Perenco UK Limited & Tullow Oil SK Limited

Thames Area Decommissioning Environmental Impact Assessment



August 2014

Rev F01
DECC Reference: TBC

Produced by Orbis Energy Limited

PERENCO

TULLOW Oil plc

Document Control Page

Client:	Perenco UK Limited and Tullow Oil SK Limited

Report Title:	Thames Area Decommissioning Environmental Impact Assessment

Date:	August 2014

Document Ref:	PER-SNS-DECOM-THA-005

Prepared By:	Perenco UK Limited, Tullow Oil SK Limited & Orbis Energy Limited John Girling Orbis Energy Limited 71-75 Shelton Street Covent Garden London WC2H 9JQ E-mail: john@orbisltd.com www.orbisltd.com

Revision Record:

DATE	REV NO.	DESCRIPTION	PREPARED	CHECKED	CLIENT APPROVED
20/03/14	00	Draft for Client Review	JG	MC/DS	OB / YW / DS / IM
03/08/14	F01	For Issue	JG	MC/DS	OB / YW / DS / IM

Table of Contents

Standard Information Sheet

Project Name	Thames Area Decommissioning Environmental Impact Assessment
Perenco Reference Number	PER-SNS-DECOM-THA-005
DECC Reference No.	TBC
Type of Project	Decommissioning
Undertaker Name	Perenco UK Limited and Tullow Oil SK Limited
Undertaker Address	Anchor House 15-19 Britten Street London SW3 3TY
Licencees/Owners	

Company	Company Registration Number	Percentage
Thames		
Perenco UK Ltd	04653066	23.33
Tullow Oil SK Ltd	05287330	66.67
Centrica Resources Limited	02855151	10
GB Gas Holdings	03186121	0
Tullow Oil Plc	03919249	0
Arthur		
Perenco UK Ltd	04653066	70
EOG Resources UK Ltd	04458621	30
Gawain		
Perenco UK Ltd	04653066	50
Tullow Oil SK Ltd.	05287330	50
Tullow Oil PLC	03919249	0
Orwell		
Tullow Oil SK Ltd	05287330	100
Tullow Oil Plc	03919249	0

	Texaco North Sea U.K. Limited	00807340	0
	Wissey		
	Tullow Oil UK Ltd	90159	62.5
	Faroe Petroleum	4848017	18.75
	First Oil	1021486	18.75
	Tullow Oil Plc	03919249	0
	Horne & Wren		
	Tullow Oil SK Ltd	05287330	50
	Centrica (Horne & Wren) Ltd	04594558	50

Short Description	Perenco and Tullow are planning to decommission the infrastructure within the Thames development area, which spans across 13 blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4) in the southern North Sea. This EIA has been prepared to support the decommissioning programmes for the Thames area. The assets will be grouped into six separate decommissioning programmes to be submitted to DECC. The Thames platform is the receiving installation for production across ten fields operated by both Perenco and Tullow. In line with international requirements, decommissioning will involve the removal of the Thames platforms (AW, AR and AP) and the Horne & Wren NUI (Tullow operated) from the seabed and also the plugging and abandoning of 22 wells, along with the complete removal of associated wellheads, templates and wellhead protection structures from the seabed. Decommissioning of pipelines, flowlines and umbilicals are not covered by legislation. In accordance with UK guidance the potential options for decommissioning of the pipelines, MEG lines and umbilicals were assessed (during a Comparative Assessment) and it was determined that the most viable option would be to flush and clean the lines and leave them, *in situ*. The stabilisation materials (except concrete mattresses, i.e. rock, frond mats, formwork and grout bags) will be assessed for integrity and burial depth. However, it is anticipated that the majority of this type of material will be left in-situ. For the concrete mattresses, an attempt to remove the mattresses safely will be made and where this is not possible a proposal will be made to DECC. This ES document is submitted as part of the Environmental Impact Assessment to determine whether the proposed operations will have a significant impact on the marine environment for the proposed.
Commencement of Offshore Works	It is currently envisaged that decommissioning activities will begin to take place in Q3 2014 and last for approximately 60 months (although this is not concurrently).

Previously Submitted Environmental Documents	None
Significant Environmental Impacts Identified	None
Statement Prepared By	Perenco UK Limited and Tullow Oil SK Limited, in conjunction with Orbis Energy Limited

Abbreviations

°C	Degrees Celsius
µm	Micrometre
AIS	Automatic Identification System
API	American Petroleum Institute
Bscf	Billion Standard Cubic Feet
Bsm^3	Billion Standard Cubic Metres
BGC	Background Concentrations
BMS	Business Management System
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CA	Comparative Assessment
CoP	Cessation of Production
CPA	Closest Point of Approach
cSAC	Candidate Special Area of Conservation
dB	Decibels
dB re. 1µPa	Decibels Relative to 1 Micro-Pascal
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DSV	Dive Support Vessel
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
ES	Environmental Statement
ESD	Emergency Shut Down
EUNIS	European Nature Information Service
FLO	Fisheries Liaison Officer
GESAMP	Group of Experts on the Scientific Aspects of Marine Environmental Protection
GWP	Global Warming Potential
hp	Horse Power
HSE	Health, Safety and Environment
ICES	International Council for the Exploration of the Sea
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
kHz	Kilohertz
LAT	Lowest Astronomical Tide

LTOBM	Low Toxicity Oil Based Mud
m/s	Metres Per Second
MARPOL	International Convention for the Prevention of Pollution from Ships
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
mm	Millimetre
MMO	Marine Management Organisation
MMO	Marine Mammal Observers
MMscf	Million Standard Cubic Feet
MMscf/d	Million Standard Cubic Feet per day
MOD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MRCC	Maritime Rescue Co-ordination Centre
MSFD	Marine Strategy Framework Directive
NFFO	National Federation of Fishermen's Organisations
NTS	Non-Technical Summary
OCNS	Offshore Chemical Notification Scheme
OPOL	Offshore Pollution Liability Association Ltd
OSCAR	Oil Spill Contingency And Response Model
OSPAR	Oslo and Paris Conventions
OSPRAG	Oil Spill Prevention and Response Advisory Group
PAH	Poly-aromatic Hydrocarbon
PAM	Passive Acoustic Monitoring
Perenco	Perenco UK Limited
PFM	Petrofac Facilities Management
PLONOR	Pose Little or No Risk to the marine environment
PON	Petroleum Operations Notices
ppt	Parts Per Thousand
PTS	Permanent Threshold Shift
RA	Reference Area
rMCZ	Recommended Marine Conservation Zone
rRA	Recommended Reference Area
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SDU	Subsea Distribution Unit

SEL	Sound Exposure Level
SHLV	Super Heavy Lift Vessel
SMRU	Sea Mammal Research Unit
SPA	Special Protection Area
stb	Standard Barrel
SUTU	Subsea Umbilical Termination Unit
TA	Thermoacoustic
THC	Total Hydrocarbon
TOC	Total Organic Carbon
TOM	Total organic matter
TTS	Temporary Threshold Shift
Tullow	Tullow Oil SK Limited
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKDMAP	United Kingdom Digital Marine Atlas
WBM	Water Based Mud
WPS	Wellhead Protection Structure

Non-Technical Summary

Introduction

Note: This is a joint EIA Submission for both Perenco UK Limited (hereafter referred to as 'Perenco') and Tullow Oil SK Limited (hereafter referred to as 'Tullow'). However, for ease of reading the Operators are referred to as 'Perenco' throughout the EIA.

Perenco ceased production from the Thames installation (situated in UKCS Block 49/28 of the southern North Sea) in May 2014 and they are therefore preparing Decommissioning Programmes to be submitted to the Department of Energy and Climate Change (DECC) for approval under the Petroleum Act 1998, as amended by the Energy Act 2008.

In support of the Decommissioning Programmes, this Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) carried out for the Thames Area Decommissioning project, as required under the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011.

This section of the document forms the Non-Technical Summary (NTS) to the EIA and is written as a separate standalone section.

Project Overview

The Cessation of Production (CoP) date was 14th May 2014. All options have been explored for continuing production but it was concluded that due to reduction of gas production by excessive water loading, operations were uneconomical, so CoP was declared in preparation for decommissioning.

The proposed Thames decommissioning area is located across thirteen (13) United Kingdom Continental Shelf (UKCS) Blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4) in the Southern North Sea (SNS) (Figure 1).

The fields and associated infrastructure included and considered within this Decommissioning ES are:

- Thames Field (Perenco);
- Arthur Field (Perenco);
- Bure West Field (Perenco);
- Bure O Field (Perenco);
- Gawain Field (Perenco);
- Orwell Field (Tullow);
- Yare C Field (Perenco);
- Horne and Wren Field (Tullow);
- Thurne Field (Tullow); and
- Wissey Field (Tullow).

A summary of the facilities that will be commissioned at each of the fields within the Thames development area is shown in Table 1.

Table 1: Summary of the Thames Area Fields and Infrastructure to be Decommissioned

	Infrastructure							
Decommissioning Field	**Platforms**	**Wells**	**Wellheads**	**WPS**	**Manifold / Template**	**Pipelines**	**Umbilicals**	**MEG Lines**
Thames	3	9	4	4	-	5	3	1
Gawain	-	3	3	1	1	1	1	-
Arthur	-	3	3	4	1	4	4	-
Horne & Wren	1	2	-	-	-	1	-	1
Orwell	-	3	3	1	1	1	1	1
Wissey	-	1	1	1	-	-	1	-
Thurne	-	1	1	-	-	-	-	-

The Bacton to Thames pipeline (PL370) connects to the UK coast at the Bacton Gas Terminal and is the main export pipeline for all of the assets. The Thames platform, which is composed of three bridge-linked steel platforms (named AP, AR and AW), is located approximately 80 kilometres north east of the nearest UK landfall, near to the town of Winterton-on-Sea and 37.5 kilometres to the west southwest of the UK/Netherlands transboundary line. The Thames platform is also the receiving station for the Horne and Wren platform which is operated by Tullow. This platform will also be decommissioned as part of the programme.

The Horne & Wren Platform is located approximately 64.5 kilometres from the nearest UK landfall, near the town of Winterton-on-Sea and approximately 38 kilometres to the UK/Netherlands transboundary line. The Orwell subsea wells represent the furthest point of the infrastructure to be decommissioned from UK landfall, at approximately 102 kilometres to the north east of Winterton-on-Sea. The Orwell subsea wells also represent the closest point to the UK/Netherlands transboundary line at approximately four kilometres to the west. The infrastructure (excluding pipelines) closest to UK landfall are the Arthur subsea wells approximately 41 kilometres from the town of Winterton-on-Sea.

Under the terms of OSPAR Decision 98/3, there is a prohibition on the dumping and leaving, wholly or partly in place, of offshore installations. The topsides of all installations must be returned to shore. All steel installations with a jacket weight less than 10,000 tonnes, as is the case for the Thames and Horne & Wren Platforms, must also be completely removed for reuse, recycling or final disposal on land. The platforms will be decommissioned by the use of a super heavy lift vessel.

Wellhead protection structures have been placed over the majority of the wells within the Thames area. Wellhead protection structures, manifolds, which are an arrangement of pipes or valves which are designed to control and distribute fluid or gas flow and other well processes, and wellheads themselves are also required to be removed from the seabed under this legislation. They will therefore also be completely removed from the seabed during decommissioning and transported to shore for re-use, recycling or disposal.

In total, 22 wells will be made safe by plugging and abandoning them to make sure they are completely isolated (Table 1). Of these, there are fifteen subsea wells and seven platform wells. Subsea wells (and the Horne & Wren Platform wells) will require the use of a Jack-up drilling rig to decommission the wells, whereas the Thames Platform wells can be decommissioned from their respective platforms.

The majority of the pipelines, flowlines and umbilicals are no longer in use and have already been flushed and cleaned. The provisions of OSPAR Decision 98/3 do not cover pipelines, flowlines and umbilicals and their respective stabilisation materials (concrete mattresses, grout bags, formwork and rock). A survey of the statues of the pipelines, flowlines and umbilicals was undertaken which found that the majority remained completely buried. Some exhibited a small percentage of exposure (up to nine per cent of the total length on one pipeline), however these were not considered to be significant.

A comparative assessment was undertaken for the possible decommissioning options for the pipelines, flowlines and umbilicals. The workshop assessed all of the decommissioning options based on their potential safety, environmental, technical, societal and commercial impacts. The comparative assessment concluded that the following decommissioning option was considered to be the most appropriate for the pipelines, MEG lines and umbilicals:

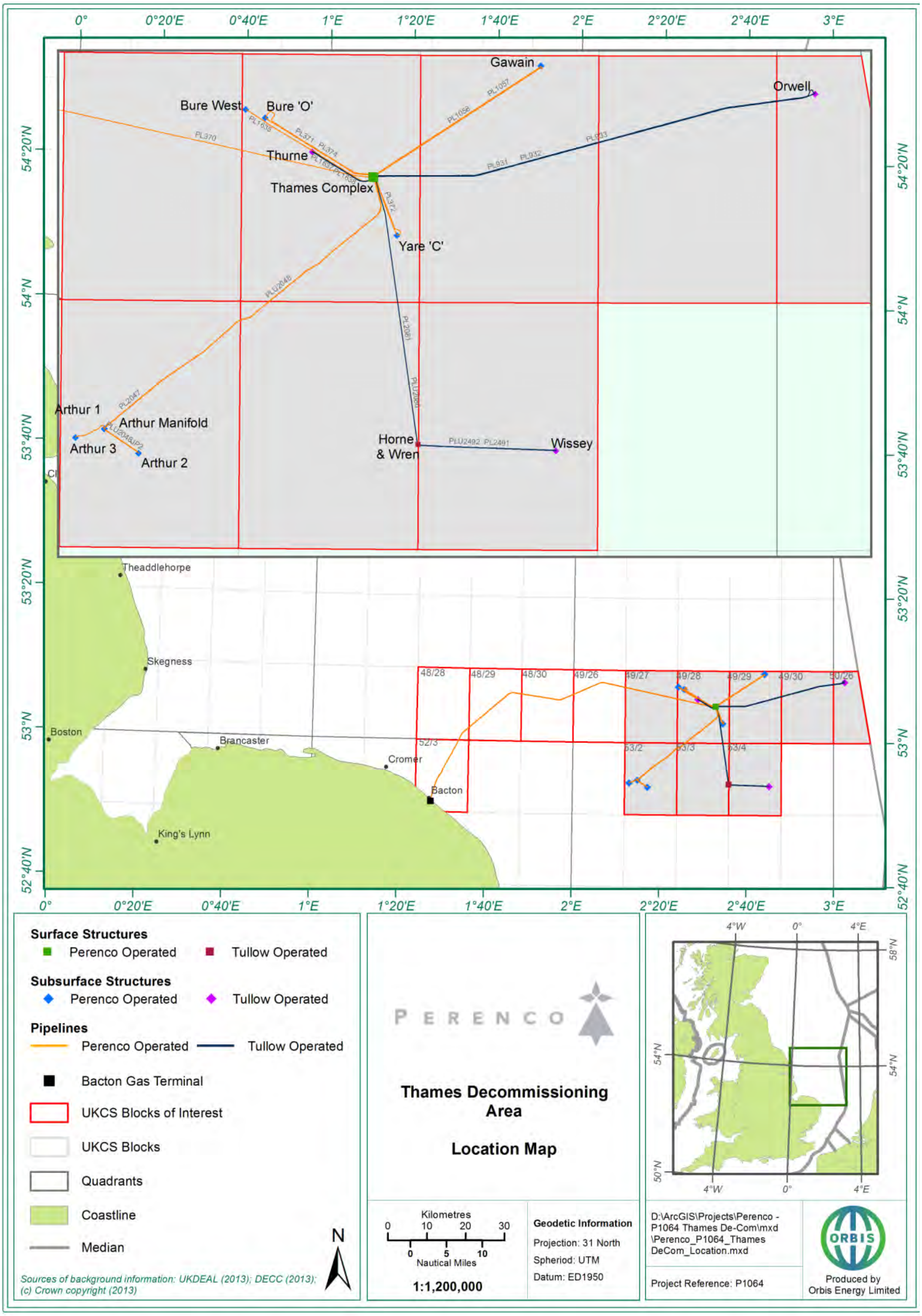
- All pipelines and umbilicals (including MEG lines, flowlines and jumpers) will be left *in situ* and subject to continuous monitoring.

The stabilisation materials, except concrete mattresses (i.e. rock, frond mats, formwork and grout bags), that are situated around the wells and pipelines, will be assessed for integrity and burial depth. The status of materials will be further assessed and remedial action considered. However, it is anticipated that the majority of this type of material will be left in-situ.

For the concrete mattresses, an attempt to remove the mattresses safely will be made and where this is not possible a proposal will be made to DECC. However, for the purposes of a 'worst-case' (in terms of seabed disturbance and atmospheric emissions) environmental impact assessment, this ES has assessed the impact of removing all of the concrete mattresses.

During the Thames area site survey, there was no evidence of drill cuttings in the immediate vicinity of any of the wells or infrastructure. This is consistent with the high energy environment of the southern North Sea.

Figure 1: The Location of the Thames Area Infrastructure to be Decommissioned



Project Schedule

It is currently envisaged that decommissioning activities will begin to take place in Q3 2014 and last for approximately 60 months (although this is not concurrently).

The Existing Environment

The Thames decommissioning area is located in the southern North Sea and spans 13 blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4). In order to assess the potential impacts from the proposed decommissioning operations, the environmental description is based on these blocks, as well as the wider southern North Sea and the coastline adjacent to the Thames area. Perenco commissioned site survey at the Thames area which was undertaken in May and July 2013. This included a pipeline survey to determine the depth of burial and state of the pipelines on the seabed. In addition, the environmental scope of the survey included an examination of the seabed for features or species of conservation importance including habitats listed under Annex I of the EC Habitats Directive such as shallow sandbanks and reefs which are both known to occur in the southern North Sea.

In addition, seabed samples were taken to analyse the physical (sediment grain size) and chemical characteristics to determine whether there has been a change or chemical contamination of the seabed as a result of historic production and drilling activity and also to determine whether there have been any deviations from baseline conditions.

Seabed images were taken to reinforce the results of the surveying using geophysical equipment (side scan sonar). A total of 36 grab samples were also taken to determine the faunal (animal) communities in the seabed sediments. These were taken offshore along the pipeline routes and also along the export pipeline to shore.

The Physical Environment

The Thames platform is located approximately 70 kilometres north east of the nearest landfall of Winterton-on-Sea on the eastern coast of England. The Horne and Wren platform is located approximately 65 kilometres from the nearest UK landfall. The Orwell subsea wells represent the most easterly (furthest from land) infrastructure which is to be decommissioned and are located over 100 kilometres from the nearest landfall at Winterton-on-Sea (refer to Figure 1).

Water depths across the southern North Sea are generally shallow compared to the majority of the central and northern North Sea. Water depths at the Thames area are approximately 32 metres (*Osiris Projects, 2013*).

Seabed sediments across the Thames area are predominantly coarse sands with some gravelly patches found in some areas surveyed and a low proportion of mud (*Osiris Projects, 2013*).

Sandbanks are a known feature in the southern North Sea. The site survey found large sand waves across the area which indicates high seabed currents and therefore highly mobile sediments which can from these large sand waves and sand banks (*CMACS, 2013*).

Marine sediments can contain hydrocarbons from natural and human (anthropogenic) sources such as oil and gas activity, from vessels and run off from roads and land. In general background hydrocarbons are higher in finer sediments compared to coarser sediments found in the southern North Sea. Surveys of offshore platforms have historically found are elevated in the immediate vicinity of the platform, but these level rapidly fall to background levels within a short distance from the platform (*DTI, 2001c*). Polycyclic aromatic hydrocarbons (PAHs) are a component of petroleum and its products and are widespread contaminants (*DECC, 2009*). Elevated levels of PAHs can signify contamination from oil and gas exploitation offshore. The results of chemical testing of the sediment samples found that PAH and total petroleum concentrations in the samples were below laboratory detection limits and therefore did not provide evidence of contamination (*CMACS, 2013*). The organic carbon concentration in the sediments, which can also be an indirect indicator of contamination, was also found to be low (*CMACS, 2013*).

Heavy metals are naturally present in seawater and sediments but some, in elevated concentrations, can have negative environmental impacts. Elevated levels of some metals (such as barium which, although is inert, is a large component of man-made drilling fluids and is often used as an indicator of drilling activity) are often found around drilling platforms tend to be higher than ambient North Sea levels. Of the sediment samples taken, only arsenic exceeded threshold levels (*CMACS, 2013*). Barium was detected at all stations but within threshold values and no hotspots of barium which indicate drilling contamination were identified (*CMACS, 2013*).

The Biological Environment

Seabed Communities

Biotopes are areas of uniform environmental conditions which provide a characteristic habitat for certain species to live in. Biotopes provide a way of defining biological communities that may be expected to occur in an area based on other physical or biological characteristics. Biotope mapping in the North Sea was undertaken in 2010 (*JNCC, 2010a*). Given the area that the Thames decommissioning project covers, several different biotope classifications were identified, particularly when comparing those along the export pipeline nearshore to those further offshore. Broad biotope classifications indicated that communities were typical of sublittoral sands and muddy sands and infralittoral coarse sediments.

Sections of the export pipeline cross the Haisborough, Hammond and Winterton candidate Special Area of Conservation (cSAC), and the North Norfolk Sandbanks and Saturn Reef cSAC. Common species at the North Norfolk Sandbanks include hermit crabs, velvet swimming crabs, shore carb and common starfish (*JNCC, 2008a*). At the Haisborough, Hammond and Winterton site the top of the sandbanks are dominated by amphipod shrimps and polychaete worms which are adapted to wave-swept mobile sands (*JNCC, 2010a*). Aggregations of the tube-building Ross worm are known to occur in the southern North Sea and at both of these sites. The dense aggregations form discrete patches of complex three-dimensional reef microhabitat which differs from that of the surrounding area.

The sandy sediments around the Thames area are dominated by echinoids (urchins) and ophiuroids (brittlestars), the arthropods (shrimp-like fauna) *Bathyporeia elegans* and *Pseudocuma longicornis* and also the annelid worm *Scoloplos armiger* (*UK Benthos, 2012*). Mobile fauna are more common in coarser sediments, and infaunal burrowing organisms such as bivalves and worms, tend to dominate in finer sediments with an increased organic content.

The fauna found at the Thames site survey was consistent with other studies undertaken in the area. Diversity was generally low and comparison between the different survey stations indicated that they were similar. Polychaete worms were the most abundant organisms found in the grab samples along with amphipod crustaceans. Razor clams and bivalves typical of coarse sandy sediments were also found (*CMACS, 2013*). Individuals of the Ross worm, which indicated the presence of potential biogenic reefs, were found in grab samples along the inshore portion of the export pipeline approximately 10 kilometres from the shore (*CMACS, 2013*).

Fish

Several fish species use the shallow waters of the southern North Sea as spawning and nursery grounds. The Thames area is a potential spawning area for cod, herring, lemon sole, mackerel, plaice, sandeels, sole, sprat, whiting and the langoustine (also referred to as *Nephrops*). The Thames area is also a potential nursery ground for cod, herring, horse mackerel, lemon sole, mackerel, *Nephrops*, plaice, sandeels, sole, sprat, thornback ray, tope shark and whiting (*Coull et al., 1998; Ellis et al., 2012*).

Herring are a commercially important fish species therefore there is protection afforded to grounds which are identified as herring spawning grounds to prevent habitat degradation. During the environmental scope of the site survey, an assessment of the suitability of the sediments for herring spawning was undertaken and no herring spawning grounds were identified (*CMACS, 2013*).

Other fish of conservation importance include those which migrate between the open sea and rivers and estuaries during specific life stages such as sea lamprey, allis shad and twaite shad (*DTI, 2002*). However, such species generally occur in shallow waters closer to the coast so whilst they may occur in the nearshore areas of the export pipeline, it is unlikely they will be present around the Thames area offshore.

Shellfish

There are a number of shellfish species that are commercially important to the southern North Sea, these include the langoustine or Norway lobster (*Nephrops norvegicus*), the European lobster (*Homarus gammarus*), the brown (or edible) crab (*Cancer pagurus*), the spider crab (*Maja squinado*), scallops (*Pecten maximus*) and queen scallops (*Aequipecten opercularis*).

Elasmobranch Species

Elasmobranchs are a group of fish which encompasses sharks, skates and rays. Based on a survey conducted by CEFAS, 11 species of elasmobranch may be present within the general vicinity of the Thames decommissioning area; blond ray, common smooth-hound, cuckoo ray, lesser spotted dogfish, spotted ray, spurdog, starry skate, starry smooth-hound, thornback ray, tope shark and undulate ray (*Ellis et al., 2004*).

Basking sharks are also known to frequent the offshore waters of the North Sea and Western English Channel between April and September, therefore this species may also occur, albeit infrequently (*DTI, 2002*).

Seabirds

In this area of the southern North Sea, fulmar are present in highest numbers during the early and late breeding seasons, leading to peak densities in September. Kittiwakes are widely distributed throughout the year. Lesser black-backed gull are mainly summer visitors, while in contrast guillemot numbers are greatest during winter months. In addition, substantial numbers of terns migrate northwards through the offshore North Sea in April and May, with return passage from July to September (*DECC, 2009*). The Thames area is located in an area of low importance for international concentrations of birds (*DTI, 2001*).

There are a number of important sites for breeding and wintering birds on the North Norfolk coast. The closes of these to Thames infrastructure is the North Norfolk Coast Special Protection Area (SPA) located 25 kilometres west of the nearshore Thames export pipeline.

An area assessment of seabird vulnerability to oil pollution in each UKCS block was undertaken by JNCC (1999) which ranks vulnerability on a four point scale, four being very high. Seabird vulnerability within the blocks of Interest is generally moderate to low (1/2 out of 4 on the JNCC scale) but is highest (2 out of 4) during February, March and December (*JNCC, 1999*).

Marine Mammals

According to Reid *et al.* (*2003*), three species of cetaceans have previously been sighted in the vicinity of the Thames development area; the harbour porpoise, minke whale and the white-beaked dolphin (*Reid et al., 2003*). he harbour porpoise is the most common cetacean in UK waters (*DECC, 2009*) and is sighted in low numbers (0.01-1 individuals per hour of effort) from December to May and August to September and moderate numbers (1-10 individuals per hour of effort). Minke whales were only observed in the Thames area during June in low numbers and white-beaked dolphins have been observed in low densities in March and May and moderate numbers in April (*Reid et al., 2003*).

Two species of seals; grey seal and the harbour (or common) seal are found around the east English coast and inshore waters. Satellite tagging studies suggest that grey seals may undertaking foraging trips to the offshore waters surrounding the Thames area and therefore may be encountered. However, at-sea usage is generally greater closer to the coast and populations of grey seals in the southern North Sea are small compared to colonies around the Scottish Isles. Populations of the harbour seal are more discrete than grey seals. There is a large population of harbour seals in The Wash which may undertake foraging trips offshore in the vicinity of the Thames decommissioning area (*SCOS, 2012*).

Protected Areas and Habitats

The offshore Thames decommissioning area overlaps with the Haisborough, Hammond and Winterton and North Norfolk Sandbanks and Saturn Reef cSAC. The Haisborough, Hammond and Winterton cSAC is designated due to the presence of shallow sandbanks which are partly covered by water most of the time. This habitat is listed under Annex I of the EC Habitats Directive whereby sites containing such features should be candidates for protection. The site also contains examples of Annex I listed biogenic reef produced by the tube-building polychaete Ross worm (*Sabellaria spinulosa*) at three identified sites within the cSAC; Haisborough Tail, Haisborough Ga and between Winterton Ridge and Hewett Ridge (*JNCC, 2010b*).

The North Norfolk Sandbanks and Saturn Reef cSAC is also designated due to the presence of Annex I shallow sandbank habitats, which form a series of ten main sandbanks and associated smaller banks, and also *Sabellaria spinulosa* biogenic reef. The North Norfolk Sandbanks is the most extensive example of offshore linear ridge sandbank type in UK waters (*Graham et al., 2001*). The Saturn Reef comprises thousands of tubes formed by the tube building Ross worm (*Sabellaria spinulosa*) which forms a microhabitat attracting a more diverse assemblage of species compared to the surrounding area.

The Cromer Shoal Chalk Beds recommended Marine Conservation Zone (rMCZ) is a nearshore site located on the north east coast of Norfolk and extends offshore. It is recommended for designation due to the presence of notable habitats (sublittoral and circalittoral rock which host a diverse fauna including sponges and soft and hard corals), subtidal chalk beds and the geologically important North Norfolk coast (*Wildlife Trusts, 2014*).

There are several other protected sites located nearshore which are within 40 kilometres of the landward portion of the export pipeline to shore. There are several sites with national and international designations due to the presence of large populations of seabirds and coast birds (wildfowl and waders) such as Special Protection Areas, Important Bird Areas and Ramsar Wetlands of International Importance. There are also several Sites of Special Scientific Interest along the North Norfolk coast near the export pipeline landfall. These are often designated to protect species (marine, aquatic and terrestrial), habitats and geological features.

As part of the environmental scope of the site survey, the presence or absence of Annex I habitats within the Thames area was also assessed. Shallow sandbanks listed under Annex I of the EC Habitats Directive may be present along some of the pipeline routes at Arthur, Gawain and Orwell (*CMACS, 2013*). Discrete populations of Annex I listed *Sabellaria spinulosa* biogenic reefs were also found, predominantly along the Thames export pipeline to shore. An assessment of the status and quality of the patches of reef identified found that the majority were of low 'reefiness' with moderate 'reefiness' observed along the export pipeline route (*CMACS, 2013*).

The Socio-Economic Environment

Commercial fisheries landings and effort are split into sectors called ICES Rectangles. The Thames decommissioning area lies within ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3. Most of these sectors have a low fishing effort (<100 days fished per year) except for 35F1 which is closest to the coast (*Marine Scotland, 2013*). Rectangle 35F1 also had the highest catches by weight whereas the other sectors further offshore typically caught less than 25 tonnes per month. The most frequently caught species include plaice, whelks, crabs (velvet swimming crab and edible crab), cod, sole and the Norway lobster (*Nephrops*) (*Marine Scotland, 2013*).

Shipping in the waters surrounding the Thames decommissioning area is relatively high. Of the 13 blocks that the area encompasses, ten are described as having 'high' or 'very high' shipping activity, two are described as having 'moderate' shipping activity and no data is available for Block 52/3 (*DECC, 2014*). Blocks which are classified this way require a vessel collision risk assessment to be undertaken to determine what measures should be undertaken to reduce the collision risk if necessary.

Oil and gas activity surrounding the Thames decommissioning area is generally high (*UK DEAL 2014*). The subsea infrastructure that will be decommissioned is crossed by a number of pipelines owned by other operators and is also crossed twice by the NORSEA COMS telecommunications cable. Three other telecommunications pass within 20 kilometres of the Thames infrastructure, two of these are no longer in use.

The blocks of Interest do not lie within any military exercise areas (*DECC, 2009*). In addition, there are no offshore licensed dredging areas within the vicinity of the Thames decommissioning area.

The Arthur 2 wellhead and manifold, Horne & Wren platform and the Wissey and Orwell wellheads lie within the East Anglia Round 3 Wind Farm Zone Search Area which is in the concept/early planning phase (*Crown Estates, 2013; 4COffshore, 2013*).

There are no charted wrecks within the blocks of Interest however during the site survey, one of the camera still locations was directly above a wreck situated in Block 52/03 approximately 13 metres from the Thames export pipeline (*CMACS, 2013*).

Summary of Seasonal Environmental Sensitivities

A summary of the key seasonal environmental sensitivities in the vicinity of the Thames decommissioning area is show in Table 2 below.

Table 2: Key Seasonal Sensitivities within the Thames Decommissioning Area

Activity in the Blocks of Interest, surrounding waters and adjacent coastline													
Component	**Abundance/Activity**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Plankton	Phytoplankton and zooplankton												
Benthic Fauna	Benthic faunal communities												
Fish	Cod			N	N	N	N						
	Herring										N	N	N
	Horse Mackerel					N	N	N	N	N	N		
	Lemon Sole						N	N	N	N	N	N	
	Mackerel							N	N	N	N		
	Nephrops	N	N	N	N	N	N	N	N	N	N	N	N
	Plaice												
	Sandeels	N	N	N	N								
	Sole					N	N	N					
	Sprat							N	N	N	N		
	Thornback Ray				N	N	N	N	N	N	N	N	
	Tope Shark	N	N	N	N	N	N	N	N	N	N	N	N
	Whiting				N	N	N	N	N				
Seabirds	Block 48/28 Offshore Vulnerability	4	3	4	4	4	4	4	3	4	1	2	2
	Block 48/29 Offshore Vulnerability	4	3	4	4	4	4	4	3	4	2	2	2
	Block 48/30 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	2	2	2
	Block 49/26 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	3	4	2
	Block 49/27 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	3	4	2
	Block 49/28 Offshore Vulnerability	4	3	2	4	3	4	4	3	4	3	4	2
	Block 49/29 Offshore Vulnerability	4	3	2	4	3	4	4	3	4	4	4	2

Activity in the Blocks of Interest, surrounding waters and adjacent coastline													
Component	**Abundance/Activity**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
	Block 49/30 Offshore Vulnerability	4	2	2	4	3	4	4	3	4	4	4	2
	Block 50/26 Offshore Vulnerability	4	2	2	4	3	4	4	4	4	4	4	3
	Block 52/03 Offshore Vulnerability	4	3	4	4	4	4	4	2	3	1	2	2
	Block 53/02 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	3	4	2
	Block 53/03 Offshore Vulnerability	3	2	2	4	3	4	4	3	4	3	4	2
	Block 53/04 Offshore Vulnerability	3	2	2	4	3	4	4	3	4	4	4	2
Cetaceans	Harbour porpoise												
	Minke whale												
	White-beaked Dolphin												
Resource Users	Commercial fishing (ICES rectangle 34F1)												
	Commercial fishing (ICES rectangle 34F2)												
	Commercial fishing (ICES rectangle 35F1)												
	Commercial fishing (ICES rectangle 35F2)												
	Commercial fishing (ICES rectangle 35F3)												
	Shipping and ports												
	Military Activity												
	Oil and gas activity (including pipelines / cables)												
	Dredging and dumping												
	Offshore wind farms												
	Marine protected areas												
	Coastal protected sites												
	Tourism, recreation & leisure activities												

Key:

	High /Peak		Medium		Low		Very low		No Activity

Impact Assessment

Decommissioning project activities with the potential to cause environmental impacts were identified from discussions with the Perenco / Tullow project team, an informal scoping exercise with key stakeholders and from the EIA team's previous oil and gas EIA project experience.

Impacts associated with the Thames Area Decommissioning project have been grouped under the following headings:

- Physical Presence;
- Seabed Impacts;
- Noise;
- Atmospheric Emissions;
- Marine Discharges;
- Unplanned Releases;
- Solid Wastes;
- Transboundary Impacts;
- Cumulative Impacts.

Any relevant social-economic issues have been assessed within these sections.

Those environmental aspects given a significance ranking of minor or negligible before the application of mitigation measures are considered insignificant and have therefore been scoped out from further assessment in the EIA (all of the environmental aspects are provided in Appendix B of the full Thames Area Decommissioning EIA).

Those environmental aspects which are considered to be significant (or positive) are assessed further within Sections 5 – 13 of the EIA and suitable mitigation measures are determined to demonstrate that the residual impact is as low as reasonably practicable (ALARP). A summary of these impacts and associated mitigation measures are shown in Table 3.

