above has been assessed as **low**.

Marine mammals:

As described above, the effects of sound to marine life vary according to frequency and intensity, and depend upon species sensitivity and distance relative to the source. Some marine mammals (cetaceans) are more sensitive to high frequency sounds while other species are sensitive to low frequency sound.

Harbour porpoise are one of the most common species of cetaceans in the southern North Sea and as described in Section 3 are the only species occurring in the vicinity of the Rose field in recordable densities. Their presence is predominantly during January to June and October to December. Porpoises belong to the odontocete suborder of cetaceans. They have very acute hearing with which they echolocate for communication. Their hearing extends well beyond 500Hz, and echolocation occurs well beyond human ultrasound, which is 20kHz. Frequencies below 10kHz travel further before attenuating than higher frequencies do, and for this reason, it is believed that lower frequencies resulting from pile driving for example, may be especially threatening and damaging to odontocetes because of their own channels of hearing [73].

There is a variety of literature documenting the response of marine mammals to various ship types, and their reactions vary from avoidance of the ship (sometimes moving more than 50 miles away from the source), sending out alarm calls in panic or changing their dive patterns. In one particularly relevant study harbour porpoise were seen to be disturbed by the noise produced by ships and boats, as boats approached, animals would dive into the water and swim away [74]. Shipping is broad banded and will therefore not cause immediate hearing damage. However, it may influence marine mammal behaviour depending on the species [75].

It is anticipated that all vessel movements associated with the decommissioning activities will be undertaken at relatively low speeds and that any harbour porpoise or other marine mammals will avoid areas in close proximity to vessel activities [76]. The significance of the impact has been therefore been assessed as **low**.

Subsea

Fish:

When in operation, the noise generated by both cutting and water-jetting activities will be continuous, producing a relatively constant intensity and frequency. The activities themselves will be very localised and intermittent, and of short overall duration when compared with the vessels programme itself.

It is considers that the level of sound generated by the use of cutting and water-jetting tools is highly unlikely to result in physiological damage to fish. It is anticipated that the initial use of cutting and water-jetting tools will elicit a startle response in fish in the immediate vicinity. The significance of the behavioural impact discussed above has therefore been assessed as **low**.

Spawning:

As described in Section 3 a number of species are known to spawn within block 47/15, including sandeel, herring, sprat, lemon sole and sole. In addition, whiting, lemon sole, and sandeel are known to use the waters of block 47/15 as a nursery area in the period immediately following spawning. Of these species, most spawn over wide areas of the North Sea, however herring have particular spawning requirements. The herring spawning potential of the site was assessed as part of the pre-decommissioning environmental survey undertaken in 2012 [5]. The survey concluded that in general there was moderate potential for herring spawning particularly in the vicinity of the Rose wellhead and the Amethyst A2D platform.

Ideally, the decommissioning activities would be undertaken outside of the herring spawning period (August to October). Given that the Rose field and vicinity is not considered to have high spawning potential, the small percentage of the available spawning grounds within the North Sea effected, and the relatively short duration of the decommissioning activities (approximately 1 month of which approximately 10 days will occur at the Rose wellhead), the significance of the impact has been assessed as **low**.

Marine mammals:

Table 6-3 below sets out the recommended noise thresholds above which porpoises experience a Temporary Threshold Shift or recoverable hearing loss [77].

Table 6-3: Recommended noise thresholds for porpoises

	Injury		Behavioural response	
	Multiple pulse	**Non-pulse**	**Multiple pulse**	**Non-pulse**
Porpoises	230dB	230dB	Unknown	90 – 129dB

The underwater noise levels anticipated to be generated from the intermittent and short duration use of underwater cutting and water-jetting tools are likely to exceed the threshold at which they will result in a behavioural response but will not be sufficient to result in physiological damage. Depending on background noise levels, marine mammals in the vicinity of the activities may be disturbed and swim away.

Given the relatively short duration of the decommissioning activities and the relatively low density of marine mammals recorded in the vicinity of the Rose field, the significance of the impact has been assessed to be **low**.

6.2.3 Transboundary and cumulative impacts

The Rose field is located approximately 130km west-south-west of the UK/Netherlands median line. The transboundary impact from underwater noise arising from the decommissioning activities has been assessed to be of **low** significance owing to the attenuation of sound emissions that will occur over distance.

The underwater noise generated from vessels and the use of underwater cutting and water-jetting tools are expected to be localised and therefore no substantive cumulative impacts are anticipated.

6.2.4 Control and mitigation measures

The following measures will be adopted to ensure that noise levels, and their effects upon potential receptors, are minimised to 'as low as reasonably practicable':

- Machinery, tools and equipment will be in good working order and well-maintained (as required under the contract with the subcontractor);
- The vessels work programme will be carefully planned to optimise use; and,
- The number of required cuts will be minimised consistent with operational (including safety) considerations.

6.2.5 Conclusion

The principal sources of underwater noise associated with the Rose field decommissioning programme are concerned with the use of vessels, and the use of water-jetting and cutting tools.

The approximately 1 month vessels programme (comprising a total of approximately 100 individual vessel days spread over a multi-year period) is of relatively short duration and represents only small increment to existing vessel traffic in the area. Water-jetting and cutting tools will only require to be used intermittently over this period and at point locations.

The level of noise that will be generated is not expected to cause physiological harm or substantive behavioural interference to either fish or mammals known to inhabit the area.

Standard measures that will be applied to control noise include planned maintenance of equipment and optimisation of the work programme to minimise vessel use.

In summary, due to the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall significance of the impact of underwater noise generated during decommissioning of the Rose field is considered to be **low.**

6.3 Seabed disturbance

This section identifies and then assesses the impact of the various sources of seabed disturbance that will result from the decommissioning programme. It also considers potential sources of unplanned (accidental) seabed disturbance.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed in the context of the sensitivity of, and the attenuating capacity of, the receiving environment.

6.3.1 Sources

The principal planned activities of the decommissioning programme, including their location and estimated duration, are described in Section 2. Of these, in requiring activities to be carried out at, or in close proximity to, the seabed, the water-jetting of sediments, the lifting of materials, and the temporary placement of objects on the seabed warrant further assessment in terms of their potential to disturb the seabed.

It can be useful to distinguish between 'primary' and 'secondary' seabed disturbance. Primary seabed disturbance is disturbance that is directly attributable to a particular activity. The total loss of substrate underneath an object that has been placed on the seabed, and the smothering of the adjacent substrate by the settlement of sediment that was suspended by the placement activity are examples of primary disturbance.

Secondary seabed disturbance is disturbance that is not directly related to the particular activity. The mobilisation (suspension into the water column) and dispersion of chemically contaminated sediments following the placement of an object on the seabed would be an example of secondary seabed disturbance.

Water-jetting

The degree of disturbance will be related to the number of required pipeline/umbilical disconnections and cuts, and the extent to which the infrastructure being removed is buried/partially buried by sediment.

Lifting of materials

The degree of disturbance will be related to the size of the item being removed and the extent to which it is buried/partially buried by sediment.

Temporary placement of objects

The degree of disturbance will be related to the size of the object's 'footprint'.

Unplanned activities and events

During all lifting activities there is the potential for materials and equipment to be accidentally dropped as a consequence of procedural failure, or mechanical failure of lifting apparatus.

The degree of disturbance will be related to the size of the object's 'footprint' and the length of time that recovery is delayed (the time taken for retrieval).

Table 6-4: Estimate of seabed area impacted by decommissioning activities

Infrastructure	Assumptions made	Area impacted (km^2)
Recovery of pipeline ends (exc. spool pieces)	Total length of pipeline ends to be recovered is approximately 0.2km. The area of seabed disturbance was assumed to be a corridor width of 10m, allowing for sediment to be moved from its current location over the partially buried pipeline ends to either side.	0.002
Recovery of umbilical ends	Total length of umbilical to be recovered is approximately 0.4km. The area of seabed disturbance was assumed to be a corridor width of 10m, allowing for sediment to be moved from current location over the buried umbilical to either side.	0.004
Recovery of spool pieces	Total length of spool pieces to be recovered is approximately 0.2km. The area of seabed disturbance was assumed to be a corridor width of 10m at each of the spool pieces as jetting will be used to clear the sediment to allow access beneath the spool pieces to facilitate disconnection and lifting.	0.002
Recovery of concrete mattresses*	To calculate the area of disturbance associated with the removal of the 112 mattresses, each measuring 6m x 3m an additional impacted area of 1m was assumed on either side of the mattresses.	0.003
Recovery of grout bags	Recovery of approximately 200 grout bags, each is assumed to impact on an area of 0.5m x 0.5m.	0.00005
Total area impacted		**0.011**

* It should be noted that the concrete mattresses are positioned over the pipeline and umbilical and therefore, by considering them separately, the areas calculated above include some double counting and can therefore be considered conservative. Likewise, grout bags may have been placed on top of each other.

6.3.2 Impacts and receptors

As described above, the ease with which sediments will become suspended by decommissioning activities, and the speed at which they will settle out of the water column will depend upon the nature of the sediments and the prevailing sediment transport system. In any given hydrodynamic regime, larger particles will settle out of the water column more quickly than smaller particles; therefore, sediment suspension will be easier and is likely to persist for longer in areas with a high percentage of fine sediments compared to areas with coarse sediment composition.

As well as the direct impacts to marine fauna as a result of increased turbidity assessed above, it is important to consider the indirect impact. Increased turbidity, as well as potentially having physiological impacts to fish, can also impair their ability to locate food which can impact the physical condition of an individual.

The sediments do not contain a high degree of fines. As described in Section 3, the pre-decommissioning environmental survey characterised the sediments as sandy gravel;

gravelly sand; and slightly gravelly sand. Both Table 4-1 and Table 4-4 demonstrate that the percentage of fines at the sites surveyed was <2%. Therefore, whilst the sediments will be displaced, not all of the sediment will become suspended. It is likely that any fine fraction of the suspended materials will be rapidly dispersed and diluted by the prevailing hydrodynamic conditions and settlement of the remaining larger particles will occur relatively rapidly after suspension.

Primary disturbance

It can be useful to recognise two types of primary seabed disturbance: the loss or removal of substrate caused either by its displacement or by placing an object directly upon it, and the smothering of substrate caused by the resettlement of suspended sediment. The suspension of sediment will lead to increased suspended solid concentrations (and to increased turbidity) in the water column.

Water-jetting, the lifting of materials and the temporary placement of objects on the seabed will each give rise to both types of disturbance.

Displacement/removal and smothering will result in the loss or impairment of existing habitats (e.g. hydroid/bryzoan turf and meadows and bryzoan crusts present within the survey area) and the physical injury or death of benthic fauna.

As described in Section 3, there are two biotopes present within the site, Circalittoral Coarse Sediment (SS.SCS.CCS) and the more frequently recorded *Flustra foliacea* and *Hydrallmania falcata* on tide-swept Circalittoral Mixed Sediment (SS.SMx.CMx.FluHyd).