Table 3: Thames Area Decommissioning Potential Significant Environmental Impacts

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
Physical Presence				
Drilling Rig	General Shipping Commercial Fishing Vessels Pleasure Craft	For the duration of the decommissioning programme (anticipated to be a maximum of 480 days) the drilling rig and associated decommissioning vessels will be on location with a 500 metre exclusion zone around the drilling rig (equalling a total area of 0.8 square kilometres). This will represent a potential for a navigation hazard and emergency situation due to increased risk of collision.	• A 500 metre exclusion zone will be maintained around the drilling rig for the duration of the decommissioning activities; • The main operators of ships passing in proximity to the site should be provided with advanced notice of the decommissioning operations. This will allow vessels to revise their passage to take account of the drilling rig at the sites, should they consider it necessary; • Reporting of the rig move should take place in line with the requirements of the Coast Protection Act and HSE Operations Notice 6 guidance. This includes informing the MoD Hydrographer and Maritime and Coastguard Agency (MCA). This will ensure details of the drilling rig location are distributed via Notices to Mariners, Navtex and NAVAREA warnings, as well as to the appropriate Maritime Rescue Co-ordination Centre (MRCC); • The crew of the Emergency Response and Rescue Vessel (ERRV) attending the rig should be experienced in traffic monitoring duties and should be briefed on the main routes of concern in the area;	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
			• A collision risk management plan should be developed for the decommissioning operations to record the pre-planning measures taken to minimise the risk of ship collision, and to define the guarding role of the ERRV whilst on location.	
Super Heavy Lift Vessel (SHLV)	General Shipping Commercial Fishing Vessels Pleasure Craft	There will be a restriction to all vessels (shipping, fishing and pleasure craft), limited to a radial area of 500 metres around the SHLV (equalling a total area of 0.8 square kilometres). This exclusion zone will be maintained for the duration that the SHLV is on location next to the platforms (anticipated to be a maximum of 112 days for all locations).	• The SHLV will remaining within the existing exclusion zones of the Thames and Horne & Wren platforms.	**Minor**
Other Decommissioning Vessels	General Shipping Commercial Fishing Vessels Pleasure Craft	In addition to the SHLV and drilling rig, there will also be different types of vessels required for decommissioning activities at the Thames Area. These include a DSV, support vessels, supply vessels for the drilling rig and SHLV, a heavy lift barge and tug. Whilst these vessels are smaller and therefore do not have a statutory exclusion zone placed around them while working, they will provide an additional obstacle to other sea users (shipping, fishing and leisure craft), particularly the DSV during diving operations. Although there will be overlap of timings between vessels, each of the vessels is not expected to be on location for a significant period of time (the longest duration being 480 days for the supply and standby vessels).	• Consultations with the Fisheries and Maritime Agencies will be undertaken; • An FLO will be in place and will be responsible for the distribution of all key information to fishermen; • A shipping hazard assessment (or addendum to the existing one) will be undertaken.	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
Removal of Thames and Horne & Wren Platforms	General Shipping Commercial Fishing Vessels Pleasure Craft	Once the removal of the Thames and Horne & Wren platforms is complete, the existing exclusion zones around each platform will be removed. This will free up an area of approximately 1.6 square kilometres to other sea user and is expected to have a minor positive impact to fishermen who regularly already fish in the area.	• None	**Positive**
Seabed Disturbance				
The Removal of Subsea Infrastructure	Seabed Sediments Benthic Flora and Fauna	Removal of these structures by high energy methods may disturb sediments and lead to an increase in sedimentation, potential destabilisation of the surrounding sediments (if the explosives are placed below the seabed) and a localised increase in turbidity. This can have an impact on water quality, plankton, fish and benthic suspension feeders.	• Subsea infrastructure removal methods will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed; • Post-decommissioning a debris survey will be undertaken to remove any objects remaining on the seabed.	**Minor**
The Removal of Concrete Mattresses	Seabed Sediments Benthic Flora and Fauna	The removal of these mattresses may disturb sediments and lead to an increase in sedimentation, potential destabilisation of the surrounding sediments and a localised increase in turbidity. This can have an impact on water quality, plankton, fish and benthic suspension feeders. It is expected that the removal of all of the concrete mattresses (estimated at 426 mattresses) will cause seabed disturbance, due to the potential size of the area of disturbance. The maximum area of disturbance is expected to be in excess of 15,336 square metres (this is based on a single mattress	• Concrete mattress removal methods will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed; • Post-decommissioning a debris survey will be undertaken to remove any concrete mattresses remaining on the seabed.	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
		having an area of 18 square metres and doubling the area for working room during removal).		
Disturbance of existing Wellbore Muds / Cuttings	Seabed Sediments Benthic Flora and Fauna	No evidence of historical drill cuttings piles were identified during the most recent site survey (CMACS, 2013). Drill cuttings piles that were generated during previous drilling activity at the Thames area are considered to have been widely distributed in the local area over time, due to the high currents associated with this area of the North Sea.	• None	**Negligible**
The Deployment of Drilling Rig Spud Cans	Seabed Sediments Benthic Flora and Fauna	Prior to drilling activities starting, the drilling rig legs need to be jacked down onto the seabed with the hull raised on the legs above the water, providing a stable platform. Excessive penetration by the legs into a soft seabed is prevented by large round feet called spud cans, at the bottom of the legs. Spud-cans typically have a diameter of 18 metres and therefore three spud-cans will disturb an area of seabed of approximately 775 square metres to a depth of 0.5 metres, directly below the rig. Once the rig has moved off station, it is expected that the indentations of the spud cans will naturally fill in with sediment.	• Perenco will actively seek to position the drilling rig in as few separate locations as is possible during decommissioning. This will reduce the number of instances that jack-up spud cans will be deployed on the seabed.	**Minor**
Drilling Rig Stabilisation (Rock Dumping)	Seabed Sediments Benthic Flora and Fauna	Once the drilling rig is on location, there may be a requirement for the jack-up legs and spud cans to be stabilised by the placement of rock to maintain the integrity of the legs in place and prevent scouring. This may be required at each of the field hubs (depending on the nature of the seabed in those areas). If rock dumping is required, it is estimated that a maximum of 1,000 tonnes of rock would be needed per leg / spud can (totalling 3,000 tonnes of	• Perenco will actively seek to minimise the amount of rock required for rig stabilisation.	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
		rock) at each of the proposed well decommissioning locations. It is estimated by Perenco that there could be a maximum of 12 (twelve) separate well decommissioning locations where the rig would need to be sited. Although unlikely, if rock dumping was required at every location that the rig was sited at, this would equate to a maximum of 36,000 tonnes of rock required.		
Remedial Actions to Address Pipeline Exposures	Seabed Sediments Benthic Flora and Fauna	Some areas of the lines may require additional remediation in the future. This can be achieved by one of three methods, using rock dumping material in order to prevent further scouring around free spans, reburial using jetting or removal of the exposure sections. All three methods will impact the seabed to varying degrees. However, it is considered highly unlikely that any free spans will develop in flooded pipelines. The total length of pipelines, flowlines and umbilicals that are exposed within the Thames decommissioning area equates to approximately 10 kilometres in length, all of which may require stabilisation material, reburial or removal. At the time of writing this EIA, the exact method of remediation for any exposed parts of the pipelines is not known. If rock dumping is chosen as the remedial method, the amount of stabilisation / protection materials that may be required to be deployed over the pipeline is unknown.	• Perenco will actively seek to minimise the amount of rock required for pipeline stabilisation.	**Minor**
Noise				
Surface and subsea noise generated by	Marine Mammals	An average source noise level of 127 dB was used to represent noise generated from a Jack-up drilling rig	• In order to minimise any potential impact on marine cetaceans from the proposed Thames	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
decommissioning operations		(which will be on location for an estimated 480 days). It is predicted that these noise levels will reach background noise levels (97 dB re. 1µPa) within 30 metres of the source. The SHLV will maintain its position by using thrusters when carrying out operations (known as Dynamically Positioned (DP) vessels). Typically these vessels tend to generate more noise and of a higher frequency than a vessel's main engines (up to 170 dB). The SHLV will be used to remove the Thames and the Horne & Wren platform, jackets, topsides, the WPS and other subsea structures across the Thames area. It is anticipated that the SHLV will be on location for 112 days and may require the use of DP thrusters throughout. Noise levels of 190 dB re 1µPa have been used as an estimate of the expected noise levels from a SHLV. Noise levels from the SHLV will be attenuated to approximately 150 dB re. 1µPa at 100 metres, but will not reach background levels within two kilometres. The noise generated may cause marine mammals to exhibit behavioural impacts in response to the elevated noise levels. To sever the piles of the Thames and Horne & Wren platforms from their jackets and remove the WPS and templates from the seabed, cutting techniques will be employed. Piles will be cut to three metres below the seabed. Explosives are often included as a contingency in the event that other mechanical severance methods are unsuccessful. Noise levels associated with the detonation of explosives have been estimated at 258 dB re. 1µPa at	Area Decommissioning operations (excluding the use of explosives), Perenco will seek to conform to the JNCC protocol for minimising the risk of disturbance and injury to marine mammals from underwater noise throughout operations; • Vessel movements and the use of DP thrusters will be minimised where possible to reduce the potential impacts on marine mammals; • Vessel movements will be minimised; • Perenco will also adhere to the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives at all times and where appropriate; • Strive to avoid undertaking explosive activity during periods of known peak cetacean abundance; • Use of trained Marine Mammal Observers (MMOs) to identify if there are any vulnerable cetaceans in the vicinity of the explosive source. It is recommended that a one kilometre radius mitigation zone be set up around the explosion source. If marine mammals are sighted within this area, operations should be ceased / halted until they have left the area at a safe distance;	

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
		1 metre based on previous decommissioning activities undertaken by Perenco at the Welland field. The noise levels will attenuate to 218 dB re. 1μPa within 100 metres of the source and 204 dB re. 1μPa within 500 metres from the source. Noise levels remain above 190 dB re. 1μPa within 2.3 kilometres of the noise source.	• Use of Passive Acoustic Monitoring (PAM), in conjunction with MMOs, to determine the presence of cetaceans in high sea states, poor visibility, during low light conditions and to identify those which may not surface regularly enough to be sighted; • Use the minimum amount of explosive required to achieve the task based on sound planning and engineering; • Implement a 'soft start' procedure whereby small amounts of explosives are used to scare fish and marine mammals from the vicinity.	
Atmospheric Emissions				
Decommissioning Emissions from Operations Decommissioning Emissions and Energy Balance from Processing of Materials Exhaust gas emissions from drilling rig, SHLV and stand-by / supply vessels	Air	Emissions to atmosphere may contribute to global warming (CH_4, CO_2) and acid effects (SOx, NOx). Potential for localised smog formation (VOC, NOx).	• Advanced planning to ensure efficient operations; • Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels; • Speed of vessels will be managed to minimise fuel consumption; • Generators will be running on the minimum power for the job task to avoid unnecessary emissions;	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
			• Well maintained and operated power generation equipment; and • Regular monitoring of fuel consumption; • Licensed waste processing contractors will be chosen for the recycling of decommissioning materials.	
Discharges to Sea				
Well Abandonment and Cementing Activities	Seabed Sediments Water Flora and Fauna	It is not expected that large volumes of chemicals would be discharged when plug and abandoning the wells. For the purposes of this EIA assessment, it is assumed that all cementing chemicals will be discharged at a volume approximately equivalent to 10 percent of their use. The exception to this is for those chemicals used as spacers / dyes, where the only way to prepare the space is to pit-mix them.	• Prior to well abandonment activities, Perenco will undertake a chemical risk assessment as part of the chemical permit applications for each well; • The mixing of cement offshore as needed; • Any chemicals identified to be high risk will be substituted for more environmentally friendly alternatives where practicable; • Perenco will actively seek to minimise the amount of cementing chemicals required.	**Minor**
Pipeline Chemicals and Residual Hydrocarbons	Water Flora and Fauna	On cutting the pipelines, there will be a release of chemicals and hydrocarbons to the environment, with a maximum estimated total volume being 94.2 cubic metres.	• Perenco will actively seek to aim for an oil in water concentration from pipeline flushing of less than 30 milligrams per litre.	**Minor**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
Drainage Water, Food Waste, Sewage and Grey Water	Water	Discharge of food waste and sewage to sea will cause transient organic enrichment of the water column and an increase in biological oxygen demand (BOD). This could lead to a minor increase in plankton and fish populations. Short term degradation of water quality. Potential for localised significant toxic effects. Mortality of individuals. May affect viability of plankton stocks, recruitment for fish stocks and base of food chain. Release of drainage water or deck water from the rig may have minor localised toxicity impacts on the local fauna in the water column.	• Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels; • Each vessel (including the drilling rig) will have a Garbage Management Plan in place; • All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons; • As part of the HSE Plan, Perenco will ensure that the drilling contractor knows how to react to spills, that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.	**Minor**
Unplanned Releases				
Unplanned Hydrocarbon Release Release of rig fuel capacity (diesel) Uncontrolled well flow releasing gas and associated condensate	Water Seabirds Protected Areas	Oiling of a birds plumage destroys its integrity as insulation and may cause the animal to die of hypothermia or by drowning. Oil can also affect water quality in the vicinity of the release. Diesel and condensate spills are more likely to affect the environment within the vicinity of the drilling rig and / or vessels. The maximum dispersion time for any of the diesel spills is 39 hours, with a 5 percent probability of beaching and a 65 percent probability of crossing the UK / Netherlands transboundary line. The worst case condensate spill (5 kilometres from the MLWM) released over a period of 4 days will	• Establishment of 500m exclusion zone around the drilling rig and presence of stand-by vessel. • A collision risk management plan will be in place for the development. • Co-ordination of all support vessel movements. • Notices to Mariners, NAVTEX and NAVAREA warnings.	**Moderate**

Environmental Aspect	Environmental Receptor(s)	Description of Potential Impacts	Proposed Mitigation Measures	Residual Impact
		beach after 3 hours, with a 55 percent probability. There is a small (13 percent) probability that the condensate spill could cross the median line, when released from the Thames platform location.	• Oil Pollution Emergency Plan will be in place, alongside other Emergency Response documents. • Perenco will also ensure that operations staff are fully aware of their responsibilities under the OPEP, are trained in the appropriate response techniques and are involved in at least one response exercise at the beginning of the programme to ensure that the OPEP can be implemented effectively.	
Solid Wastes				
Operational Waste Management Decommissioning Materials	Air	Typically, up to 8 tonnes of waste per month is generated from a drilling / decommissioning programme. The Thames Area Decommissioning activities will result in the generation of decommissioning materials that will need to be brought to shore for appropriative disposal and processing.	• Perenco will ensure that an effective waste management plan is put in place prior to decommissioning activities commencing; • Perenco will ensure all waste contractors are audited and meet relevant legislation; • Perenco will actively seek to reduce the amount of recovered materials that are sent to landfill.	**Minor**

Transboundary Impacts

Unplanned Hydrocarbon Releases

The Orwell subsea wells are the closest of the Thames Area Decommissioning infrastructure to a transboundary line. The wells are located approximately 4 kilometres to the west of the UK / Netherlands transboundary line.

Given the distance from the transboundary line to some of the Thames Area Decommissioning infrastructure (Orwell in particular) it is likely that should a spill occur the UK/Netherlands transboundary line would be crossed and foreign waters impacted. However, as the hydrocarbons involved are diesel and condensate, in the event of a spill neither would persist on the surface of the sea for a significant time. Even a complete fuel inventory loss from the SHLV (releasing 18,700 cubic metres), the diesel would only persist for a maximum of approximately 4 days (scenario 3). Therefore, the residual impact to transboundary areas from hydrocarbon releases would be minor.

The residual impact from potential unplanned hydrocarbon releases on transboundary areas is considered to be Minor

Atmospherics Emissions

Due to the distance of the Orwell subsea wells to the UK/Netherlands transboundary line (approximately 4 kilometres) there could be minor increases of the atmospheric greenhouse concentrations over the median line. However, due to atmospheric dispersion, the concentrations are expected to be minute over a few kilometres from source. In addition, the operations will be temporary in nature and therefore the transboundary impact from atmospheric emissions is expected to be minor.

Chemical and Planned Hydrocarbon Discharges

Due to the planned volumes of chemicals and hydrocarbons to be discharged, and distances from the discharges to the transboundary line, no transboundary impacts are expected.

Cumulative Impacts

Physical Presence

The presence of the drilling rig and other decommissioning vessels may pose an additional hazard to navigation in the area and add to the over cumulative impact to shipping, fishing and other sea users. The cumulative impact from the physical presence of the decommissioning vessels / rig is expected to be temporary in nature and therefore the residual impact is expected to be minor.

Atmospheric Emissions

Atmospheric emissions from the decommissioning activities will also contribute to those from other nearby developments. However, the emissions from the Thames Area Decommissioning are only considered to represent a very small proportion of the regional and UK totals.

Due to the temporary nature of the atmospheric emissions from the decommissioning activities and the dispersive capacity of the receiving environment, any cumulative impacts are anticipated to be minor. In addition to this, the atmospheric emissions will not originate from the same location throughout the decommissioning operations and therefore the cumulative will be varied during this period. The cumulative residual impact to from atmospheric emissions is expected to be minor.

Chemical and Planned Hydrocarbon Discharges

Due to the planned volumes of chemicals and hydrocarbons to be discharged and distances from the discharges to other installations, no cumulative impacts are expected.

Noise

Due to the temporary nature of the decommissioning activities, any cumulative impacts from noise are anticipated to be minor. In addition to this, the noise source will not originate from the same location throughout the decommissioning operations and therefore the cumulative will be varied during this period. The cumulative residual impact to from noise is expected to be minor.

Environmental Management

Both Perenco and Tullow are certified to ISO 14001 standard and therefore have relevant documentation in place to support the decommissioning process from an environmental standards perspective. Where there is a need for documents to be compiled to reflect joint operations during the decommissioning process then these will be jointly assessed and approved accordingly.

The following sections describe the key elements of Perenco / Tullow EMS, indicating how they will be applied to the Thames Area Decommissioning.

The Environmental Impact Assessment (EIA) is a key principle of the EMS of both companies. It allows the comparison of the environmental impacts of alternative solutions during the evolution of the project, from design through procurement and construction of plans to implementation and execution of the plans for the operation, and to seek mitigation and control measures that aim to prevent pollution and minimise waste.

In addition to providing the means to implement the identified mitigation and control measures, the EMS enables the monitoring of their effectiveness through checks on actual environmental performance.

The EMS will allow Perenco / Tullow to control environmental impacts and will provide assurance that the environmental management is effective. The basis of the EMS is the Environmental Policy statement.

Conclusion

In conclusion, all residual impacts are considered to be of minor significance, provided the proposed mitigation and management measures, as identified within the ES, are implemented during the Thames Area Decommissioning.

The exception to this is in the event of an accidental spill, where there would be a release of condensate from the pipeline or diesel fuel loss from the drilling rig / SLV; here the residual impact has been assessed as moderate.

In addition, the assessment of potential cumulative impacts indicated that there would be no significant impacts and no significant transboundary impacts are expected to occur as a result of the decommissioning operations.

1 Introduction

1.1 Purpose

Note: This is a joint EIA Submission for both Perenco UK Limited (hereafter referred to as 'Perenco') and Tullow Oil SK Limited (hereafter referred to as 'Tullow'). However, for ease of reading the Operators are referred to as 'Perenco' throughout the EIA.

Perenco ceased production from the Thames installation (situated in UKCS Block 49/28 of the southern North Sea) in May 2014 and they are therefore preparing Decommissioning Programmes to be submitted to the Department of Energy and Climate Change (DECC) for approval under the Petroleum Act 1998, as amended by the Energy Act 2008.

In support of the Decommissioning Programmes, this Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) carried out for the Thames Area Decommissioning project, as required under the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011.

1.2 Project Overview

The Cessation of Production (CoP) date was 14th May 2014. All options have been explored for continuing production but it was concluded that due to reduction of gas production by excessive water loading, operations were uneconomical, so CoP was declared in preparation for decommissioning.

The two Operators will then commence decommissioning activities in this same area as early as Q3 2014.

The proposed Thames decommissioning area is located across thirteen (13) United Kingdom Continental Shelf (UKCS) Blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4) in the Southern North Sea (SNS) (Figure 1.1).

The fields and associated infrastructure included and considered within this Decommissioning ES are:

- Thames Field (Perenco);
- Arthur Field (Perenco);
- Bure West Field (Perenco);
- Bure O Field (Perenco);
- Gawain Field (Perenco);
- Orwell Field (Tullow);
- Yare C Field (Perenco);
- Horne and Wren Field (Tullow);
- Thurne Field (Tullow); and
- Wissey Field (Tullow).

Figure 1.1: Thames Area Decommissioning Location Map

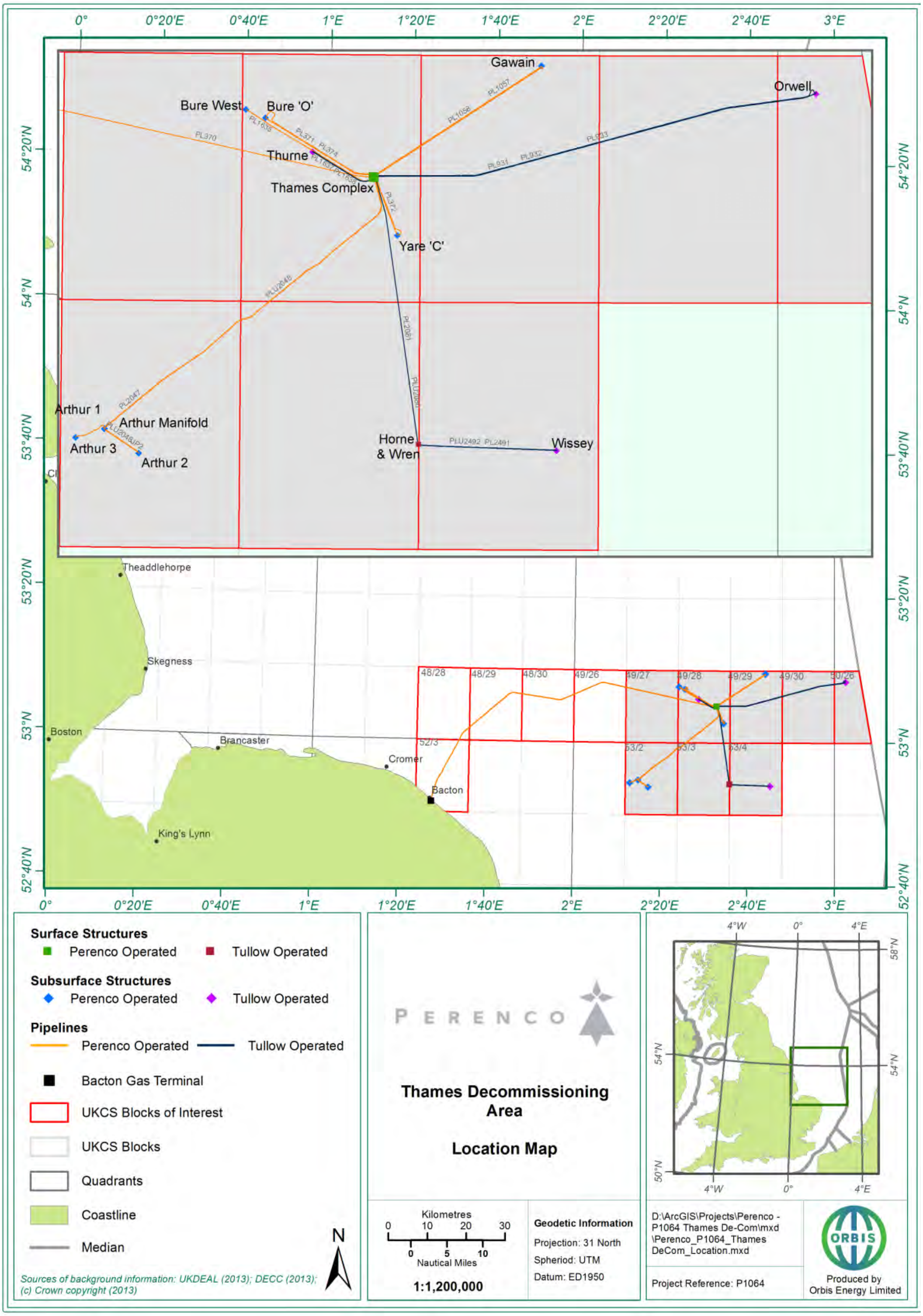


Table 1.1 shows a summary of the assets and infrastructure that are included in this Decommissioning ES.

Table 1.1: A Summary of the Decommissioning Fields and Infrastructure (matching the Decommissioning Programmes) which are included in the Thames Decommissioning ES

		Infrastructure							
Decommissioning Field	Decommissioning Programme	Platforms	Wells	Wellheads	WPS	Manifold / Template	Pipelines	Umbilicals	MEG Lines
Thames	DP1	3	9	4	4	-	5	3	1
Gawain	DP2	-	3	3	1	1	1	1	-
Arthur	DP3	-	3	3	4	1	4	4	-
Horne & Wren	DP4	1	2	-	-	-	1	-	1
Orwell	DP5	-	3	3	1	1	1	1	1
Wissey	DP6	-	1	1	1	-	-	1	-
Thurne	N/A	-	1	1	-	-	-	-	-

The technical assessment of the decommissioning options has been undertaken and is fully detailed in Section 2 of this ES.

It is currently envisaged that decommissioning activities will begin to take place in Q3 2014 and last for approximately 60 months (although this is not concurrently).

1.3 The Applicants

1.3.1 Perenco UK Limited

Perenco is an independent oil & gas company with operations in 16 countries across the globe, ranging from Northern Europe to Africa and from South America to the Middle East. Perenco is involved in operations both onshore and offshore.

Perenco currently produces approximately 300,000 barrels of oil equivalent per day (boepd), of which 180,000 boepd is net to the company. The group is present in world-class exploration basins such as Brazil, Peru, Northern Iraq, Australia and the North Sea. While Perenco's growth has been driven by acquisitions, the Group's strategy evolved rapidly towards increasing production and reserves, renewing licenses and securing additional acreage for new exploration and development opportunities.

In the southern North Sea Gas Basin, Perenco operates seventeen fields which include: Indefatigable, Bell, Leman, Davy, Thames, Trent, Tyne, Pickerill, and Waveney fields, with associated pipelines and onshore processing facilities including the Bacton Terminal.

The gross gas production for these fields is approximately 400 million standard cubic feet per day (MMscfd), or about 60,000 boepd over a total production acreage of 1,767 square kilometres.

Perenco operate under an Environmental Management System (EMS). The EMS provides the framework for managing HSE issues within the business. This EMS is intended for application to all of Perenco activities as directed under the OSPAR recommendation 2003/5 to promote the use and implementation of Environmental Management Systems by the Offshore Industry.

1.3.2 Tullow Oil SK Limited

Tullow's portfolio of over 140 licences spans 24 countries and is organised into three regions. Tullow has headquarters in London and also has corporate offices in Ireland, Ghana, Uganda and South Africa. Tullow has a total global workforce of over 2,000 people, with shares listed on the London, Irish and Ghana Stock Exchanges, and the Group is a constituent of the FTSE 100 index.

Tullow first entered the UK offshore exploration, development and production arena in 2000, when it acquired a significant number of southern North Sea gas assets from BP. The acquisition comprised of assets in the CMS and Thames-Hewett Areas. The portfolio has since been expanded through a number of new licence awards and bolt-on acquisitions including transactions with Shell, Chevron-Texaco and Conoco-Phillips. Tullow has succeeded in extending the life of these mature assets through focused cost reduction, successful exploration and innovative developments. Tullow's first offshore operated development was the Horne and Wren project in the Thames Area where production commenced in 2005.

The Tullow Assets are operated and maintained under a contract held by Petrofac Facilities Management (PFM) who are operationally based from their Yarmouth premises. PFM as duty holder for the Schooner & Ketch Normally Unattended Installations (NUIs) on behalf of Tullow Oil SK Limited (Tullow), are engaged to ensure that the operations for the installations meet the Environment, Health & Safety (EHS) standards and that the risk to personnel on the installations during periods of operational activity is as low as reasonably practicable (ALARP). In the context of offshore Schooner & Ketch these operations are principally those concerned with any required intervention maintenance visits to platforms including well interventions and routine helicopter / marine activates associated with such intervention visits. The change of Duty holder to Petrofac occurred in 2005.

In June 2008 the £35 million sale of non-core CMS exploration and development assets to Venture Production completed. Following this, in November 2008, Tullow completed the sale of its whole interest in the Hewett-Bacton producing assets and terminal to Eni for £210 million.

The southern North Sea assets in the UK and Netherlands provide cash flow to the Group from gas production. In December 2012 Tullow announced its intent to sell these gas assets due to the continued focus on high-impact oil exploration activities in Africa and the Atlantic Margins. The sales process is ongoing.

1.4 Legislation and Policy

1.4.1 Summary of Decommissioning Regulations

The UK's international obligations in relation to decommissioning are governed principally by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention). Under the terms of OSPAR Decision 98/3 on Disposal of Disused Offshore Installations, there is a prohibition on the dumping and leaving wholly or partly in place of offshore installations. The topsides of all installations must be returned to shore. All installations with a jacket weight less than 10,000 tonnes must be completely removed for reuse, recycling or final disposal on land.

OSPAR Decision 98/3 recognises that there may be difficulty in removing the 'footings' of large steel jackets weighing more than 10,000 tonnes and in removing the substructures of concrete installations. As a result there is provision for derogation from the general rule of reuse, recycling or final disposal on land for these categories of installations. However, none of the Platforms included in this ES are classed at being over 10,000 tonnes and will therefore require removal.

Note the provisions of OSPAR Decision 98/3 do not apply to pipelines and there are no international guidelines on the decommissioning of disused pipelines.

On the UKCS, the decommissioning of offshore oil and gas installations and pipelines is controlled through **the Petroleum Act 1998, as amended by the Energy Act 2008**.

Under the Petroleum Act 1998, before the owners of an offshore installation or pipeline can proceed with its decommissioning, they must obtain approval of a decommissioning programme from DECC.

As detailed within the DECC guidance notes 'Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998', the chosen decommissioning option must be supported by an EIA, which should form part of the decommissioning programme and should assess the impact of the project on the environment and climate change.

1.4.2 EIA Regulations

The Environmental Impact Assessment (EIA) that has been carried out for the Thames Area Decommissioning project, was conducted under the Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011.

1.4.3 The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001

These regulations apply the Habitats Directive and the Wild Birds Directive in relation to offshore oil and gas plans and projects wholly or partly on the UKCS. The regulations apply to decommissioning proposals and in the light of the information provided in the ES, DECC in consultation with the Joint Nature Conservation Committee (JNCC) and/or the Countryside Agencies (Natural England, Countryside Council for Wales and Scottish Natural Heritage), will decide whether the proposals are likely to have a significant effect on the habitats and species covered by the regulations, and whether there is a requirement to undertake an 'Appropriate Assessment'.

1.4.4 The Offshore Chemical Regulations 2002

These regulations implement, OSPAR Decision 2000/2 on a Harmonised Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals. Where it is proposed to use or discharge chemicals during the decommissioning of an offshore installation or pipeline, Perenco will need to apply to DECC for the appropriate permit. The application should be submitted using a Chemical Permit Application (formally known as PON 15E) or, if chemical use and discharge is minimal, using an existing Production Chemical Permit Application (formally known as a PON 15D) to request a variation of the production chemical permit.

1.4.5 The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005

These regulations prohibit the discharge of oil into the sea from an offshore installation or pipeline, except under authority of a permit. Perenco will be required to make provision for the removal and recycling of oil recovered during the decommissioning, but it will be possible to apply for a permit for the discharge or reinjection of certain types and quantities of oil. Applications should be submitted to DECC, using the electronic OPPC application, through the DECC portal

1.4.6 The Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001

These regulations implement the Integrated Pollution Prevention and Control (IPPC) Directive for offshore oil and gas installations. Under the regulations a permit is required from DECC if the aggregated thermal capacity of the combustion equipment on the installation exceeds 50 MW(th). Such permits will have been issued prior to decommissioning and when the aggregated thermal capacity of the relevant plant falls below the 50 MW(th) threshold during the course of the decommissioning operations, the installation will no longer be subject to the controls and the Operator will be required to surrender the permit.

1.4.7 The Greenhouse Gases Emission Trading Scheme (ETS) Regulations 2003

These regulations implement the EU Emissions Trading Scheme (EUETS). Under the regulations, operators are required to apply to DECC for a permit covering the emission of greenhouse gases (currently only CO_2), if the aggregated thermal capacity of the combustion equipment on the installation exceeds 20 MW(th). Such permits will have been issued prior to decommissioning, and must be surrendered when the aggregated thermal capacity falls below the threshold. The installation will then be deemed "closed", and will drop out of the EU Emissions Trading Scheme. Installations will be able to retain and trade any surplus allowances for the year of "closure" (i.e. when they fall below the threshold and drop out of the Scheme, but will not receive any allowances for future years).

1.4.8 The Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation Convention) Regulations 1998 & The Offshore Installation (Emergency Pollution and Control) Regulations 2002

Under these regulations operators of offshore oil and gas installations and pipelines are responsible for preparing and submitting an Oil Pollution Emergency Plan (OPEP) to DECC. The expectation is that the OPEP will cover all activities where there is a risk of a hydrocarbon spill, including activities relating to decommissioning. This may be achieved by the incorporation of decommissioning activities into the existing field OPEP or by producing a decommissioning specific OPEP.

1.4.9 Marine and Coastal Access Act 2009 (MCAA)

Introduced a marine licensing system to cover those offshore energy activities that are the responsibility of DECC, and which are not excluded from the MCAA licensing provisions. The licensable activities are principally related to decommissioning and include:

- Seabed disturbance (i.e. to access platform legs or relocate cuttings piles or carry out trenching work that is not covered by a Pipeline Works Authorisation (PWA));
- Temporary deposits during abandonments;
- Deposits or removal of certain cables (not covered by PWA);
- Deposits (including setting the provisions for marking objects on the seabed) or removal of objects e.g. rock dumping, mattress placement or burial operations not covered by a PWA, or to remove platforms or other structures from the seabed;
- Deposit and use of explosives to remove structures.

1.4.10 Other Regulatory Requirements

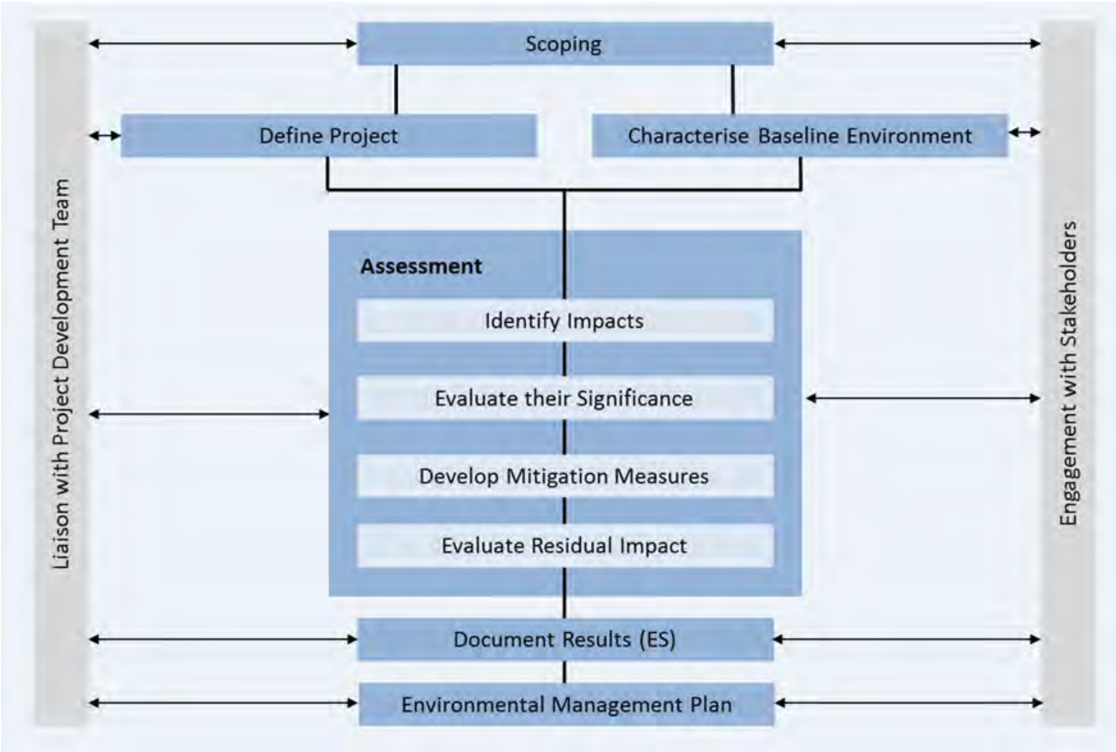
The Thames Area Decommissioning project is also subject to a wide range of other UK and EU legislation in addition to other international treaties and agreements such as the Oslo and Paris Commission (OSPAR). Key environmental legislation relevant to the project are summarised in Appendix A.

1.5 The EIA Process

EIA is a systematic process that identifies and evaluates the potential impacts a proposed project may have on aspects of the physical, biological and socio-economic environment. Mitigation measures are then developed and incorporated into the project to eliminate, minimise or reduce adverse impacts and, where practicable, to enhance benefits. The process also ensures that planned activities are compliant with legislative requirements and with the Operator's Environmental Policy and EMS (refer to Section 14).

The overall EIA process, which has been followed for the Thames Area Decommissioning project, is shown schematically in Figure 1.2. The key elements of this process are described below.

Figure 1.2: Overview of EIA Process



Scoping and Consultation: Scoping is undertaken in the early stages of the EIA process and aims to determine the scope of the EIA and the subsequent ES by identifying the issues that are likely to be of most importance during the EIA and eliminating those that are of little concern. For the Thames Area Decommissioning project an informal scoping letter was sent to DECC and a number of other key statutory consultees on the 21st August 2013 (refer to Section 1.6). Perenco will continue to engage with stakeholders throughout the EIA process to discuss potential issues, project goals and environmental strategies.