The fauna within the biotope SS.SCS.CCS was observed to be impoverished with only the mobile crustacea Paguridae and Liocarcinus sp. being recorded as frequent along with Ammodytidae. The bryozoan A. *diaphanum* and F. *follacea* were noted as rare. The SS.SMx.CMx.FluHyd biotope complex typically comprised medium to coarse sand with variable compositions of overlaying gravel and pebbles with the bryozoan F. *foliacea* and the hydroid H. *falcata* the characterising species. The anemone *Urticina felina* and the soft coral A. *digitatum* were also present with tube worms *Pomatoceros triqueter* and the robust bryozoans A. *diaphanum* and *Vesicularia spiniosa*.

The area of seabed being physically displaced or smothered as a result of the planned activities is relatively small, estimated to be 0.011km^2, Table 5-4.

Species coming into direct contact with the water-jet will be torn from their substrate, suspended into the water column, and likely be broken up. Species such as the sand lance (Ammodytidae) which burrow under the surface of the sediment are likely to be killed by the action of the water- jetting.

Lifting of materials is likely to damage/destroy any sensitive surface species settled on the sediment. It is unlikely however to affect mobile species, either on, and under the surface of the sediment, which are likely to move away from the disturbance.

The intentional or unintentional temporary placement of objects on the seabed will result in the effected substrate being no longer available for colonisation by either surface dwelling and burrowing species..

Given that the area of seabed/infrastructure that will be affected by water-jetting, lifting of materials, or temporary placement of objects represents a very small proportion only of these biotopes available in the southern North Sea, and that recolonization of affected substrate is expected to occur rapidly via recruitment of individuals from adjacent undisturbed areas, the significance of these impact has been assessed as **low**.

Protected sites and spawning

The suspension of sediments into the water column can result in the smothering of benthic species [78] with the impact related to their ability to clear particles from their feeding and respiratory surfaces [79]. Whilst some may be exposed to some settlement of sediments and be unaffected, others may be unable to tolerate any covering at all. Species such as the bryzoans, hydroids, anemones, soft corals and tube worms which inhabit the surface of the seabed are sensitive to smothering and fine particulate matter may clog their filtering and respiratory apparatus. Infaunal species that burrow in to the sediment are less susceptible to negative impacts of smothering. However, the survey of the site revealed that the sediments are predominantly sandy gravel and gravelly sand, which are expected to resettle relatively rapidly after suspension, thereby limiting the areas likely to be impacted by smothering to those in the vicinity of the decommissioning activities.

As shown in Figure 4.11 the**Error! Reference source not found.** pipeline and umbilical both pass through the Holderness Offshore and Silver Pit rMCZs, which were both recommended for their mixed sediment substrates, supporting a diverse array of benthic species. As described above, the removal of sections of pipeline and umbilical, as well as spool pieces, mattresses and grout bags, and any associated water-jetting, will disturb the overlying and immediately adjacent sediments which in turn will disturb, and is likely to damage/destroy sensitive species present. As the majority of the pipeline and umbilical is being left *in-situ* it will not result in any disturbance to the marine environment. The sections of pipeline and umbilical, as well as other materials to be removed represent a total area of approximately 0.005km^2, which when compared with the area of the Silver Pit (168.09km^2) rMCZ, represents less than 0.0001%. The recolonization of any impacted benthic fauna is expected to occur rapidly via recruitment of individuals from adjacent, undisturbed areas, as such the direct impacts of seabed displacement upon the rMCZs have been assessed to be short-term, reversible, localised and of **low** significance.

Since the sections of pipeline and umbilical being removed are within the Silver Pit rMCZ, it is likely that the suspension of sediment could impact the benthic habitats within those sites. However as described above, sediments are expected to settle relatively rapidly after suspension, limiting the areas likely to be impacted by smothering of those in the immediate vicinity of the activities. Given the area of disturbance described above, the significance of the impact of smothering caused by the settlement of suspended sediments on marine habitats and the rMCZs has been assessed as **low**.

As discussed previously a number of species of fish are known to spawn within block 47/15, with others using it as a nursery area in the period immediately following spawning. Smothering of these areas, particularly during spawning is likely to affect the spawning success which could have wider impacts to the population as a whole.

Ideally, the decommissioning activities would be undertaken outside of the spawning period to ensure there is no impact. However the overlap of spawning periods throughout the year would make this impossible, herring in particular spawn from August to October which may coincide with activities. Given that the areas likely to be impacted represent a very small percentage of the available spawning grounds within the North Sea, the short duration of the decommissioning activities (approximately 1 month), and the small percentage of fines, the significance of the overall impact of smothering caused by the settlement of suspended sediments on fish spawning has been assessed as **low**.

Secondary disturbance

The pre-decommissioning environmental survey found no evidence of sediment contamination. As described in Section 3, concentrations of hydrocarbons and heavy metals were lower than generally expected within sediments of the North Sea and with the few exceptions discussed, all were within the appropriate guidance levels (Table 4-2 and Table 4-3). Other than the increased turbidity addressed above, there are no anticipated impacts to water as a result of the decommissioning activities. The significance of the impact has therefore been assessed as **low**.

6.3.3 Transboundary and cumulative impacts

The Rose field is located approximately 130km west-south-west of the UK/Netherlands median line. Given this distance and the short-term and localised nature of the impacts resulting from the seabed disturbances, no substantive transboundary impacts are anticipated.

Decommissioning activities will cause some disturbance to the seabed. However, due to the limited percentage of fines in the sediment, and the short-term and localised nature of the activities, significant cumulative impacts are not anticipated.

6.3.4 Control and mitigation measures

The following measures will be adopted to ensure that seabed disturbance and its impacts are minimised to ‘as low as reasonably practicable’:

- All activities which may lead to seabed disturbance will be planned, managed and implemented in such a way that disturbance is minimised;
- The careful planning, selection of equipment, and management and implementation of activities (especially water-jetting); and,
- A debris survey will be undertaken at the completion of the decommissioning programme. Any ‘foreign’ material, identified as resulting from decommissioning activities will be recovered from the seabed where possible.

6.3.5 Conclusion

The principal sources of seabed disturbance associated with the Rose field decommissioning programme concern the water-jetting of sediments and the lifting of materials from the seabed during their recovery. These activities will result in the displacement of substrate and the suspension and subsequent settlement of sediment.

Water-jetting and lifting operations will only be undertaken at the pipeline and umbilical ends.

Standard measures to control disturbance include operational planning and equipment selection.

The species and habitats observed in the vicinity of Rose are relatively widespread throughout the southern North Sea and the area anticipated to be impacted represents a very small percentage of the available habitat. Furthermore, all disturbed sediments are expected to recover rapidly though recruitment from adjacent undisturbed areas.

In summary, due to the localised and relatively short duration of the decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the impact of seabed disturbance as a result of the decommissioning of the Rose field is considered to be **low.**

6.4 Discharges and releases to sea

This section identifies the various sources, and assesses the impact, of planned discharges to the marine environment that will result from the decommissioning programme. It also considers (with the exception of large hydrocarbon releases which are addressed in the following section) the potential for, and the effects of, unplanned (accidental) releases ('spills') to the marine environment.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts (and the risk of such) are assessed in the context of the sensitivity of, and the assimilative capacity of, the receiving environment.

6.4.1 Sources

The principal planned activities of the decommissioning programmes, including their location and estimated duration, are described in Section 2. Of these, the use of specialist and support vessels, unbolting and cutting (breaking containment), and lifting have been identified as warranting further assessment in terms of the potential impact of their discharges and releases.

Surface discharges and releases

Specialist and support vessels:

- Planned (operational) discharges (ballast water, bilge water, general shipboard drainage; treated sewage and grey water from accommodation and amenities;
- Planned discharge of marine growth removed from the WHPS, pipeline and umbilical sections, and concrete mattresses and grout bags recovered to surface; and,
- Unplanned releases of hydrocarbons or chemicals (e.g. from diesel bunkering).

Seabed and water column discharges

Unbolting and cutting, and lifting:

- Planned discharge (post-cleaning), upon breaking containment of the umbilical, of residual concentrations of production chemicals and of hydraulic fluid at the seabed, and through the water column during recovery;
- Planned discharge (post-cleaning), upon breaking containment of spool pieces/pipeline, of residual concentrations of production chemicals (corrosion inhibitor and methanol), and hydrocarbons and solids at the seabed, and through the water column during recovery; and,
- Planned discharge of marine growth during cleaning of WHPS, and pipeline/umbilical surfaces to allow access for unbolting and cutting.

6.4.2 Impacts and receptors

The discharges and releases into the water column or at the seabed from decommissioning activities identified above, have the potential to impact the marine environment (plankton, benthos and fish, etc.) in the immediate vicinity of the discharge point. Bioaccumulation in the food chain may occur depending on constituents' characteristics [80].

Operational discharges and releases from vessels

Planned operational discharges to sea from vessels will be subject to on-board control measures designed to secure compliance with the requirements of MARPOL [64].

Decommissioning activities will comprise approximately 100 vessel days spread over a multi-year period (Table 3-6 and Table 2-7). During this time discharges will be controlled and minimised using operating procedures and systems for optimum performance, including planned preventative maintenance systems for peak operating efficiency of on-board systems for the management of effluent, ballast water and bilge water.

- It is possible that technical problems or operator error may lead to unplanned small volume releases of diesel or other hydrocarbons (e.g. through the drainage system). The likelihood of such releases is considered very low.

While water quality will be reduced at their immediate time and location, the effects of routine vessel discharges and any small volume unplanned releases will be minimised due to the expected rapid dilution and dispersal of contaminants under ambient hydrodynamic conditions. It is considered unlikely that impacts beyond those associated with normal shipping activities will occur. The significance of the impacts from these discharges has and releases has therefore been assessed as **low**.

Marine growth

Marine growth is entirely organic in origin. Its discharge into the marine environment either at the seabed, or at the surface will result in a short-term increase in suspended solids in the water column which would be expected to be rapidly dispersed under prevailing hydrodynamic conditions. Removed marine growth will however naturally biodegrade within the normal ecosystem cycle and it is considered highly unlikely that it will lead to detectable impacts. The significance of the impact of marine growth discharged in this manner has therefore been assessed as **low**.

Residual chemicals

During their cleaning, the pipeline, and the umbilical cores containing methanol/corrosion inhibitor mix will be flushed with, respectively, inhibited seawater and potable water. Following cleaning, the contained seawater and potable water (‘wash water’) is expected to contain only ‘trace’ residual concentrations of production chemicals.

Upon cutting, the contents of the pipeline and umbilical (wash waters including the residual chemicals) will begin to be discharged, initially at the seabed. Upon lifting of cut pipeline and umbilical sections, further and complete discharge of contained wash waters is expected to occur through the water column *en route* to surface.

It is further expected that the wash water contained within the sections of the pipeline and umbilical being decommissioned *in-situ* will be lost to the surrounding sediment and water column over time as their structures gradually deteriorate.

The discharge of residual production chemicals to sea is not expected to result in any detectable impact on the surrounding water quality. The significance of the impact of trace residual concentrations of production chemicals being discharged in this manner has therefore been assessed as **low**.

Residual hydrocarbons

During its cleaning, the pipeline will first be pigged and then flushed with inhibited seawater. Upon cutting, the contents of the pipeline (wash waters including residual hydrocarbons) will begin to be discharged, initially at the seabed. Upon lifting of cut pipeline sections, further and complete discharge of contained wash waters is expected to occur through the water column *en route* to surface.

As Rose was a gas producing well the concentration of residual hydrocarbons in the pipeline following cleaning is expected to be very low. Furthermore, hydrodynamic conditions at the seabed and in the water column are likely to be such that rapid dilution and dispersion of contaminants will occur. Any impacts would therefore be expected to be short-term and localised.

It is expected that the wash water contained within the sections of the pipeline being decommissioned *in-situ* will be lost to the surrounding sediment and water column over time as its structure gradually deteriorates.

The discharge of any residual hydrocarbons to sea is therefore not expected to result in a detectable impact on the surrounding water quality. The significance of the impact of residual concentrations of hydrocarbons being discharged in this manner has therefore been assessed as **low**.

Hydrocarbon discharges will be permitted under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended) (OPPC) [13].

Hydraulic fluid

The umbilical cores containing hydraulic fluid, Oceanic HW540 v2, will not be flushed. Upon cutting, the contents of the cores will begin to be discharged, initially at the seabed. Upon lifting of cut sections, further and complete discharge of the contents is expected to occur through the water column e*n route* to surface.

Oceanic HW540 v2 is a commonly used hydraulic fluid in subsea systems. The use and discharge of Oceanic HW540 v2 at Rose during production was permitted under the Offshore Chemicals Regulations 2002 (OCR) [12]. Oceanic HW540 v2 is rated as OCNS A and has been categorised as a UK National Plan Level 2 chemical. Over 95% of the components of Oceanic HW540 v2 are OCNS E rated. The OCNS A rating and substitution warning are a result of three components that enable the fluid to lubricate the valves. It is soluble in seawater and once discharged will rapidly disperse below the no effect concentrations (NOEC) of all its components.

As this is a subsea discharge, an Osborne-Adams risk assessment was performed and included in the existing PON15D. The residual current speed for this area of the North Sea is 0.01m/s, in a water depth of 27m (Rose). The worst case toxicity of Oceanic HW540v2 is 0.22mg/l, giving a PNEC of 0.022mg/l based on 3 tests. As a worst case, it was assumed that 13.7kg of Oceanic HW540 v2 (5,000kg per year/365 days) will be discharged subsea over a 24 hour period. These volumes are comparable to the volume likely to be discharge when the sections of umbilical are recovered. The Osborne-Adams risk assessment show that T1>T2 indicating that the subsea discharge of this product is not expected to pose a significant risk to the receiving marine environment.

It is expected that the fluid contained within the sections of the umbilical being decommissioned *in-situ* will be lost to the surrounding sediment and water column over time as its structure gradually deteriorates.

A more detailed, specific chemical assessment of the impact of the discharge will be included in the environmental permits submitted prior to the execution of the work under the Offshore Chemicals Regulations 2002 (OCR) 2002 [12].

The significance of the impact of hydraulic fluid being discharged in this manner has been assessed as **low**.

Naturally Occurring Radioactive Material (NORM)

Upon cutting and lifting of the pipeline, it is possible that residual solid material (e.g. scale) may be discharged to the seabed and water column, entrained with contained wash water.

Levels of NORM in the gas produced from Rose have historically been very low and it is considered unlikely that solids will contain detectable levels of radioactive material.

The significance of the impact of NORM being potentially discharged in this manner has therefore been assessed as **low**.

6.4.3 Transboundary and cumulative impacts

The Rose field is located approximately 130km west-south-west of the UK/Netherlands median line. Given this distance, and the short-term and localised nature of the discharges and potential releases to the marine environment associated with the decommissioning activities, no substantive transboundary impacts are anticipated.

Discharges and releases to the marine environment may lead to short-term and localised impacts on marine organisms which are relatively close to the discharge point. The marine fauna that has colonised recovered infrastructure will also be lost. Cumulative impacts are however considered unlikely since the impacts arising from discharges are expected to be short-term with rapid dispersion, dilution and degradation.

6.4.4 Control and mitigation measures

All operational activities will be undertaken in compliance with regulations (particularly OPPC, OCR and MARPOL and all its annexes).

The following measures will be adopted to ensure that seabed disturbance and its impacts are minimised ‘to as low as reasonably practicable’:

- Procedures and systems for the minimisation of waste and effluent generation (maintained as required under the contract with the subcontractor);
- Procedures and systems for the management of ballast and bilge water (maintained as required under the contract with the subcontractor);
- Accident prevention measures will be in place in order to minimise the potential for accidental spillages of hydrocarbons or other polluting materials;
- Vessels will be selected and audited to ensure that effective operational systems and on-board control measures are in place; and,
- Vessels’ work programmes will be optimised to minimise use.

6.4.5 Conclusion

The principal sources of discharges and releases to sea associated with the Rose field decommissioning programme concern vessels and the breaking containment/lifting of sections of pipeline and umbilical.

The approximately one month vessels programme (comprising a total of approximately 10 individual vessel days) is of relatively short duration. Operational discharges from vessels during this time are expected to be rapidly diluted and dispersed under prevailing hydrodynamic conditions.

With the exception of hydraulic fluid, residual traces of chemical and hydrocarbons only are expected to be discharged to the marine environment during recovery of the end sections of the pipeline and umbilical.

The hydraulic fluid, which will be discharged in ‘native’ form, has previously been permitted for use and discharge during production operations at this location. The volume will be small and being water soluble, the discharge is expected to undergo rapid dilution and dispersion under the prevailing hydrodynamic conditions.

Standard measures to manage vessel discharges include operating procedures and management systems, and planning to optimise vessel utilisation.

In summary, given the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall impact of discharges and releases to sea as a result of decommissioning the Rose field is considered to be **low**.

6.5 Large hydrocarbon releases and oil spill response

This section identifies the potential sources, and assesses the impact of large unplanned (accidental) releases (‘spills’) to the marine environment resulting from the decommissioning programme.

Following the adoption of appropriate prevention and response measures, the overall risk of impact presented by identified release scenarios are assessed in terms of probability of occurrence, and the consequences given the sensitivity of, and the assimilative capacity of, the receiving environment.

6.5.1 Potential sources

Unplanned releases to sea

The principal planned activities of the decommissioning programme, including their location and estimated duration, are described in Section 2. Of these, the use of specialist and support vessels, in having the potential to release a large volume of hydrocarbon (diesel fuel) to the marine environment, is the only activity considered to warrant further assessment.

Specialist and support vessels:

Unplanned large volume releases of diesel to sea associated with these vessels could occur as a result of:

- Loss of structural integrity of storage tanks following a collision with another vessel or fixed facility;
- Loss of structural integrity of storage tanks following corrosion or mechanical failure; and
- Operator error or equipment failure.

The worst case in terms of volume and rate of release would be the immediate total loss of diesel inventory to sea as a consequence of collision or mechanical failure. This eventuality is considered to be highly unlikely owing to vessels management systems and operational controls that will be applied.

6.5.2 Oil spill fate and trajectory modelling

The Rose OPEP OSIS (Oil Spill Information System) modelling [6] considered the accidental instantaneous release of 2,212m^3 of diesel over the Rose wellhead during well abandonment. This modelled scenario is comparable to the potential release from a large DSV.

Oil spill computer modelling predicts both the fate and trajectory of spilt oil. Both single trajectory and stochastic modelling, using OSIS was undertaken. Stochastic modelling takes its input data in the form of identified spill scenarios, location-specific statistical wind speed and wind direction frequency data (supplied by the Meteorological Office). A probability range of sea surface oiling representative of the prevailing conditions is then calculated. Single trajectory modelling, as required by the MCA, investigates the shortest beaching time for a set of worst case meteorological conditions.

The full modelling output for the release of diesel is included in Appendix B, however a summary of the results is provided below.

Overall conclusions of the modelling

Stochastic modelling output for instantaneous release of 2,212 tonnes of diesel

The stochastic modelling predicts that the diesel will be transported predominantly to the north-north-west, north, north-north-east, north-east, east, south–east, and south-south-west of the Rose location. Under this scenario, the model indicates that no beaching would occur.

The model also considered single trajectory scenarios towards both the UK and the Netherlands.

Instantaneous diesel release of 2,212m^3 from the Rose well location towards onshore UK

The UK scenario assumed a 30-knot wind from 100 degrees. Upon release the diesel evaporated and mixed into the water column, persisting for 9 hours. The diesel covered an approximate distance of 21.4km. Of the original release, the total volume evaporated was 784m^3 and the volume dispersed was 1,428m^3. No beaching occurred.

Instantaneous diesel release of 2,212m^3 from the Rose well location towards offshore Netherlands

The Netherlands scenario assumed a 30-knot wind from 270 degrees. Upon release the diesel evaporated and mixed into the water column, persisting for 9 hours. The diesel covered an approximate distance of 23.2km and did not cross the UK/Netherlands median line. Of the original release, the total volume evaporated was 781m^3 and the volume dispersed was 1,431m^3. No beaching occurred.

OSCAR modelling

In addition to the stochastic and single trajectory modelling, OSCAR [81] modelling was undertaken to determine the maximum uptake of hydrocarbons to sediment after an instantaneous diesel release of 3,550m^3 over the Rose wellhead. This modelling assumes a worst case of the instantaneous complete loss of diesel inventory of several vessels. In addition, the modelling is undertaken using worst case environmental conditions.

The modelling predicts that after 18 days under the offshore scenario, the maximum mass of diesel in the sediment would be 34% (1,207m^3). Under the onshore scenario, the maximum mass in the sediment after 3 days is 59% (2,102m^3), which declines to 51% (1,810m^3) after 30 days.

6.5.3 Impacts and receptors

As a consequence of the vessels management systems and operational controls that will be applied the likelihood of a major hydrocarbon release is considered to be very low. This assertion is supported by historical spill reporting data, two examples of which are:

- PON1 data from 2011 – 2014 showed that there were only four hydrocarbon releases over 1 tonne with the largest being 7.16 tonnes (it is acknowledged that larger spills may have occurred which are not reportable under PON1s).

- The summary of spills from the most recent vessel data published by ACOPS for 2012 reported 37 incidents of which the largest was 605.5 tonnes (from an unknown source) [82]. The report states that each incident was believed to have dispersed naturally without posing a threat to wildlife or the coastline.

As demonstrated by the modelling however, both surface and benthic ecosystems and species would be at risk of harm as a consequence of such a release. The severity of the impact would depend on the type and number of vulnerable species and habitats in the vicinity of the release and the trajectory of the diesel on, and within, the sea.

In general, the modelling indicates that the majority of the diesel will be present in the surface and near surface waters, ultimately either evaporating or becoming dispersed as a result of prevailing conditions. The species most likely to be impacted as a result of diesel in the surface and near surface waters are seabirds, and to a lesser extent, fish and marine mammals. Section 3 identified that the seabirds are most vulnerable during August, November and December, fish throughout the year and marine mammals predominantly from January to June and August and September. As described in Section 2, the main decommissioning activities are scheduled to be undertaken during between June and August.

Although there is some overlap between the possible timing of activities and periods of sensitivity, the modelling demonstrated that in all scenarios, the majority of the hydrocarbon release, whilst initially present at the surface and near surface, will rapidly disperse and/or evaporate, therefore this risk is relatively short term.

Given the very low likelihood of a large volume release of diesel, the timing of the activities and the short duration the diesel is predicted to persist (approx. 9 hours), the significance of the impact on surface and near-surface dwelling species has been assessed as **low**.