Project Definition: The identification and, where necessary, quantification of activities and aspects of the project which might have an impact on the environment has been undertaken in consultation with the Perenco project development team. Alternative decommissioning solutions have also been considered and the chosen options justified.

Baseline Characterisation: Baseline data, appropriate to the proposed project's potential impacts, has been gathered to describe the relevant existing conditions (e.g. physical, biological, and socio-economic). Published information sources have been referenced and data gathered from recent surveillance surveys undertaken to assess the condition of the existing infrastructure.

Assessment: Impact assessment and development of mitigation measures is an ongoing process that commences during the scoping stage and continues throughout the EIA process. The key objectives of the assessment process are to:

- Analyse how the project may interact with the baseline environment in order to identify and evaluate the likely significant impacts of the proposed project on the environment;
- Define mitigation measures in order to avoid, reduce, control or compensate for adverse impacts or enhance positive benefits;
- Evaluate the residual impacts of the project (i.e. the impact that is predicted to remain once mitigation measures have been designed into the intended activity).

The impact assessment methodology which has been used for the Thames Area Decommissioning project is described in detail in Section 4.

Reporting: The outcome of the EIA process is documented in this ES, which has been structured in accordance with the guidance provided in DECC's Guidance Notes on the 'Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' document (*DECC, 2011*).

Environmental Management Plan (EMP): An EMP is a project specific plan developed to ensure that appropriate environmental management practices are followed during implementation of the project. An EMP will be developed for the Thames Area Decommissioning project to ensure compliance with the Perenco Environmental Policy and EMS, as well as with statutory requirements. The EMS will incorporate all the mitigation measures which Perenco has committed to implement, as identified during the EIA process, and will outline the processes Perenco will follow in order to monitor compliance.

Areas of Uncertainty: At present, Perenco have not finalised the contracts to carry out the required work, thus some details of the exact methodology to be employed in the decommissioning methodology may be subject to future modification. Any variations to the operations as described in this document will be evaluated for potential to alter the conclusions drawn by the EIA in updated applications.

1.6 Consultations

During preparation of this ES, the views of a number of organisations were solicited by an informal scoping letter on the 21st August 2013. These organisations included:

- DECC;
- Centre for Environment, Fisheries and Aquaculture Science (CEFAS);
- Joint Nature Conservation Committee (JNCC) and Natural England (NE);
- Ministry of Defence (MoD);
- North Norfolk District Council (NNDC);
- Crown Estates;
- National Federation of Fishermen's Organisation (NFFO).

The main issues raised during this informal consultation exercise, and how Perenco has or is proposing to address them, are summarised in Table 1.2. Where these issues are discussed further within this ES the relevant section reference has been provided.

Of note is that consultations and liaison with interested parties is a continuous part of the environmental management process and will continue throughout the Thames Area Decommissioning project.

Table 1.2: Summary of Consultation Responses for the Thames Area Decommissioning Project

Consultee	Issues Raised	Perenco's Response	ES Section
DECC	No specific response to the Thames EIA at the time of writing, although Perenco have been in constant communications with DECC regarding the Decommissioning Programmes.	-	-
JNCC / NE (joint Response)	The Bacton-Thames pipeline (PL370) and some of the wellheads to be removed are within European Natura 2000 sites such as the North Norfolk Sandbanks & Saturn Reef cSAC and Haisborough, Hammond and Winterton cSAC which have both been recommended for the presence of Annex I habitats represented by biogenic reefs constituted by *Sabellaria spinulosa* and sandbanks; the Bacton-Thames pipeline crosses a number of sandbanks particularly within the NNS&SR cSAC. Although not primary features, harbour porpoise (*Phocoena phocoena*) and grey seal (*Halichoerus grypus*) have been included as non-qualifying features. Depending on the outcome of the CA, the option that might imply removal of the pipeline or deposition of hard substrate to protect exposed sections of the pipeline(s) is likely to have a significant effect on these conservation features and their conservation objectives. To this purpose we suggest that the ES / CA considers the	The chosen option is to leave the pipelines *in-situ*.	Section 2.10.2

Consultee	Issues Raised	Perenco's Response	ES Section
	full benefits and impacts of pipeline removal vs. leaving in-situ; should removal of pipeline or removal/deposition of hard substrate be selected this must be clearly explained along with proposed mitigation measures.	Included in Section 3 of the ES.	Section 3.3.6
	The ES should also consider additional sensitivities within the Cromer Shoal Chalk Beds rMCZ, especially the subtidal chalk features (which are a UK BAP habitat). Whilst not proposed for designation in 2013 the rMCZ contains some of the best examples of subtidal chalk within the Southern North Sea, forming part of the longest chalk reef in Europe.		
	We also note that the subsea wells Bure O and Bure West are adjacent to, or within, the NNS & SR cSAC boundary, and that the scoping letter suggests that the subsea wells infrastructure is outside the scope of the CA. If this is the case, the impacts of their removal on the SAC become a matter of consideration.	The wellheads have to be removed in line with the decommissioning regulations. The impact of this has been included in the ES.	Section 5
	We are now advising the use of marine mammals management units (MMMUs) which represent more up to date data on reference populations for marine mammals.	Perenco has had further discussions with JNCC and have agreed to reference the MMMU data, but to also use SCANS II.	Section 3.3.5
	We note that seals have not been mentioned in the environmental scoping: in this respect we advise that impacts on harbour seals (*Phoca vitulina*) are considered within the ES; even though they are not features of any affected designated sites, the East Coast is important to the species.	The impact to seals has been included in the ES.	Section 3.3.5
	We have also noted the potential overlap of the end of operations (identified as "late 2014" in the scoping letter) with heightened seabird vulnerabilities in some of the affected blocks. We recommend that the ES consider these and for any relevant activities to be limited to times of lower vulnerability.	The exact timings of the decommissioning operations are not yet known, other the ES has considered impacts to seabirds over the whole year.	Section 2.6
	Site specific environmental survey must be based on good geophysical data that can allow targeted sampling for both infauna (grabs) and epifauna (video or	A site survey was completed at the Thames Area and the results (alone with the report) are included within this ES.	Section 3.3.2

Consultee	Issues Raised	Perenco's Response	ES Section
	camera) in relation to the acoustic signature and seabed texture.		
MoD	No response at the time of writing	-	-
NFFO	No response at the time of writing	-	-
CEFAS	There are currently Cefas seismic restrictions in blocks 49/26-30 between January and March and in blocks 53/2-4 between January and Mid-May. However there are no Cefas fisheries related restrictions relating to decommissioning activity. We would also likely recommend consent regarding any pipeline work and any deposit consents to protect pipelines and related subsea infrastructure. Any fishing vessels encountered in the vicinity should be contacted by VHF radio to advise them of the type and duration of the activity, and regular broadcasts should also be made for the benefit of all vessels. Contact details for fishermen's organisations operating in this block can be obtained from Defra's local MMO office at Grimsby - Tel: (01472) 355112/3, e-mail: Grimsby@marinemanagement.org.uk and at Lowestoft - Tel: (01502) 573149/572769, e-mail: Lowestoft@marinemanagement.org.uk.	A Fisheries Liaison Officer (FLO) will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.	Section 5
NNDC	No response at the time of writing	-	-
Crown Estates	No response at the time of writing	-	-

1.7 Structure of the Document

The ES document is laid out in following sections:

Non-Technical Summary

Section 1 **Introduction** - provides a background to the project and the applicant;

Section 2 **The Proposed Development** – outlines the proposed Thames Area Decommissioning project, providing details on the options considered, schedule, project lifecycle activities and key discharges and emissions to the environment.

Section 3 **The Existing Environment** – provides an overview of the existing physical, biological and socio-economic environment within the zone of influence of the Thames Area Decommissioning project.

Section 4 **Environmental Assessment Methodology** – describes the assessment methodology that has been used to identify, describe and assess the likely significant impacts of the proposed Thames Area Decommissioning project on the environment.

Sections 5 – 13 **Assessment of Potentially Significant Environmental Impacts and Mitigation Measures** – assesses the identified potentially significant environmental impacts and determines suitable mitigation measures to demonstrate that the residual impact is as low as reasonably practicable (ALARP).

Section 14 **Environmental Management** – provides an outline of how Perenco and Tullow will manage the project to ensure the protection of the environment throughout the life of the development;

Section 15 **Conclusions**

Section 16 **References**

Appendices

1.8 Contact Address

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

Oliver Brandon
HSE Advisor (Environment)
Perenco UK Ltd
Thames House
Thamesfield Way
Great Yarmouth
NR31 0DN

E-mail: obrandon@uk.perenco.com
Telephone: +44 (0)1493 414 008

2 The Proposed Decommissioning Programme

2.1 Introduction to Oil and Gas Exploration, Production and Decommissioning

The production of oil and gas is the process of extracting and removing hydrocarbons from the earth.

To begin the process, geologists will use seismic survey data to locate geological structures that may contain oil and gas reservoirs. Areas that are predicted to contain economically viable deposits of oil and gas are then usually chosen as sites for exploration drilling. If exploration drilling is successful, then the project will usually move into a development phase, leading on to oil and gas production.

Once all of the 'economically viable' hydrocarbons have been extracted from the field or reservoir, then the development will cease production and the process of decommissioning the infrastructure begins.

As the gas supplies deplete and production profiles indicate significant reduction in the Southern North Sea Thames area production, Perenco and Tullow ceased production in May 2014 and commence decommissioning activities in this area as early as Q3 2014.

Both Operators are therefore preparing a number of Decommissioning Programmes (DP) to be submitted to the Department of Energy and Climate Change (DECC) for approval under the Petroleum Act 1998, as amended by the Energy Act 2008 (for further information, please refer to Appendix A).

In support of the Decommissioning Programmes, an Environmental Statement (ES) and a Comparative Assessment (CA) document will also need to be submitted to DECC. The ES will be submitted under The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2011.

This ES covers the proposed decommissioning activities for the Thames Area infrastructure.

2.1.1 Pipeline cleaning methodology

Before beginning decommissioning activities can begin at the Thames Area, there is a cleaning regime which will be adopted on all pipelines and umbilicals. This will be conducted prior to the approval of the EIA. The methodology for different lines is split into three distinct sections; umbilical and MEG line flushing, pipeline flushing and export pipeline cleaning. Each methodology is designed upon a zero platform discharge principle.

Umbilical and MEG line cleaning

To ensure MEG and Methanol are removed from their associated umbilicals / lines a flushing methodology is to be adopted. Two line volumes of seawater will be pumped down each individual line to displace the fluid. This will be injected into the pipeline in preparedness for the gas pipeline flushing down subsea wells. All pipelines except for the Horne & Wren pipeline have been flushed.

Pipeline Flushing

To clean the pipelines between subsea and platform seawater will be used as the cleaning medium. Sufficient turbulent flow is required whilst retaining low velocities to achieved a suitable level in line with the methodology.

A third party pump spread will be erected on the Thames platform. Each pipeline will be initially filled with seawater and subsequently two pipeline volumes will be discharge down their associated subsea wells at pressure to overcome the current well shut in wellhead pressure.

If the methodology to pump seawater to the subsea well is unsuccessful the water will be flushed from the well to the platform using a pumping spread on a DSV connected to the well manifold.

Water will be routed either to the export line or a current platform reinjection well or an alternative subsea well.

Export Pipeline Cleaning

The export pipeline will be cleaned using bi-directional pigs. Firstly a single pig will be sent down the export line using water as the motive fluid. This will remove all remaining gas and produced liquids from the export line. Seawater will be used as the motive fluid. After the initial pig, a further 4 pig bidirectional train will be sent down the pipeline to remove the remaining hydrocarbons. The liquid will be dealt with at the Bacton gas terminal using the exiting slug-catcher and modification to the liquid handling route.

2.2 The Thames Decommissioning Area

The proposed Thames decommissioning area is located across 13 UKCS Blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4) in the southern North Sea (SNS) (Figure 2.1). The Thames area infrastructure and assets are operated by either Perenco or Tullow (Figure 2.2), on behalf of their partners.

The fields and associated infrastructure included and considered within this Decommissioning ES is:

- Thames Field (Perenco);
- Arthur Field (Perenco);
- Bure West Field (Perenco);
- Bure O Field (Perenco);
- Gawain Field (Perenco);
- Orwell Field (Tullow);
- Yare C Field (Perenco);
- Horne and Wren Field (Tullow);
- Thurne Field (Tullow); and
- Wissey Field (Tullow).

The Bacton to Thames pipeline (PL370) connects to the UK coast at the Bacton Gas Terminal and is the main export pipeline for all of the assets. The Thames platform is located approximately 80 kilometres north east of the nearest UK landfall, near to the town of Winterton-on-Sea and 37.5 kilometres to the west southwest of the UK/Netherlands transboundary line. The Horne & Wren Platform is located approximately 64.5 kilometres from the nearest UK landfall, near the town of Winterton-on-Sea and approximately 38 kilometres to the UK/Netherlands transboundary line. The Orwell subsea wells represent the furthest point of the infrastructure to be decommissioned from UK landfall, at approximately 102 kilometres to the north east of Winterton-on-Sea. The Orwell subsea wells also represent the closest point to the UK/Netherlands transboundary line at approximately four kilometres to the west. The infrastructure (excluding pipelines) closest to UK landfall are the Arthur subsea wells approximately 41 kilometres from the town of Winterton-on-Sea.

Table 2.1 shows the coordinates of each of the assets.

Table 2.1: The Coordinates, Description and Water Depth

Field	Description	Coordinates (ED50)	Water Depth (metres LAT)
Thames	Three platforms, wells, umbilicals, flowlines, jumpers, wellhead protection structures, stabilisation materials and pipelines (including the Thames to Bacton export pipeline PL370)	469,653 E 5,881,884 N	33
Arthur (3)	Arthur 3 wellhead: 53/2-13 Arthur 2 wellhead: 53/2-13 Arthur distribution manifold Arthur well P1 wellhead protection frame;	447,323 E 5,862,339 N	49
Bure West	Bure West wellhead and protection structure (49-28-18)	460,096 E 5,886,941 N	34
Bure O	Bure 'O' wellhead and protection structure (49/28-8)	461,569 E 5,886,318 N	36
Gawain Field	Gawain 3 well manifold protection structure Gawain G2 wellhead (49/29a-g2) Gawain G1 wellhead(49/29a-g1) Gawain G3 wellhead (49/29a-g3)	482,281 E 5,890,192 N (Gawain 3 well manifold protection structure)	33.2
Yare C	Yare 'C' wellhead and protection structure (49/28-13)	471,458 E 5,877,482 N	37
Horne & Wren Platform	Normally Unmanned Installation (NUI), two-well platform with dry trees. Reception for Wissey subsea well and export to Thames	473,001 E 5,861,790 N	41
Wissey	Single subsea well tied back to Horne & Wren	483,405 E 5,861,331 N	39
Orwell	Three well subsea template tied back to Thames AW Platform	502,870 E 5,888,090 N	34
Thurne	Single subsea well tied back to Thames AR Platform	465,103 E 5,883,756 N	34

Figure 2.1: The Location of the Thames Area Infrastructure Intended for Decommissioning

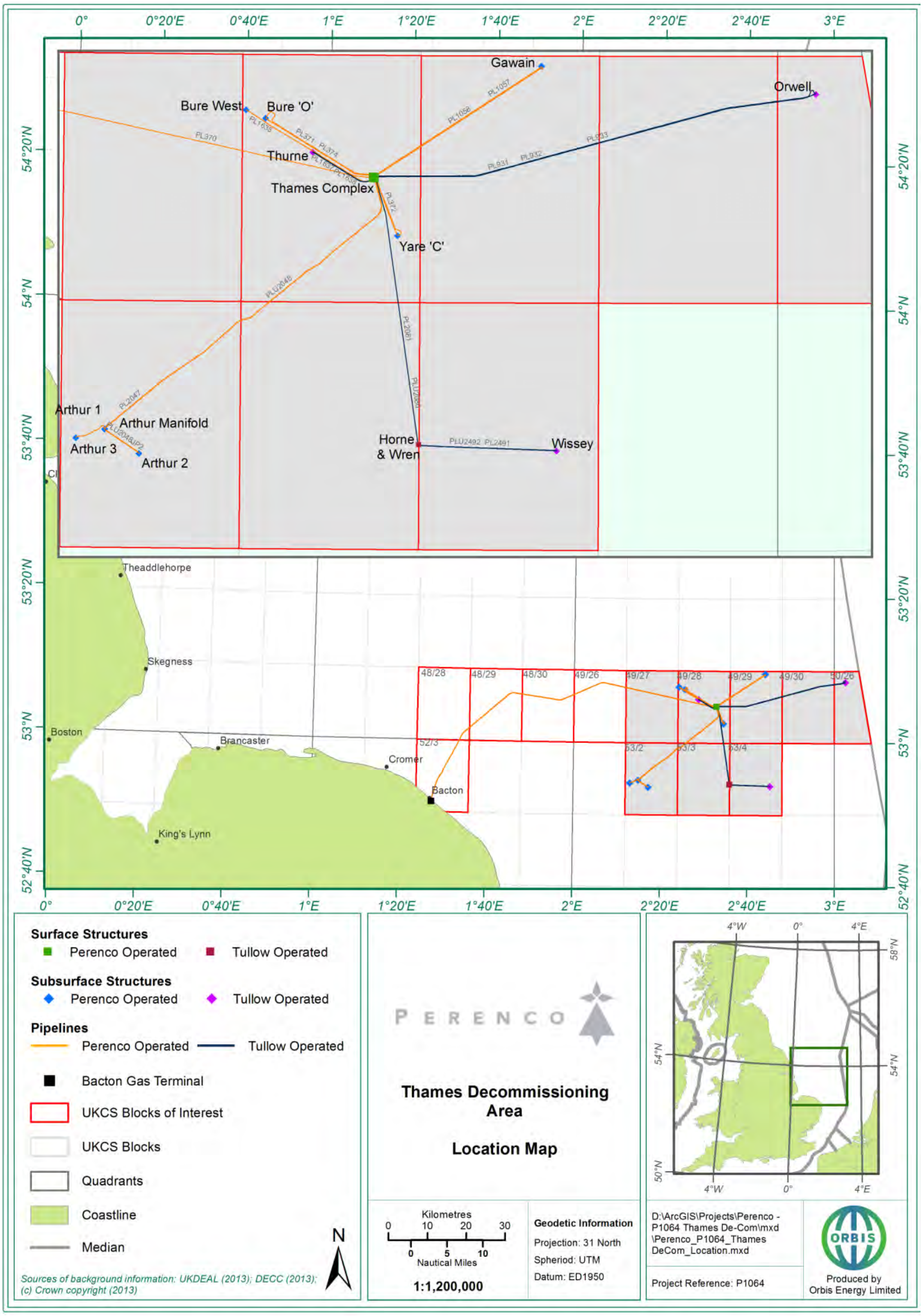
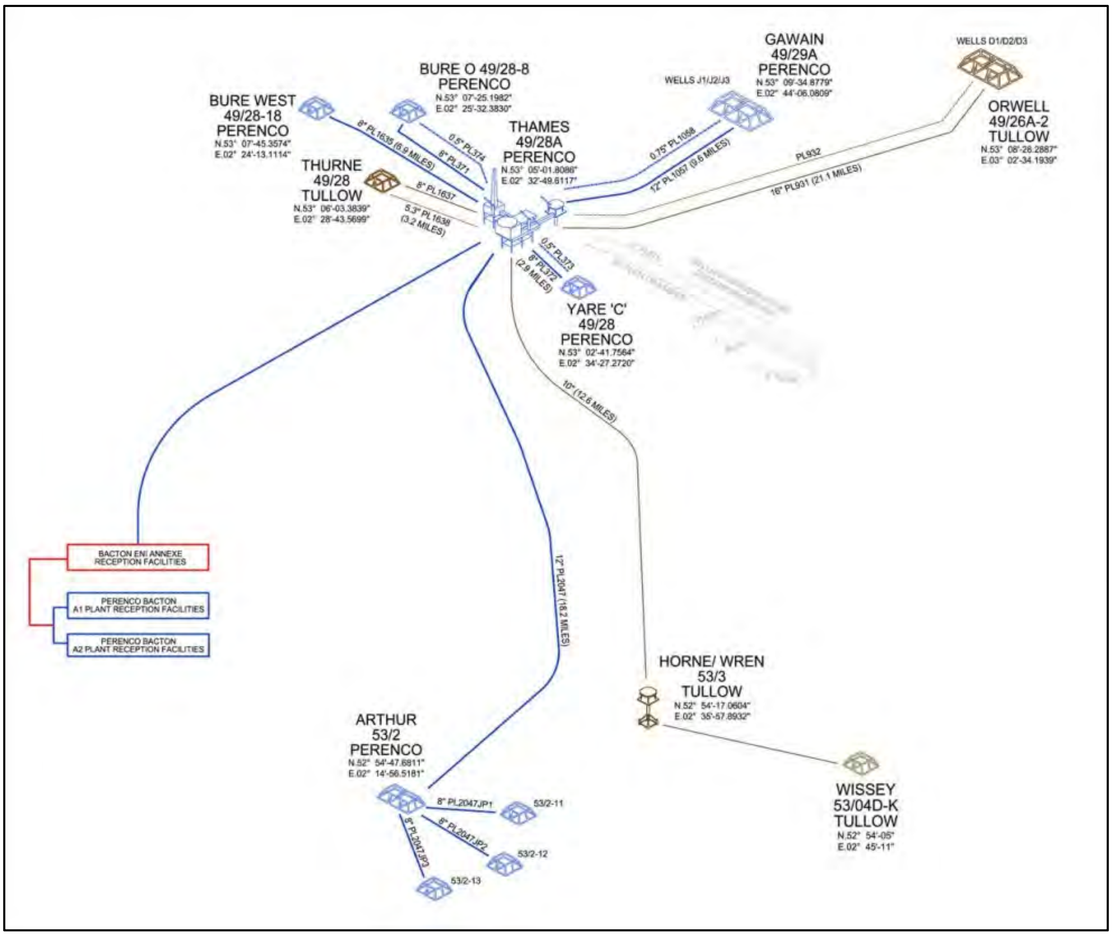


Figure 2.2: The Thames Area Assets by Operator



2.3 The Decommissioning Programmes

The assets will be grouped into the following Decommissioning Programmes:

Perenco Assets

1. Thames Field Decommissioning Programme (DP1)
   a. **Thames**: Platforms, Wells, Umbilicals, Flowlines, Jumpers, Wellhead Protection Structures, Stabilisation Materials and Pipelines (including the Thames to Bacton export pipeline PL370);
   b. **Bure O:** Well, Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline;
   c. **Bure West**: Well, Monoethylene Glycol (MEG) line, Wellhead Protection Structure, Stabilisation Materials and Pipeline;
   d. **Yare C:** Well, Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline.
   e. **Thurne:** Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline.
2. Gawain Field Decommissioning Programme (DP2)
   a. **Gawain:** Wells, Umbilical, Wellhead Protection Structures, Stabilisation Materials and Pipelines.
3. Arthur Field Decommissioning Programme (DP3)

   a. **Arthur:** Wells, Umbilicals, Flowlines, Jumpers, Wellhead Protection Structures, Stabilisation Materials and Pipelines.

Tullow assets

1. Horne & Wren Field Decommissioning Programme (DP4):
   a. **Horne & Wren:** Platform, Wells, MEG line, Stabilisation Materials and Pipeline.
2. Orwell Field Decommissioning Programme (DP5)
   a. **Orwell:** Wells, Umbilical, MEG line, Wellhead Protection Structures, Stabilisation Materials and Pipelines.
3. Wissey Field Decommissioning Programme (DP6):
   a. **Wissey:** Well, Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline.
4. Thurne Field [Note 1]
   a. **Thurne:** Wellhead (all other infrastructure covered by DP1).

Note 1: For the decommissioning of the Thurne Field, all of the infrastructure, except the Thurne wellhead, will be covered by the Thames decommissioning programme (DP1). The Thurne wellhead is not included in DP1, as it is a contractually responsibility of Tullow. However, as only a wellhead is being decommissioned, it is not subject to a full decommissioning programme; instead it will be removed under a Marine License. However, for completeness of the environmental impact assessment process, the removal of the Thurne Wellhead has been included in this decommissioning EIA.

2.4 The Decommissioning Infrastructure

2.4.1 Thames Field Decommissioning Programme (DP1) Infrastructure

The Thames development area comprises Thames, Yare, Bure, Thurne and Wensum reservoirs. The Thames installation acts as the gathering station for export from subsea completions at the other fields and the Horn and Wren normally unattended installation (NUI). The Thames installation is a normally attended three-jacket gas production complex, designated AP, AW and AR which can accommodate up to 47 personnel on board. The initial development, AP and AW, were installed and commissioned in 1986 and operational thereafter.

Table 2.2 shows the infrastructure that will be decommissioned as part of the Thames Field Decommissioning Programme (DP1).

Table 2.2: A Summary of the Infrastructure to be decommissioned as part of the Thames Decommissioning Programme (DP1)

Infrastructure	Included in Thames Decommissioning Programme (DP1)
Fields	Thames, Bure O, Bure West, Thurne & Yare C
Number of Platforms	3 – Thames AP, AR & AW (Large Steel Jacket)
Number of Wells	5 Platform Wells (all at Thames) 4 Subsea Wells (Thames A5, Bure West, Bure O & Yare C)
Number of Subsea Installations	4 Wellheads (Bure West, Bure O, Yare C and Thames A5) 1 Template (Thames A5) 4 Wellhead Protection Structures (Bure West, Bure O, Yare C and Thurne)
Number of Pipelines (gas)	5 (PL370, PL371, PL372, PL1635 & PL1637)
Number of Umbilicals, MEG lines and/or Flowlines	3 Umbilicals (PL374, PL1638 & PL373) 1 MEG Line (PL1636)

The Thames Platform

The 49/28 Thames installation comprises a series of three bridge-linked platforms which together form a natural gas production and compression installation, located approximately 80 kilometres East North East of Bacton Terminal off the coast of Norfolk in the southern North Sea (Figure 2.3). The installation provides the central facilities for the extraction and conditioning of gas from its own wells and also from the subsea developments Yare C, Bure O, Bure West, Arthur, Gawain, Orwell, Thurne and the Horne & Wren/Wissey NUI platform. The platform is linked to the Bacton Onshore Gas Terminal via a 24 inch diameter export pipeline to shore.

Figure 2.3: The Thames Platform Complex (AP, AR & AW)

The Thames Platform complex is a steel structure of approximately 14,000 tonnes in approximately 32.5 metres water depth above lowest astronomical tide (LAT). Table 2.3 shows a summary of information for the Thames Platform complex.

Table 2.3: A Summary of Information for the Thames Platform Complex

Name	Facility Type	Topside		Jacket			
		Weight (tonnes)	Modules	Weight (tonnes)	Number of legs	Number of Piles	Weight of Piles (tonnes)
Thames AP	Fixed steel jacket	6,488	1	1,100	6	6	1,050
Thames AW	Fixed steel jacket	2,035	1	950	4	4	748
Thames AR	Fixed steel jacket	406	1	600	4	4	375

Note: The topside facilities weights include the bridges

The Cessation of Production (CoP) date was 14th May 2014. All options have been explored for continuing production but it was concluded that due to reduction of gas production by excessive water loading, operations were uneconomical, so CoP was declared in preparation for decommissioning.

Wells

There are a total of eight (8) wells that will be decommissioned as part of the Thames Decommissioning Programme (DP1). Five of these wells are classed as 'platform wells' and are associated with the Thames Platform complex. The remaining three wells are classed as 'subsea wells' and are situated at each of the three other fields included in this Decommissioning Programme, namely Bure O, Bure West and Yare C.

Table 2.4 gives a summary of the eight wells to be decommissioned for DP1.

Table 2.4: A Summary of Wells to be decommissioned as part of the Thames Decommissioning Programme (DP1)

Platform Wells					
Field	**UKCS Block**	**Associated Wellhead Protective Structures**	**Well Number**	**Well Type**	**Status**
Thames	49/28	None	49/28-A1	Gas Production	Producing
Thames	49/28	None	49/28-A2	Water Injection	Disposal
Thames	49/28	None	49/28-A3	Water Injection	Disposal
Thames	49/28	None	49/28-A4	Gas Production	Producing
Thames	49/28	None	49/28-A6	Gas Production	Suspended
Subsea Wells					
Thames	49/28	Wellhead Protection Structure	49/28-A5	Dry Developme-nt	Suspended
Bure O	49/28	Wellhead Protection Structure	49/28-8	Gas Production	Producing
Bure West	49/28	Wellhead Protection Structure	49/28-18	Gas Production	Producing
Yare C	49/28	Wellhead Protection Structure	49/28-13	Gas Production	Producing

Wellheads, Wellhead Protection Structures and other Subsea Structures

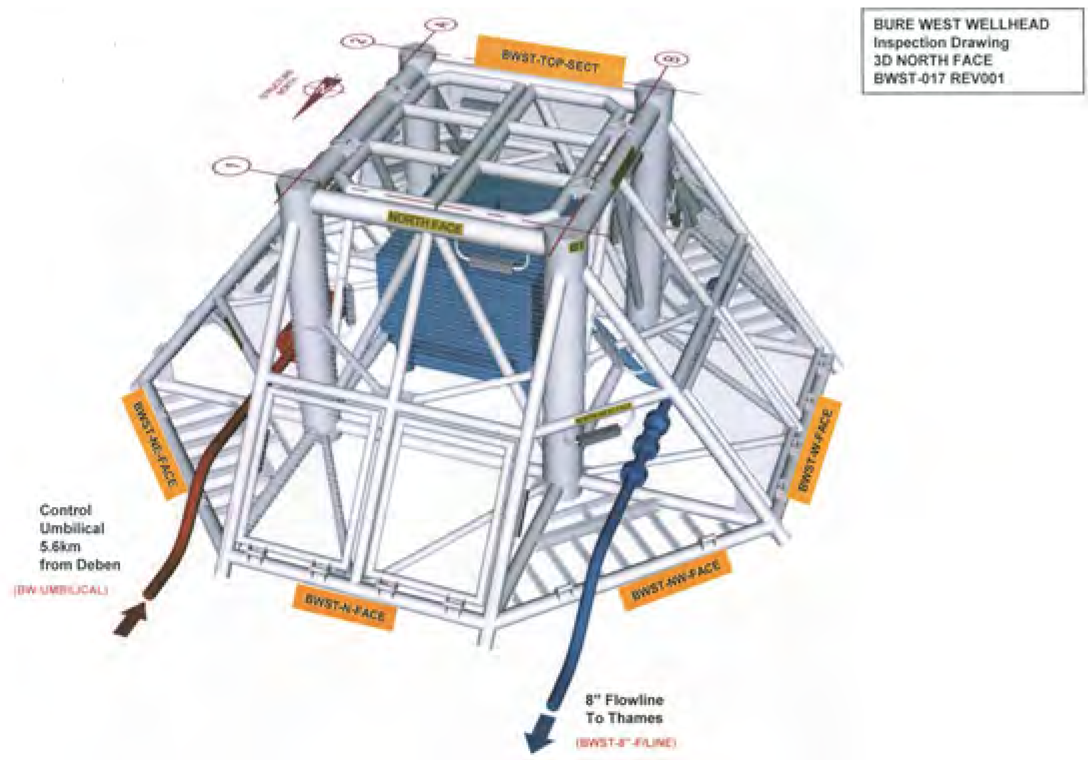
There are three subsea wellheads to be decommissioned for the Thames Decommissioning Programme (DP1). The three subsea wells all have an associated Wellhead Protection Structure (WPS) that will be decommissioned. The protection structures are over-trawlable and were installed by piling the legs into the seabed. Each WPS weighs approximately 90 tonnes and are piled approximately 18 metres into the seabed. Figure 2.4 shows the WPS that is currently installed on each of the three subsea wells.

Table 2.5 shows a summary of the wellheads, template and WPS, which will be decommissioned for the Thames Decommissioning Programme (DP1).

Table 2.5: A Summary of the Wellheads and Wellhead Protection Structures for the Thames Decommissioning Programme (DP2)

Field(s) or Well(s)	Wellhead or Subsea Structure	Number	Weight (tonnes)
Bure West, Bure O, Thames A5 & Yare C	Wellheads	4 (1 at each well)	42 each
Thames A5	Template	1	45
Bure West, Bure O, Thurne & Yare C	WPS	4 (1 at each well)	90 each

Figure 2.4: The Wellhead Protection Structure on each of the Four Subsea Wells (Bure O, Bure West, Yare C and Thurne)



Stabilisation Materials

There are a number stabilisation features that exist around the Thames Platform Complex and along the Thames area pipelines, umbilicals and MEG line. These include concrete mattresses, grout bags and rock. Table 2.6 shows a summary of the expected stabilisation features that are situated around the Thames Platform and on the Thames area pipelines, umbilicals and MEG line. There has been a number of rock dumping operations that have taken place over the last 20 years within the Thames Decommissioning Area. However, at the time of writing the amount of rock that has been deposited has not been able to be accurately quantified.

Table 2.6: A Summary of Stabilisation Material to be decommissioned as part of the Thames Decommissioning Programme (DP1)

Stabilisation Features	Number	Weight (tonnes)	Location	Exposure
Concrete mattresses	129	1,354	Within 500m of Thames complex Flowlines to/from Bure West, Bure 'O', Yare 'C', Thurne (Deben)– outside of 500m zone of Thames complex	47 (estimated) - 11 at Bure West - 36 at Thurne
Grout bags	31	0.8	Within 500m of Thames complex	To be further assessed
Rock Dump	5	13,000	Within 500m of Thames complex	To be further assessed
Grout bags	306	8	Flowlines to/from Bure West, Bure 'O', Yare 'C', Thurne (Deben) – outside of 500m zone of Thames complex	To be further assessed

Pipelines, Umbilicals and Flowlines

For the Thames Decommissioning Programme (DP1) there are four (4) pipelines, two (2) umbilicals and one (1) MEG line that will be decommissioned.

Table 2.7 shows a summary of the pipelines, umbilicals and MEG lines that will be decommissioned.

Table 2.7: A Summary of Pipelines, Umbilicals and MEG lines that will be decommissioned as part of the Thames Decommissioning Programme (DP1)

Pipeline Number	From and to End Points	Composition	Description	Nominal Diameter (inches)	Length (km)	Condition	Status	Contents
Pipelines (gas)								
PL370	Thames AW to Bacton	Steel with concrete coating	24" Trunkline from Thames AW to Bacton	24	89.5	Trenched and buried to 91%	Operational	Cleaned and Flushed
PL371	Bure 'O' to Thames AW	Steel with concrete coating	8" Interfield line from Bure 'O' to Thames AW	8	9.3	Trenched and buried to 99%	Operational	Flushed
PL372	Yare 'C' to Thames AW	Steel with concrete coating	8" Interfield line from Yare 'C' to Thames AW	8	4.8	Trenched and buried to 99.5%	Operational	Flushed
PL1635	Bure West to	Steel with concrete coating	8" Interfield line from	8	11.2	Trenched and	Operational	Flushed

Pipeline Number	From and to End Points	Composition	Description	Nominal Diameter (inches)	Length (km)	Condition	Status	Contents
	Thames AR		Bure West to Thames AR			buried to 95.5%		
PL1637	Thurne to Thames AR	Steel	Gas Export Pipeline to Thames 49/28A facility	8	4.6	Trenched and buried to 98%	Out of Use	Flushed
Umbilicals								
PL374	Thames AW to Bure O	Umbilical	Umbilical from Thames AW to Bure 'O'	4	9.3	Trenched and buried; no free spans	Operational	Flushed
PL373	Thames AW to Yare C	Umbilical	Umbilical from Thames AW to Gawain	4	4.8	Trenched and buried to 97%	Operational	Flushed
PL1638	Thames AR to Thurne	Umbilical	Control Umbilical	5	4.5	Trenched and buried; no free spans	Out of Use	Flushed
MEG Flowlines								
PL1636	Bure West to Thames AR	Umbilical	MEG line from Bure West to Thames AR	5	11.2	Trenched and buried to 98%	Operational	Chemical Cores Flushed, Hydraulic Cores hold Transaqua

2.4.2 Gawain Field Decommissioning Programme (DP2) Infrastructure

The Gawain Field is located in block 49/29a in the Southern North Sea, approximately 86 kilometres off the coast of Norfolk, north-east of Bacton. The Gawain pipeline delivers untreated wet gas to the Thames AW platform. The Gawain field is produced by three subsea wells. The three wells were drilled through a subsea manifold and produced gas is piped by a pipeline to the Thames platform.

Table 2.8 shows the infrastructure that will be decommissioned as part of the Gawain Field Decommissioning Programme (DP2).