Protected sites

As described above the potential receptors to the release of hydrocarbon would include the benthic habitats and species. Section 3.2.5 described the protected sites within the vicinity of Rose field. The Inner Dowsing Race Bank and North Ridge cSAC, the Humber Estuary SAC and SPA as well as the Holderness Inshore, Lincs Belt, Wash Approach, Holderness Offshore and Silver Pit rMCZs are all recognised and either currently designated, or recommended for designation as a result of the benthic habitats (e.g. sandbanks, biogenic reefs etc.) and associated species present (Ross worms, brittle stars, sea squirts, etc.) which support a variety of fish and marine mammal species. Holderness Offshore and Silver Pit rMCZs are of particular note given that the existing pipeline and umbilical cross their boundaries (Figure 4.11) and the decommissioning activities will be undertaken in the immediate vicinity. Section 3.2.5 provides further description of the protected sites listed above.

The impact on benthic communities from elevated levels of hydrocarbons is not well defined. In response to oil exposure, benthic invertebrates can either move, tolerate the pollutant or die, depending on: the life cycle, feeding behaviour, as well as ability to metabolise toxins, especially PAH compounds. There is a lack of long-term studies that could reveal indirect or protracted impacts [83] & 84]. Recolonization rates are affected by the type of organism, time of year, availability of juvenile recruits, climatic conditions and many other influences. Some reviews indicate that recovery from oil spills occurs within three years [85 & 86] whereas others find that recovery requires up to ten years [84, 87 & [88]. In general, more dynamic environments recover more rapidly than sheltered environments. Under the modelled conditions, which due to a number of assumptions within the model (e.g. sediment type, currents etc. and volume of spill) offers an extreme worst case, the maximum mass of hydrocarbon partitioned to the sediment after 3 days is 59% (2,102m^3), which then declines to 51% (1,810 m^3) after 30 days. The exact area over which the volume partitions to the sediment is not available from the figures, however the modelling results demonstrate that a concentration exceeding 0.1kg/m^2 does not occur in either onshore or offshore wind scenarios. Generally concentrations are less than 0.01kg/m^2 in both scenarios; only in the immediate vicinity of the spill does the hydrocarbon concentration exceed this value.

Under the offshore wind scenario, the model output (Appendix B) shows the deposition is predominantly to the east. Deposition concentrations of less than 0.0001kg/m^2 are predicted to occur within a number of the adjacent protected sites. The benthic habitats to the east of the spill may experience concentrations up to 0.01kg/m^2. It should be noted that these are extremely low concentrations and are comparable to, and in some cases less than the existing background concentrations of hydrocarbons within the Rose field (Table 4-2).

Under the onshore wind scenario, the model output (Appendix B) shows the deposition is predominantly to the west. Deposition concentrations of less than 0.0001kg/m^2 will be experienced over the majority of the area, however Holderness Offshore and Silver Pit rMCZs may experience deposition concentrations up to 0.1kg/m^2.

It is, therefore, possible that the benthic communities within the Holderness Offshore and Silver Pit rMCZs could be impacted by a worst case diesel release, however the modelled concentration of the diesel in the sediment is relatively low.

A worst case has been modelled (large instantaneous release of total inventory) with a conservative assumption of using silt rather than sand. Additionally, the likelihood of a release is very low. Recovery rates are unknown, however as the area is not, in general, sheltered, the recovery rate is anticipated to be relatively quick. These considerations combined with the control and mitigation measures in place, the overall significance of the impact on benthic habitats and associated species is **low**.

6.5.4 Transboundary and cumulative impacts

The principal risk of hydrocarbon release from the Rose activities is from a diesel release, of which the impact to the environment has been assessed as low. In conjunction with the procedural response it is unlikely that releases would remain present in the environment for extended periods as they will evaporate and be dispersed by weather and currents. There is therefore, limited potential for cumulative or transboundary impacts.

6.5.5 Control and mitigation measures

Centrica has developed comprehensive management and operational controls to minimise the likelihood of large hydrocarbon releases and to mitigate their impacts should they occur. These include the Marine Assurance Standard and the Rose Area OPEP. In addition, all vessels undertaking decommissioning activities will have an approved Shipboard Oil Pollution Emergency Plan developed within the requirements of Regulation 37 of MARPOL Annex 1 [64].

These control measures are considered to be effective in reducing and minimising the risk of release during the decommissioning activities to ‘as low as reasonably practicable’.

6.5.6 Conclusion

The only source of a large release of hydrocarbon (diesel) associated with the Rose field decommissioning programme concerns the use of vessels.

Oil spill modelling using worst case volumes indicates that the diesel, whilst initially present at the surface and near surface, will rapidly disperse and/or evaporate. No beaching is indicated, nor is any international boundary shown to be transgressed. The modelling also indicates that the concentration of diesel partitioning into seabed sediments and the benthic habitat will be relatively low and comparable to the baseline concentrations recorded within the Rose field.

In summary, with the adoption of the mitigation and control measures identified above, the likelihood of a large hydrocarbon release during the decommissioning activities is considered to be very low. If a release did occur, a number of impacts have been identified. The overall significance of these impacts has however been assessed as **low**.

6.6 Waste

6.6.1 Regulatory requirements

The Revised Waste Framework Directive (WFD) (Directive 2008/98/EC) was adopted in December 2008 [89], with Member States being required to implement revisions by December 2010. The overriding aim is to ensure that waste management is carried out without endangering human health and without harming the environment. Article 4 also states that the waste hierarchy shall be applied as a priority order in waste prevention and management legislation and policy.

The Waste (England and Wales) (Amendment) Regulations 2012 [90] outlines the requirement for collection, transport, recovery and disposal of waste. It sets out the principles of the waste hierarchy which should be considered when treating and handling waste. In addition, the DECC Guidance Notes [3] under the Petroleum Act 1998 [2] require all decommissioning decisions to be made in line with the waste hierarchy.

Whether a material or substance is determined as a ‘waste’ is determined under EU law. The EU WFD (2006/12/EC) [89] defines waste as:

“any substance or object in the categories set out in Annex 1 of the Directive which the holder discards or intends or is required to discard”.

Materials disposed of onshore must comply with the relevant health and safety, pollution prevention, waste requirements and relevant sections of the Environmental Protection Act 1990 [16]. The waste management assessment should be based on the worst case scenario and follow the hierarchy shown in Figure 6.1, in line with relevant legislation, permits and consents.

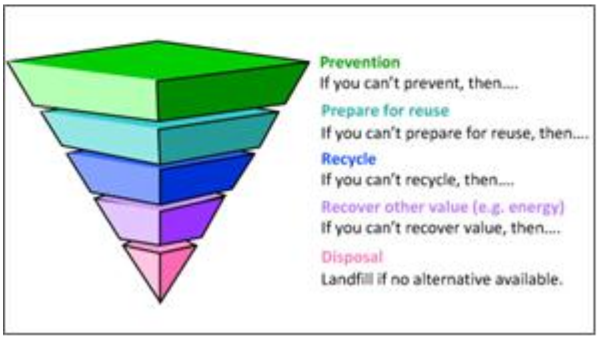


Figure 6.1: Waste hierarchy

Management of radioactive materials is governed under:

- Radioactive Substances Act 1993 [91];
- Transfrontier Shipment of Radioactive Waste [20]; and,
- Spent Fuel Regulations 2008 [20].

The handling and disposal of radioactive waste requires additional authorisation.

Onward transportation of waste or recycled materials must also be in compliance with applicable legislation, such as the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 [93], a highly prescriptive regulation governing the carriage of dangerous goods by road.

6.6.2 Potential for waste generation

The decommissioning will generate hazardous and non-hazardous waste that will need to be managed to ensure best use is made of the material.

Non-hazardous materials, which include metals (steel, aluminium), plastics and concrete will be kept separately from any potentially hazardous substances (mainly chemicals).

It is intended that recovered infrastructure will be returned to shore and transferred to a waste management facility, which will have all necessary approvals and licenses in place and possess the capability to reuse or recycle the majority of recovered material.

The minimisation of waste arising from the decommissioning will be of particular significance at the engineering stage, where opportunities for reuse will be considered initially prior to any other disposal route selection.

The inventory of Rose materials and the reuse, recycling and disposal aspirations of material recovered to shore are presented in Table 6-5 and Table 6-6 below and include mattresses and grout bags. For consistency these tables are as stated in the Decommissioning Programmes [24].

Table 6-5: Inventory disposition

Inventory (excludes rock)	Total Inventory Tonnage	Planned tonnage to shore	Planned tonnage to be decommissioned *in-situ*	Planned tonnage left *in-situ* for potential re-use or deferred decommissioning
Installations	62	62	0	0
Pipelines	1620	495	1123	2

Table 6-6: Re-use, recycling & disposal aspirations for material recovered to shore

Inventory	Re-use	Recycle	Disposal
Installations (62 tonnes)	Approx. 45%	Approx. 55%	<5%
Pipelines (495 tonnes)	<5%	Approx. 95%	<5%

The planned tonnage recovered and returned to shore includes, pipeline spool pieces, sections of pipeline, sections of umbilical, mattresses, grout bags, the WHPS, the Xmas tree and the wellhead. Figure 6.2 shows a pie chart of the material breakdown for the material recovered to shore associated with the pipeline and umbilical (including mattresses and grout bags). No breakdown of materials is provided for installations, since they are entirely comprised of steel.

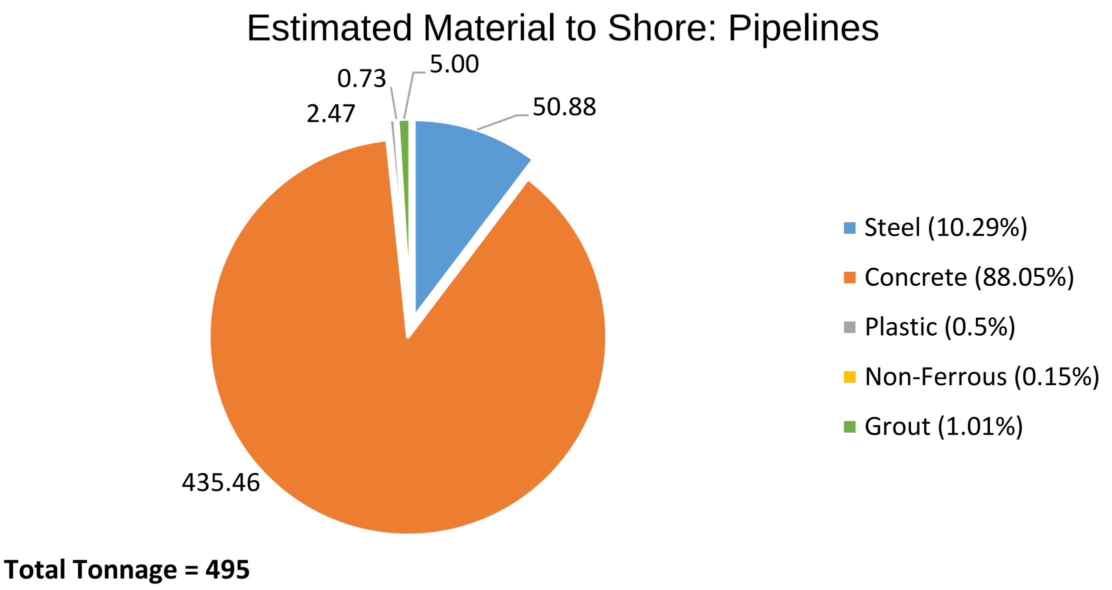


Figure 6.2: Estimated materials to shore: pipelines

Naturally Occurring Radioactive Material (NORM)

NORM is not expected to be present within the infrastructure recovered. Recovered items that will have been exposed to production fluids will however be tested for NORM. Should NORM be encountered appropriate management measures will be implemented.