Table 2.8: A Summary of the Infrastructure to be decommissioned as part of the Gawain Decommissioning Programme (DP2)

Infrastructure	Included in Gawain Decommissioning Programme (DP2)
Fields	Gawain
Number of Platforms	None
Number of Wells	3 Subsea Wells
Number of Subsea Installations	3 Wellheads 1 Manifold & Template 1 Wellhead Protection Structure
Number of Pipelines (gas)	1 (PL1057)
Number of Umbilicals, MEG lines and/or Flowlines	1 Umbilical (PL1058)

Wells

There are a total of three (3) wells that will be decommissioned as part of the Gawain Decommissioning Programme (DP2). All of these three wells are classed as 'subsea wells' and are situated beneath one WPS. The three wells were drilled through a subsea manifold and template.

Table 2.9 gives a summary of the three wells to be decommissioned for DP2.

Table 2.9: A Summary of Wells to be decommissioned as part of the Gawain Decommissioning Programme (DP2)

Subsea Wells					
Field	**UKCS Block**	**Associated Wellhead Protective Structures**	**Well Number**	**Well Type**	**Status**
Gawain	49/29	A single Wellhead Protection Structure for all three wells	49/29a-G1 (J2)	Gas Production	Producing
Gawain	49/29	A single Wellhead Protection Structure for all three wells	49/29a-G2 (J3)	Gas Production	Shut in
Gawain	49/29	A single Wellhead Protection Structure for all three wells	49/29a-G3 (J1)	Gas Production	Producing

The three subsea wells have a single subsea wellhead and manifold / template that will need to be decommissioned as part of the programme.

Wellheads, Wellhead Protection Structures and other Subsea Structures

There are three wellheads at the Gawain Field, all of which are situated under a single WPS. In addition, there is also both a manifold and subsea template located at Gawain, which will also be decommissioned as part of the Gawain Decommissioning Programme (DP2).

The WPS is over-trawlable and was installed by piling the legs into the seabed. The WPS weighs approximately 89 tonnes and was piled approximately 18 metres into the seabed. Figure 2.5 shows the WPS that is currently installed on the three subsea wells at Gawain.

The Gawain manifold is situated next to the wellheads (under the WPS) and weighs approximately 25 tonnes. The template is situated below the wellheads and weighs 30 tonnes.

Table 2.10 shows a summary of the wellheads, WPS and other subsea structures which will be decommissioned for the Gawain Decommissioning Programme (DP2).

Table 2.10: A Summary of the Wellheads, Wellhead Protection Structures and other Subsea Structures for the Gawain Decommissioning Programme (DP2)

Field(s) or Well(s)	Wellhead or Subsea Structure	Number	Weight (tonnes)
Gawain (wells: 49/29a-G1 (J2), 49/29a-G2 (J3) & 49/29a-G3 (J1))	Wellheads	3 (1 at each well)	17 each
Gawain	WPS	1	89
Gawain	Manifold	1	25
Gawain	Template	1	30

Figure 2.5: The Wellhead Protection Structure on the Three Gawain Subsea Wells

Stabilisation Materials

There are a number of stabilisation features that protect and stabilise infrastructure around the Gawain wellheads and the Gawain pipeline and umbilical. These include concrete mattresses, grout bags, frond mats and rock. Table 2.11 shows a summary of the expected stabilisation features that are situated around the Gawain wellhead and the Gawain pipeline and umbilical.

There has been a number of rock dumping operations that have taken place over the last 20 years, within the Thames Decommissioning Area. However, at the time of writing the amount of rock that has been deposited has not been able to be accurately quantified.

Table 2.11: A Summary of Stabilisation Material to be Decommissioned as Part of the Gawain Decommissioning Programme (DP2)

Stabilisation Features	Number	Weight (tonnes)	Location	Exposure
Concrete mattresses	61	640	Within 500m of manifold Outside 500m zone of manifold	28 exposed (estimated)
Grout bags	352	8.8	Within 500m of manifold	To be further assessed
Formwork	4	32.8	Umbilical protection at manifold	To be further assessed
Frond Mats	27	366	Within 500m of manifold	To be further assessed
Grout bags	225	5.6	Umbilical protection at Thames	To be further assessed
Formwork	1	535.6	Umbilical protection at Thames	To be further assessed

Pipelines, Umbilicals and Flowlines

For the Gawain Decommissioning Programme (DP2) there is one (1) pipeline and one (1) umbilical, both of which will be decommissioned.

Table 2.12 shows a summary of the Gawain pipeline and umbilical that will be decommissioned.

Table 2.12: A Summary of the Pipeline and Umbilical that will be decommissioned as Part of the Gawain Decommissioning Programme (DP2)

Pipeline Number	From and to End Points	Composition	Description	Nominal Diameter (inches)	Length (km)	Condition	Status	Contents
Pipelines (gas)								
PL1057	Gawain to Thames AW	Steel with concrete coating	12" Interfield line from Gawain to Thames AW	12	15.1	Trenched and buried to 99%	Operational	Flushed
Umbilical								
PL1058	Thames AW to Gawain	Umbilical	Umbilical from Thames AW to Gawain	5	15.4	Trenched and buried; no free spans	Operational	Flushed

2.4.3 Arthur Field Decommissioning Programme (DP3) Infrastructure

The Arthur Field is located in Block 53/02 in the Southern North Sea approximately 42 kilometres off the coast of Norfolk, east of Bacton and 28 kilometres south west of Thames field. The Arthur pipelines deliver wet gas to the Thames platform complex. The Arthur Field is produced by three subsea wells. Each well is tied back to a subsea manifold and then by a single pipeline to the Thames platform complex.

Table 2.13 shows the infrastructure that will be decommissioned as part of the Arthur Field Decommissioning Programme (DP3).

Table 2.13: A Summary of the Infrastructure to be decommissioned as part of the Arthur Decommissioning Programme (DP3)

Infrastructure	Included in Arthur Decommissioning Programme (DP3)
Fields	Arthur
Number of Platforms	None
Number of Wells	3 Subsea Wells
Number of Subsea Installations	3 Wellheads 1 Manifold 4 Wellhead Protection Structures (1 for each well and 1 for the manifold)
Number of Pipelines and Jumpers (gas)	4 (PL2047, PL2047JP1, PL2047JP2, PL2047JP3)
Number of Umbilicals, MEG lines and/or Flowlines	4 Umbilicals (PLU2048, PLU2048JP1, PLU2048JP2, PLU2048JP3)

Wells

There are a total of three (3) wells that will be decommissioned as part of the Arthur Decommissioning Programme (DP3). All of these three wells are classed as 'subsea wells' and all have an associated WPS. There is also a WPS that covers the Arthur manifold.

Table 2.14 gives a summary of the three wells to be decommissioned for DP3.

Table 2.14: A Summary of Wells to be decommissioned as part of the Arthur Decommissioning Programme (DP3)

Subsea Wells					
Field	**UKCS Block**	**Associated Wellhead Protective Structures**	**Well Number**	**Well Type**	**Status**
Arthur	53/02	Wellhead Protection Structure	53/2-11 (A1)	Gas Production	Producing
Arthur	53/02	Wellhead Protection Structure	53/2-12 (A2)	Gas Production	Producing
Arthur	53/02	Wellhead Protection Structure	53/2-13 (A3)	Gas Production	Shut in

Wellheads, Wellhead Protection Structures and other Subsea Structures

There are three wellheads at the Arthur Field, all of which have their own associated WPS. In addition, there is also a manifold (which also has a WPS) located at Arthur, which also will be decommissioned as part of the Arthur Decommissioning Programme (DP3).

The WPS are all over-trawlable and were installed by piling the legs into the seabed. Each WPS weighs 89 tonnes and all were piled approximately 18.5 metres into the seabed.

Figure 2.6 shows an example of the WPS that is currently installed on the three subsea wells and the Arthur manifold. The Arthur manifold is situated under a separate WPS and the manifold weighs approximately 23 tonnes.

Table 2.15 shows a summary of the wellheads, WPS and other subsea structures which will be decommissioned for the Arthur Decommissioning Programme (DP3).

Table 2.15: A Summary of the Wellheads, Wellhead Protection Structures and other Subsea Structures for the Arthur Decommissioning Programme (DP3)

Field(s) or Well(s)	Wellhead or Subsea Structure	Number	Weight (tonnes)
Arthur (wells: 53/2-11 (A1), 53/2-12 (A2) & 53/2-13 (A3))	Wellheads	3 (1 at each well)	17.5 each
Arthur	WPS	4 (one for each well and one for the manifold)	89 each
Arthur	Manifold	1	23

Figure 2.6: The Wellhead Protection Structure on the Three Arthur Subsea Wells and Manifold

Stabilisation Materials

There are a number stabilisation features that protect and stabilise around the Arthur wellheads and manifold. These include concrete mattresses, formwork and rock. Table 2.16 shows a summary of the expected stabilisation features that are situated around the Arthur wells, manifold, pipelines and umbilical. There has been a number of rock dumping operations that have taken place over the last 20 years, within the Thames Decommissioning Area. However, at the time of writing the amount of rock that has been deposited has not been able to be accurately quantified.

Table 2.16: A Summary of Stabilisation Material to be decommissioned as part of the Arthur Decommissioning Programme (DP3)

Stabilisation Features	Number	Weight (tonnes)	Location	Exposure
Concrete mattresses	140	1,470	Within 500m of manifold and wells Flowlines to/from Arthur manifold and each of the 3 wellheads	140 (estimated)
Formwork	1	42	Crossing between PL2047 and shell PL311	To be further assessed

Pipelines, Jumpers and Umbilicals

For the Arthur Decommissioning Programme (DP3) there are four (4) pipelines (including 3 jumpers) and four (4) umbilicals, all of which will be decommissioned.

Table 2.17 shows a summary of the Arthur pipelines and umbilicals that will be decommissioned.

Table 2.17: A Summary of the Pipelines and Umbilicals that will be decommissioned as part of the Arthur Decommissioning Programme (DP3)

Pipeline Number	From and to End Points	Composition	Description	Nominal Diameter (inches)	Length (km)	Condition	Status	Contents
Pipelines (gas) and Jumpers								
PL2047	Arthur to Thames AW	Steel	12” Interfield line from Arthur to Thames AW	12	30	Trenched and buried to 99.8%	Operational	Flushed
PL2047J P1	Arthur 1 to Arthur Manifold	Steel	8” well production line from 53/2-11 to Arthur	8	0.07	Trenched and buried; no free spans	Operational	Flushed
PL2047J P2	Arthur 2 to Arthur Manifold	Flexible pipe	8” well production line from 53/2-12 to Arthur	8	3.24	Trenched and buried; no free spans	Operational	Flushed
PL2047J P3	Arthur 3 to Arthur Manifold	Flexible pipe	8” well production line from 53/2-13 to Arthur	8	2.6	Trenched and buried; no free spans	Operational	Flushed
Umbilicals								
PLU2048	Arthur to Thames AW	Umbilical	Umbilical from Thames AW to Arthur	8	30	Trenched and buried to 99%	Operational	Flushed
PLU2048 JP1	Arthur 1 to Arthur Manifold	Umbilical	Chemical umbilical from Arthur 1 to Arthur Manifold	3	0.07	Trenched and buried; no free spans	Operational	Flushed
PLU2048 JP2	Arthur 2 to Arthur Manifold	Umbilical	Chemical umbilical from Arthur 2 to Arthur Manifold	3	3.3	Trenched and buried to 98%	Operational	Flushed
PLU2048 JP3	Arthur 3 to Arthur Manifold	Umbilical	Chemical umbilical from Arthur 3 to Arthur Manifold	3	2.6	Trenched and buried to 99.8%	Out of Use	Flushed

2.4.4 Horne & Wren Field Decommissioning Programme (DP4) Infrastructure

The Horne & Wren installation is located in Block 53/03 in the southern North Sea approximately 80 kilometres off the coast of Norfolk, east of Bacton and approximately 18 kilometres south west of Thames field. The Horne & Wren pipeline delivers wet gas to the Thames platform complex. The Horne & Wren Field is produced by two wells.

The Horne & Wren Platform is a normally unmanned installation (NUI) three-jacket gas complex with the topsides structure consisting of a cellar and a weather deck. There are no processing facilities on the platform; as it is essentially a wellhead platform only. Table 2.18 shows the infrastructure that will be decommissioned as part of the Horne & Wren Field Decommissioning Programme (DP4).

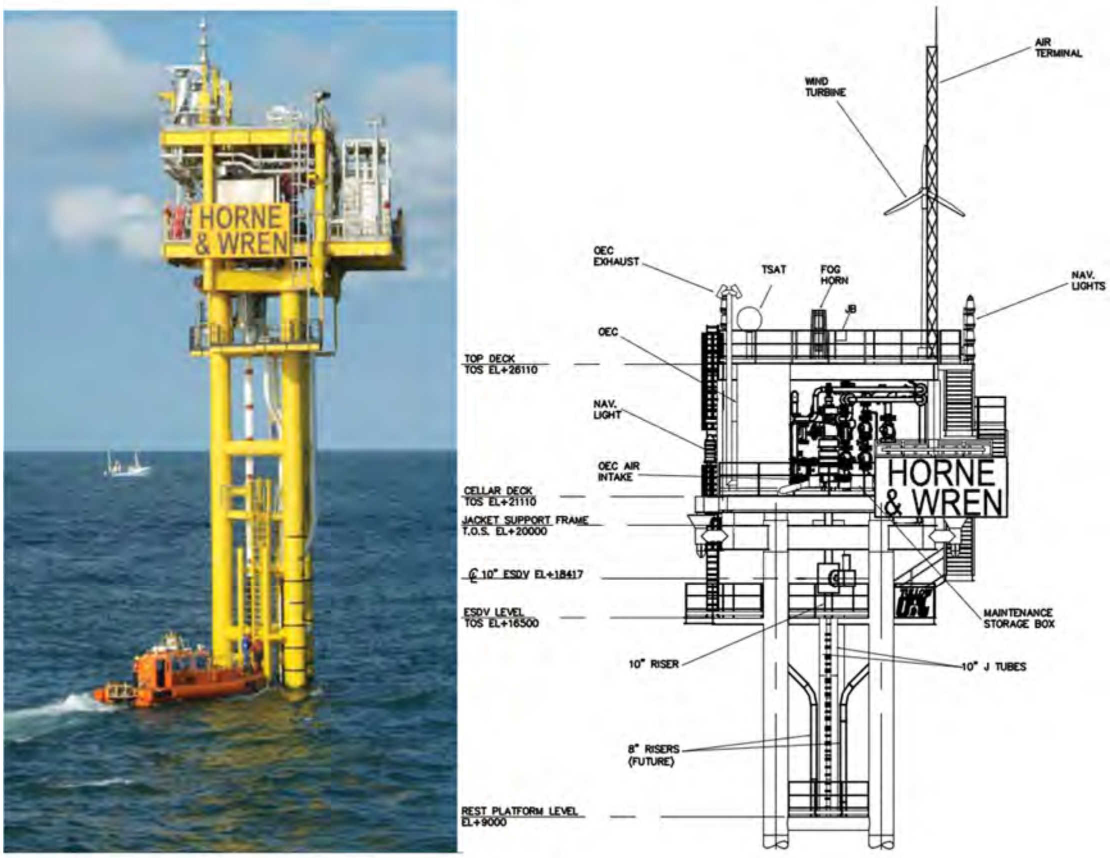
Table 2.18: A Summary of the Infrastructure to be decommissioned as part of the Horne & Wren Decommissioning Programme (DP4)

Infrastructure	Included in Horne & Wren Decommissioning Programme (DP4)
Field(s)	Horne & Wren
Number of Platforms	1 – Horne & Wren (Steel)
Number of Wells	2 Platform Wells
Number of Subsea Installations	None (besides the platform piles) Two 30 inch Conductors
Number of Pipelines (gas)	1 (PL2080)
Number of Umbilicals, MEG lines and/or Flowlines	1 MEG Line (PL2081)

The Horne & Wren Platform

The Horne & Wren installation is a three legged piled steel structure that provides surface access for well control. The platform is aligned over two preinstalled conductors with the wellhead and processing facilities tied back to the Thames Platform Complex. There is no separation or processing facilities and the platform is classed as an NUI. The platform consists of three main decks, Top Deck, Cellar Deck and ESDV Deck (Figure 2.7). It should be noted that the platform can only be accessed by boat and there are no helideck, crane or lifting facilities. Control of the platform from the Thames central hub is via a line of sight microwave, there is no umbilical between the two facilities.

Figure 2.7: The Horne & Wren Platform



The Horne & Wren Platform is approximately 90 tonnes (topside weight) steel structure in approximately 40.6 metres water depth above LAT. Table 2.19 shows a summary of information for the Horne & Wren Platform.

Table 2.19: A Summary of Information for the Horne & Wren Platform

Name	Facility Type	Topside		Jacket				Conductors	
		Weight (tonnes)	Modules	Weight (tonnes)	No. of legs	No of Piles	Weight of Piles (tonnes)	No.	Weight (tonnes)
Horne & Wren	Fixed steel jacket	90	1	455	3	3	316	2	120

The Cessation of Production (CoP) date was 14th May 2014. All options have been explored for continuing production but it was concluded that due to reduction of gas production by excessive water loading, operations were uneconomical, so CoP was declared in preparation for decommissioning.

Wells

There are a total of two (2) wells that will be decommissioned as part of the Horne & Wren Decommissioning Programme (DP4). Both of these wells are classed as 'platform wells' and are associated with the Horne & Wren Platform.

Table 2.20 gives a summary of the two wells to be decommissioned for DP4.

Table 2.20: A Summary of Wells to be decommissioned as part of the Horne & Horne Decommissioning Programme (DP4)

Platform Wells					
Field	**UKCS Block**	**Associated Wellhead Protective Structures**	**Well Number**	**Well Type**	**Status**
Horne & Wren	53/03	None	53/3c-9A	Gas Production	Producing
Horne & Wren	53/03	None	53/3c-8	Gas Production	Producing

Stabilisation Materials

There are a number stabilisation features that exist around the Horne & Wren Platform, pipelines, umbilical and MEG line. These include concrete mattresses and grout bags. Table 2.21 shows a summary of the expected stabilisation features that are situated around the Horne & Wren Platform, pipelines, umbilical and MEG line. There has been a number of rock dumping operations that have taken place over the last 20 years, within the Thames Decommissioning Area. However, at the time of writing the amount of rock that has been deposited has not been able to be accurately quantified.

Table 2.21: A Summary of Stabilisation Material to be decommissioned as part of the Horne & Wren Decommissioning Programme (DP4)

Stabilisation Features	Number	Weight (tonnes)	Location	Exposure
Grout bags	7	0.175	H&W Platform	To be further assessed
Concrete mattresses	69 Note 1	1,008	H&W and Wissey Platform and umbilical trench Various areas long the pipeline route	69 exposed
Grout bags	36	0.9	Various areas long the pipeline route	To be further assessed

Note 1: Eight concrete mattresses are on the Wissey pipeline but are covered by the Horne & Wren DP (DP4)

Pipelines, Umbilicals and Flowlines

For the Horne & Wren Decommissioning Programme (DP4) there are two (2) pipelines, one (1) umbilical and one (1) MEG line that will be decommissioned.

Table 2.22 shows a summary of the pipelines, umbilicals and MEG line that will be decommissioned.

Table 2.22: A Summary of Pipelines, Umbilicals and MEG line that will be decommissioned as part of the Horne & Wren Decommissioning Programme (DP4)

Pipeline Number	From and to End Points	Composition	Description	Nominal Diameter (inches)	Length (km)	Condition	Status	Contents
Pipelines (gas)								
PL2491	Wissey to Horne & Wren	Steel	Gas Flow line from the Wissey Facility	8	10.3	Trenched and buried to 99.9%	Operational	Flushed
PL2080	Horne & Wren to Thames AR	Steel	Gas Export Pipeline to Thames 49/28A facility	10	20.3	Trenched and buried; no free spans	Operational	Flushed
Umbilical								
PLU2492	Horne & Wren to Wissey	Umbilical	Control Umbilical	4	10.4	Trenched and buried; no free spans	Operational	Flushed
MEG Flowline								
PL2081	Thames AR to Horne & Wren	Steel	MEG / Corrosion Inhibitor	2.5	20.3	Trenched and buried; no free spans	Operational	Flushed

2.4.5 Orwell Field Decommissioning Programme (DP5) Infrastructure

The Orwell Field is located in Block 50/03 in the Southern North Sea approximately 110 kilometres off the coast of Norfolk, east of Bacton and 30 kilometres west of Thames field. The Orwell pipeline delivers wet gas to the Thames platform complex. The Orwell Field is produced by three subsea wells. Each well is comingled via a spool within the seabed structure and then by a single pipeline to the Thames platform complex, which is buried for most of its length and covered by concrete mattresses.

Table 2.23 shows the infrastructure that will be decommissioned as part of the Orwell Field Decommissioning Programme (DP5).

Table 2.23: A Summary of the Infrastructure to be decommissioned as part of the Orwell Decommissioning Programme (DP5)

Infrastructure	Included in Orwell Decommissioning Programme (DP5)
Fields	Orwell
Number of Platforms	None
Number of Wells	3 Subsea Wells
Number of Subsea Installations	3 Wellheads 1 Wellhead Protection Structure (for all 3 wells and the template) 1 Template
Number of Pipelines (gas)	1 (PL931)
Number of Umbilicals, MEG lines and/or Flowlines	1 Umbilical (PL933) 1 MEG line (PL932)

Wells

There are a total of three (3) wells that will be decommissioned as part of the Orwell Decommissioning Programme (DP5). All of these three wells are classed as ‘subsea wells’ and all situated under a single WPS. In addition to the wellheads, there is also a subsea template that is also situated under the Orwell WPS. Controls for all three wells are provided via a single umbilical from the Thames central hub.

Table 2.24 gives a summary of the three wells to be decommissioned for DP5.

Table 2.24: A Summary of Wells to be decommissioned as part of the Orwell Decommissioning Programme (DP5)

Subsea Wells					
Field	**UKCS Block**	**Associated Wellhead Protective Structures**	**Well Number**	**Well Type**	**Status**
Orwell	50/03	Wellhead Protection Structure (a single structure for all 3 wells)	50/26a-D1	Gas Production	Shut In
Orwell	50/03	Wellhead Protection Structure (a single structure for all 3 wells)	50/26a-D2	Gas Production	Shut In
Orwell	50/03	Wellhead Protection Structure (a single structure for all 3 wells)	50/26a-D3	Gas Production	Shut In

Wellheads, Wellhead Protection Structures and other Subsea Structures

There are three wellheads at the Orwell Field, all of which are situated underneath a single WPS. In addition, there is also a subsea template (which is also situated under the WPS) located at Orwell, which also will be decommissioned as part of the Orwell Decommissioning Programme (DP5).

The WPS is over-trawlable and was installed by piling the legs into the seabed. The WPS weighs approximately 200 tonnes and all were piled approximately 18 metres into the seabed.

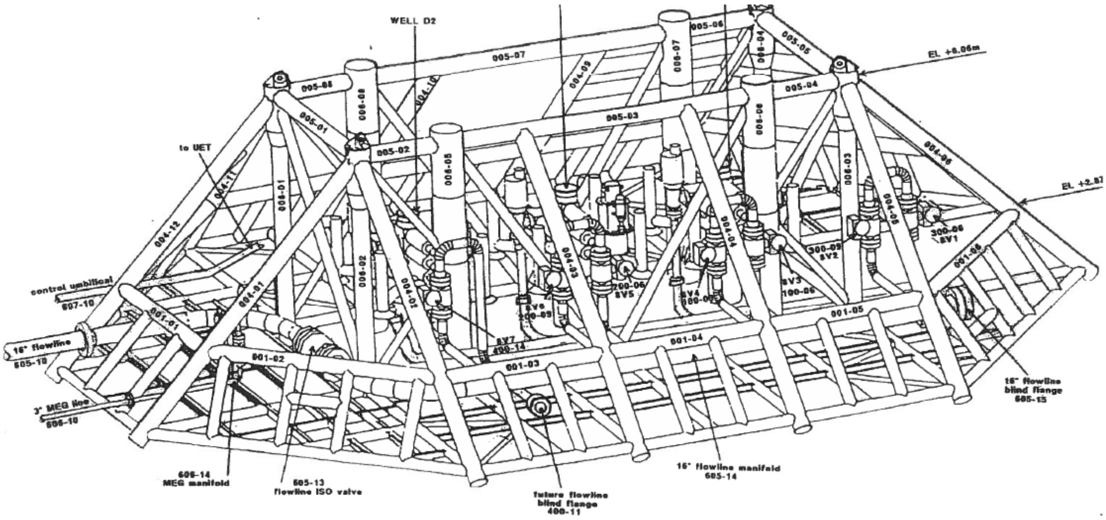
Figure 2.8 shows the WPS that is currently installed on the three subsea wells and Orwell template. The Orwell template weighs approximately 250 tonnes.

Table 2.25 shows a summary of the wellheads, WPS and other subsea structures which will be decommissioned for the Orwell Decommissioning Programme (DP5).

Table 2.25: A Summary of the Wellheads, Wellhead Protection Structures and other Subsea Structures for the Orwell Decommissioning Programme (DP5)

Field(s) or Well(s)	Wellhead or Subsea Structure	Number	Weight (tonnes)
Orwell (wells: 50/26a-D1, 50/26a-D2 & 50/26a-D3)	Wellheads	3 (1 at each well)	50 for all three
Orwell	WPS	1	200
Orwell	Template	1	250

Figure 2.8: The Wellhead Protection Structure on the Three Orwell Subsea Wells and Template



Stabilisation Materials

There are a number stabilisation features that protect and stabilise around the Orwell wellheads, template, pipeline, umbilical and MEG Line. These include grout bags and frond mats. Table 2.26 shows a summary of the expected stabilisation features that are situated around the Orwell wellheads, template, pipeline, umbilical and MEG Line. There has been a number of rock dumping operations that have taken place over the last 20 years, within the Thames Decommissioning Area. However, at the time of writing, the amount of rock that has been deposited has not been able to be accurately quantified.

Table 2.26: A Summary of Stabilisation Material to be decommissioned as part of the Orwell Decommissioning Programme (DP5)

Stabilisation Features	Number	Weight (tonnes)	Location	Exposure
Frond Mats	57	600	Within the 500m zone Outwith the 500m zone at Orwell	To be further assessed
Grout Bags	50	1.25	Within the 500m zone	To be further assessed
Grout Bags	50	1.25	Outwith the 500m zone at Orwell	To be further assessed

Pipeline, Umbilical and MEG Line

For the Orwell Decommissioning Programme (DP5) there is (1) pipeline, one (1) umbilical and one (1) MEG line, all of which will be decommissioned.

Table 2.27 shows a summary of the Orwell pipeline, umbilical and MEG line that will be decommissioned.

Table 2.27: A Summary of the Pipeline, Umbilical and MEG line that will be decommissioned as part of the Orwell Decommissioning Programme (DP5)

Pipeline Number	From and to End Points	Composition	Description	Nominal Diameter (inches)	Length (km)	Condition	Status	Contents
Pipeline (gas)								
PL931	Orwell to Thames AW	Steel	Gas Export Pipeline to Thames 49/28A facility	16	35	Trenched and buried to 99.9%	Out of Use	Flushed
Umbilical								
PL933	Thames AW to Orwell	Umbilical	Control Umbilical	4	35.0	Trenched and buried to 99.9%	Out of Use	Flushed
MEG Line								
PL932	Thames AW to Orwell	Steel	MEG	3	35	Trenched and buried; no free spans	Out of Use	Flushed

2.4.6 Wissey Field Decommissioning Programme (DP6) Infrastructure

The Wissey Field is located in Block 53/04 in the Southern North Sea approximately 120 kilometres off the coast of Norfolk, east of Bacton and approximately 40 kilometres south east of Thames field. The Wissey pipeline delivers wet gas to the Thames platform complex, via the Horne & Wren Platform. The pipelines and umbilical associated with the Wissey Field are all covered by the Horne & Wren Decommissioning Programme (DP4). The Wissey Field is produced by a single subsea well, which pumps gas, by a single pipeline, to the Thames platform complex (via Horne & Wren).

Table 2.28 shows the infrastructure that will be decommissioned as part of the Wissey Field Decommissioning Programme (DP6).

Table 2.28: A Summary of the Infrastructure to be decommissioned as part of the Wissey Decommissioning Programme (DP6)

Infrastructure	Included in Wissey Decommissioning Programme (DP6)
Fields	Wissey
Number of Platforms	None
Number of Wells	1 Subsea Well
Number of Subsea Installations	1 Wellhead 1 Wellhead Protection Structure
Number of Pipelines (gas)	1 (PL2491)
Number of Umbilicals, MEG lines and/or Flowlines	1 Umbilical (PLU2492)

Wells

There is one (1) well that will be decommissioned as part of the Wissey Decommissioning Programme (DP6). The well is classed as a 'subsea well' and is situated under a single WPS.

Table 2.29 gives a summary of the Wissey well to be decommissioned for DP6.

Table 2.29: A Summary of the Well to be decommissioned as part of the Wissey Decommissioning Programme (DP6)

Subsea Wells					
Field	UKCS Block	Associated Wellhead Protective Structures	Well Number	Well Type	Status
Wissey	53/04	Wellhead Protection Structure	53/4d-11	Gas Production	Shut In

Wellheads, Wellhead Protection Structures and other Subsea Structures

There is one wellhead at the Wissey Field, which is situated underneath a single WPS.

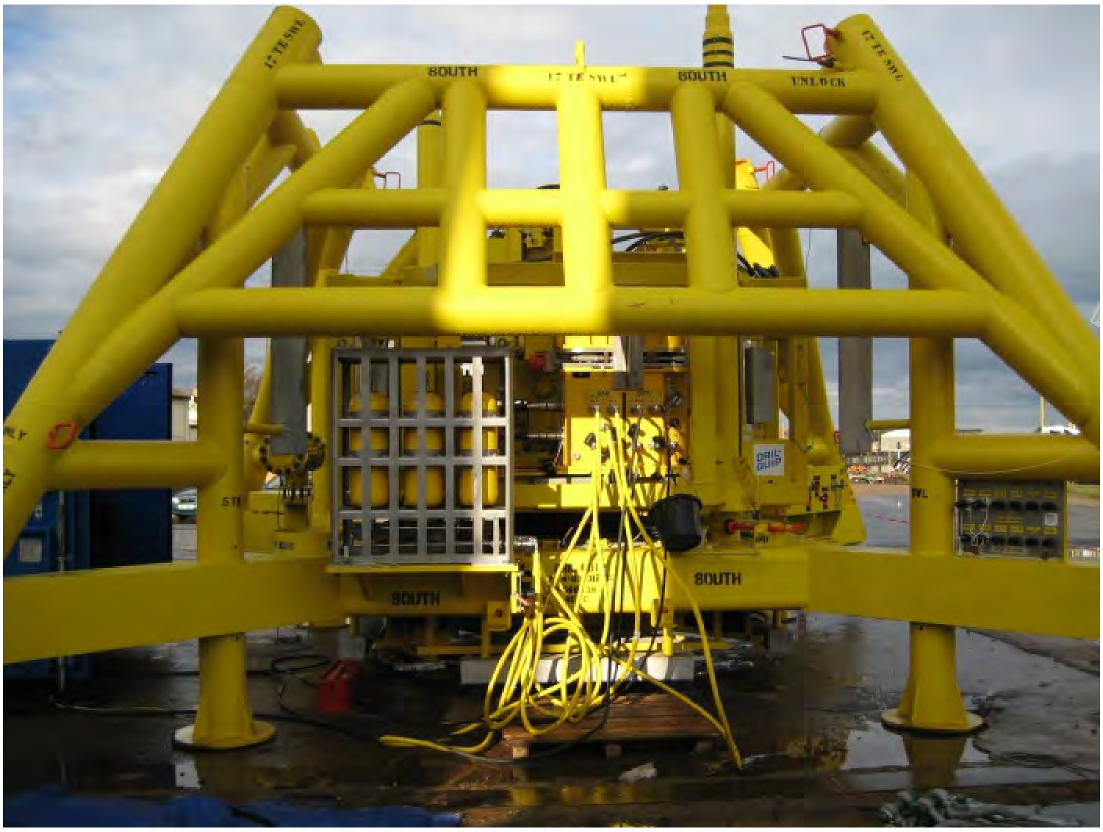
The WPS is over-trawlable and was installed by piling the legs into the seabed. The WPS weighs approximately 100 tonnes and all legs were piled approximately 12-15 metres into the seabed.

Figure 2.9 shows the WPS that is currently installed on the Wissey subsea well. Table 2.30 shows a summary of the wellhead and WPS, which will be decommissioned for the Wissey Decommissioning Programme (DP6).

Table 2.30: A Summary of the Wellheads, Wellhead Protection Structures and other Subsea Structures for the Wissey Decommissioning Programme (DP6)

Field(s) or Well(s)	Wellhead or Subsea Structure	Number	Weight (tonnes)
Wissey (well: 53/4d-11)	Wellhead	1	100 (for both)
Wissey	WPS	1	

Figure 2.9: The Wellhead Protection Structure on the Wissey Subsea Well



Stabilisation Materials

There are a number of concrete mattresses that protect and stabilise around the Wissey wellhead. Table 2.31 shows a summary of the expected stabilisation features that are situated around the Wissey well.

Table 2.31: A Summary of Stabilisation Material to be decommissioned as part of the Wissey Decommissioning Programme (DP6)

Stabilisation Features	Number	Weight (tonnes)	Location	Exposure
Concrete mattresses	27	157	Wissey Platform and umbilical trench	20 exposed

2.4.7 Thurne Field Wellhead

The Thurne Field is located in Block 49/28 in the Southern North Sea approximately 50 kilometres off the coast of Norfolk, east of Bacton and approximately 10 kilometres west of Thames field. The Thurne Field is produced by a single subsea well, which used to pump gas, by a single pipeline, to the Thames platform complex. The well is no longer in service and has been shut in. The Thurne infrastructure (pipelines and WPS) are covered by the Thames decommissioning programme (DP1), however the Thurne wellhead is subject to removal by Tullow.

Wells

There is one (1) well that will be decommissioned at Thurne. The well is classed as a 'subsea well' and is situated under a single WPS.

Table 2.32 gives a summary of the Thurne well to be decommissioned.

Table 2.32: A Summary of the Thurne Well to be decommissioned

Subsea Wells					
Field	**UKCS Block**	**Associated Wellhead Protective Structures**	**Well Number**	**Well Type**	**Status**
Thurne	49/28	Wellhead Protection Structure (covered in DP1)	49/28a-20	Gas Production	Shut In

Wellhead

There is one wellhead at the Thurne Field, which is situated underneath a single WPS. The WPS will be decommissioned as part of the Thames decommissioning programme DP1.

Table 2.33 shows a summary of the wellhead that will be decommissioned at Thurne.

Table 2.33: A Summary of the Wellhead for the Thurne Field

Field(s) or Well(s)	Wellhead or Subsea Structure	Number	Weight (tonnes)
Thurne (well: 49/28)	Wellhead	1	100

Stabilisation Materials

There are a number of stabilisation features that protect and stabilise around the Thurne wellhead. These are included the Thames decommissioning programme (DP1).

Pipeline and Umbilical

The Thurne pipeline, umbilical and pipeline stabilisation material are all included in the Thames decommissioning programme (DP1).

2.5 Drill Cuttings at the Thames Infrastructure Area

During the Thames area site survey, there was no evidence of drill cuttings in the immediate vicinity of any of the wells or infrastructure (*Osiris, 2013*). This is consistent with the high energy environment of the southern North Sea. Drill cuttings that were generated during drilling activity are considered to have been disturbed widely during drilling due to the local currents. This is further supported by low barium levels detected at all stations (*Osiris, 2013*). There are no advisory contamination levels for barium, which is a relatively inert metal that is widely used in drilling muds to add weight, and can therefore be used as an indicator for possible contamination by drilling activities (including cuttings piles). However, the distribution of barium at between 6 and 36 ppm suggests that there are no ‘hot spots’ and likely results from wider drilling activities followed by natural dispersal in the southern North Sea region (*Osiris, 2013*).

2.6 Project Schedule

It is currently envisaged that decommissioning activities will begin to take place in Q3 2014 and last for approximately 60 months (although this is not concurrently).

Figure 2.10a and 2.10b shows the Project Schedule for all 6 Decommissioning Programmes.

Figure 2.10a: The Thames Area Project Schedule (for Perenco Decommissioning Programmes)

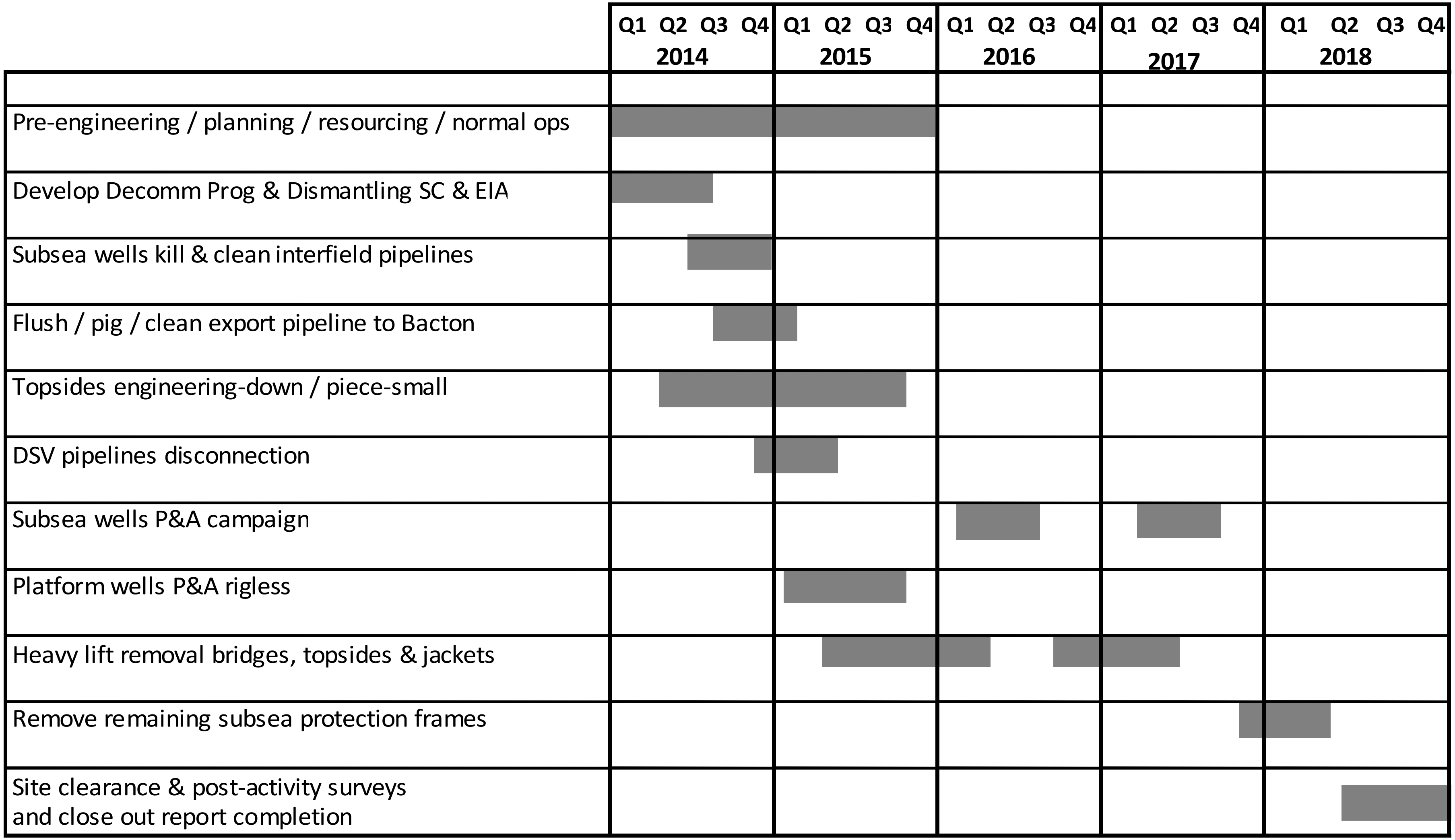


Figure 2.10b: The Thames Area Project Schedule (for Tullow Decommissioning Programmes)

2.7 Inventory of Materials

During the decommissioning of the Thames Area infrastructure, there will be a wide range of materials that will need to be processed and, where possible, recycled. Table 2.35 gives a summary of the expected materials to be decommissioned. Everyday facilities and equipment within the installations will be stripped from the installation topsides in advance to prepare for decommissioning so that the only material remaining on the topsides will be steel. The topsides of platforms have been designed to minimise hydrocarbon inventories, therefore normal shutdown procedures will be employed to make the assets hydrocarbon free. Where possible, Perenco and Tullow will endeavour to ensure that materials and equipment will be re-used or recycled onshore. This will be in accordance with the waste hierarchy principles and Perenco's waste management principles. As this will be undertaken prior to the decommissioning of the installations themselves, they are not included in Tables 2.34 and 2.35.

There are no issues with toxic gases such as hydrogen sulphide (H_2S) or carbon monoxide (CO) and well fluids have reported no carbon dioxide (CO_2). There should be a minimal build-up of sands on the topsides therefore a very small quantity of produced solids on the topsides should require disposal.

Table 2.34: A Summary of the Expected Materials from the Thames Area Project

<table>
<tr><th>Item</th><th>Material</th><th>Total Weight (tonnes)</th></tr>
<tr><td>Topsides (Thames and Horne & Wren) including bridges</td><td>Steel</td><td>8,929</td></tr>
<tr><td rowspan="2">Jackets, conductors and piles (Thames and Horne & Wren)</td><td>Steel</td><td>3,225</td></tr>
<tr><td>Cement</td><td>2,489</td></tr>
<tr><td>Wellheads / Risers</td><td>Steel</td><td>472</td></tr>
<tr><td>Wellhead Protection Structures</td><td>Steel</td><td>1,055</td></tr>
<tr><td>Other Subsea Structures (i.e. manifold / template)</td><td>Steel</td><td>373</td></tr>
<tr><td>Subsea Stabilisation Materials – Concrete Mattresses (based on 426 mattresses)</td><td>Concrete</td><td>4,629</td></tr>
<tr><td rowspan="4">Subsea Stabilisation Materials (except concrete mattresses i.e. frond mattresses, form work and grout bags)</td><td>Concrete</td><td>1,237</td></tr>
<tr><td>Steel</td><td>610</td></tr>
<tr><td>Plastic</td><td>30 (Polypropylene rope frond mats)</td></tr>
<tr><td>Rock</td><td>13,000</td></tr>
<tr><td rowspan="4">Pipelines</td><td>Steel</td><td>34,250</td></tr>
<tr><td>Plastic</td><td>-</td></tr>
<tr><td>Aluminium</td><td>-</td></tr>
<tr><td>Concrete</td><td>78,216</td></tr>
</table>

Item	Material	Total Weight (tonnes)
	Copper	-
	Chemicals	No chemicals for pipelines
	Hydrocarbons	4
Umbilicals (including MEG lines)	Steel	425
	Plastic	105
	Aluminium	N/A
	Copper	20
	Lead	156
	Chemicals	Negligible
	Hydrocarbons	N/A
Cladding	Plastic	20
Batteries and cables	Metal	62 (copper cable) 16 (Nickel-Cadmium batteries)

The proposed fate of the recoverable decommissioning materials from the Thames Area Project is shown in Table 2.35. Table 2.36 shows the estimated amount materials that will remain in-situ. At the time of writing this ES, Perenco cannot estimate the amount of rock that has been dumped within the Thames Decommissioning area and therefore although all rock will remain in-situ, no estimates on the amounts are presented.

Naturally Occurring Radioactive Material (NORM) is present within the earth's crust and can be concentrated and enhanced by oil and gas recovery as it may be present in drilling sludges, muds and pipe scale and accumulate in dead spaces in equipment over time (*OGP, 2008*). During decommissioning this material will be disposed of separately (Refer to Section 2.8.6)

Any waste that arises from the decommissioning of Thames will be treated and disposed of in accordance with all relevant legislation and company policy. Wastes will be categorised and handled in a manner that will minimise the threat to personnel and the environment. In order to maximise the reuse and recycle rate of platform wastes, Perenco will minimise the volume of materials destined for incineration/landfall. Materials will be segregated for ease of handling and to reduce the energy used when transporting different materials to their respective recycling, reuse or disposal facilities. Each waste stream will be assessed individually in order to implement the most favourable option.

Table 2.35: A Summary of the Proposed Fate of the Decommissioning Materials from the Thames Area Project

Material	Total Weight to be Recovered (tonnes)	Proposed Fate (tonnes)		
		Recycle	Disposal	Reuse
Steel	14,664	>90%	<5%	<5%
Plastic	50	>85%	<10%	<5%
Concrete	4,629 Note 1	-	100%	-
Cement	2,489	0	100%	0
Copper	62	>95%	0	<5%
Lead	-	-	-	-
Chemicals	0.1	N/A	100%	N/A
Hydrocarbons	4	0	100%	0
Other Metals	16	>95%	0	<5%

Note 1: This value assumes that all of the concrete mattresses (426 mattresses) will be removed from the seabed. This is the assumption for the impact assessment, however an attempt to remove the mattresses safely will be made and where this is not possible a proposal will be made to DECC.

Table 2.36: A Summary of the Decommissioning Materials from the Thames Area Project that will remain *in-situ*

Material	Total Weight to remain in-situ (tonnes)
Steel	34,675
Plastic	105
Concrete	78,216
Cement	-
Rock	13,000
Copper	20
Lead	156
Chemicals	-
NORM Scale	-
Hydrocarbons	-
Other Metals	-

2.8 Decommissioning Options for the Pipelines, Umbilicals and MEG lines

2.8.1 Introduction

Under the terms of OSPAR Decision 98/3, there is a prohibition on the dumping and leaving, wholly or partly in place, of offshore installations. The topsides of all installations must be returned to shore. All steel installations with a jacket weight less than 10,000 tonnes, as is the case for the Thames and Horne & Wren Platforms, must also be completely removed for reuse, recycling or final disposal on land. Subsea installations (including wellhead protection structures) also fall within the definition of a steel or concrete installation and must be completely removed for reuse, recycling or final disposal on land.

Therefore, all of the subsea structures that lie within the Thames Area Decommissioning Project (i.e. platforms, jackets, wellheads, WPS etc.) will be completely removed from the seabed and returned to shore for recycling and / or disposal.

However, the provisions of OSPAR Decision 98/3 do not cover pipelines, MEG lines and umbilicals. Instead, a Comparative Assessment (CA) was undertaken on 16th October 2013 to assess all feasible decommissioning options, which fall within the scope of the Thames Area Decommissioning Project.

This section presents the options that were considered and the results of the CA. The full description of the CA methodology is given in the Thames Area Decommissioning Project Comparative Assessment document (document reference: P1064CA), however a summary has been provided below.

2.8.2 Comparative Assessment Methodology

The methodology used for the CA workshop was developed by Perenco and based upon the guidance provided in the DECC Guidance Notes (*DECC, 2011a*).

The following five options for decommissioning of the pipelines, MEG lines and umbilicals were assessed in the workshop:

1. Completely remove the line(s);
2. Trench and bury the exposed / uncovered areas of the line(s);
3. Rock dump the line in specific areas where the line is uncovered;
4. Partial removal of uncovered sections of the line;
5. Leave in situ with continuous monitoring.

Each decommissioning option was scored against a set of assessment criteria using the following five categories:

1. Safety;
2. Environmental;
3. Technical;
4. Societal;
5. Commercial;

An overall comparative score was then generated for each decommissioning option to allow for a comparison of options. Generally, the lower the overall comparative score the more favourable the option.

Legal compliance was not assessed, as any of the chosen methodologies will require regulatory approval before proceeding.

2.8.3 Summary of the Comparative Assessment Results

As outlined in the DECC guidance notes it is recommended that the following decommissioning options should be considered for pipelines:

1. Re-Use

The potential for reuse of the Thames Decommissioning project pipelines, MEG lines and umbilicals in connection with further hydrocarbon developments or with other existing projects (such as hydrocarbon storage and carbon capture and storage) was initially explored by Perenco and Tullow, however, no suitable opportunities could be identified. However, due to the age of the pipelines and the technical issues with re-use, Perenco and Tullow deemed this option not feasible. Therefore, the option to re-use is no longer considered within the CA.

2. Leave *in-situ*

The DECC guidance notes recommend the following pipelines (inclusive of any "piggyback" lines and umbilicals that cannot easily be separated) may be considered for in-situ decommissioning:

- Those which are adequately buried or trenched and which are not subject to development of spans and are expected to remain so;
- Those which were not buried or trenched at installation but which are expected to self-bury over a sufficient length within a reasonable time and remain so buried;
- Those where burial or trenching of the exposed sections is undertaken to a sufficient depth and it is expected to be permanent;
- Those which are not trenched or buried but which nevertheless are candidates for leaving in place if the comparative assessment shows that to be the preferred option (e.g. trunk lines);
- Those where exceptional and unforeseen circumstances due to structural damage or deterioration or other cause means they cannot be recovered safely and efficiently.

As a base case, regardless of the fate of the lines, Perenco and Tullow are committed to flushing all gas pipelines to reduce hydrocarbon content to as low as reasonably practicable (ALARP). MEG lines and umbilicals will be flushed where possible, otherwise chemical cores will be left in-situ.

3. Remove

Small diameter pipelines, including flexible flowlines and umbilicals which are neither trenched nor buried should normally be entirely removed. The removal of a pipeline or remedial actions should be performed in such a way as to cause no significant adverse effects upon the marine environment.

2.8.4 Comparative Assessment Conclusions

The CA workshop concluded that the following decommissioning option was considered to be the most appropriate for the pipelines, MEG lines and umbilicals:

- All pipelines and umbilicals (including MEG lines, flowlines and jumpers) will be left *in situ* and subject to continuous monitoring.

This was based on the ranking of each of the options listed in Section 2.7.2 (the results of which can be found in Appendix D). During the site survey, the majority of the pipelines were found to be buried, with a small percentage of exposed areas (usually less than three per cent). However two pipelines; the Thames export pipeline and Bure West to Thames, were found to have 9 per cent and 4.5 per cent of its length exposed, respectively (refer to Section 2.4).

Therefore the majority of the pipelines and associated protective structure were considered to be suitably buried. As discussed in Section 2.4, the majority of the pipelines have already been flushed. All pipelines, MEG lines and umbilicals will be disconnected from the wells and cleaned (by pigging and chemical cleaning) and flushed. As all of the pipelines have been used for gas / condensate, the cleaning requirements are not expected to be extensive therefore flushing is considered to be sufficient (*Xodus Group, 2013*). Although there are no specific cleanliness criteria for pipelines, previous decommissioning projects ion the North Sea have aimed for an oil in water content of <30 milligrams per litre (*Xodus Group, 2013*).

Given that some of the pipelines pass through protected areas (*Perenco, 2014*), and that they are suitably buried along the majority of their route, removal of the pipelines, MEG lines and umbilicals would cause greater seabed disturbance and would have greater emissions associated with it when compared to leaving them *in situ*.

2.9 Selected Removal and Decommissioning Options

2.9.1 Introduction

This section presents the proposed programme of work that will be conducted offshore to decommission the entire Thames infrastructure.

It is proposed that with the exception of the decommissioning of the subsea wells, all decommissioning activities will be conducted by the use of a either a Heavy Lift Vessel (HLV) or a Super Heavy Lift Vessel (SHLV), and Dive Support Vessel (DSV). Other support vessels will also be required, such as a heavy left barge and tugs.

At the time of writing this ES, Perenco and Tullow were yet to finalise competitive tenders for the decommissioning work and therefore the final decommissioning methodology may vary depending on the contractor selected.

2.9.2 Platform Topsides Decommissioning (DP1 & DP4)

For the Thames and the Horne & Wren platform topsides, the infrastructure will be removed by the use of a HLV or SHLV and other support vessels such as a heavy barge.

There are currently three methods of removal that could be deployed to remove the platform topsides, these are:

- Single lift removal by SHLV/HLV - Removal of topsides as complete units and transportation to shore for re-use of selected equipment, recycling, break up and/or disposal;
- Modular removal and re-use/recycle by HLV - Removal of parts/modules of topsides for transportation and reuse in alternate location(s) and/or recycling/disposal;
- Offshore removal ‘piece small’ for onshore reuse/disposal - Removal of topsides by breaking up offshore and transporting to shore using work barge. Items will then be sorted for re-use, recycling or disposal.

A final decision on the decommissioning method will be made following a commercial tendering process. It is likely that for all topsides, a combination of the above the methods will be deployed to provide the optimum safety/cost solution.

No matter which method of decommissioning is chosen, the topside materials will be brought to shore (be it in the UK or Europe) for appropriate disposal and recycling where possible. Perenco and Tullow have actively sought to identify potential options where the topsides could be reused, however to date no such options have been identified.

2.9.3 Jackets (DP1 and DP4)

Both platform jackets will be removed from the seabed piles. The jacket legs will be cut just underneath the topsides and then severed from the piles (made below the seabed level at such a depth to ensure that any remains are unlikely to become uncovered). The jackets will then be removed and transported to shore for cleaning, disposal and potential recycling. The remaining piles, which will be cut below natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered, will remain *in situ*.

The final methodology detailing how the jackets will be severed from the piles and removed will be decided once detailed engineering studies and contractor selection have been completed.

However, there are two main methods of severance; using either a cutting tool to sever the jackets (such as a grit-cutter) or by the use of explosives. As detailed engineering design is yet to be completed, both methods could be employed for the Thames and / or Horne & Wren jackets.

If explosives are required, and as part of the programme to manage the potential environmental impacts of decommissioning, the JNCC guidelines on minimising the risk of disturbance and injury to marine mammals would be followed (see section 7)

Either method will require the use of a HLV and DSV, with crew and equipment of the chosen method.

2.9.4 Wellheads, WPS and other Subsea Structures Decommissioning

As all of the WPS are piled into the seabed, they will also need to be removed from their seabed piles. As with the jacket legs, the WPS legs will be severed from the piles (usually below natural seabed level at such a depth to ensure that any remains are unlikely to become uncovered) before removal. The WPS will then be removed and transported to shore for cleaning, disposal and potential recycling. Perenco and Tullow will actively seek to find a reuse for the WPS.

The final methodology detailing how the WPS will be severed from the piles and removed will be decided once detailed engineering studies and contractor selection have been completed.

However, there are two main methods of severance; using either a cutting tool to sever the legs or by the use of explosives. As detailed engineering design is yet to be completed, both methods could be employed for the removal of all of the WPSs.

The Wissey WPS is integral to the tree and will therefore be removed during plug and abandonment tree recovery (*Xodus, 2013*). The Orwell template and WPS were rig installed and therefore will need to be removed with the aid of a rig in order to avoid heavy lifting over live wells. A DSV is required to remove the Thurne WPS.

Two 30 inch conductors on the Horne & Wren platform will be cut to three metres below the seabed by the well P&A contractor. This will also be undertaken with a HLV.

Wellheads and other subsea structures (i.e. manifolds) will be removed from the seabed and taken back to shore for disposal and / or possible recycling.

All methods of removal will require the use of a DSV, with crew and equipment of the chosen method. Other support vessels may also be required, as necessary.

2.9.5 Stabilisation Material Decommissioning Excluding Concrete Mattresses

The stabilisation materials (except concrete mattresses, i.e. rock, frond mats, formwork and grout bags), that are situated around the wells and pipelines, will be assessed for integrity and burial depth.

The status of materials will be further assessed and remedial action considered. However, it is anticipated that the majority of this type of material will be left *in-situ*.

2.9.6 Stabilisation Material – Concrete Mattresses

The concrete mattresses that are situated around the wells and on pipelines, will be assessed for integrity and burial depth. The status of materials will be further assessed and remedial action considered.

An attempt to remove the mattresses safely will be made and where this is not possible a proposal will be made to DECC.

For the purposes of a 'worst-case' (in terms of seabed disturbance and atmospheric emissions) environmental impact assessment, this EIA will assess the impact of removing all of the concrete mattresses.

2.9.7 NORM (Naturally Occurring Radioactive Material)

Any NORM-contaminated material returned to shore will be treated, recycled or disposed of as appropriate. The selected contractor will have the experience and management procedures in place to handle and dispose of the NORM in a responsible way and in accordance with the relevant legislation. Generally, special wastes will be transported from the site in sealed containers. Procedures for NORM, low specific activity (LSA) scale and radioactive components will be in accordance with company procedures.

2.10 Well Decommissioning

All of the twenty two (22) wells will be plugged and abandoned in accordance with Oil and Gas UK Guidelines for the suspension and abandonment of wells. A PON5, chemical permit application and an MCAA Application will be submitted at a later date in support of any such work that is to be carried out.

Table 2.37 shows the expected method of decommissioning for all of the twenty two (22) Thames Area Decommissioning Project wells. It is expected that the majority of the wells will be decommissioned by the use of a Jack-up drilling rig (such as the Ensco 80).

Table 2.37: A Summary of the chosen Decommissioning method for the Thames Area Decommissioning Project wells

Well Type	Well Numbers	Decommissioning Method
Platform Wells (Thames)	49/28-A1, 49/28-A2, 49/28-A3, 49/28-A4, 49/28-A6,	'Rigless' 'through-completion' abandonment
Platform Wells (Horne & Wren)	53/3c-9A & 53/3c-8	Requires a Jack Up Drilling Rig
Subsea Wells	49/28-8, 49/28-18, 49/28-13, 49/28-A5, 49/29a-G1 (J2), 49/29a-G2 (J3), 49/29a-G3 (J1), 53/2-11 (A1), 53/2-12 (A2), 53/2-13 (A3), 50/26a-D1, 50/26a-D2, 50/26a-D3, 49/28a-20 & 53/4d-11	Requires a Jack Up Drilling Rig

2.10.1 The Drilling Rig

A Jack-up drilling rig will be used for the decommissioning of the majority of the Thames Area wells. The selected drilling rig for the decommissioning will be confirmed and stated in the Thames Area Decommissioning well intervention chemical permit applications, prior to operations.

However, for the purpose of assessing the environmental impacts from decommissioning activities, it has been assumed that the Ensco 80 (Figure 2.11) Jack-up drilling rig would be used for the activities.

The Ensco 80 is a three-legged Jack-up rig with a cantilever drilling derrick. The accommodation capacity of the Ensco 80 is 94 people. The rig is designed to operate in water depths up to 68 metres (225 feet). The Ensco 80 operational equipment comprises:

- A cantilever deck to position the derrick over the well;
- A 48 metre high derrick for suspending tubulars in the hole;
- A 3,000hp draw-works, brake, and cable for moving the tubulars into and out of the hole;
- Tanks for storage for mud and cement at 282 cubic metres.

Power total is 5,070 KW from 3 x Cat D-399 thermoacoustic (TA) engines each rated at 1,215 HP and 2 x Cat 3,516 engines each rated at 1,615 HP.

The Ensco 70 comprises a flat bottomed hull with three vertical legs fitting through openings on the outer hull. The legs are raised and lowered by a jacking mechanism on the deck that usually employs a hydraulic or electric rack and pinion arrangement. Prior to placement, the legs are jacked down onto the seabed with the hull raised on its legs above the water providing a stable platform. Excessive penetration by the legs into soft seabed is prevented by large round feet called "spud cans" at the bottom of the legs measuring 18 metres in diameter.

Whilst in position, a statutory 500 metre exclusion zone will be established around the rig, in accordance with safety legislation. Unauthorised vessels including fishing vessels will not be permitted access to the area. The drilling rig will be equipped with navigation lights, radar and radio communications. A stand-by vessel will patrol the 500 metre zone while the rig is on location. A Consent to Locate permit will also be required, which will be supported by a traffic survey and collision risk assessment as appropriate

Figure 2.11: The Ensco 80 Jack-Up Drilling Rig (*www.shipspotting.com*)

Well decommissioning will involve flushing and cleaning the wells, pulling completions to access the wellbores and placing permanent cement barriers at the appropriate depths according to the specific features of each well/reservoir. The Thames platform wells, fluids may be discharged into successive wells rather than discharged. Fluids from the final well, may be shipped to shore. The well abandonment is subject to applicable legislation (as detailed in a future well intervention chemical permit application).

2.11 Summary of chosen Decommissioning Options

Table 2.38 shows the chosen decommissioning options for the Thames Area Decommissioning Project.

Table 2.38: A Summary of the Chosen Decommissioning Outcome for the Thames Area Decommissioning Project

Infrastructure	Chosen Decommissioning Outcome
Platforms Topsides	Removal (by single, modular or offshore (small piece))
Jackets	Removal to shore
Wellhead Protection Structures	Removal to shore
Other Subsea Structures	Removal to shore
Wellheads	Removal to shore
Stabilisation Materials (except concrete mattresses)	Leave *in-situ*
Concrete Mattresses	Removal will be attempted [Note 1]
Pipelines, MEG lines and Umbilicals	Flush and leave *in situ*

Note 1: Further assessment of remedial actions will be undertaken

2.12 Decommissioning Emissions

During the Thames Area decommissioning operations, there will be a range of atmospheric and waste emissions from both the infrastructure materials and from the different decommissioning vessels used.

Atmospheric emissions from vessels result from power generation by burning diesel fuel. In addition to vessel atmospheric emissions, there will also be atmospheric emissions from the disposal, processing and / or recycling of the Thames Area infrastructure.

2.12.1 Decommissioning Operations Emissions

Table 2.39 shows the vessel type, estimated diesel usage, waste generated and the estimated time on location for the proposed Thames Area Decommissioning Project.

The atmospheric emissions from the decommissioning vessel operations are detailed in Section 8.

Table 2.39: Total Emissions and Discharges from Vessels during the Thames Area Decommissioning Project

Decommissioning Activity Description	Approximate Duration (days)	Rig/Vessel Type	Aspect	Estimated Quantity Disposed or Discharged (tonnes)	Fate
Platforms, Jackets and Platform wells (Thames and Horne and Wren)	112	Super Heavy Lift Vessel (SHLV)[1]	Power Generation (diesel burnt)	3,360	Emitted to atmosphere
			Waste Water (sewage and grey water)	1,680	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Platforms, Jackets and Platform wells (Thames and Horne and Wren)	112	Supply Vessel for the SHLV[2]	Power Generation (diesel burnt)	1,120	Emitted to atmosphere
			Waste Water (sewage and grey water)	425	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Platforms, Jackets and Platform wells (Thames and Horne and Wren)	112	Guard Vessel for the SHLV[3]	Power Generation (diesel burnt)	336	Emitted to atmosphere
			Waste Water (sewage and grey water)	425	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Platforms, Jackets and Platform wells (Thames and Horne and Wren)	112	Heavy Barge[4]	Power Generation (diesel burnt)	1,120	Emitted to atmosphere
			Waste Water (sewage and grey water)	1,344	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore

Decommissioning Activity Description	Approximate Duration (days)	Rig/Vessel Type	Aspect	Estimated Quantity Disposed or Discharged (tonnes)	Fate
Subsea wells, Subsea Infrastructures and Well Stabilisation Materials	480 (30 days per well)	Jack-up Drilling Rig[5]	Power Generation (diesel burnt)	4,800	Emitted to atmosphere
			Waste Water (sewage and grey water)	8,640	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	378	Returned to shore
Subsea wells, Subsea Infrastructures and Well Stabilisation Materials	480 (30 days per well)	Supply Vessel for the Drilling Rig[6]	Power Generation (diesel burnt)	4,800	Emitted to atmosphere
			Waste Water (sewage and grey water)	1,824	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Subsea wells, Subsea Infrastructures and Well Stabilisation Materials	480 (30 days per well)	Standby Vessel for the Drilling Rig[7]	Power Generation (diesel burnt)	4,800	Emitted to atmosphere
			Waste Water (sewage and grey water)	1,824	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Subsea wells, Subsea Infrastructures and Well Stabilisation Materials	100	Dive Support Vessel (DSV)[8]	Power Generation (diesel burnt)	3,000	Emitted to atmosphere
			Waste Water (sewage and grey water)	1,400	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Pipelines, Umbilicals,	90	DSV[8]	Power Generation (diesel burnt)	2,700	Emitted to atmosphere

Decommissioning Activity Description	Approximate Duration (days)	Rig/Vessel Type	Aspect	Estimated Quantity Disposed or Discharged (tonnes)	Fate
Flowlines and Pipeline Stabilisation Materials			Waste Water (sewage and grey water)	1,260	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Pipelines, Umbilicals, Flowlines and Pipeline Stabilisation Materials	20	Rock dumping Vessel[9]	Power Generation (diesel burnt)	200	Emitted to atmosphere
			Waste Water (sewage and grey water)	36	Discharged to sea
			Solid Waste (bulk waste e.g. garbage, scrap etc.)	Negligible	Returned to shore
Helicopter Trips[10]	138	Helicopter	Power Generation (diesel burnt)	179	Emitted to atmosphere

[1] SHLV Assumptions - Fuel consumption = 30 tonnes per day; Waste water = 75 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[2] SHLV Supply Vessel Assumptions - Fuel consumption = 10 tonnes per day; Waste water = 19 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[3] SHLV Guard Vessel Assumptions - Fuel consumption = 3 tonnes per day; Waste water = 19 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[4] Heavy Barge Assumptions - Fuel consumption = 10 tonnes per day; Waste water = 60 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[5] Jack-up Rig Assumptions - Fuel consumption = 10 tonnes per day; Waste water = 90 personnel @ 200 l/man/day; Solid waste = 24 tonnes/month

[6] Supply Vessel for Drilling Rig Assumptions - Fuel consumption = 10 tonnes per day; Waste water = 19 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[7] Standby Vessel for drilling rig Assumptions - Fuel consumption = 10 tonnes per day; Waste water = 19 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[8] Dive Support Vessel Assumptions – Fuel consumption = 30 tonnes per day; Waste water = 70 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[9] Rock Dumping Vessel Assumptions – Fuel consumption = 10 tonnes per day; Waste water = 84 personnel @ 200 l/man/day; Solid waste discharges are assumed to be negligible.

[10] Helicopter Trip Assumptions based on two trips per week over 480 days (ca. 68 weeks) – Fuel consumption = 1.3 tonnes per return trip.

2.12.2 Decommissioning Materials Disposal Emissions and Energy Balance

All of the decommissioned materials that are recovered from the Thames Area infrastructure will be sent to shore for processing.

At the time of writing, the waste disposal contractor has not been selected, but it is assumed the waste materials will be processed in a similar way, whether the waste materials are processed in Europe or within the UK.

Material quantities, as they pass through processing operations, can be described by material balances. Such balances are statements on the conservation of mass. Similarly, energy quantities can be described by energy balances, which are statements on the conservation of energy (*BEE, 2005*). As materials are processed, energy is required to recycle that material into a reusable form. This is usually represented as energy spent in gigajoules (GJ). The energy consumption to process one tonne of said material is often then compared to the energy consumption required to manufacture one new tonne of the material.

The Institute of Petroleum have produced a paper *(IoP, 2000*) on the energy use of materials during decommissioning. A summary of data from this paper is presented in Table 2.40, which shows the estimated energy consumption to convert a selection of common decommissioning materials and how the energy values compare to the production of new materials.

Table 2.40: A Comparison of Energy Consumption and CO_2 emissions between Recycling and Manufacturing from New for Common Decommissioning Materials (*IoP, 2000*)

Material	Energy Consumption to Recycle (GJ/Tonne)	CO_2 emitted (kg) per tonne of Material Recycled	Energy Consumption to Manufacture New (GJ/Tonne)	CO_2 emitted (kg) per tonne of Material Manufactured (new)
Steel Note 1	9	960	25	1,889
Copper Note 1	25	300	100	7,175
Concrete / Cement Note 1	N/A	-	1	880
Plastic Note 2	20	693	105	3,179

Note 1: *IoP (2000*); Note 2: *Harvey (2010) & DEFRA / DECC (2011b)*

Table 2.41 shows the expected inventory of the common decommissioning materials from the Thames Area Decommissioning Project and the energy consumption required to recycle compared to manufacturing the same material from the new. In addition, Table 2.41 also illustrates the calculated CO_2 emissions from both recycling and manufacturing from new, along with the energy consumption of materials left in situ (sometimes referred to as 'lost') to manufacture from new (i.e. concrete mattresses). A detailed breakdown and discussion of atmospheric emissions from the Thames Area Decommissioning activities can be found in Section 8.

Table 2.41: A summary of decommissioning materials from the Thames Area Decommissioning Project and the energy consumption (and CO_2 emissions produced) required to recycle compared to producing the same material from the new.

Decommissioning Infrastructure	Steel (tonnes)	Concrete (tonnes)	Plastic (tonnes)	Copper (tonnes)	Total Energy Required to Recycle (GJ)	Estimated CO_2 Emissions from Recycling the Material (tonnes)	Total Energy Required to Manufacture from new (GJ)	Estimated CO_2 Emissions from Manufacturing the Materials New (tonnes)
Platforms, Jackets and piles	12,154	-	-	-	123,030	11,667	303,850	22,958
Wellheads, Risers, WPS and other Subsea Structures	1,900	3,249	-	-	17,100 Note 1	1,823 Note 1	50,551	7,658
Subsea Stabilisation Materials	610	5,846	30	-	6,090 Note 1	585 Note 1	24,246	6,391
Pipelines	34,675	78,216	-	-	312,075 Note 1	33,288 Note 1	937,997	134,032
Umbilicals (including MEG lines)	425	-	78	20	5,885	468	20,815	1,192
Other Materials (i.e. cladding, batteries and cables)	-	-	47	62	2,490	50	11,135	593

Note 1: Excluding concrete, as this cannot be recycled

2.13 Post-Decommissioning Debris Clearance and Verification

A post decommissioning site survey will be carried out around 500 metres radius of installation sites and a 200 metre corridor along each existing pipeline route. Significant seabed debris will be recovered for onshore disposal or recycling in line with existing disposal methods.

Independent verification of seabed state will be obtained by trawling the platform area. This will be followed by a statement of clearance to all relevant governmental departments and non-governmental organisations.

All pipeline routes and infrastructure sites will be the subject on-going surveys when decommissioning activities have concluded. After the survey reports have been sent to DECC and reviewed, a post monitoring survey regime will be agreed by both parties, typically one (or more) post decommissioning environmental and structural pipeline surveys.

2.14 Post-Decommissioning Monitoring and Evaluation

The scope and extent of any further post decommissioning surveys will be devised and agreed with DECC, on completion of the decommissioning work.

3 Environmental Description

3.1 Introduction

This section provides a review of the key features of the environment in the proposed Thames Decommissioning Programme Area which is located across thirteen (13) UKCS Blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4) in the southern North Sea (SNS).

A key consideration when planning and finalising the decommissioning of the Thames field infrastructure is a clear understanding of the surrounding environment. In order to understand the potential for the project to interact with the environment, so that appropriate controls can be adopted to mitigate negative impacts, the physical, biological and socio-economic environments have been assessed.

This assessment has been conducted on two different levels: from within the UKCS Blocks 48/28-30, 49/26-30, 50/26, 52/3, 53/2-4 and in the surrounding area encompassing them, including along the adjacent coastline of the east coast of England.

It is largely based on data provided in published information sources, including:

- The DECC (formerly DTI) Offshore Strategic Environmental Assessment (SEA) Reports (2002-2011);
- The UK Digital Marine Atlas (*UKDMAP, 1998*);
- Fisheries Sensitivity Maps in British Waters (*Coull et al., 1998*);
- Spawning and Nursery Grounds of Selected Fish Species in UK waters (*Ellis et al., 2012*);
- The JNCC Cetacean Atlas of Cetacean distribution in north-west European waters (*Reid et al., 2003*);
- Scientific Advice on Matters Related to the Management of Seal Populations by the Special Committee on Seals (*SCOS, 2012*);
- SCANS-II 2008 data (in *DECC, 2009*);
- Seabird Vulnerability in UK Waters (*JNCC, 1999*); and
- Fishing Effort and Quantity and Value of Landings by ICES Rectangle (Marine Scotland, *2008-2013*);
- UK-DEAL (2012).

In addition to the above, Perenco has undertaken site specific geophysical, geotechnical and environmental (including Annex I habitat assessment) surveys within the proposed Thames Decommissioning Programme area (*Osiris Projects, 2013*), the results of which are discussed, where relevant, throughout this section of the ES.

3.1.1 The Thames Environmental Survey

Osiris Hydrographic & Geophysical Projects Ltd (hereafter referred to as Osiris Projects) were commissioned in May 2013 by Perenco UK to carry out pipeline acoustic inspection and depth of burial surveys on a number of pipelines and subsea assets in the Thames Field, southern North Sea. The survey was completed under LOGIC 'General Conditions of Contract for Services (onshore and offshore), Edition 2 – October 2003' and were carried out between 10th June and 5th July 2013 using MV Chartwell.

The main objectives of the Thames pipeline surveys were to complete:

- A side scan and multibeam echo-sounder survey of the pipeline network (see Table 3.1), with the exception of PL370;
- A pinger survey of the Thames pipeline network to assess the depth of burial of the pipeline network.