An application has been made for an environmental permit to allow Centrica to accumulate and dispose of radioactive waste under regulation 13 of the Environmental Permitting (England and Wales) Regulations 2010. This will be in place prior to recovery of infrastructure potentially contaminated with NORM.

6.6.3 Control and mitigation measures

Segregating materials at source and maintaining the separation between hazardous and non-hazardous streams will reduce the amount of material requiring treatment back at shore.

If hazardous waste is produced it will be pre-treated to reduce hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling. Under the Landfill Directive [94], pre-treatment will be necessary for most hazardous wastes which are destined to be disposed of to landfill sites. Other non-hazardous wastes that cannot be reused or recycled will be disposed of to landfill.

Any NORM contaminated equipment must be handled, transported, stored, maintained or disposed of in a controlled manner. Protocols are required to ensure that equipment is not released or handled without controls to protect the worker and prevent contamination of the environment.

6.7 Socio-economic impacts

This section examines the various offshore and onshore sources (or types) of socio-economic impact (beneficial as well as detrimental) that will (or may) result from the decommissioning programme.

Following the adoption of appropriate control and mitigation measures, residual effects and impacts are assessed in terms of the sensitivity of known receptors.

6.7.1 Sources

The principal planned activities of the decommissioning programme, including their location and estimated duration, are described in Section 2. Of these, the use of specialist and support vessels, and the onshore processing of recovered materials have been identified as the activities warranting further assessment in terms of their potential socio-economic impact.

In addition, the in-situ decommissioning of subsea infrastructure will inherently and permanently present a small, residual risk of interaction with third party users of the seabed.

Specialist and support vessels and onshore processing of recovered materials

Denial of access and interference with navigation:

The physical presence of vessels engaged in decommissioning activities may temporarily deny commercial fishing vessels access to fishing grounds, or oblige shipping (whether utilising recognised shipping lanes or involved in servicing energy industry related activities etc.) to alter their course.

Contribution to the economy:

Vessels will require the use a range of port facilities and will also need to purchase a variety of local goods and services. The light processing (cleaning, cutting etc.) of recovered materials will be undertaken at a local shore base.

Partial removal of infrastructure:

The permanent physical presence of the majority of the pipeline and umbilical following its *in-situ* decommissioning could present a permanent snagging risk to fishing vessels deploying bottom-trawled gear should sufficiency of trench/burial cover fail to be maintained for any reason (there are no indications that this will occur and bottom-trawled gear is not used in the area).

6.7.2 Impacts and receptors

Specialist and support vessels and onshore processing of recovered materials

As explained in Section 2.3, a range of vessel types will be required at various times, and for various durations, to undertake particular component activities of the decommissioning programme. Vessel activity will primarily be concentrated at, and in the vicinity of, the Rose wellhead and the Amethyst A2D platform. Operations in these areas will largely be associated with infrastructure removal and recovery. There will also be vessel activity along the pipeline/umbilical corridor between the wellhead and the platform. Operations in this area will largely be associated with surveying/monitoring.

The impact (loss of opportunity) associated with any denial of access to, or navigation through, an area of sea is a function of the requirement of third parties to access or transit that area, and the time over which their free access or navigation will be denied.

Third party vessels are already prevented from entering the 500m exclusion zone that has been established around the Amethyst platform. An similar exclusion zone is not currently in place however around the Rose wellhead.

Removal and recovery operations at the Rose wellhead are estimated to take 10 days. During this time third party vessels will be denied access/navigation to an approximate $1km^2$ area of sea.

In combination, the various components of the decommissioning and post-decommissioning surveying/monitoring programme are estimated to take 9 days spread over a multi-year period. The area of sea, to which at any given time, access to third party vessels will be denied, is estimated to be 1km^2.

Given the localised, short-term or infrequent nature of the activities, the significance of the impact with regard to denial of access or free navigation has been assessed as **low**.

Specialist vessel management services (including shore base and waste management services) will be required to support the decommissioning programme. Such services may be sourced from ports and harbours local to the Rose field and in so doing will support offshore and onshore employment.

Given the relatively small scale and duration of decommissioning operations, the significance of this beneficial impact has been assessed as **low**.

In-situ decommissioning

The impact associated with sections of the pipelines/umbilical that have been decommissioned in-situ will be a function of the snagging risk associated with potentially impaired trench/burial status, and the requirement of third parties (predominantly commercial fishing vessels) to deploy equipment that may interact with this hazard.

A pipeline and umbilical ‘as-left’ trench/burial status survey and a seabed over-trawlability assessment will be undertaken upon conclusion of the decommissioning activities. Additional post-decommissioning trench/burial status monitoring will also be undertaken. Any requirement for trench/burial remediation (which is considered very unlikely) would be agreed with the DECC.

It is known that the commercial fishery in the Rose – Amethyst area predominantly employs pots and traps rather than bottom-trawled gear. Trawl scars were not observed in any of the pre-decommissioning seabed surveys.

Given the relatively low utilisation of the seabed by commercial fishing interests using static gear, and Centrica’s ongoing commitment to trench/burial status monitoring, the significance of the potential impact has been assessed as **low**.

The removal of the WHPS (and subsequent well abandonment), and spool pieces and their protection at Rose will completely remove the risk of snagging presented to third parties by this infrastructure and provide them full access to this area of seabed. The significance of this beneficial impact has been assessed as **low**.

6.7.3 Transboundary and cumulative impacts

The Rose field is located approximately 130km west-south-west of the UK Netherlands median line. Given this distance, and the short duration, relatively small scale and localised nature of the decommissioning activities, no substantive transboundary socio-economic impacts are anticipated.

Cumulative impacts from operations

The following socio-economic activities, if they occur at the same time, and in the same area as the decommissioning activities, could result in an ‘in-combination’ effect:

- Oil and gas production (including inspection, maintenance, supply);
- Oil and gas development (surveys, drilling, installation of infrastructure); and,
- Oil and gas decommissioning (installation or pipelines removal and recovery).
- Wind farm development and operation.

The oil and gas infrastructure in the vicinity of the Rose field is mature. There is no known planned installation of oil and gas infrastructure that would lead to construction activity taking place at the same time as the decommissioning of Rose.

The closest wind farm licence lies approximately 15km south of the Rose field. The Humber Gateway wind farm, which is under construction, lies some 30km to the west.

The impacts associated with Rose decommissioning activities have been assessed to be localised and therefore no substantive in-combination effects are anticipated with respect to the either the operation of Amethyst A2D (a NUI located approximately 9km distant from the Rose wellhead) or the other platforms of the Amethyst field, all of which are located even further away.

Cumulative legacy impacts

Should other pipelines (or sections of pipelines) in the area (Figure 1.1) be decommissioned *in-situ* there could be a cumulative legacy impact (Table 5-7). Note that in addition to the local infrastructure itemised, the Amethyst field is served by a trunk gas export pipeline.

Given the relatively small number of pipelines and installations in the area, the total area potentially affected (0.006km^2) is considered relatively small. The potential significance of the cumulative impact has therefore been assessed as **low**.

Table 6-7: Cumulative legacy seabed take

Pipeline description: To – From	Pipeline length (km)	Area (km^2)
Rose to Amethyst A2D platform	9x2 (pipeline and umbilical.)	0.0018
Hevellyn to Amethyst A2D platform	14x2 (pipeline and umbilical.)	0.0028
Amethyst B1D to A2D platform	11	0.0011
Amethyst A2D to A1D platform	4	0.0004
Total area impacted		**0.0061**

6.7.4 Control and mitigation measures

The following measures will be adopted to ensure that detrimental socio-economic impacts are minimised to 'as low as reasonably practicable':

- The timing and location of decommissioning activities, and the location of infrastructure that has been decommissioned in-situ, will be advertised via the Kingfisher bulletin and via Notices to Mariners.
- Decommissioning and post-decommissioning seabed assessments, surveys and monitoring.
- The vessels' work schedule will be optimised.

6.7.5 Conclusion

The principal source of socio-economic impact associated with the Rose field decommissioning programme concerns the use of vessels.

The physical presence of vessels engaged in decommissioning activities will deny commercial fishing access to the Rose wellhead and its vicinity, and to the Rose – Amethyst pipeline/umbilical corridor. The approximately one month vessels programme (comprising a total of approximately 100 individual vessel days that are spread over a multi-year period) is however of relatively short duration. Furthermore, the area to which access is denied on these days is very limited (estimated to be 1km^2).

The in-situ decommissioning of subsea infrastructure will present a very small but permanent potential for interaction with commercial fishing activities. This residual risk however will be mitigated by a commitment to ongoing trench/burial status monitoring.

In summary, due to the localised and short duration of decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the socio-economic impact from the decommissioning of the Rose field is considered to be **low.**

7. CONCLUSIONS

The decommissioning of the Rose field and facilities is to be carried out over the period 2015 - 2018.

A Comparative Assessment has been undertaken in order to identify the recommended decommissioning option. The EIA assessed the environmental impacts and risks associated with this selected option - the 'partial removal' of the pipeline and umbilical, leaving the majority of the pipeline and umbilical *in-situ,* and making safe the ends. The Rose WHPS and protection structures will also be removed, while the four buried concrete mattresses placed over the remaining section of umbilical will be left *in-situ*.

The impacts upon energy use and atmospheric emissions, underwater noise, seabed disturbance, discharges and releases to sea, waste and socio-economic impact have been assessed. The outcome of the EIA is presented in Section 5, and a summary of the key environmental sensitivities is presented in Section 3, Table 4-12.

The key conclusions from the EIA are summarised below:

Energy use and atmospheric emissions

The principal energy use and associated atmospheric emissions associated with the Rose field decommissioning programme concerns the use of vessels. The emissions from them will have components with the potential to contribute to global warming and acid rainfall, to deposit dry particulate, or to cause impacts on local air quality.

The total energy requirement of the decommissioning programme is estimated to be 62,251GJ of which the direct energy use (related to vessel use) is estimated to be 36,171GJ and the indirect energy use (attributable to materials replacement and recycling) is estimated to be 26,080GJ.

The direct atmospheric emissions generated by the decommissioning have the potential to impact both local and regional air quality. The prevailing offshore meteorological conditions in the Rose area are expected however to rapidly dilute and disperse airborne contaminants.

The direct and indirect CO_2 emissions generated by the decommissioning represent approximately 0.02% of the total CO_2 produced annually in the North Sea and ports. On this basis it is concluded that they do not make a substantive contribution to global warming potential.

Standard mitigation measures to optimise energy usage by vessels will include operational practices and power management systems for engines, generators and any other combustion plant and planned preventative maintenance systems for all equipment for peak operational efficiency.