Table 3.1: Pipelines Surveyed (*Osiris Projects, 2013*)

Pipeline	Details	Length (km)	Comments
PL-370	Thames AW - Tullow Bacton	84.00	24 inch Gas Export
PL-371 & PL-374	Bure 'O' – Thames AW	11.25	8 inch Gas 2 inch Piggyback MEG
PL-372 & PL-373	Yare 'C' – Thames AW	4.71	8 inch Gas 2 inch Piggyback MEG
PL-931, PL-932 & PL-933	Orwell – Thames AW	33.9	16 inch Gas 3 inch Piggyback MEG
PL-1057 & PL-1058	Gawain – Thames AW	15.45	12 inch Gas 0.75 inch Piggyback MEG
PL-1635 & PL-1636	Bure West – Thames AR	11.17	8 inch Gas
PL-1637 & PL-1638	Thurne – Thames AR	5.18	8 inch Gas 3 inch Piggyback MEG
PL-2047 & PLU-2048	Arthur – Thames AW	30.00	8 inch Gas
PL-2047JP1 & PLU-2048JP1	Arthur 1 – Arthur Manifold	0.05	8 inch Jumper
PL-2047JP2 & PLU-2048JP2	Arthur 2 – Arthur Manifold	3.28	8 inch Jumper
PL-2047JP3 & PLU-2048JP3	Arthur 3 – Arthur Manifold	2.58	8 inch Jumper
PL-2080 & PL-2081	Horne & Wren – Thames AW	~20.4	10 inch Gas Condensate 2 inch Piggyback MEG
PL-2491 & PL 2492	Horne and Wren - Wissey	~10.4	8 inch Gas 93mm OD Umbilical Parallel to PL2491

Data acquisition was undertaken from Osiris Projects' dedicated survey vessel MV Chartwell, equipped with multibeam bathymetry, side scan sonar, sub-bottom profiler and magnetometer systems. Vessel positioning was provided using an Applanix POS MV 320 INS, integrated with a C-NAV 2050 digital GPS system, which utilised RTG subscription service. Primary heading and motion was provided by an Applanix POS MV 320 INS.

Despite the time of year, weather conditions were challenging, however, each weather window was utilised to collect good data whenever possible. The location of the pipelines is within exposed waters, and therefore suffered from bad weather conditions frequently.

The objectives of the environmental aspect of the site survey were to examine the seabed for features of conservation interest that may be impacted by the decommissioning of oil wells and associated pipelines. In addition the survey was used to identify the level of contamination in the sediments which may be attributed to historical drilling and production and determine any deviations from baseline conditions established during previous site surveys.

Potential ecological characteristics across the site were investigated, in particular the presence or absence of EC Habitats Directive Annex 1 Habitats and *Sabellaria spinulosa* reef aggregations.

Drop down camera work was undertaken at 51 seabed imaging sample stations where areas of high reflectivity or seabed elevation, which can indicate coarse ground or biogenic reef, were found on side scan sonar data. Particular focus was paid to the potential presence of any Annex I habitats. The camera locations were initially identified from a review of the side scan sonar data by a CMACS biologist and Osiris Projects Geophysicist.

In addition, a total of 36 seabed grab samples were also collected using a 0.1 square metre area weighted Day grab, with the location of each grab recorded and each location sampled twice; one sample was required for physical and chemical analysis (particle size analysis (PSA), total organic carbon (TOC), polycyclic aromatic hydrocarbons (PAHs) and metals analysis), which was kept cool and frozen at the laboratory, and the second sample was placed under a 1 millimetre mesh sieve, fixed and retained for faunal analysis. CMACS Limited assisted with the biological sampling element and sediment contaminant samples (hydrocarbons and metals) were analysed by a UKAS accredited laboratory.

Two grab sampling sites were selected for each pipeline and one site near each structure, with a further string of samples collected at approximately 4 kilometre intervals along the main route back towards Bacton.

The results from the above surveys are included where relevant throughout this section of the ES. The full sampling methodology and laboratory treatments and techniques are provided in the survey report provided in Appendix C.

3.2 Physical Environment

3.2.1 Geography

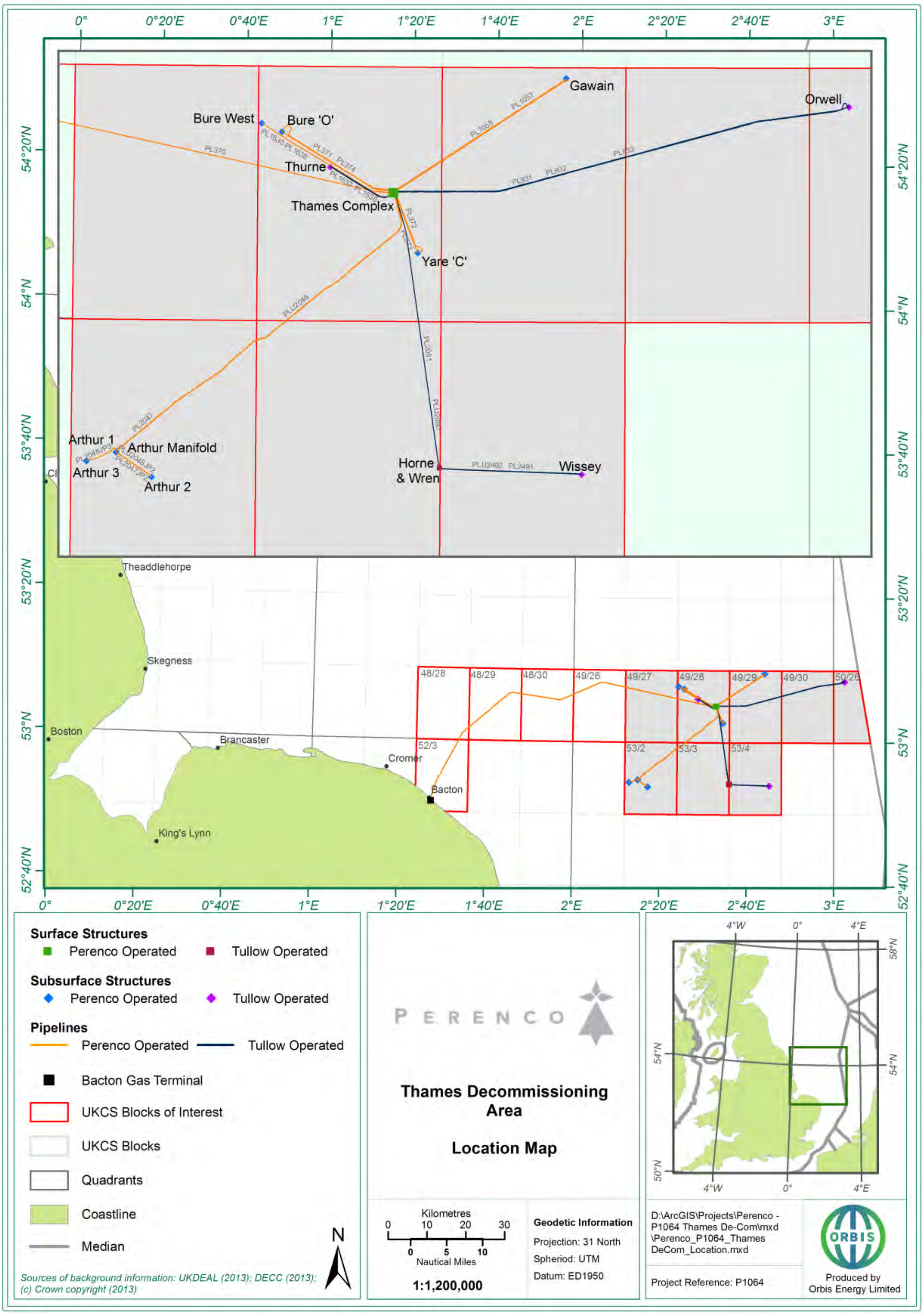
The proposed Thames Decommissioning Programme area is situated in UKCS Blocks 48/28-30, 49/26-30, 50/26, 52/3, 53/2-4 (hereafter referred to as the 'Blocks of Interest') of the southern North Sea. The Bacton to Thames pipeline (PL370) connects to the UK coast at the Bacton Gas Terminal. The Thames platform is located approximately 70 kilometres north east of the nearest UK landfall, near to the town of Winterton-on-Sea and 37.5 kilometres to the west southwest of the UK/Netherlands transboundary line (Figure 3.1).

The Horne & Wren Platform is located approximately 64.5 kilometres from the nearest UK landfall, near the town of Winterton-on-Sea and approximately 38 kilometres to the UK/Netherlands transboundary line.

The Orwell subsea wells represent the furthest point of the infrastructure to be decommissioned from UK landfall, at approximately 102 kilometres to the north east of Winterton-on-Sea. The Orwell subsea wells also represent the closest point to the UK/Netherlands transboundary line at approximately four kilometres to the west.

The infrastructure (excluding pipelines) closest to UK landfall are the Arthur subsea wells approximately 41 kilometres from the town of Winterton-on-Sea.

Figure 3.1: The Location of the Thames Decommissioning Programme



3.2.2 Bathymetry

Water depth within the proposed Thames Decommissioning Programme site is approximately 32 metres (*Osiris Projects, 2013*). Across the area, water depths ranged between 30 and 40 metres (*Xodus Group, 2013*) and therefore they did not show much variation in depth across the survey area. Some areas along the Thames export, Gawain and Orwell pipelines did show changes in water depth which was attributed to the presence of sandbanks (*CMACS, 2013*).

3.2.3 Seabed Sediment and Features

The UKSeaMap 2010 project indicates the seabed sediments in the proposed Thames Decommissioning Programme area to be largely comprised of three types. Between the shoreline and approximately halfway along pipeline PL370 there is predominantly 'coarse sediment' with a small area of 'rock or reef'. The remainder of the infrastructure lies within an area of 'sand and muddy sand' (*JNCC, 2010a*).

Seabed features in the vicinity of the proposed Thames Decommissioning Programme area include the North Norfolk Sandbanks and the Haisborough, Hammond and Winterton sandbanks. The following four individual sandbanks are traversed by the pipeline PL370:

- Leman Bank (North Norfolk Sandbanks);
- Owen Bank (North Norfolk Sandbanks);
- Well Bank (North Norfolk Sandbanks);
- Haisborough Sands (Haisborough, Hammond and Winterton sandbanks).

Survey Results

The results of the drop down camera work were analysed by CMACS. The results indicate that the seabed sediments across the site generally comprise granular sediments (Table 3.2), mainly sands (69-100 percent) or sands with varying amounts of gravel (0-30 percent) and a low proportion of mud (typically less than 1 percent) (*Osiris Projects, 2013*). At sample stations 2 and 8 there were quantities of bivalve shell, particularly the mussel *Mytilus edulis*, mixed in with the sandy sediments (*CMACS, 2013*).

Table 3.2: Particle Size Distribution at each Sample Station (*CMACS, 2013*)

Sample Station	Mean Size (µm)	Mean ϕ	% Gravel	% Sand	% Mud	Sediment Type
1	352.81	1.50	0.6	99.3	0.1	Sand
2	472.81	1.08	12.6	87.3	0.2	Gravelly Sand
4	1415.09	-0.50*	30.4	69.0	0.6	Sandy Gravel
5	376.66	1.41	13.6	85.2	1.1	Gravelly Sand
6	866.99	0.12	28.1	71.7	0.2	Gravelly Sand
7	371.77	1.43	2.4	97.5	0.1	Slightly Gravelly Sand
8	440.85	1.18	9.9	89.9	0.2	Gravelly Sand
9	321.88	1.64	0.7	99.1	0.2	Sand
10	392.21	1.35	3.5	96.4	0.1	Slightly Gravelly Sand
11	336.65	1.57	3.4	96.3	0.3	Slightly Gravelly Sand
12	451.61	1.15	2.0	97.8	0.1	Slightly Gravelly Sand
13	393.55	1.35	2.0	97.8	0.1	Slightly Gravelly Sand
14	355.83	1.49	2.1	97.8	0.1	Slightly Gravelly Sand
15	349.62	1.52	2.1	97.3	0.6	Slightly Gravelly Sand
16	426.05	1.23	0.5	99.4	0.1	Sand
17	330.93	1.60	3.8	95.1	1.1	Slightly Gravelly Sand
18	350.04	1.51	0.1	99.8	0.1	Sand

19	348.72	1.52	1.8	97.9	0.3	Slightly Gravelly Sand
20	330.75	1.60	2.1	97.7	0.2	Slightly Gravelly Sand
21	306.56	1.71	0.6	98.4	1.0	Sand
22	294.60	1.76	1.0	98.4	0.6	Slightly Gravelly Sand
23	355.79	1.49	2.8	97.0	0.2	Slightly Gravelly Sand
24	342.17	1.55	0.7	99.2	0.1	Sand
25	337.52	1.57	0.5	98.2	1.3	Sand
26	355.65	1.49	0.7	99.2	0.1	Sand
27	377.76	1.40	1.6	98.2	0.2	Slightly Gravelly Sand
28	302.69	1.72	0.3	97.2	2.4	Sand
29	343.67	1.54	1.4	98.2	0.4	Slightly Gravelly Sand
30	320.27	1.64	0.5	97.5	1.9	Sand
31	336.443	1.57	1.0	98.9	0.1	Slightly Gravelly Sand
32	1044.92	-0.06*	0.2	99.7	0.1	Sand
33	316.81	1.66	0.6	98.6	0.8	Sand
34	286.72	1.80	0.8	98.8	0.4	Sand
35	301.45	1.73	9.1	89.5	1.5	Gravelly Sand
36	276.40	1.86	0.5	99.0	0.5	Sand

Note * - Negative phi (ϕ) values are due to the negative log calculation and occur where certain grain sizes are less common (positive values are more commonly encountered grain sizes)

3.2.4 Seabed Features

Seabed imagery found that much of the surveyed area comprised bare sand with some areas of gravel and shell fragments (*CMACS, 2013*).

Side scan sonar data demonstrated that sand waves across large areas of the seabed. This indicates strong seabed and water column currents, and subsequently highly mobile sediments (*CMACS, 2013*) which is consistent with the southern North Sea in general. The results also indicated that the seabed around the Thames gas field and along the export pipeline has been formed by powerful tidal forces with high sediment transport and loading at the seabed as indicated by sand waves and ripples. The presence of scour-resilient epifaunal species in inshore areas of coarser gravelly sediments is also an indicator or strong currents (*CMACS, 2013*).

3.2.5 Sediment Chemistry

Total Hydrocarbons

Marine sediments contain hydrocarbons derived from many sources which enter the marine environment via three general processes: biosynthesis (marine and land organisms biosynthesise hydrocarbons), geochemical processes (submarine and coastal land oil-seeps) and anthropogenic sources (from accidental or intentional discharge of fossil fuel). The latter includes oil and gas developments and associated shipping; these and other sources of contaminants are assessed in the reports NSTF (1993) and OSPAR (2000).

Overall, the quantity of total hydrocarbons (THCs) in sediments tends to show an increase from the southern North Sea to the northern North Sea. This trend, however, is closely linked to the spatial distribution of sediment type. 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, so may not accurately reflect the actual amount of oil discharged by the industry (*DECC, 2009*).

In the North Sea, produced water is now the major on-going source of hydrocarbons produced by the oil and gas industry. The replacement of oil based mud (OBM) discharges during drilling with alternative mud systems and disposal methods has meant that the hydrocarbon input from drill cuttings have been essentially eliminated. There remains, however, a "legacy" of contamination resulting from historic cuttings discharges in the form of piles of cuttings around some installations (*DECC, 2009*).

Law and Fileman (*1985*) showed that THCs of sediment samples collected from sites in the North Sea, English Channel, Irish Sea and a number of estuarine areas ranged from 0.27-340 micrograms per gram (µg g^{-1} (dried weight)) of Ekofisk crude oil equivalents. In further work by CEFAS, the highest THC found in offshore samples was 120 µg g^{-1} in the gas field area off north Norfolk (*CEFAS, 2001*).

Studies on the Leman and Thames Gas Fields in 1987 revealed that in this area of the North Sea, turbulence and unstable mobile sediments quickly disperse discharged drilling materials away from the platforms (*CEFAS, 2001*).

In general the concentrations of total hydrocarbons in the immediate vicinity of offshore installations tends to be high (Table 3.3), with concentrations generally falling to background levels within a very short distance from discharge (*CEFAS, 2001*).

Given the above, it is expected that sediment concentrations of THCs in the vicinity of the proposed Thames Decommissioning Programme area will be highest around wells and platforms.

Table 3.3: Summary of Contaminant Levels Typically Found in Surface Sediments from the North Sea (*DECC, 2009*)

Location	THC (µg/g)	PAH (µg/g)	PCB (µg/g)	Ni (µg/g)	Cu (µg/g)	Zn (µg/g)	Cd (µg/g)	Hg (µg/g)
Oil & Gas Installations	10-450[1]	0.02-74.7[2]	-	17.79[6]	17.45	129.74	0.85	0.36
Offshore	17-120[2]	0.2-2.7[3,4]	<1[4]	9.5	3.96	20.87	0.43	0.16

(Sources: [1] *Daan et al. 1992*, [2] *Law and Fileman 1985*, [3] *Klamer and Fomsgaard 1993*, [4] *OSPAR 2000*, [5] *CEFAS 1998*, [6] *Harries et al. 2001*)

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) are ubiquitous environmental contaminants. They are created during the incomplete combustion of coal, oil, petrol and wood, but they are also components of petroleum and its products (*DECC, 2009*).

Offshore, the most common type of PAHs are naphthalene, phenanthrene, chrysene and benzo[*a*]pyrene with total PAH concentrations generally found to vary between 0.028 and 0.2 mg kg^{-1} (Table 3.3; *OSPAR, 2000; CEFAS, 2001*).

The lower molecular weight PAH can be acutely toxic to aquatic organisms, but the major concern is that some PAH form carcinogenically-active metabolites (e.g. benzo[*a*]pyrene). Elevated PAH concentrations may therefore present a risk to aquatic organisms and potentially also to human consumers of fish and shellfish. Environmental Assessment Criteria have been set by OSPAR for eight individual PAH in sediments. All eight compounds are included in the 10 PAH routinely measured under the National Marine Monitoring Programme. The sum of the upper Ecological Assessment Criteria is roughly equivalent to 10,000 µg/kg for the ten PAH compounds (*DECC, 2009*).

Heavy and Trace Metals

Metals, including barium, cadmium, copper, iron, lead, mercury, nickel and zinc, are naturally present in seawater and marine sediments, in a range of forms and concentrations. In excessive concentrations, metals can exhibit toxicity and result in significant environmental effects (*DECC, 2009*).

While concentrations of all metals at offshore sites were relatively low compared with those of estuaries (*CEFAS, 2001*), sediment concentrations around offshore oil and gas installations tend to be elevated compared to the North Sea in general (Table 3.3).

Survey Results

Sediment contaminant sampling was undertaken at all but two of the stations due to coarse ground which was unsuitable for grab sampling (*CMACS, 2013*).

The results of the chemical testing indicate that the concentrations of the individual PAH compounds all fall below the laboratory detection limits.

Similarly, the aliphatic and aromatic total petroleum hydrocarbon (TPH) compounds also fall beneath lab detection limits, along with the other organic compounds and phenols listed. The exception to this is sample station 31 where individual and total PAH concentrations were recorded. Total recorded PAH concentrations at sample station 31 were 4.4mg/kg (*Osiris Projects, 2013*).

The organic content of sediments was generally low, ranging from 0.47 per cent to 1.54 per cent, with no discernible trend across the survey area (*CMACS, 2013*).

Samples for heavy metal concentrations were assessed in the laboratory against the Centre for Environment, Fisheries and Aquaculture Science (Cefas) 'action levels', which although usually applied to the testing of dredge spoil before being disposed at sea, are used in the absence of more definitive acceptable contamination limits in seabed sediments associated with oil and gas activity. Contaminant concentrations below Level 1 thresholds are thought to be of no danger to the environment if disposed of at sea, concentrations above Level 2 are considered unsuitable for disposal at sea. Values which are between Levels 1 and 2 require further testing and consideration before disposal is permitted (*CMACS, 2013*).

Of all the metal contaminants, only arsenic was present above Level 1 thresholds (Cefas L1 threshold is 20 ppm) at the majority of stations but only exceeded Level 2 (100 ppm) at Station 27 (centre of the offshore survey area; Figure 3.6) with values of 147 ppm. Elevated levels of arsenic can occur following geological inputs and/or industrial discharge (*CMACS, 2013*). Cadmium was the only other metal found at concentration above the Level 1 threshold with 0.4 ppm, also at station 27 (Cefas L1 threshold is 0.4 ppm).

Barium is a key component in barite which is used as a weighting agent in drilling muds, the primary form of well control. As such, it tends to dominate the heavy metal component of drilling wastes, including cuttings discharged at the seabed, and therefore is often found at higher levels that would occur naturally in sediments exposed to historical drilling activity (*Melton et al., 2000*). Although relatively inert, barium is often used as an indicator for contamination by drilling *(CMACS, 2013).* Barium was detectable at all stations sampled with levels of between 6 and 36 ppm across the sites and no evidence of any 'hotspots' of barium concentration *(CMACS, 2013).*

The range of heavy metal concentrations detected across the site are summarised in Table 3.4.

Table 3.4: Range of Heavy Metal Concentrations

Contaminant	Minimum Value (mg/kg)	Maximum Value (mg/kg)
Arsenic	9.3	147.4
Barium	6	36
Beryllium	0.5	0.8
Cadmium	0.1	0.5
Chromium	3.5	11.5
Copper	2	4
Lead	5	31
Mercury	0	0
Nickel	2.5	8.6
Selenium	0	0
Vanadium	14	122
Water Soluble Boron	1.9	9.4
Zinc	9	57

3.2.6 Oceanography

Waves

Waves are the result of energy being transferred between two fluids moving at different rates (*Dobson & Frid, 1998*). They are caused at sea by the differential motion of the air (wind) and the seawater. The height of a wave is the distance from the crest to trough, but as the waves at any one time are not of equal size, the significant wave height (Hs) is taken and corresponds approximately to the mean height of the highest third of the waves. The wave period is the (mean) time between two wave crests, called the zero up-crossing period and is given in seconds. The wave climate of the area provides information on the physical energy acting on structures and dictates the structural design requirements.

The worst case significant wave heights in the vicinity of the proposed Thames Decommissioning Programme exceed three metres for 10 percent of the year (Table 3.5). However, there is considerable seasonal variation between sea states, with waves in excess of 2 metres recorded for 25 percent of the time in autumn and winter, but only two percent of the time in summer (*Smith, 1998*). Wave direction is variable throughout the year.

Table 3.5: Worst Case Yearly Significant Wave Height in the Vicinity of the Blocks of Interest (*UKDMAP, 1998*)

10% Exceedance	25% Exceedance	50% Exceedance	75% Exceedance
3 metres	2 metres	1.5 metres	1 metres

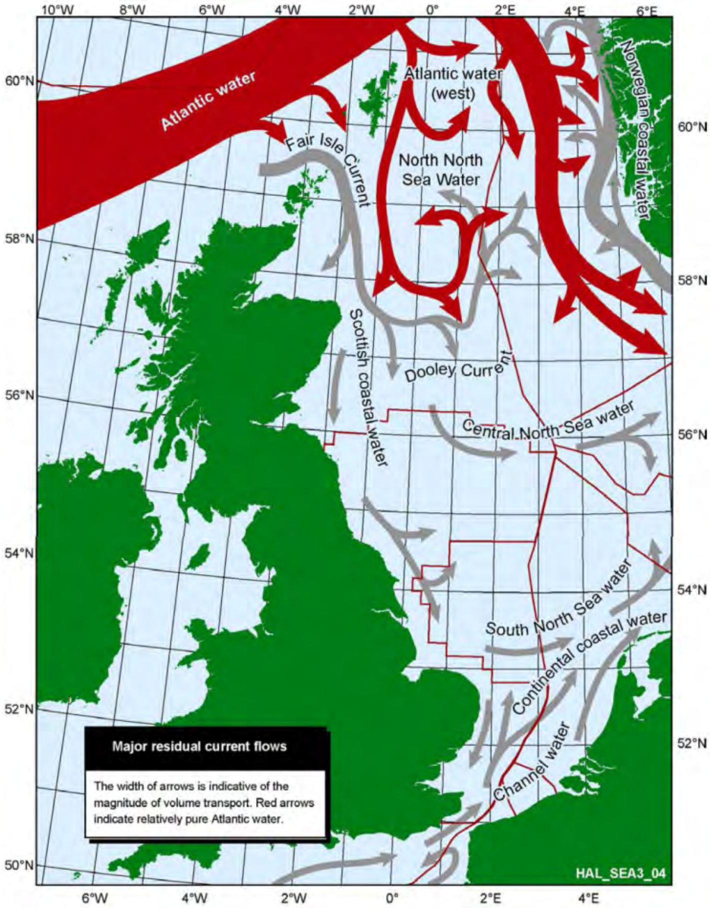
Tides and Water Circulation

Tidal stream patterns in the North Sea have been extensively studied for navigational purposes over a period exceeding a thousand years.

The general circulation of near-surface water masses in the North Sea is cyclonic, mostly driven by the ingression of Atlantic surface water in the western inlets of the northern North Sea. As a result, residual water currents near the sea surface tend to move in a south-easterly direction along the coast towards the English Channel. In addition, counter currents occur towards the

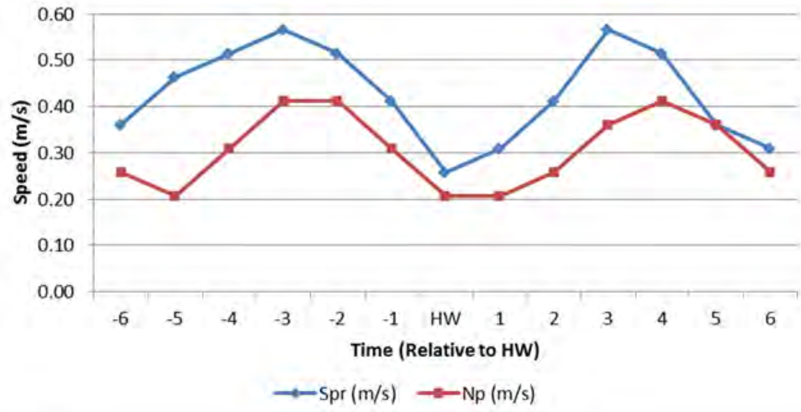
English/Dutch sector median line, flowing north-east towards Denmark (Figure 3.2). The effect of this counter current in the proposed Thames Decommissioning Programme area pushes the near-surface water movement towards a more southerly and easterly direction (*NSTF, 1993*).

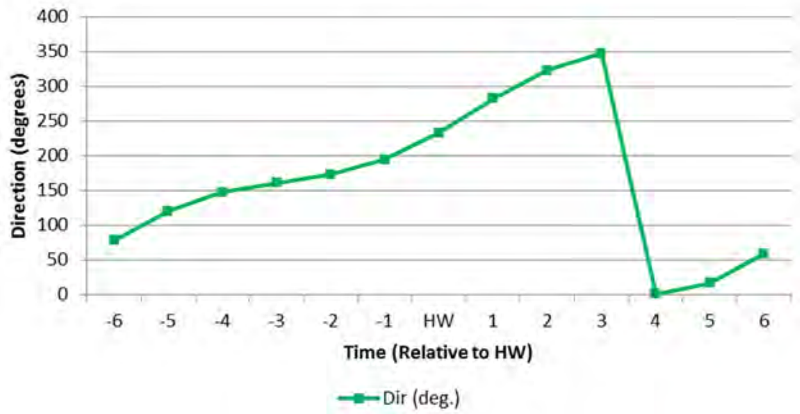
Figure 3.2: Major Water Masses and Residual Circulation in the North Sea (*DECC, 2009*)



Tides in the southern North Sea are predominately semi-diurnal and tidal waters offshore in this area flood southwards and ebb northwards. Maximum tidal rates in the region of the Blocks of Interest are 0.57 and 0.41 metres per second (m/s) respectively for spring and neap tides (*Hydrographer of the Navy, 2008*) (Figure 3.3). Currents were generally fastest at approximately two hours prior to high water during both spring and neap tides.

Figure 3.3: Tidal Current Speeds (top) and Direction measured at 53˚20'N, 02°44'E (*Admiralty Chart 2182A, Tidal Diamond P, Hydrographer of the Navy, 2008*)





Sea Temperature

The sea surface temperature in the area varies between a mean winter temperature of around 6 degrees Celsius (°C) and a mean summer temperature of approximately 16°C (Table 3.6), although in the shallower waters, the variation may be more extreme.

Table 3.6: Summary of Sea and Air Temperature (*DTI, 2004*)

Type	Average Winter Temperature (°C)	Average Summer Temperature (°C)
Air	8.0	19.0
Sea surface	6.0	16.0
Seabed	2.0	15.0

Salinity

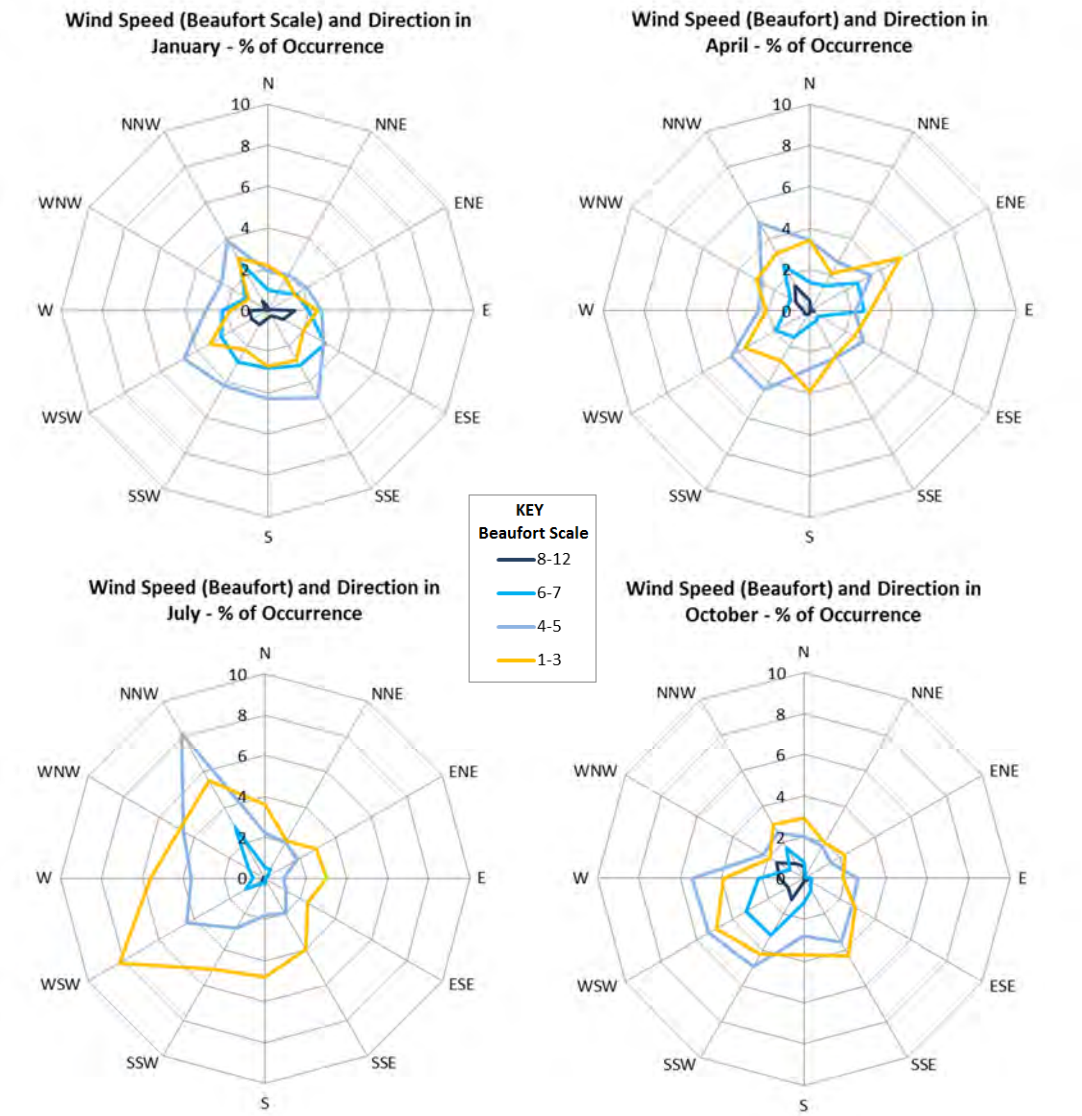
The salinity in the region of the proposed Thames Decommissioning Programme remains relatively stable throughout the year. The mean salinity of the sea surface varies between a winter mean of 34.75 parts per thousand (ppt) and a summer mean of 34.25 ppt. While the mean salinity of the bottom is 34.6 ppt in winter and 34.4 ppt in summer (*UKDMAP, 1998*)

3.2.7 Wind

The winds in the area are variable but predominantly from the west (Figure 3.4). During the winter and early summer north-easterly and south-westerly winds are most common. From July to September however, south-westerly and westerly winds predominate.

The windiest months are December and January, with wind speeds of greater than Beaufort Force 7 (14 to 16.5 m/s) achieved on six to ten days a month. The calmest months are May to August with wind speeds of Force 7 or more reached only on between one and three days (*Barne et al., 1995*).

Figure 3.4: Wind Roses for the Area 54.0N – 55.9N, 2.0E – 3.9E (*Korevaar, 1990*)



3.3 Biological Environment

3.3.1 Plankton

Plankton is defined as small marine or freshwater organisms, of both plants (phytoplankton) and animals (zooplankton), which live freely in the water column (*Lawrence, 2000*). Plankton are classified by size, although there is overlap as many species will change to a larger size classification as they grow older (*Dobson & Frid, 1998*). Plankton classification from Dobson & Frid (*1998*) is as follows:

1. Picoplankton: 0.2 - 2µm
2. Nanoplankton: 2 - 20µm
3. Microplankton: 20 - 200µm
4. Mesoplankton: 200 - 2,000µm
5. Macroplankton: >2mm

Plankton forms a fundamental link in the food chain. They are vulnerable to discharges to the sea and accidental chemical or hydrocarbon spills. The composition of plankton communities at any time is variable and depends upon the circulation of water into and around the North Sea, the time of year and nutrient availability. Plankton abundance is strongly influenced by several factors such as depth, tidal mixing, temperature stratification, nutrient concentrations and the location of oceanographic fronts. Species distribution is directly influenced by temperature, salinity, water inflow and the presence of local benthic (bottom dwelling) communities.

The southern North Sea is characterised by shallow, well-mixed waters, which undergo large seasonal temperature variations. The region is largely enclosed by land and, as a result, the environment here is dynamic with considerable tidal mixing and nutrient-rich run-offs from the land (eutrophication). In these conditions, there will be relatively little stratification throughout the year and constant replenishment of nutrients, so opportunistic organisms such as diatoms are particularly successful (*Margalef, 1973,* cited in *Leterme et al., 2006*); diatoms comprise a greater proportion of the phytoplankton community than dinoflagellates from November to May, when mixing will be at its greatest. The phytoplankton community is dominated by the dinoflagellate genus Ceratium (*C. fusus, C. furca, C. lineatum*), along with higher numbers of the diatom, Chaetoceros (subgenera *Hyalochaete and Phaeoceros*) than are typically found in the North Sea. The zooplankton community comprises *C. helgolandicus* and *C. finmarchicus* as well as *Paracalanus spp*., *Pseudocalanus spp*., *Acartia spp*., *Temora spp*. and cladocerans such as *Evadne spp*. (*DECC, 2009*).

The planktonic assemblage in the vicinity of the proposed Thames Decommissioning Programme area is not considered unusual.

Studies indicate that zooplankton appear to be the most vulnerable group to toxic effects of discharges such as produced water, whereas the phytoplankton and fish larvae tend to be more robust to any direct effects (*GESAMP, 1993*).

Planktonic organisms are generally short lived however and recovery following a pollution-induced population reduction is usually rapid. Natural seasonality is also important as the plankton comprises different types and quantities of organisms at different times of the year.

3.3.2 Benthic Communities

Seabed sediments provide support, protection and the food source for many macrofaunal species. The macrofauna, most of which are infaunal (living within the sediment), are therefore particularly vulnerable to external influences and changes in the sediment, such as those of a physical, chemical or biological nature.

Some infaunal animals are largely sedentary and are thus unable to avoid unfavourable conditions. Each species has its own response and degree of sensitivity to changes in the physical and chemical environment and consequently the species composition and their relative abundance in a particular location provides a reflection of the immediate environment, both current and historical. The recognition that aquatic contaminant inputs may alter sediment characteristics, together with the relative ease of obtaining quantitative samples from specific locations, has led to the widespread use of infaunal communities in monitoring the impact of disturbances to the marine environment over a long period of time.

Data from the Mapping European Seabed Habitats (MESH) project (2010) supports the sediments identified in Section 3.2.2 by indicating the presence of EUNIS habitats A5.14 Circalittoral coarse sediment in the nearshore area and A5.25 Circalittoral fine sand or A5.26 Circalittoral muddy sand in the offshore area. The area of 'rock or reef' corresponds to EUNIS habitat A4.2 Atlantic and Mediterranean moderate energy circalittoral rock (*JNCC, 2010a*). .

Studies of benthic communities have revealed a strong correlation with habitat (or substrate) type (*DECC, 2009*). The predominant sediment types in the vicinity of the Thames Decommissioning Programme area are predicted to be the following EUNIS habitats (Section 3.2.3 and Figure 3.5):

<u>Shoreline to halfway along PL370</u>

- **A5.14 (Circalittoral coarse sediment)** – This habitat may be characterised by robust infaunal polychaetes, mobile crustacea and bivalves. Certain species of sea cucumber (e.g. *Neopentadactyla*) may also be prevalent in these areas along with the lancelet *Branchiostoma lanceolatum* (*Conner et al., 2004*).

<u>Remaining offshore Infrastructure</u>

- **A5.25 (Circalittoral fine sand)** - This habitat is characterised by a wide range of echinoderms (in some areas including the pea urchin *Echinocyamus pusillus*), polychaetes and bivalves. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community (*Conner et al., 2004*); or
- **A5.26 (Circalittoral muddy sand)** - This habitat supports animal-dominated communities characterised by a wide variety of polychaetes, bivalves such as *Abra alba* and *Nucula nitidosa*, and echinoderms such as *Amphiura* spp., *Ophiura* spp., and *Astropecten irregularis*. These circalittoral habitats tend to be more stable than their infralittoral counterparts and as such support a richer faunal community (*Conner et al., 2004*).

Seabed surveys were conducted by BP in 2000 for the Davy field in Block 49/30 (approximately 25 kilometres to the south west of the Thames platform). These surveys found that the benthos was dominated by the echinoderms *Echinoidea* spp. (juv) and *Ophiuroidea* spp. (juv), the arthropods *Bathyporeia elegans* and *Pseudocuma longicornis* and the annelid *Scoloplos armiger* (*UK Benthos, 2012*).

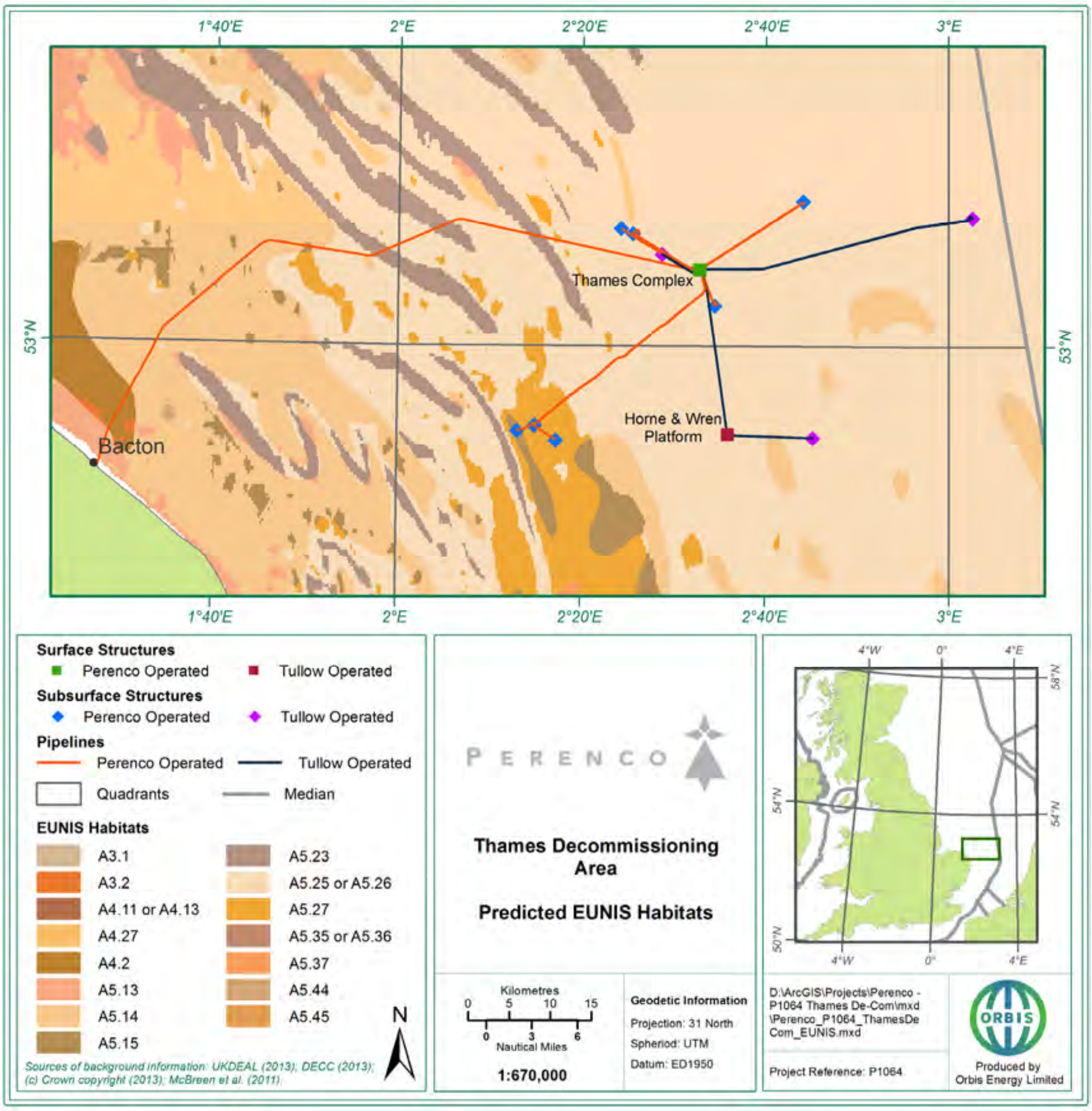
Given the similar bathymetric and sediment characteristics of the Davy survey site to the Blocks of Interest, the benthic communities present within the Blocks of Interest are likely to resemble those described above.

Sections of the pipeline PL370 cross the North Norfolk Sandbanks and the Haisborough, Hammond and Winterton candidate Special Areas of Conservation (cSACs) (refer to Section 3.3.6 and 3.3.7). The benthic communities at both sites have been subject to previous studies.

North Norfolk sandbanks as a group are the best example of tidal linear sandbanks in UK waters. Sandwaves are present on the banks indicating that the surface sediment is regularly mobilised by tidal currents. Previous studies have identified the biological communities present over the North Norfolk sandbanks to be typical of the biotope 'infralittoral mobile clean sand with sparse fauna' (*Connor et al., 2004*). This biotope is characterised by common epifaunal species such as hermit crabs *Pagurus bernhardus*, swimming crab *Liocarcinus depurator*, common shore crab *Carcinus maenas* and starfish *Asterias rubens*. Where the substratum is highly mobile, there are fewer infaunal species due to the difficulty in burrowing through coarser sediments and the generally lower organic content within the sediments which is used as a food source for infaunal species (*JNCC, 2008a*).

The Haisborough, Hammond and Winterton site contains a number of non-vegetated sublittoral headland associated sandbanks with alternating ridges. The site contains a mosaic of different physical habitats with correspondingly different biological communities. The fauna of the sandbank crests is predominantly low diversity polychaete-amphipod communities which are typical of mobile sediment environments. The banks are separated by troughs which contain more gravelly sediments and support diverse infaunal and epifaunal communities with occurrences of reefs of the tube-building Ross worm *Sabellaria spinulosa*. Aggregations of *S. spinulosa* provide a complex three-dimensional and hard substratum for the development of rich epifaunal communities (*JNCC, 2010a*).

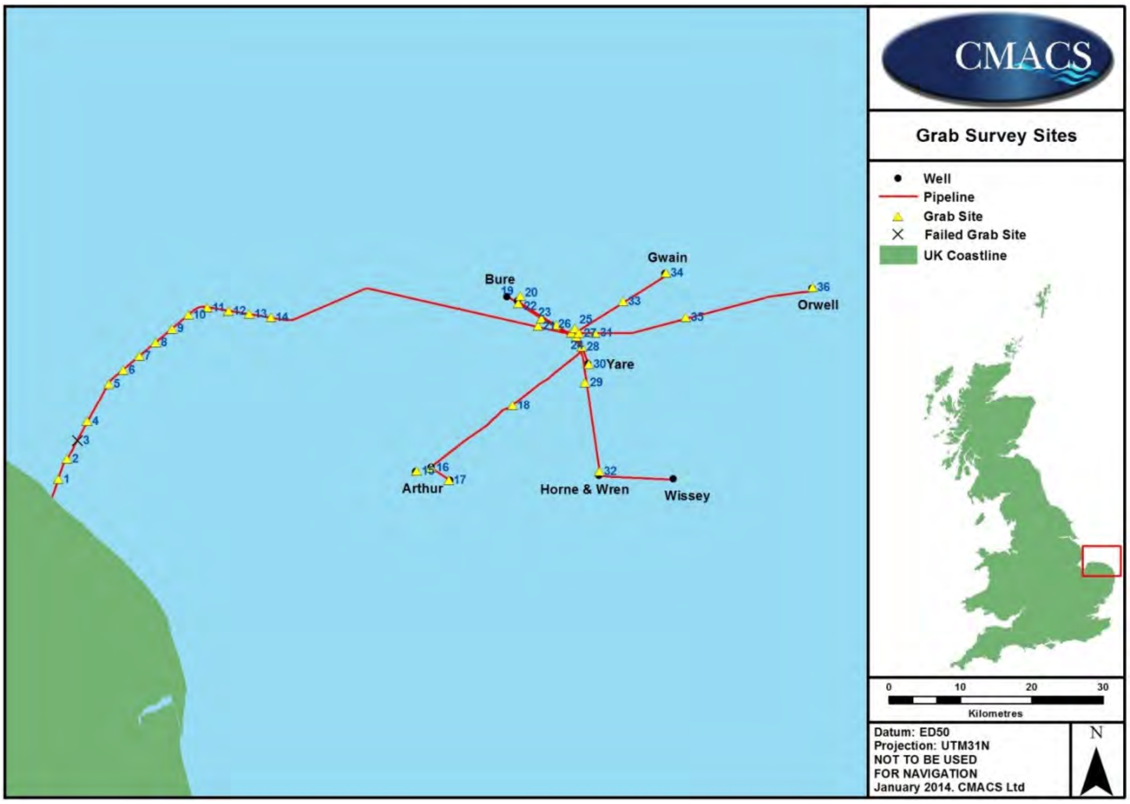
Figure 3.5: Predicted EUNIS Habitat Types in the Vicinity of the Thames Decommissioning Programme Area



Survey Results

A total of 263 taxa were identified in the grab samples undertaken as part of the environmental scope of the survey (*CMACS, 2013*). Most sample stations contained few species; between 20-30 taxa per grab, however station 4 was an exception with 133 taxa recorded. Across the survey area, diversity was variable but generally low, therefore leading to a high evenness and low similarity between sample stations. There did not appear to be any significantly numerically dominant species (*CMACS, 2013*). Figure 3.6 shows the locations of the grab samples.

Figure 3.6: Sample Locations for Grab Survey (*CMACS, 2013*)



The most abundant species in the samples were typical of offshore mobile sediments and included the polychaetes *Lagis koreni, Ophelia borealis, Spiophanes bombyx, Scoloplos armiger*, *Spio armata* and *Lanice conchilega*. These species were found across the survey area. The tube building polychaete *S. spinulosa* was also found to be abundant based on total number of individuals recorded, however this was slightly skewed as the majority of individuals were recorded from station 4 (*CMACS, 2013*) rather than being present across all sample stations.

Amphipod (*Urothoe* spp.) and cumacean crustaceans (*Monopseudocuma gilsoni* and *Pseudocuma longicornis*) were also relatively abundant across the samples (*Osiris Projects, 2013*). Unidentified razor clams and the bivalve *Angulus fabula*, which is a species typical of coarse sandy sediments, were also found.

The site survey findings were consistent with the finding from other benthic faunal surveys undertaken in this area of the southern North Sea and found that the majority of communities comprised scour-tolerant epifauna in inshore areas and sandy sediments dominated by polychaetes in the offshore areas.

Based on statistical analysis of the benthic faunal assemblage using Primer software, all of the samples could be separated into twelve distinct faunal communities which are shown in Table 3.7, along with their suggested biotope classification. There were five groups (A, B, C, D and K), which contained only one sample, and were less than 40 percent similar to other samples, based on species abundance and diversity. Note that biotope classification was undertaken based on the grab samples and also separately based on the results of the seabed imagery, which were undertaken at different locations (refer to Figures 3.6 and 3.7).

Group E was made up of samples from the landward half of the Thames export pipeline in an area of large sand waves. The fauna was dominated by the polychaetes *S. armata, O. borealis*, and *Spiophanes bombyx,* nematode worms were also abundant. Samples in group F were spread across a wider area and were characterised by low abundance and diversity of species which also included *O. borealis*, *S. armata*, and *Urothoe brevicornis* in addition to nematode and nemertean worms (*CMACS, 2013*).

Group G was made up of samples within the central hub where the pipelines meet; species found include *U. brevicornis*, *N. cirrosa*, *M. gilsoni*, nematode species, *Bathyporeia* spp. and the bivalve *A. fabula*.

Groups H and I are made up of samples taken across the survey area and include a variety of taxa including *O. borealis* (in moderate abundance), *S. armiger, S. bombyx* and nematode worms, similar to many other stations sampled. Group I stations also had juvenile razor fish and *M. gilsoni* and in general shared some bivalve species typically found within several biotopes (Table 3.7).

Stations classified into group J had relatively high abundances of species but the stations were also spread across the survey area. However a common feature of these stations was the presence of a higher proportion of silt than at other stations. This group was however also classified as a similar biotope to group I stations.

Group L was made up of three inshore samples with the highest proportion of gravel and also had the highest diversity of all the stations sampled. The faunal assemblage at these sites, predominantly station 4, contained the *S. spinulosa* individuals, nemertean worms and the polychaetes *Exogone naidina* and *S. armata*. Epifaunal taxa (which live on the seabed, usually attached to a substratum as opposed to within the sediment) such as hydroids and bryozoans were also present due to the gravelly nature of the sediment. Although *S. spinulosa* was present in the samples, seabed imagery did not suggest that it was a biogenic reef.

Table 3.7: Summary of Grouping and Biotope Classification of each Grab Sample Site

Group	Sample Station(s) within Group	Biotope Classification	Location
A	1	SS.SCS.ICS – Infralittoral coarse sediment	Broadly spread across survey area
B	12		
C	9	SS.SSA – Sublittoral sands and muddy sands	
D	2	SS.SCS.ICS – Infralittoral coarse sediment.	
E	7, 8, 10, 11, 13	These groups did not match any biotope well but 'SS.SSA.CFiSa.EpusOborApri – *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' was the closest match	Landward half of export pipeline
F	14, 16, 18	SS.SSA.IFiSa.IMoSa – Infralittoral mobile clean sand with sparse fauna	Broadly spread across survey area
G	23, 24, 26, 27, 31	SS.SSA.IFiSa.NcirBat – *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand	Central 'hub' where all pipelines meet
H	15, 19, 20	SS.SSA – Sublittoral sands and muddy sands This group could not be classified any lower	Broadly spread across survey area
I	21, 29, 32, 34	Shares species with the following biotopes: SS.SSA.IMuSa,FfabMag – *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand; SS.SCS.ICS.SLan – Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand	Broadly spread across survey area

J	17, 22, 25, 28, 30, 33, 35	SS.SSAIMuSa.FfabMag - *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	Broadly spread across survey area
K	36	See groups A-D	
L	4, 5, 6	CR.MCR.CSab.Sspi.ByB – *Sabellaria spinulosa* with bryozoan turf and barnacles on silty, turbid circalittoral rock.	Inshore samples

Seabed imagery found that across the survey area there was little visible fauna on the seabed with the exception of some mobile epifaunal species of crabs and starfish and dense aggregations of the infaunal sand mason worm *L. conchilega (CMACS, 2013).* Examples of seabed images taken at the Thames complex area are shown in Table 3.9, additional images can be found in the site survey report in Appendix C.

At stations further inshore, the seabed was made up of blue mussel shell interspersed amongst fine sediments with boulders and cobbles which supported epifaunal communities of barnacles and the horn wrack seaweed *Flustra foliacea*. Images also showed a community of sessile epifauna including hydroids and sponges (Table 3.9: *CMACS, 2013*).

Of the 51 stations which were analysed by seabed imagery (Figure 3.7), 17 supported growths of *S. spinulosa,* on sandy sediments and also growing as a crust over gravel and pebbles, of varying density. The tubes of these species provided complex habitat which in turn supported various crab, hydroid, soft coral and common starfish (*Asterias rubens*). The aggregations of some of these communities showed signs of damage, this may be natural (storm/wave action) or anthropogenic (vessel action or towed fishing gear) *(CMACS, 2013).* A further discussion of the presence of *S. spinulosa* as an Annex I habitat is provided in Section 3.3.7.

Biotope classification based on the results of the seabed imagery was difficult due to the dominance of sandy sediment. Where there was coarser sediment and/or diverse epifauna identified in the image, the following biotopes were applied (Table 3.8).

Table 3.8: Summary of Biotope Classifications based on Seabed Images (*CMACS, 2013*)

Sample Stations within Group	Biotope Classification	Location
2	SS.SMX.CMX.FluHyd – '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment'	Inshore along the Thames export pipeline
4, 5, 13, 14	CR.MCR.CSab.Sspi.ByB – '*Sabellaria spinulosa* with a bryozoan turf and barnacles on silty turbid circalittoral rock'	Within 30 km of the shore close to the Thames export pipeline
15-18, 22, 24-26, 28-31, 35-39, 42	SS.SBR.PoR.SspiMx - '*Sabellaria spinulosa* on stable circalittoral mixed sediment'	Broadly distributed across the survey area
32, 48	SS.SSA.IFiSa.ScupHyd – '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles'	Broadly distributed across the survey area
6	CR.FCR.FouFa.AdigMsen '*Alcyonium digitatum* with *Metridium senile* on a moderately wave-exposed circalittoral steel wrecks'	Inshore above a wreck

Figure 3.7: Sample Locations for Drop Down Camera Survey (note that camera locations were chosen based on the side scan sonar data) (*CMACS, 2013*)

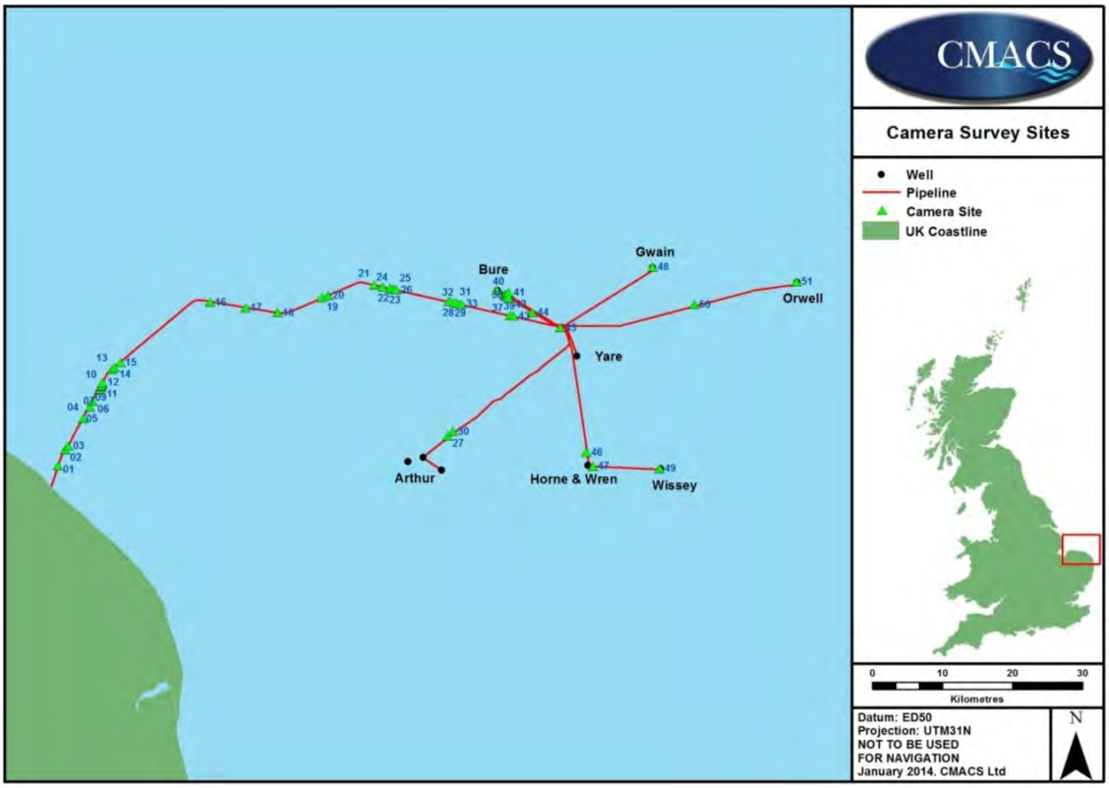
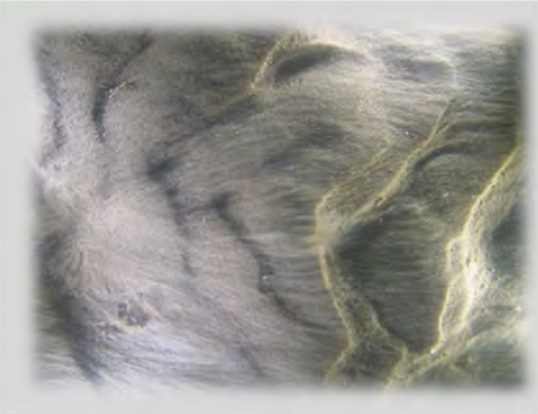
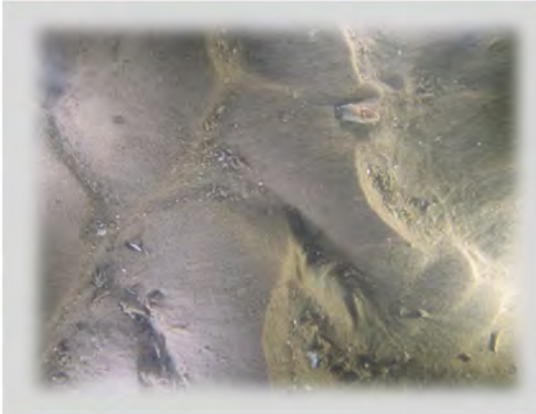
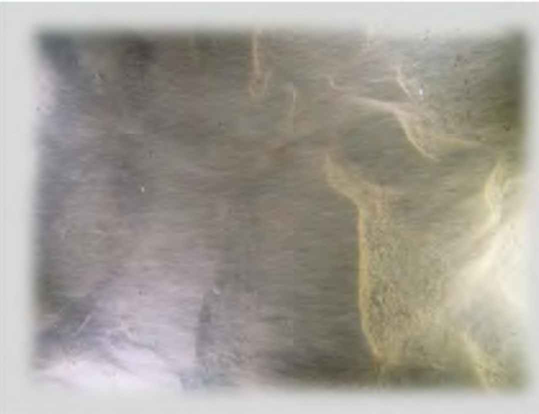
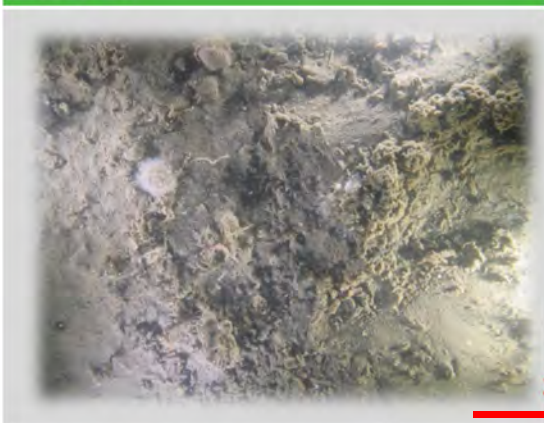
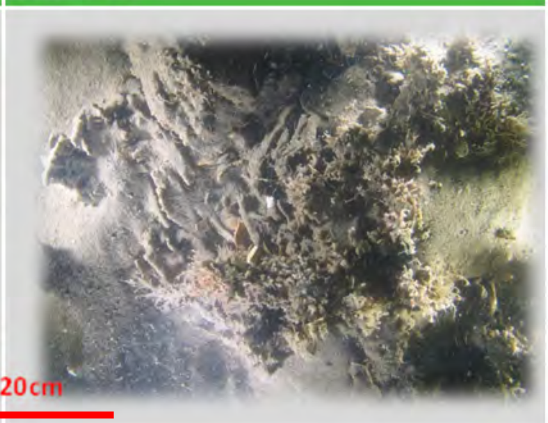


Table 3.9: Example Seabed Images from Across the Survey Stations (*CMACS, 2013*)

Station 2		**Station 4**	
			
Seabed description	Sand with boulder and mussel shells	**Seabed description**	Coarse sand, fine gravel and shell fragments (*Modiolus modiolus*)
Organisms	*Flustra foliacea* attached to hard substratum and barnacle spp.	**Organisms**	Aggregations of *S. spinulosa* and hydroid turf *(Halecium halecium).* Anemone also present

Table 3.9 (continued): Example Seabed Images from Across the Survey Stations (*CMACS, 2013*)

Station 19	**Station 33**
	
Station 39	**Station 41**
	
Seabed description	Rippled sand
Organisms	None visible
Station 24	**Station 25**
	
Seabed description	Sand
Organisms	Aggregations of *S. spinulosa* which also supports dead man's fingers *A. digitatum* and hydroids (including *Tubularia* sp.). A hermit crab, *Pagurus* sp., is visible in Station 24.

3.3.3 Fish Populations

Generally, there is little interaction between fish and offshore developments, although some species congregate around platforms and along pipelines. However, spawning individuals and juveniles can be sensitive to seismic and installation activities, discharges to sea and, in some cases, accidental spills. Fish are separated into pelagic (living at the surface or in the middle parts of the water column) and demersal (bottom dwelling) species:

- Pelagic species occur in shoals swimming in mid-levels of the water, typically making extensive seasonal movements or migrations between sea areas. Pelagic species include herring, mackerel, blue whiting and sprat;
- Demersal species live on or near the seabed and include haddock, cod, plaice, sandeel, sole and whiting.

Data on the spawning and nursery areas of fish on the UKCS were initially reported in 1998 by Coull *et al.* as unique polygons and then in 2012 Ellis *et al.* published data to a resolution of half an ICES rectangle. The Blocks of Interest lie within ICES rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 (Figure 3.8a and Figure 3.8b). For the purpose of this report fish spawning and nursery areas within the vicinity of the proposed Thames Decommissioning Programme area have been identified according to whether they overlap with the boundary of ICES rectangles 34F1, 34F2, 35F1, 35F2 and 35F3.

There are potential fish spawning areas (Table 3.10, Figure 3.8a and Figure 3.8b) in ICES rectangles 34F1, 34F2, 35F, 35F2 and 35F3 for cod (*Gadus morhua*), herring (*Clupea harengus*), lemon sole (*Microstomus kitt*), mackerel (*Scomber scombrus*), *Nephrops*, plaice (*Pleuronectes platessa*), sandeels (*Ammodytidae*), sole (*Solea solea*), sprat (*Sprattus sprattus*) and whiting (*Merlangius merlangus*) (*Coull et al., 1998; Ellis et al., 2012*).

In addition to the spawning grounds described above, the waters of ICES rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 also act as nursery areas for cod, herring, horse mackerel (*Trachurus trachurus*), lemon sole, mackerel, *Nephrops*, plaice, sandeels, sole, sprat, thornback ray (*Raja clavata*), tope shark (*Galeorhinus galeus*) and whiting (Table 3.10, Figure 3.8a and Figure 3.8b; *Coull et al., 1998; Ellis et al., 2012*).

It is estimated that the proposed Thames Decommissioning Programme will take up to 60 months (not concurrently), commencing in Q3 2014. Therefore, there is the potential for decommissioning activities to take place during any month of the year. Table 3.10 indicates which fish species have active nursery and or spawning areas in the vicinity of the Thames infrastructure during the proposed decommissioning period.

Table 3.10: Fish Spawning and Nursery Areas in the Vicinity of the Blocks of Interest (*Coull et al., 1998* and *Ellis et al., 2012*)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Cod			N	N	N	N						
Herring										N	N	N
Horse Mackerel [2]					N	N	N	N	N	N		
Lemon Sole						N	N	N	N	N	N	
Mackerel							N	N	N	N		
Nephrops	N	N	N	N	N	N	N	N	N	N	N	N
Plaice		N	N	N	N							
Sandeels	N	N	N	N								
Sole					N	N	N					
Sprat							N	N	N	N		
Thornback Ray [1]				N	N	N	N	N	N	N	N	
Tope Shark [1]	N	N	N	N	N	N	N	N	N	N	N	N
Whiting				N	N	N	N	N				

Key:

	Peak Spawning		Spawning (high intensity)		Spawning (low intensity)	N	Nursery (high intensity)	N	Nursery (low intensity)		Outwith Spawning Period

[1] Insufficient data available on spawning grounds (*Ellis et al., 2012*)

[2] Horse mackerel appear to be widespread and with no spatially discrete nursery grounds.

Note: The red box marks the proposed period for decommissioning.

Figure 3.8a: Fish Spawning and Nursery Areas in ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 (1 of 2)

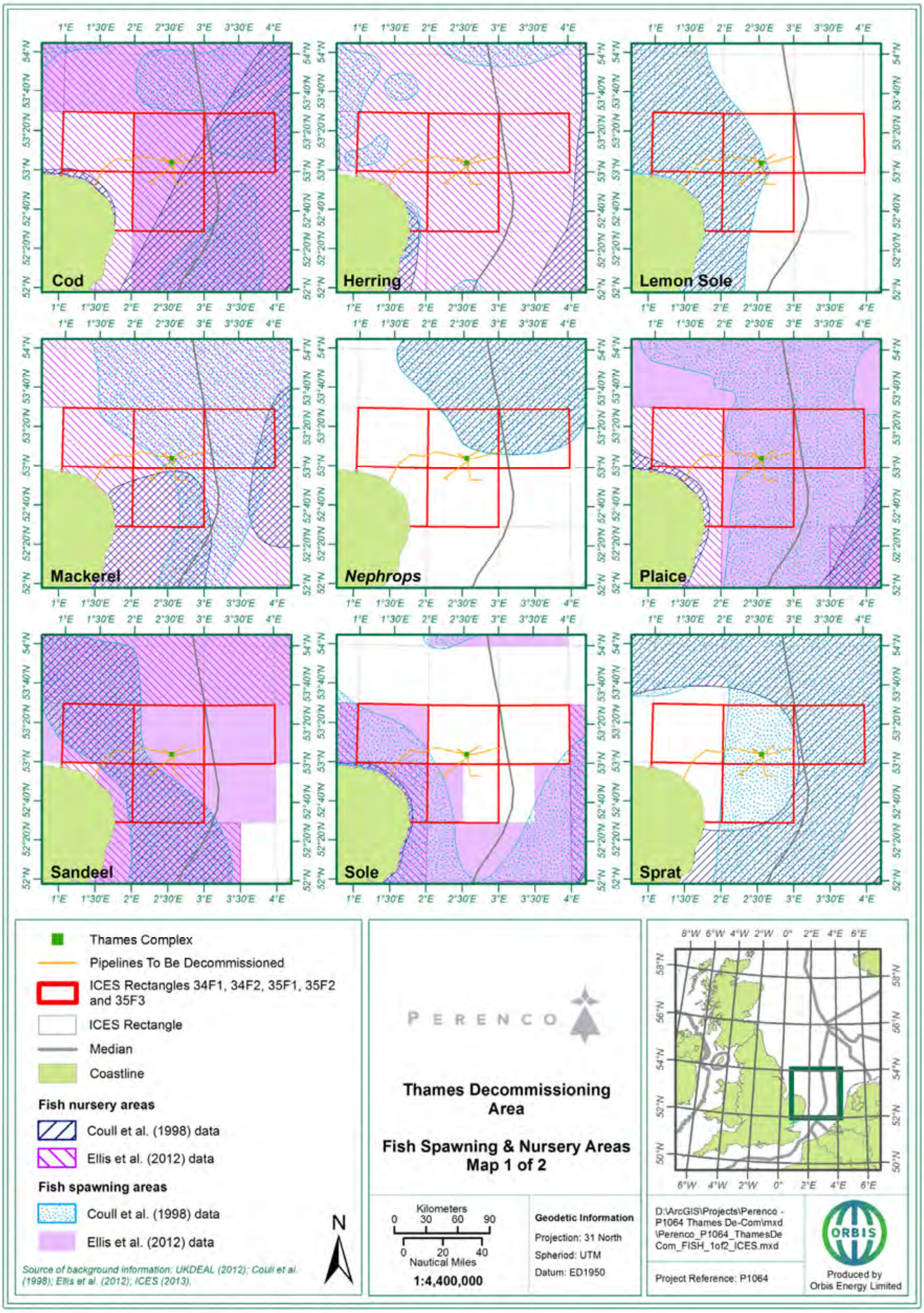
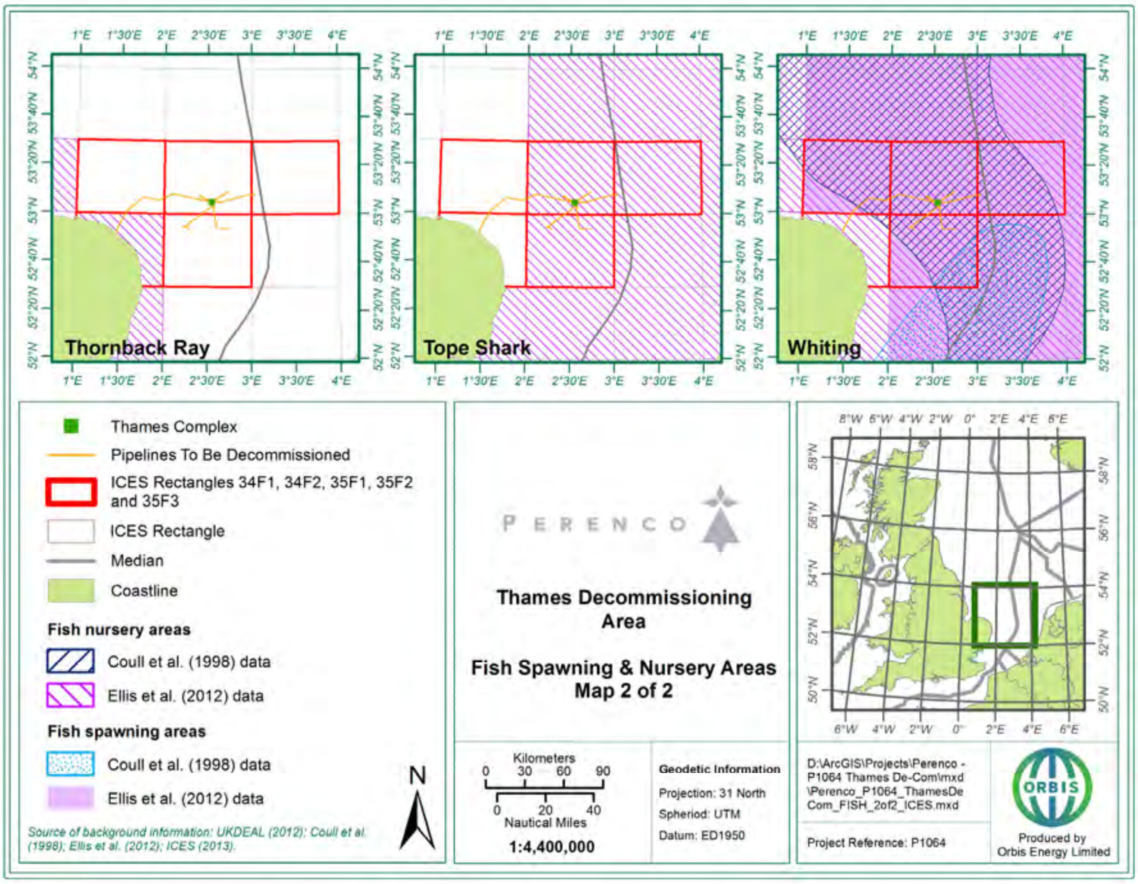


Figure 3.8b: Fish Spawning and Nursery Areas in ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 (2 of 2)



Shellfish

The benthic fauna of the UK waters is rich and diverse (*DECC, 2009*). An important component of this benthic fauna is a collection of molluscs and crustaceans loosely referred to as shellfish, a number of which are of commercial importance.