In summary, due to the localised and relatively short duration of activities, and with the identified control and mitigation measures in place, the overall significance of the impact of energy use and associated atmospheric emissions arising from the decommissioning of the Rose field is considered to be **low.**

Underwater noise

The principal sources of underwater noise associated with the Rose field decommissioning programme are concerned with the use of vessels, and the use of water-jetting and cutting tools.

The approximately 1 month vessels programme (comprising a total of approximately 100 individual vessel days spread over a multi-year period) is of relatively short duration and represents only small increment to existing vessel traffic in the area. Water-jetting and cutting tools will only require to be used intermittently over this period and at point locations.

The level of noise that will be generated is not expected to cause physiological harm or substantive behavioural interference to either fish or mammals known to inhabit the area.

Standard measures that will be applied to control noise include planned maintenance of equipment and optimisation of the work programme to minimise vessel use.

In summary, due to the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall significance of the impact of underwater noise generated during decommissioning of the Rose field is considered to be **low.**

Seabed disturbance

The principal sources of seabed disturbance associated with the Rose field decommissioning programme concern the water-jetting of sediments and the lifting of materials from the seabed during recovery. These activities will result in the loss or removal of substrate and the smothering of substrate, as well increased turbidity in the water column.

Water-jetting and lifting operations will only be undertaken at the pipeline and umbilical ends.

Standard measures to control disturbance include operational planning and equipment selection.

The species and habitats observed in the vicinity of Rose are relatively widespread throughout the southern North Sea and the area anticipated to be impacted represents a very small percentage of the available habitat. Furthermore, all disturbed sediments are expected to recover rapidly though recruitment from adjacent undisturbed areas.

In summary, due to the localised and relatively short duration of the decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the impact of seabed disturbance as a result of the decommissioning of the Rose field is considered to be **low.**

Discharges and releases to sea

The principal sources of discharges and releases to sea associated with the Rose field decommissioning programme concern vessels and the breaking containment/lifting of sections of pipeline and umbilical.

The approximately one month vessels' programme (comprising a total of approximately 100 individual vessel days) is of relatively short duration. Operational discharges from vessels during this time are expected to be rapidly diluted and dispersed under prevailing hydrodynamic conditions.

With the exception of hydraulic fluid, residual traces of chemical and hydrocarbons only are expected to be discharged to the marine environment during recovery of the end sections of the pipeline and umbilical.

The hydraulic fluid which will be discharged has previously been permitted for use and discharge during production operations at this location. The volume will be small and being water soluble, the discharge is expected to undergo rapid dilution and dispersion under the prevailing hydrodynamic conditions.

Standard measures to manage vessel discharges include operating procedures and management systems, and planning to optimise vessel utilisation.

In summary, given the localised, and short duration or intermittent nature of the activities, and with the identified control and mitigation measures in place, the overall impact of discharges and releases to sea as a result of decommissioning the Rose field is considered to be **low**.

Large hydrocarbon releases to sea

The only source of a large release of hydrocarbon (diesel) associated with the Rose field decommissioning programme concerns the use of vessels.

Oil spill modelling using worst case release volumes indicates that the diesel, whilst initially present at the surface and near surface, will rapidly disperse and/or evaporate. No beaching is indicated, nor is any international boundary shown to be transgressed. The modelling also indicates that the concentration of diesel partitioning into seabed sediments and the benthic habitat will be relatively low and comparable to the baseline concentrations recorded within the vicinity of the Rose field.

In summary, with the adoption of the mitigation and control measures identified above, the likelihood of a large hydrocarbon release during the decommissioning activities is considered to be very low. If a release did occur, a number of impacts have been identified. The overall significance of these impacts has however been assessed as **low**.

Waste

All wastes returned to shore will be handled and disposed of in accordance with legislation and the waste hierarchy. Segregating materials at source, and maintaining separation between hazardous and non-hazardous waste streams during transport, will reduce the amount of material requiring treatment onshore. Landfill will only be used as a last resort.

Socio-economic impacts

The principal source of socio-economic impact associated with the Rose field decommissioning programme concerns the use of vessels.

The physical presence of vessels engaged in decommissioning activities will deny commercial fishing access to the Rose wellhead and its vicinity, and to the Rose – Amethyst pipeline/umbilical corridor. The approximately one month vessels' programme (comprising a total of approximately 100 individual vessel days that are spread over a multi-year period) is however of relatively short duration. Furthermore, the area to which access is denied on these days is very limited (estimated to be $1km^2$).

The in-situ decommissioning of subsea infrastructure will present a very small but permanent potential for interaction with commercial fishing activities. This residual risk however will be mitigated by a commitment to ongoing trench/burial status monitoring.

In summary, due to the localised and short duration of decommissioning activities, and with the identified control and mitigation measures in place, the overall significance of the socio-economic impact from the decommissioning of the Rose field is considered to be **low.**

Transboundary and cumulative impacts

Given the distance from the Rose field to the UK/Netherlands median line, the short-term and localised nature of all identified impacts, no substantive transboundary impacts are anticipated. Given the short-term and localised nature of all identified impacts, no substantive cumulative impacts are anticipated.

The initial environmental management workshop and the subsequent environmental impact assessment has concluded that all impacts and potential impacts identified have been reduced to ‘as low as reasonably practicable’ and assessed to be of as low significance.

The overall significance of the impact as a result of the decommissioning of the Rose field is considered to be **low**. Most impacts will be localised and short term. There is low potential for longer term impacts.

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9. APPENDIX A– ENVIRONMENTAL WORKSHOP OUTPUT

Rose Decommissioning Project - Define Phase - Environmental Management Worksheet
Subsea Infrastructure

Activity /Aspect				CE E&P Mitigations, Controls and Ranking									
				Existing controls - Industry Standard, Legislative or Prescriptive	Initial Ranking following controls and mitigation					Residual Ranking after controls and mitigation			
					Impact		Probability (Likelihood)	Rank		Impact		Probability (Likelihood)	Rank
Project Infrastructure	General Activity	Detailed Activity	Summary of Environmental Impact Description	1. Administrative or Procedural Controls 2. Engineering or Physical Controls	Consequence (Severity)	Duration/Frequency	Probability (Likelihood)	Initial Risk / Impact Ranking	Project Specific and CE E&P Best Practice	Consequence (Severity) Post Mitigation	Duration / Frequency Post Mitigation	Probability (Likelihood) Post Mitigation	Final Risk / Impact Ranking
Preparation	Hydrocarbon Management	Blowdown	**Gaseous emissions to atmosphere** Increased degradation of local/regional air quality (NO_x and particulates). Trans boundary air pollution. Contributing to global warming (CO_2)	1. Normal shutdown procedures e.g. permit to work, operating instructions. 2. Existing controls for A2D shutdown. Tanks for liquids.	0	1			Blowdown to A2D - normal operation for shutdown. Optimal to put gas to process rather than vent. Inventory expected to be small as production has stopped and pressure very low. Tank to capture liquids on A2D. Water may contain heavy metals and NORM. Anticipated to be few metres cubed of mixed hydrocarbon and water as per shutdown.	0	1		
			Liquid discharge to sea Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		2		2			2		2	
			Gaseous emissions to atmosphere Increased degradation of local/regional air quality (NOx and particulates). Trans boundary air pollution. Contributing to global warming (CO_2).		1		2			1		2	
		Breaking containment	**Gaseous emissions to atmosphere** Increased degradation of local/regional air quality (NOx and particulates). Trans boundary air pollution. Contributing to global warming (CO2).	1. Procedures for opening vessels as possible NORM (and heavy metal) contamination. 2. Tanks on A2D to contain material returned.	1		2		Assess to see where low points in the system which will provide an idea where residues could remain. Treat all process pipes as if contaminated with NORM and heavy metals.	1		2	
			Liquid discharge to sea Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		1		2			1		2	
			Liquid discharge to sea Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. NORM impacts?		1	2				1	2		
	Modify	Pipework	**Liquid discharge to sea** Excessive increase in suspended solids in water column and on seabed with potential to change the physical chemical characteristics of the seabed.	1. Changes to pipework and installation of temporary equipment may result in an increased potential for releases, particularly during flushing activities. Assess on an equipment by equipment basis. Procedures for installation of temporary equipment.	1		3			1		3	
	Displacement	Displacement of chemicals in umbilical with potable water	**Liquid discharge to sea** Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor.	1. Volume of umbilical cores limited to 'several' m3 only. 2. Operational permit (Permit to Work and TBT) for the discharge and valve operation.	1	1			The content of the umbilical will be displaced to the topsides and shipped to shore. Therefore only a small amount of methanol and CI may be discharged to sea when the flushing loops are installed. During this operation the valves in the topsides umbilical termination unit will be closed to contain the head therefore limiting discharge. This will be controlled through lock valve procedures. HF will be left in the umbilcal.	1	1		
			Liquid discharge to sea Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		1		3			1		3	

Activity /Aspect				Existing controls - Industry Standard, Legislative or Prescriptive	CE E&P Mitigations, Controls and Ranking: Initial Ranking following controls and mitigation – Impact		Probability (Likelihood)	Rank		Residual Ranking after controls and mitigation – Impact		Probability (Likelihood)	Rank
Project Infrastructure	General Activity	Detailed Activity	Summary of Environmental Impact Description	1. Administrative or Procedural Controls 2. Engineering or Physical Controls	Consequence (Severity)	Duration/Frequency	Probability (Likelihood)	Initial Risk / Impact Ranking	Project Specific and CE E&P Best Practice	Consequence (Severity) Post Mitigation	Duration / Frequency Post Mitigation	Probability (Likelihood) Post Mitigation	Final Risk / Impact Ranking
Preparation	Cleaning of pipeline	Water Flushing	**Liquid discharge to sea** Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor. NORM impacts?	1. All Chemical use and discharges will be permitted, Term OPPC and MAT/SATs. Standard operating procedures.	1	1			Cold vent to air at A2D when pig receiver installed. This can't go into the process system as it is at a higher pressure. The pipeline will be pigged towards the platform. There will be a requirement for some discharge to sea at pig laucher. Ensure that samples are taken and analysed NORM (all items returned to the vessel what could be contaminated).	1	1		
			Liquid discharge to sea Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		1		2			1		2	
			Gaseous emissions to atmosphere Increased degradation of local/regional air quality (NO_x and particulates). Trans boundary air pollution. Contributing to global warming (CO_2).		1	1				1	1		
			Solids deposit to sea Increased suspended solids in the water column and dilution and dispersion before settling on seabed.		1	1				1	1		
			Solids deposit to sea Excessive increase in suspended solids in water column and on seabed with potential to change the physical chemical characteristics of the seabed.		1		2			1		2	
		Chemical use	**Liquid discharge to sea** Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water ; planktonic organisms most vulnerable receptor.	Chemical use will be incompliance with the OCR.	1	1				1	1		
			Liquid discharge to sea Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		1		3			1		3	
			Solids deposit to sea Increased suspended solids in the water column and dilution and dispersion before settling on seabed.		1	1				1	1		
			Solids deposit to sea Excessive increase in suspended solids and/or pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		1		3			1		3	
Subsea Protection Structure	Cutting legs	Cutting	**Solids deposit to sea** Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	The removal of the infrastructure will all be proceduralised to minimise deposits to the sea.	1	1				1	1		

Activity /Aspect				CE E&P Mitigations, Controls and Ranking									
				Existing controls - Industry Standard, Legislative or Prescriptive	Initial Ranking following controls and mitigation: Impact		Initial Ranking: Probability (Likelihood)	Initial Ranking: Rank		Residual Ranking after controls and mitigation: Impact		Residual Ranking: Probability (Likelihood)	Residual Ranking: Rank
Project Infrastructure	General Activity	Detailed Activity	Summary of Environmental Impact Description	1. Administrative or Procedural Controls 2. Engineering or Physical Controls	Consequence (Severity)	Duration/Frequency	Probability (Likelihood)	Initial Risk / Impact Ranking	Project Specific and CE E&P Best Practice	Consequence (Severity) Post Mitigation	Duration / Frequency Post Mitigation	Probability (Likelihood) Post Mitigation	Final Risk / Impact Ranking
Subsea Infrastructure Removal	Cutting legs	Cutting	**Solids deposit to sea** Excessive increase in suspended solids in water column and on seabed with potential to change the physical chemical characteristics of the seabed.	The removal of the infrastructure will be proceduralised to minimise the deposits to the sea. Trials for cutting of the WHPS have been undertaken onshore to ensure the feasibility of the operations.	1		2			1		2	
			Noise in air Behavioural modifications to birds and marine mammals.		1	1				1	1		
	Removal	Lifting	**Solids deposit to sea** Navigation or socio-economic impact e.g. to fisheries. Potential to change the physical chemical or habitat characteristics of the seabed. Extensive seabed disturbance resulting in significant community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within the relevant EIA. Significant lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Extensive smothering of organisms following settlement of resuspended particles.	1. Covers the possibility of dropping sections of the subsea structure. Trials for dismantling of the WHPS have been undertaken onshore to ensure the feasibility of the operations.	1		3			1		3	
			Resource use - Physical Area Localised physical seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within the relevant EIA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.		1	1				1	1		
			Gaseous emission to atmosphere Increased degradation of local/regional air quality (NOx and particulates). Trans boundary air pollution. Contributing to global warming (CO_2);		3		3		Guard vessel over wellhead once the WHPS has been removed and before the rig arrives on site.	3		2	
	Marine Growth	Offshore waste disposal	**Solids deposit to sea** Increased suspended solids in the water column and dilution and dispersion before biodegradation.	1.Jetting marine growth off connection points underwater with HP water jets. Recover to vessel deck and wash down on deck. Tree will be cleaned with HP water jet for rig to have access. 2. Jetting procedures - part of lifting procedures or tree cleaning procedures.	1	1				1	1		
			Liquid discharge to sea Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in massive receiving body of water; planktonic organisms most vulnerable receptor.		1	1				1	1		
Subsea Infrastructure Removal	Umbilical	Jetting	**Solids deposit to sea** Increased suspended solids in the water column and dilution and dispersion before settling on the seabed.	1. Possibility for a requirement for localised jetting to clear sediment and rock away to access umbilical prior to reverse reel. The jetting will be proceduralised to minimise disturbance, and avoided if possible.	1	2				1	2		
			Solids deposit to sea Prolonged increase in suspended solids in water column and on seabed with potential to change the physical chemical characteristics of the seabed.		1		3			1		3	
	Umbilical Preparation	Lowering from J tube to seabed	**Solids deposit to sea**	1. Need to lower the umbilical from the J-tube. This may require the umbilical to be laid on the seabed, prior to recover. Procedure will be prepared that will minimise disturbance.	1	1				1	1		
					1		3			1		3	
			Liquid discharge to sea	1. The umbilical may contain relatively small quantities of residual chemical which may be released to sea when the umbilical is moved from the J-tube. 2. Flushing procedures	1		3			1		3	
			Resource Use - Physical Area	1. Need to lower the umbilical from the J-tube. This may require the umbilical to be laid on the seabed momentarily as pulled up and over mattresses that will still be in position. 2. Within 500 m and will be handed back. 3. Lifting procedures, stakeholder register.	1	1				1	1		

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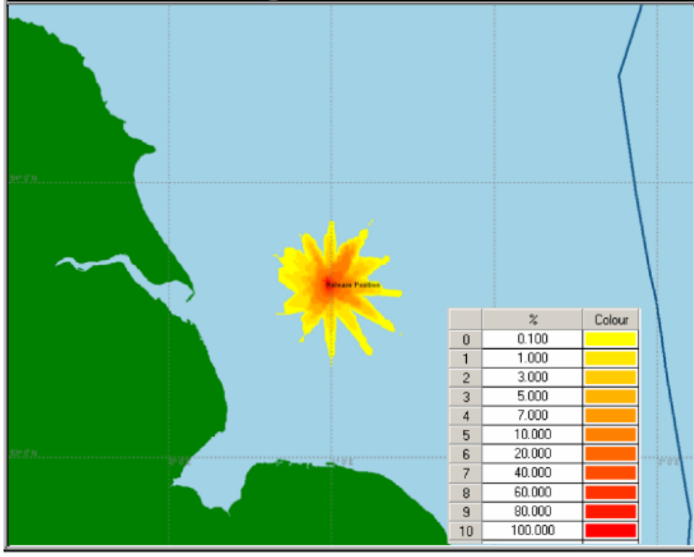
Activity /Aspect				CE E&P Mitigations, Controls and Ranking									
				Existing controls - Industry Standard, Legislative or Prescriptive	Initial Ranking following controls and mitigation					Residual Ranking after controls and mitigation			
					Impact		Probability (Likelihood)	Rank		Impact		Probability (Likelihood)	Rank
Project Infrastructure	General Activity	Detailed Activity	Summary of Environmental Impact Description	1. Administrative or Procedural Controls 2. Engineering or Physical Controls	Consequence (Severity)	Duration/Frequency	Probability (Likelihood)	Initial Risk / Impact Ranking	Project Specific and CE E&P Best Practice	Consequence (Severity) Post Mitigation	Duration / Frequency Post Mitigation	Probability (Likelihood) Post Mitigation	Final Risk / Impact Ranking
Subsea Infrastructure Removal	Umbilical removal of sections	Lifting	**Solids deposit to sea**	1. Disruption to the seabed (as some natural backfill of the trench will have occurred) the umbilical sections are lifted out of the trench, though the water column and onto the back of the vessel. (The section within 500 m and will be left in place as it is under the same mattresses as the flexible riser for which there is an opportunity for reuse. It will be removed at the same time as the flexible riser.) Unlikely potential unplanned deposits to sea include dropping the umbilical or snapping the umbilical. For both they will be recovered. 2. Procedures, analysis prior to work offshore. Work packs, HAZIDs and HIRAs etc.	1	2			Analysis to establish if jetting of the rock and burial is required.	1	2		
			Solids deposit to sea		1		2			1		2	
			Liquids discharge to sea	1. Discharge from the umbilical as it is being lifted from the seabed. Residues and chemicals left in the umbilical will have been permitted on the SAT/MAT. Possible leakage of hydraulic fluid.	1		2			1		2	
	Pipeline and umbilical sectioning	Cutting	**Solids deposit to sea** Excessive increase in suspended solids in water column and on seabed with potential to change the physical chemical characteristics of the seabed.		1		2			1		2	
			Noise in water Physiological harm, behavioural modifications to marine mammals, turtles and potentially fish. Population impacts due to cumulative impact or impacting a reproductively significant number of individuals or location.	1. Cutting locations and procedures indented to minimise the number and duration of cutting. 2. Cutting locations and procedures indented to minimise the number and duration of cutting.	1	1			Cutting tool selected on the technical capability, mechanical cutters, likely to be selected which also are likely to be quieter.	1	1		
			Noise in water Increased physiological harm, behavioural modifications to marine mammals, turtles and potentially fish. Population impacts due to cumulative impact or impacting a reproductively significant number of individuals or location.		1		2			1		2	
	Infrastructure (including, pipeline sections, mattresses and grout bags)	Lifting	**Liquid discharge to sea** Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments. ; planktonic organisms most vulnerable receptor. NORM impacts?	1. Any liquid/hydrocarbon left after flushing/cleaning. Retrieved with both ends open - water moving through. Pipeline sections will drain as they are lifted through the water column. 2. Chemical use and discharge will have been permitted during the flushing and cleaning process. OPPC permit for hydrocarbon residues. Pigging will have been undertaken.	1		3		OPPC permit - estimate volume from volume of pipe - planned activity. Likely residues will be assessed following flushing and cleaning. Controlled through lifting procedures. Any dropped objects will be recovered.	1		3	
			Solids deposit to sea Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	1. Suspension of sediment when lifting (no cuttings pile). 2. Controlled through lifting procedures.	1	1				1	1		
			Solids deposit to sea Excessive increase in suspended solids in water column and on seabed with potential to change the physical chemical characteristics of the seabed.	1. Suspended solids from dropped objects interaction with the seabed. 2. Controlled through lifting procedures. Dropped objects will be recovered.	1		2			1		2	
			Solids deposit to sea Navigation or socio-economic impact e.g. to fisheries. Potential to change the physical chemical or habitat characteristics of the seabed. Extensive seabed disturbance resulting in significant community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within the relevant EIA. Significant lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Extensive smothering of organisms following settlement of resuspended particles.	1. Dropping of the pipelines and spools 2. Controlled through lifting procedures. Dropped objects will be recovered.	1		2			1		2	

Activity /Aspect				CE E&P Mitigations, Controls and Ranking									
				Existing controls - Industry Standard, Legislative or Prescriptive	Initial Ranking following controls and mitigation					Residual Ranking after controls and mitigation			
					Impact		Probability (Likelihood)	Rank		Impact		Probability (Likelihood)	Rank
Project Infrastructure	General Activity	Detailed Activity	Summary of Environmental Impact Description	1. Administrative or Procedural Controls 2. Engineering or Physical Controls	Consequence (Severity)	Duration/Frequency	Probability (Likelihood)	Initial Risk / Impact Ranking	Project Specific and CE E&P Best Practice	Consequence (Severity) Post Mitigation	Duration / Frequency Post Mitigation	Probability (Likelihood) Post Mitigation	Final Risk / Impact Ranking
Subsea Infrastructure Removal	Infrastructure (including, pipeline sections, mattresses and grout bags)	Lifting	**Solids deposit to sea** Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	1. Suspension of sediment when lifting (no cuttings pile)	1	1				1	1		
			Solids deposit to sea Increased suspended solids in the water column and dilution and dispersion before settling on seabed.	1. Jetting of pipeline ends only as contingency. 2. Procedures and workpacks. A dredging tool suitable for the size of job will be used to ensure that only the area that requires to be dredged will be disturbed.	1	1			Jetting tool will be selected to be the correct size and type to undertake the work.	1	1		
			Solids deposit to sea Navigation or socio-economic impact e.g. to fisheries. Potential to change the physical chemical or habitat characteristics of the seabed. Extensive seabed disturbance resulting in significant community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within the relevant EIA. Significant lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Extensive smothering of organisms following settlement of resuspended particles.	1. Jetting (only as a contingency) of an area larger than required to lower the ends of the pipeline.	1		3			1		3	
General	Waste Production (All)	Onshore waste disposal	**Gaseous emissions to atmosphere** Degradation of local/regional air quality (NO_x and particulates). Trans boundary air pollution. Contributing to global warming (CO_2);	1. Dependent on disposal options selected e.g. treatment, incineration. Heavy metals and NORM. 2. Waste inventory - EU waste catalogue - will highlight hazardous materials (needed for transportation information etc.). Possible quarantine of NORM or heavy metal contaminated equipment on the vessel for segregation - minimise cross contamination.	1	2				1	2		
			Gaseous emissions to atmosphere Increased degradation of local/regional air quality (NOx and particulates). Trans boundary air pollution. Contributing to global warming (CO_2);	1. Dependent on disposal options selected e.g. treatment. Include knock on impacts of liquid discharge to sewer.	1		3			1		3	
			Liquid discharge to surface water Water quality in immediate vicinity of discharge will be reduced, but effects are usually minimised by rapid dilution in receiving body of water.	1. Cutting onshore. 1. Dependent on disposal options selected e.g. treatment - hazardous landfill might be needed.	1	2				1	2		
			Liquid discharge to surface water Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and sediments.	2. Waste Management Plan. Waste handling and transportation procedures. Offshore waste management	1		3			1		3	
			Noise in air Nuisance to commercial / residential neighbourhood.		1	1				1	1		
			Noise in air Nuisance to commercial / residential neighbourhood.		1		3			1		3	
			Solid deposit to land Use of landfill and landfill resource take.		1	2				1	2		
			Solid deposit to land Increased use of landfill and landfill resource take.		1		3			1		3	
	Power generation	Fuel Combustion	Degradation of local/regional air quality (NO_x and particulates). Trans boundary air pollution. Contributing to global warming (CO_2);	1. Temporary during preparation activities. Temporary equipment e.g. diesel generators for flushing and cleaning and well kill. Also required for onshore waste disposal, e.g. cutting prior to loading onto transportation.	1	2				1	2		
			Increased degradation of local/regional air quality (NO_x and particulates). Trans boundary air pollution. Contributing to global warming (CO_2).		1		3			1		3	
			Resource use - energy Impact on climate change and reduction of resources of hydrocarbons.	2. CE E&P Assurance of contractor equipment/maintenance procedures	1	2				1	2		
			Resource use - energy Excessive impact on climate change and reduction of resources of hydrocarbons.		1		3			1		3	

Activity /Aspect				CE E&P Mitigations, Controls and Ranking									
				Existing controls - Industry Standard, Legislative or Prescriptive	Initial Ranking following controls and mitigation					Residual Ranking after controls and mitigation			
					Impact		Probability (Likelihood)	Rank		Impact		Probability (Likelihood)	Rank
Project Infrastructure	General Activity	Detailed Activity	Summary of Environmental Impact Description	1. Administrative or Procedural Controls 2. Engineering or Physical Controls	Consequence (Severity)	Duration/Frequency	Probability (Likelihood)	Initial Risk / Impact Ranking	Project Specific and CE E&P Best Practice	Consequence (Severity) Post Mitigation	Duration / Frequency Post Mitigation	Probability (Likelihood) Post Mitigation	Final Risk / Impact Ranking
Legacy Issues	Result of all Activities	Seabed	**Resource use - Physical area** **Disturbance of the ecosystem within the recovery estimate in the EIA.** Localised seabed disturbance resulting in community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within the relevant EIA. Lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Smothering of organisms following settlement of resuspended particles.	1. Debris survey after removal. 2. After removal the over trawling will sweep seabed to check for snag hazards. 3.Coarse sediments and dynamic water currents also encouraging sediment movement.	1	2				1	2		
			Disturbance of the ecosystem exceeding the recovery estimate in the EIA. Extensive seabed disturbance resulting in significant community change. Recovery time and extent dependent on type of seabed and species present and location specific estimate within the relevant EIA. Significant lethal/sub-lethal effects on benthic and epibenthic fauna from physical abrasion; Extensive smothering of organisms following settlement of resuspended particles.		1		3			1		3	
		Socioeconomic Use	**Resource use - Physical Area** Complete removal and return of seabed to pre-development status for socioeconomic use e.g. fishing.	1. Removing the safety zone for e.g. fishing and wind farm use. Confirm depth of burial of pipeline.	1	2				1	2		
		Navigation	**Resource use - Physical Area** Other sea users are able to have complete use of the area for navigation and not confined by infrastructure.	1. Removing the safety zone. Depth of burial survey and pipeline conditions survey - will demonstrate if infrastructure buried or not. Post decommissioning surveys will review the status of the infrastructure burial. If surveys show rest of pipeline has remained buried then end of pipeline is likely to remain buried.	1	2				1	2		
			Resource use - Physical Area Other sea users are unable to have complete use of the area for navigation and continue to be confined by infrastructure longer and/or for a greater area than estimated.		1		3			1		3	
			Resource use - Physical Area Extensive seabed disturbance resulting in significant community change.		1		3			1		3	
			Resource use - Physical Area Obstacle for navigation longer than expected - or in a slightly different location.		1		3			1		3	
			Liquid discharge to the sea Pollution of the marine ecosystem. Organic enrichment and chemical contaminant effects in water column and seabed sediments.		1		3			1		3	

10. APPENDIX B – CENTRICA OPEP MODELLING 2011

Figure 4: Stochastic Model Results for 2212m³ Diesel Spill



The prevailing metocean data indicates that the diesel will be transported predominantly to the North North West, North, North North East, North East, East, South East and South South West of the Rose location.

The model indicates that no beaching occured.

The percentage probability of the diesel beaching is detailed in the corresponding key.

Figure 5: Single Trajectory 2212m³ Diesel Spill towards the UK Coastline

A 30-knot, 100⁰ wind. Upon release the diesel evaporated and mixed into the water column, persisting for 9 hours. The diesel covered an approximate distance of 21.4km.

Resultant volumes were as follows:

Evaporated Volume: 784.09m³
Dispersed Volume: 1427.91m³
Beached Volume: 0m³

Figure 6: Single Trajectory 2212m^3 Diesel Spill towards the Transboundary Line

A 30-knot, 270^0 wind. Upon release the diesel evaporated and mixed into the water column, persisting for 9 hours. The diesel covered an approximate distance of 23.2km and did not cross the UK / Norway transboundary line.

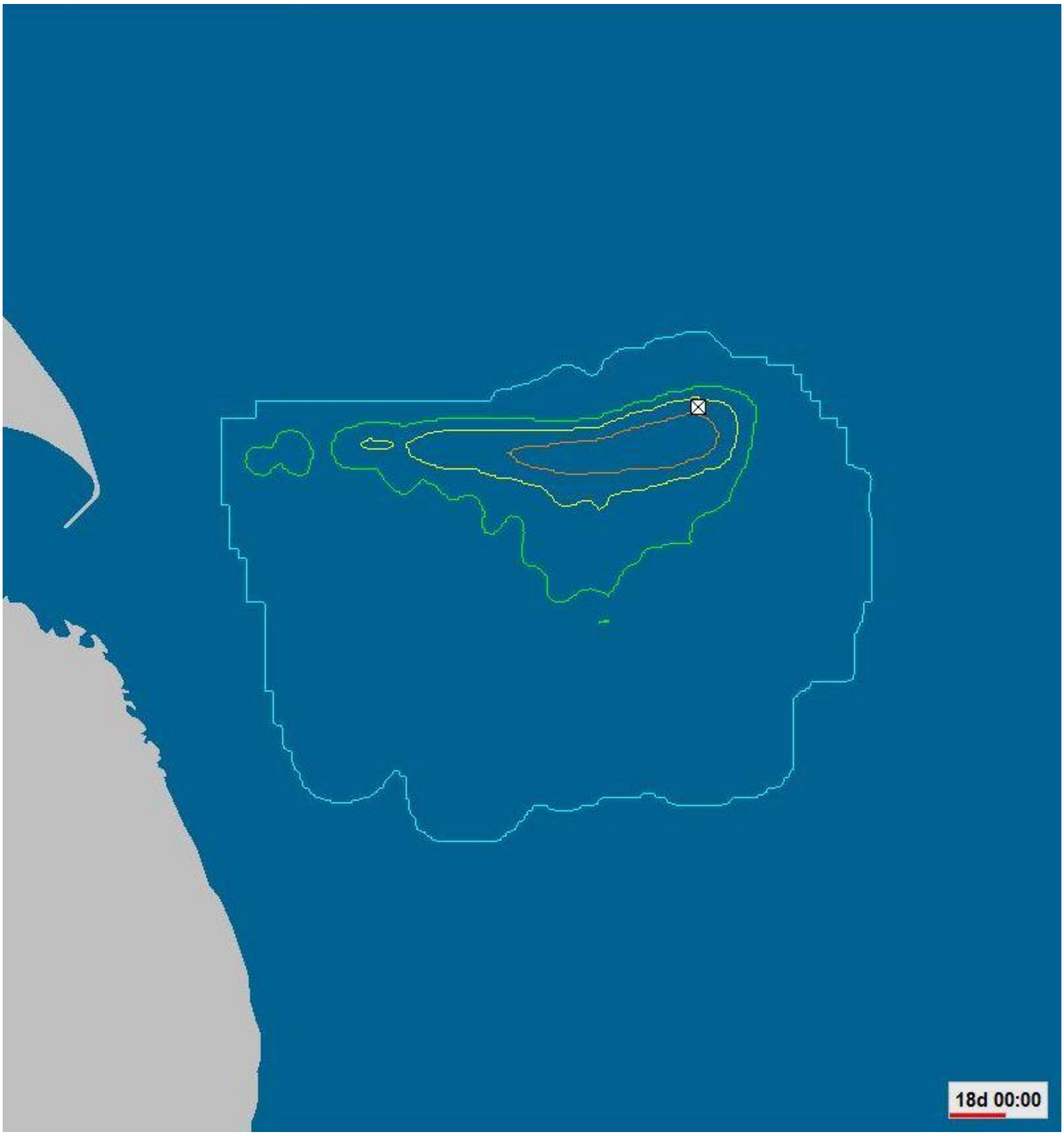
Resultant volumes were as follows:

Evaporated Volume: 781.11m^3
Dispersed Volume: 1430.89m^3
Beached Volume: 0m^3

Summary

- Identified potential spill sources associated with well abandonment activity within the Rose field could potentially result in worst case spills of 2212m^3 of diesel, 78.3m^3 of lube oil and 23.82m^3 of Hydraulic Oil.
- Worst case stochastic modelling of diesel indicated that no beaching occurred.
- Worst case single trajectory modelling for diesel illustrates that the high proportions of light ends in diesel will cause the oil to evaporate and disperse within approximately 9 hours covering a distance of 21.4km (towards UK) and 23.2km (towards Netherlands).
- The impact of an oil spill on ecological receptors is dependent on the presence of vulnerable species at the time of the spill and the concentration of hydrocarbons present on the sea water surface. However, diesel has a tendency to disperse and breakdown via evaporation, therefore the period of vulnerability is likely to be much shorter than for a spillage of crude oil. The potential for harm to vulnerable species is further minimised by the deployment of emergency response and mitigation/ control measures.

OSCAR Modelling Output - Onshore Wind Scenario



OSCAR Modelling Output - Offshore Wind Scenario