The Norway lobster (*Nephrops norvegicus*), commonly known as *Nephrops*, lives in burrows dug into muddy and sandy sediments, at depths between 20 to 800 metres. Eggs hatch in spring or summer, the relative inactivity of females during this period, when they remain hidden in burrows, means that males are more heavily exploited in the fishery through most of the year (*DECC, 2009*). *Nephrops* is more abundant in northern UK waters, although significant populations exist on the Dogger Bank.

The European lobster (*Homarus gammarus*) is found from the shoreline to depths of 150 metres, usually on hard substrata such as rock or hard mud, growing to lengths of 60 centimetres. Lobsters are most active at night, remaining in crevices during the day. Females lay eggs in July and carry them for 10 or 11 months (*DECC, 2009*).

The brown (or edible) crab (*Cancer pagurus*) is most abundant on rocky grounds, where it hides in holes and crevices. The crab is generally found in shallow water close to shorelines, particularly along the east coast and the southwest of England, although it can be found in water as deep as 100 metres (*DECC, 2009*). The species spawns between November and February, during which time the females remain in deeper waters offshore (*DECC, 2009*).

Long distance migrations are a feature of many crabs and lobsters, particularly the edible crab, European lobster, crawfish and spider crab (*Maja squinado*) (*DECC, 2009*). A number of valuable shrimp species are found around the UK. The three most important are the brown shrimp (*Crangon crangon*), the pink shrimp (*Pandalus montagui*) and the deep-water shrimp (*Pandalus borealis*). The brown shrimp generally favours areas with soft, sandy sediments, in which it can burrow, while the pink shrimp is more common over hard substrata. Eggs are carried by females over the winter months, before hatching in spring (*DECC, 2009*).

The most commercially valuable molluscs are scallops (*Pecten maximus*). Scallops are found predominantly to the south and west of the UK on sandy, muddy, shell and gravel substrata, down to depths of over 100 metres. Queen Scallops (*Aequipecten opercularis*) are a smaller shellfish and are able to live on harder gravel and shell substrata although generally habitats and distributions of the two species are similar (*DECC, 2009*). Cockles (*Cerastoderma edule*) live on inter-tidal beaches of sand, muddy sand and fine gravel, where they burrow into the sediment. Cockles mature after two years and spawn in spring (*DECC, 2009*). Mussels (*Mytilus edulis*) are suspension feeders generally found attached to hard substrata within the inter-tidal zone, although they also attach to reefs and man-made structures in shallow waters with spawning taking place in late spring (*DECC, 2009*). The most harvested gastropod molluscs in UK waters are whelks (*Buccinum undatum*) and periwinkles (*Littorina littorea*). They spawn in November, with eggs attaching to the seabed (*DECC, 2009*). Winkles are herbivorous and spawn between January and July.

Elasmobranch Species

Skates and rays (Chondrichthyan fishes or elasmobranchs) are an important part of the North Sea ecosystem, although there is not enough known about their abundance and distribution to fully facilitate the protection they require in the marine environment. Elasmobranchs typically have a slow growth rate and low fecundity (reproduction rate), leaving them vulnerable to over-fishing pressures and pollution events and subsequent recovery of populations in response to disturbance events is low. Historically, many species have been fishery targets due to their fins and liver oils (*Kunzlik, 1988*). However, they are not often specifically targeted by commercial fisheries anymore, but are still under threat from by-catch, which continues to deplete stocks in UK waters. Work is underway to develop National Plans of Action for the conservation and management of the chondrichthyes. The species identified as being in need of immediate protection are the angel shark, common skate, long-nosed skate, Norwegian skate and white skate. It has been proposed to protect these species in UK waters in the same way as the basking shark is protected, under the Wildlife and Countryside Act (1981).

In a survey conducted by CEFAS, twenty six species were identified and recorded throughout the North Sea and surrounding waters. Of these, 11 may be present within the general vicinity of the proposed Thames Decommissioning Programme area (*Ellis et al., 2004*); these are shown in Table 3.11. Of the 11 elasmobranch species, four are listed as 'Vulnerable', two are listed as 'Near Threatened' and one is listed as 'Endangered' on the IUCN Red List (*IUCN, 2014*).

Table 3.11: Distribution, Abundance and Current Status on the IUCN Red List of the Elasmobranchs Species Likely to be found in the Area Surrounding the Proposed Thames Decommissioning Programme Area (*Ellis et al., 2004; IUCN, 2014*)

Species	Location	Depth range (m)	Number (individuals/hr)	Current status on IUCN Red List
Blond Ray *Raja brachyura*	South and west British borders	14-146	72	Near Threatened
Common Smooth Hound *Mustelus mustelus*	South and west British borders	9-421	(occasional)	Vulnerable
Cuckoo Ray *Leucoraja naevus*	Irish Sea, Celtic Sea & northern North Sea	12-290	58	Least Concern
Lesser Spotted Dogfish *Scyliorhinus canicula*	South and west British borders	6-308	500	Least Concern
Spotted Ray *Raja montagui*	South and west British borders	8-283	88	Least Concern

Species	Location	Depth range (m)	Number (individuals/hr)	Current status on IUCN Red List
Spurdog *Squalus acanthias*	Widespread	10-200	-	Vulnerable
Starry Skate *Amblyraja radiata*	North Sea	32-209	232	Vulnerable
Starry Smooth Hound *Mustelus asterias*	Widespread	10-199	-	Least Concern
Thornback Ray *Raja clavata*	South and west British borders	7-192	200	Near Threatened
Tope Shark *Galeorhinus galeus*	Widespread	17-200	(regular)	Vulnerable
Undulate Ray *Raja undulata*	English Channel	0-72	8	Endangered

Basking Sharks

Basking sharks (*Cetorhinus maximus*) are thought to make extensive migrations both vertically and horizontally to locate high concentrations of plankton that will often be associated with fronts, and that they principally migrate north to south during the winter months along the continental shelf of Europe (*Sims et al., 2003; 2005*). Populations have been decreasing globally, predominantly as a consequence of historical fishing pressures and are currently listed as 'Vulnerable' on the IUCN Red List (*IUCN, 2014*).

Basking sharks appear in UK waters from April to September, with peak numbers observed in June/July and are known to occur in the North Sea in small numbers (*DTI, 2002*). Therefore, basking sharks may be present in the vicinity of the Thames Infrastructure during the proposed decommissioning activities.

Fish Species of Conservational Significance

The majority of fish species of conservational significance (e.g. anadromous / catadromous fish species, sea lamprey, allis shad and twaite shad), are coastal and occur in greatest abundance in relatively shallow coastal water (*DTI, 2002*). They are therefore unlikely to be present in the vicinity of the majority of the Thames infrastructure (approximately 130 kilometres northeast of the nearest UK landfall, near to Cromer on the Norfolk Coastline and in approximately 34 metres water depth). However, they may be present in the vicinity of the pipeline PL370, which connects to Bacton the coast.

European sturgeon is relatively rare and there are only sporadic catches of adults around the North Sea coasts, with a few individuals recorded off Flamborough Head in the 1970s (*DTI, 2002*). In addition, porbeagles are also known to occur in only small numbers in the North Sea (*DTI, 2002*).

Given the above it is unlikely that fish species of conservational significance will occur in the vicinity of the Thames infrastructure for significant periods of time or in significant numbers.

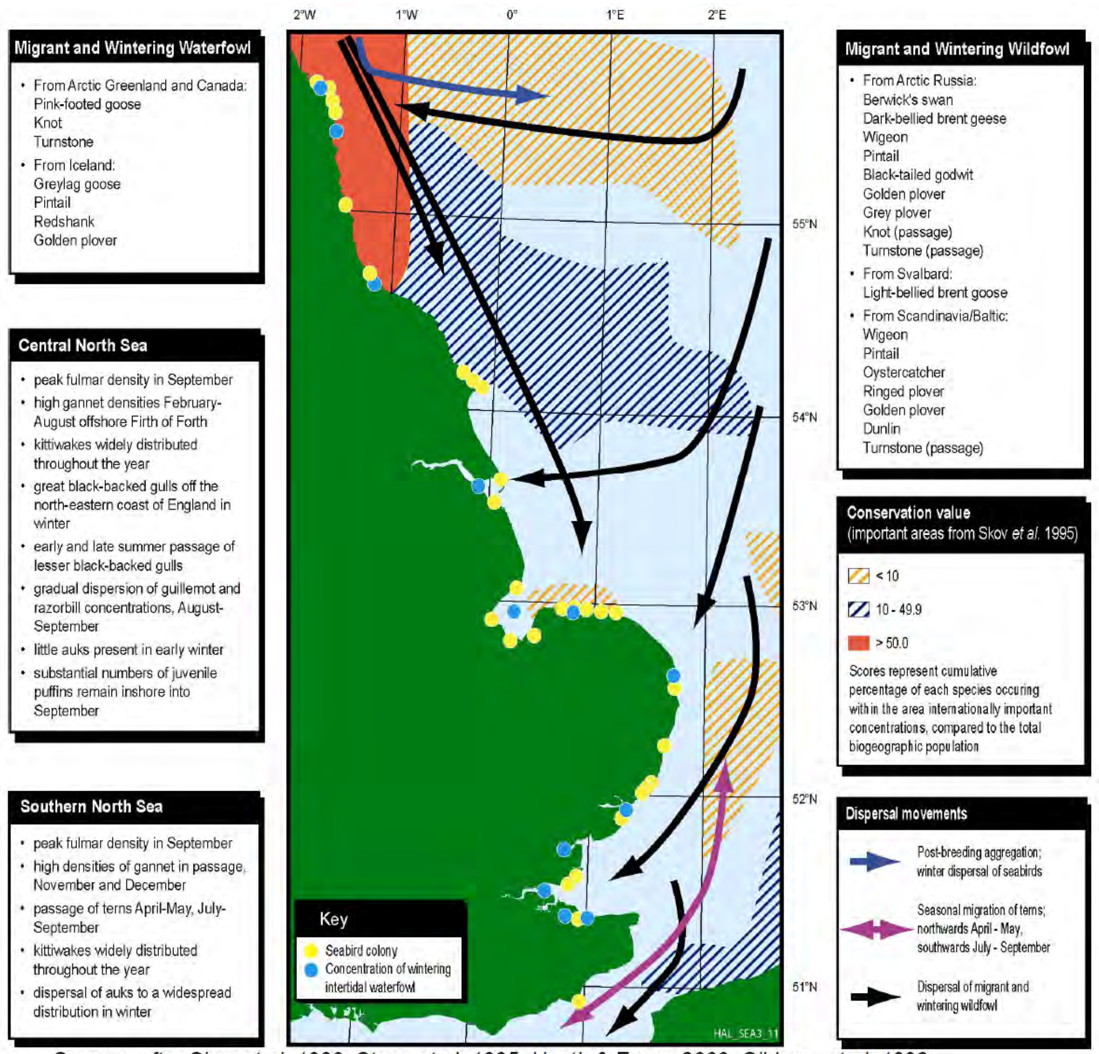
3.3.4 Seabirds

Seabirds are defined as birds which frequent coastal waters and the open ocean (*Lawrence, 2000*). Seabird distribution and abundance in the southern North Sea varies throughout the year, with offshore areas, in general, containing peak numbers of birds following the breeding season and throughout winter (*DECC, 2009*).

Fulmar are present in highest numbers in the southern North Sea during the early and late breeding seasons, leading to peak densities in September. Kittiwakes are widely distributed throughout the year. Lesser black-backed gulls are mainly summer visitors, while in contrast guillemot numbers are present in greatest numbers during winter months. In addition, substantial numbers of terns migrate northwards through the offshore North Sea in April and May, with return passage from July to September (*DECC, 2009*).

Figure 3.9 shows the seasonal distribution of seabirds in the vicinity of the proposed Thames Decommissioning Programme area. It indicates that the proposed Thames Decommissioning Programme area is in an area of low importance for international concentrations of birds <10 percent of biogeographic population.

Figure 3.9: The Broadscale Seasonal Distribution and Movements of Birds in the North Sea (*DTI, 2002*)



Source: after Skov et al. 1990, Stone et al. 1995, Heath & Evans 2000, Gibbons et al. 1993

Along the adjacent UK coastline to the proposed Thames Decommissioning Programme area there are a number of important site for breeding and wintering birds. These sites include:

- the North Norfolk Coastline Special Protection Area (SPA) and Ramsar Wetlands of International Importance (approximately 25 kilometres to the west of the Thames to Bacton pipeline (PL370));
- the Outer Thames Estuary SPA (approximately 30 kilometres to the south of the Arthur P2 Wellhead);
- the Wash SPA and Ramsar (approximately 67 kilometres to the north west of the Thames to Bacton pipeline (PL370)); and
- the Humber Estuary SPA and Ramsar (approximately 98 kilometres to the north west of the Thames to Bacton pipeline (PL370)).

An overview of the seasonal distribution of the key seabirds in the vicinity of the proposed Thames Decommissioning Programme area is provided in Table 3.12. It can be seen from this that species which are present throughout the year, albeit in varying densities, are fulmar and kittiwake. Densities of fulmar are high (<5 individuals per square kilometre) from February to March and in August, while densities of kittiwake are high in February, May and October. Other species that reach high densities are; the lesser black-backed gull in August, the herring gull from February to March, great black-backed gull in February and September, the guillemot in May, October and December and the razorbill in March.

Other frequent visitors to this area (present for six months of the year or more) include red-throated diver, gannet, common gull, lesser black-backed gull, herring gull, great black-backed gull, little tern, guillemot, razorbill and puffin. The abundance of gannet and puffin peak at high (up to 4.99 individuals per square kilometre) in September and December, respectively. Generally, it appears that the greatest number of seabird species are present, in the vicinity of the proposed Thames Decommissioning Programme area, during the first quarter of the year (Table 3.12; *UKDMAP, 1998*).

Table 3.12: Seasonal Distribution of Seabird in and around Blocks of Interest (*UKDMAP, 1998*)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Red-Throated Diver (*Gavia stellata*)												
Black-Throated Diver (*Gavia arctica*)												
Fulmar (*Fulmarus glacialis*)												
Sooty Shearwater (*Puffinus griseus*)												
Leach's Storm-Petrel (*Oceanodroma leucorhoa*)												
Gannet (*Morus bassanus*)												
Red-Breasted Merganser (*Mergus serrator*)												
Pomarine Skua (*Stercorarius pomarinus*)												
Arctic Skua (*Stercorarius parasiticus*)												
Long-tailed Skua (*Stercorarius longicaudus*)												
Great Skua (*Catharacta skua*)												
Little Gull (*Larus minutus*)												
Black-Headed Gull (*Larus ridibundus*)												
Common Gull (*Larus canus*)												
Lesser Black-Backed Gull (*Larus fuscus*)												
Herring Gull (*Larus argentatus*)												
Great Black-Backed Gull (*Larus marinus*)												
Kittiwake (*Rissa tridactyla*)												
Sandwich Tern (*Sterna sandvicensis*)												
Common Tern (*Sterna hirundo*)												
Arctic Tern (*Sterna paradisaea*)												
Little Tern (*Sterna albifrons*)												
Guillemot (*Uria aalge*)												
Razorbill (*Alca torda*)												
Little Auk (*Alle alle*)												

Species	J	F	M	A	M	J	J	A	S	O	N	D
Puffin (*Fratercula arctica*)												
Key (Number of individuals per square kilometre)												
Very High (>5)	High (1-4.99)	Moderate (0.5-0.99)	Low (<0.49)									

* No data

Note: The period for decommissioning are currently scheduled to take place during any month of the year.

The JNCC ranks seabird vulnerability on a four-point scale, with one representing the highest vulnerability and four the lowest. Seabird vulnerability in the Blocks of Interest, in general, is moderate to low. The wellheads and platforms to be decommissioned are located within Blocks 49/28-29, 50/26, 53/2-4. Within these Blocks, seabird vulnerability generally peaks to high (2 out of 4 on the JNCC scale) during February, March and December. The Blocks containing only pipeline follow a similar trend. The highest seabird vulnerability on the JNCC ranked scale (1 out of 4) only occurs in Blocks 48/28 and 52/3 during October (Table 3.13 and Figures 3.10a and b).

It is estimated that the proposed Thames Decommissioning Programme will take up to 60 months (not concurrently), commencing in Q3 2014. Therefore, there is the potential for decommissioning activities to take place during any month of the year.

Table 3.13: Seabird Vulnerability In and Around the Blocks of Interest (*JNCC, 1999*)

Block	J	F	M	A	M	J	J	A	S	O	N	D
Blocks of Interest												
48/28	**4**	**3**	**4**	**4**	**4**	**4**	**4**	**3**	**4**	**1**	**2**	**2**
48/29	**4**	**3**	**4**	**4**	**4**	**4**	**4**	**3**	**4**	**2**	**2**	**2**
48/30	4	3	3	4	3	4	4	3	4	2	2	2
49/26	4	3	3	4	3	4	4	3	4	3	4	2
49/27	4	3	3	4	3	4	4	3	4	3	4	2
49/28	4	3	2	4	3	4	4	3	4	3	4	2
49/29	4	3	2	4	3	4	4	3	4	4	4	2
49/30	4	2	2	4	3	4	4	3	4	4	4	2
50/26	**4**	**2**	**2**	**4**	**3**	**4**	**4**	**4**	**4**	**4**	**4**	**3**
52/03	4	3	4	4	4	4	4	2	3	1	2	2
53/02	**4**	**3**	**3**	**4**	**3**	**4**	**4**	**3**	**4**	**3**	**4**	**2**
53/03	**3**	**2**	**2**	**4**	**3**	**4**	**4**	**3**	**4**	**3**	**4**	**2**
53/04	**3**	**2**	**2**	**4**	**3**	**4**	**4**	**3**	**4**	**4**	**4**	**2**
Adjacent Blocks												
48/22	4	3	4		3	4	4	2	3	1	2	2
48/23	4	2	3	4	3	4	4	2	3	1	2	2
48/24	4	2	3	4	3	4	4	3	4	2	2	2
48/25	4	2	2	4	3	4	4	3	4	2	2	2
48/27	4	3	4		4		4	3	4	1	2	2
49/21	4	2	2	4	3	4	4	3	4	3	4	2
49/22	4	2	2	4	3	4	4	3	4	3	4	2
49/23	3	2	2	4	3	4	4	3	4	3	4	2
49/24	3	3	2	4	3	4	4	3	4	4	4	2
49/25	3	2	2	4	3	4	4	3	4	4	3	2
50/21	3	2	2	4	3	4	4	4	4	4	3	3

Block	J	F	M	A	M	J	J	A	S	O	N	D
50/22	3	2	2	4	3	4	4	4	4	4	3	3
50/27	4	2	2	4	3	4	4	4	4	4	4	3
52/02	4	3	4		4		4	3	4	1	2	2
52/04	4	3	4	4	4	4	4	2	3	2	2	2
52/05	4	3	3	4	3	4	4	2	3	2	2	2
52/07	4	3	4		4		4	3	4		2	2
52/08	3	3	4	4	4	4	4	2	3	3	2	1
52/09	3	4	4	4	4	4	4	2	3	3	3	1
53/01	4	3	3	4	3	4	4	3	4	3	4	2
53/05	3	1	2	4	3	4	4	3	4	4	4	2
53/06	3	3	4	4	3	4	4	3	4	3	4	2
53/07	3	3	4	4	3	4	4	3	4	3	4	2
53/08	2	1	2	4	3	4	4	3	4	3	4	2
53/09	2	1	2	4	3	4	4	3	4	4	4	2
53/10	2	1	2	4	3	4	4	3	4	4	4	2
54/01	3	1	2	4	3	4	4	4	4	4	4	3
54/02	3	1	2	4	3	4	4	4	4	4	4	3

Key (seabird vulnerability - sensitivity to oiling)

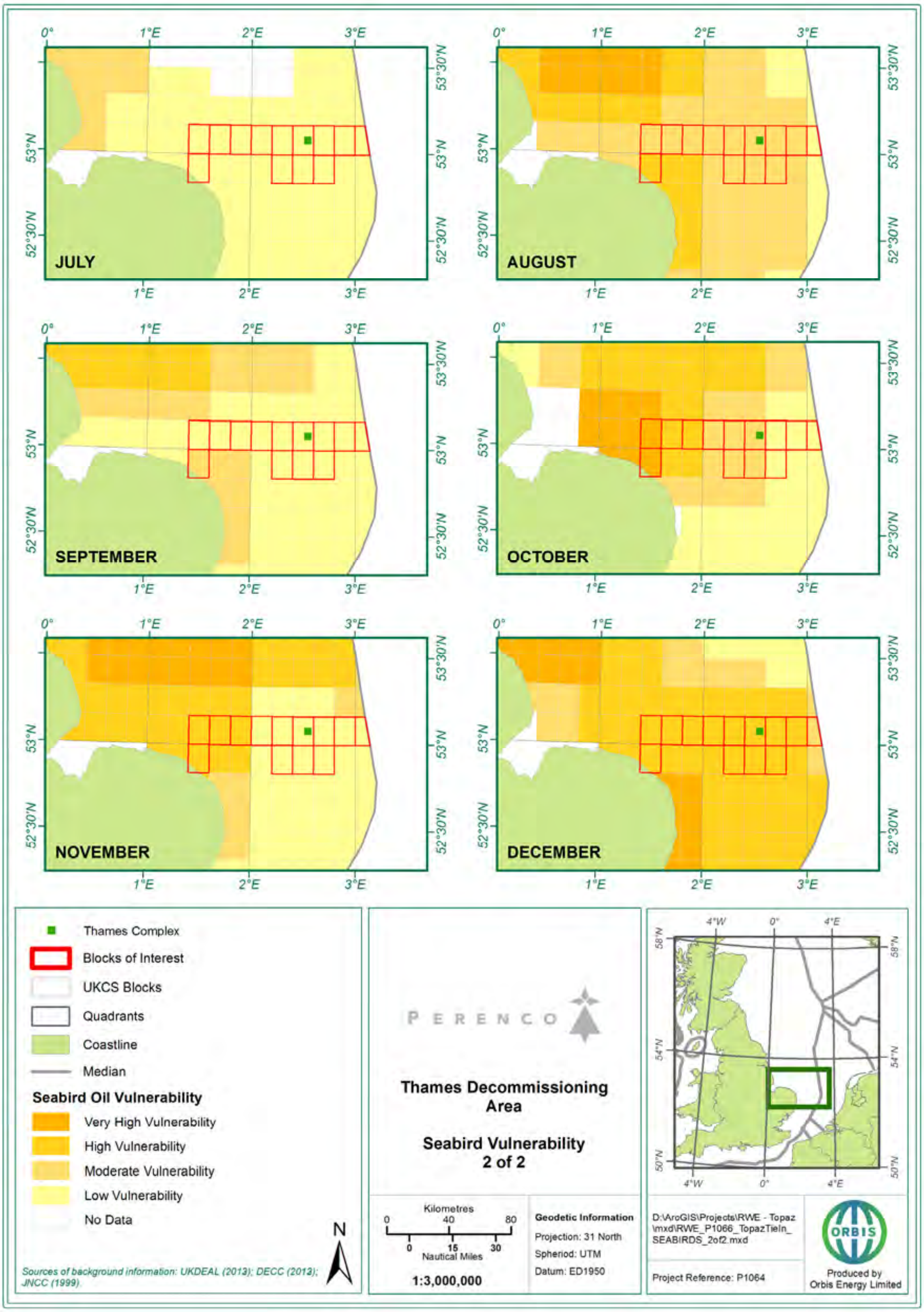
	Very High (4 out of 4)		High (3 out of 4)		Moderate (2 out of 4)		Low (1 out of 4)		No Data

Rows highlighted in **BOLD** Indicate Blocks containing wellheads and / or platforms for decommissioning

Note: The period for decommissioning is currently scheduled to take place during any month of the year.

Figure 3.10a: Seabird Vulnerability Index for Blocks of Interest (January – June) (*JNCC, 1999*)

Figure 3.10b: Seabird Vulnerability Index for Blocks of Interest (July – December) (*JNCC, 1999*)



3.3.5 Marine Mammals

Cetaceans

There is a concern that offshore exploration activities can impact the movement and feeding behaviour of cetaceans, primarily through the generation of underwater noise.

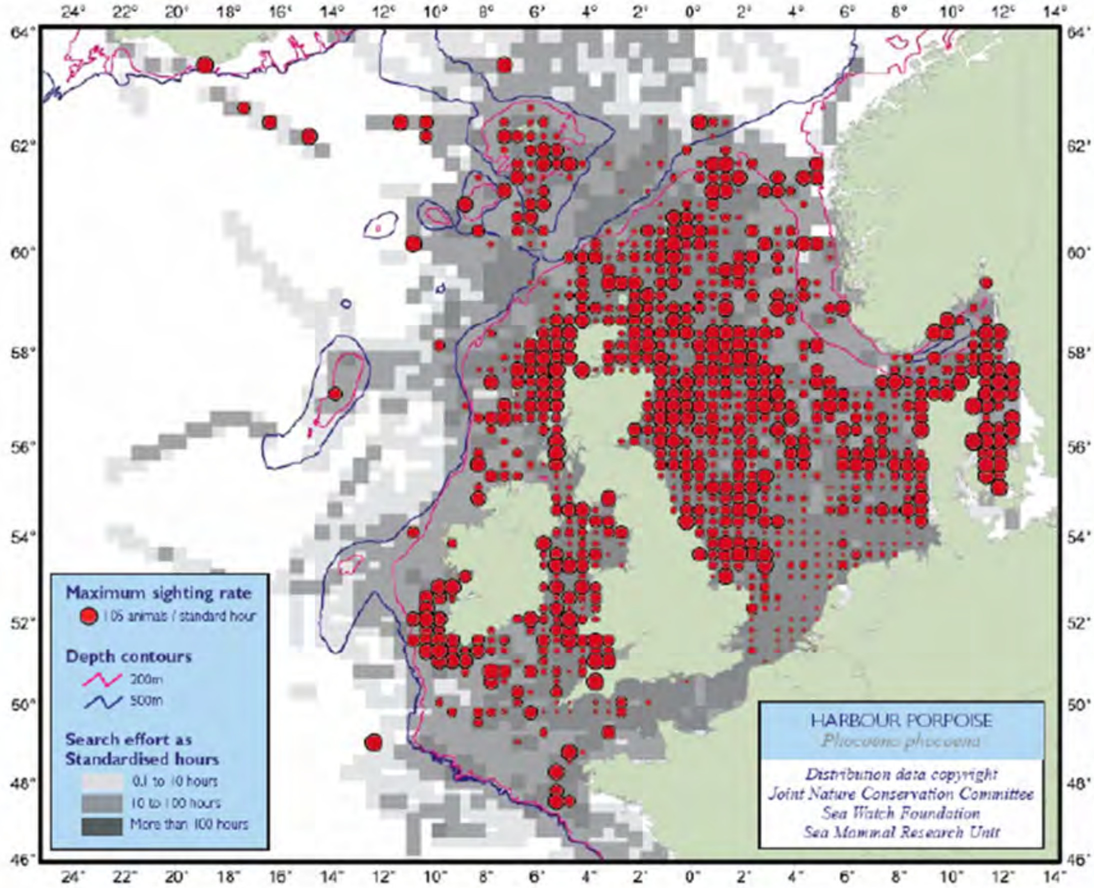
More than twenty cetacean species have been recorded in UK waters. Of these, ten species are known to occur regularly, these are (*DECC, 2009*):

- Minke whale (*Balaenoptera acutorostrata*);
- Harbour porpoise (*Phocoena phocoena*);
- Bottlenose dolphin (*Tursiops truncatus*);
- Short-beaked common dolphin (*Delphinus delphis*);
- White-beaked dolphin (*Lagenorhynchus albirostris*);
- White-sided dolphin (*Lagenorhynchus acutus*);
- Killer whale (*Orcinus orca*);
- Risso's dolphin (*Grampus griseus*); and
- Long-finned pilot whale (*Globicephala melas*).

Species which are known to occur in the southern North Sea sector (around the area of the proposed Thames Decommissioning Programme area) include the harbour porpoise, minke whale, white-beaked dolphin and white-sided dolphin (*Reid et al., 2003*). Cetaceans are protected under Annex IV of the Council Directive 92/43/EEC (also known as the Habitats Directive) which obliges member states to maintain or restore species of community interest to favourable conservation status as well as establish effective management and monitoring strategies to ensure that any incidental capture or killing does not have a significant negative impact on the species concerned (*Baxter et al., 2011*).

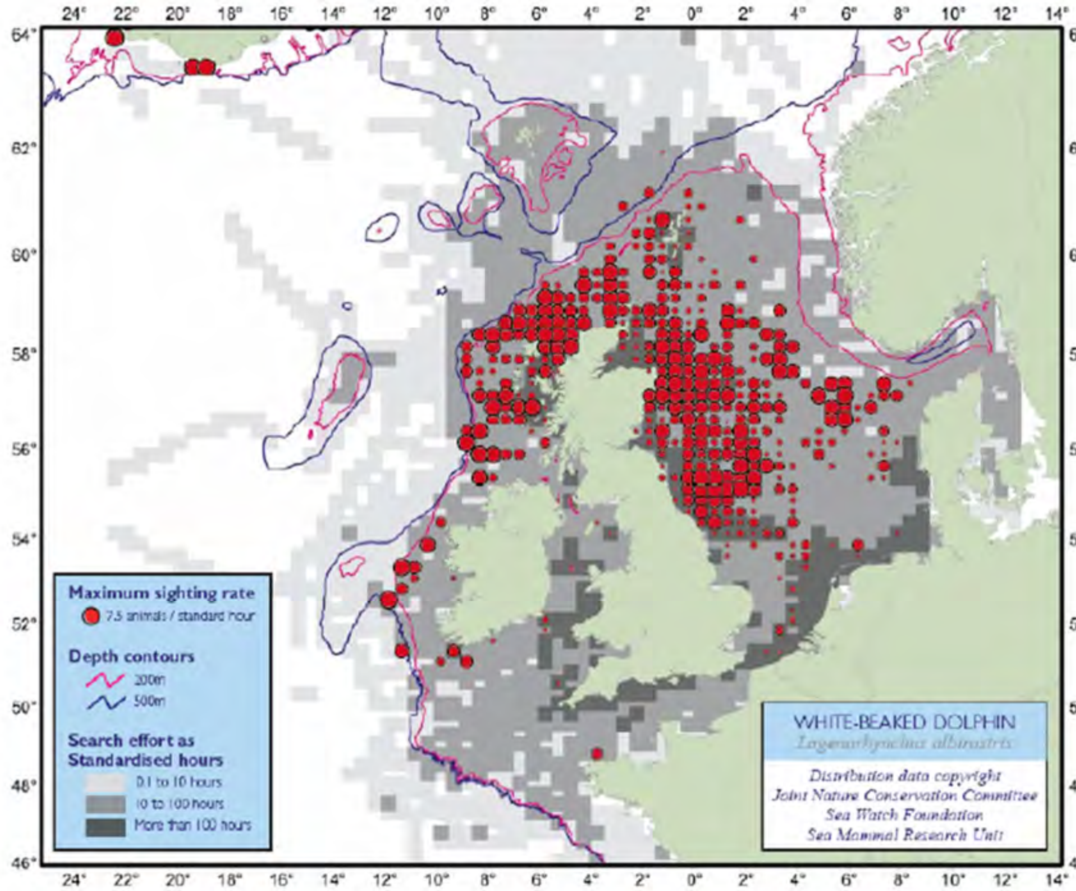
Harbour porpoise is the most common cetacean in UK waters. They are widely distributed and abundant throughout the majority of UK shelf seas, both coastally and offshore, with notably fewer sightings in the far southern and south-eastern North Sea and eastern Channel (Figure 3.11) (*Reid et al., 2003*). In coastal waters, they are often encountered close to islands and headlands with strong tidal currents (*DECC, 2009*). Sightings become increasingly rare close to the continental shelf edge, with relatively few records of porpoises in deeper waters beyond the shelf edge.

Figure 3.11: Sighting Rates of Harbour Porpoise Around the United Kingdom (*DECC, 2009*)



White-beaked dolphins are restricted to the North Atlantic. In the Northeast Atlantic their range extends from the British Isles to Spitsbergen. They are the second most commonly occurring cetacean in UK shelf waters, and are regularly encountered in coastal and offshore waters (Figure 3.12) (*DECC, 2009*). Their distribution is generally restricted to the northern half of UK waters, with sightings rare below 54°N in the North Sea, while they are very rare in the Channel and Irish and Celtic Seas. Analysis of summer sightings on shelf waters around the UK, from 1983-1998, showed the vast majority of white-beaked dolphins to occur in waters with a temperature of 13°C (*DECC, 2009*). While sighted throughout the year, sightings are slightly more frequent from July to October.

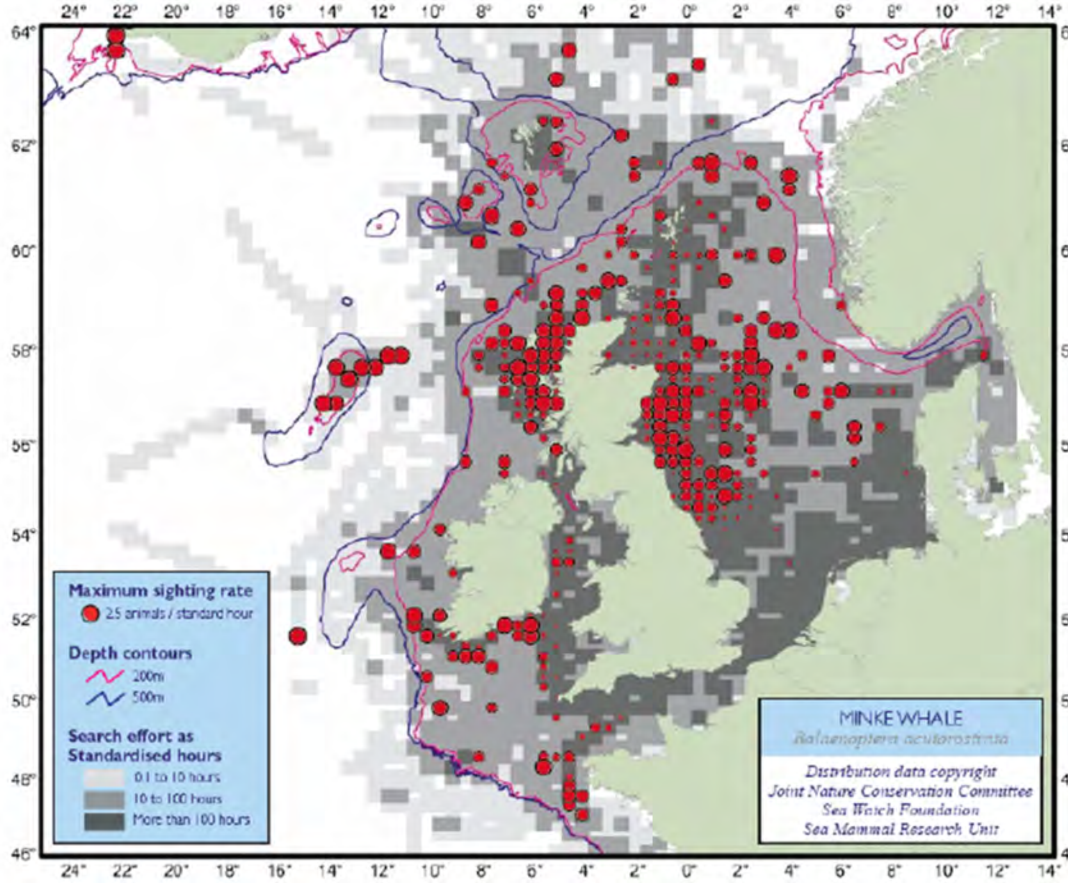
Figure 3.12: Sighting Rates of White-Beaked Dolphin Around the United Kingdom (*DECC, 2009*)



Minke whales are widely distributed in all the major oceans of the world from tropical to polar seas; they are most abundant in relatively cool waters, and on the continental shelf in waters less than 200 metres (*DECC, 2009*). Within UK waters, minke whales are most frequently sighted in the western central-northern North Sea, and west of Scotland around the Hebrides. They are primarily a seasonal visitor to UK waters, with whales appearing to move south into the North Sea and western Scotland at the beginning of May and remaining present until October; sightings are rare outside of this period. During these summer months, they are widely distributed throughout the region, including coastal and offshore shelf waters, and deeper waters on and beyond the shelf slope (Figure 3.13) (*DECC, 2009*).

Minke whales are rare in the southernmost North Sea and eastern English Channel; North Sea sightings generally extend no further south than the Dogger Bank. In the western English Channel they are evenly distributed in low numbers along the continental shelf edge, and also present throughout much of the Celtic Sea and western Irish Sea during summer.

Figure 3.13: Sighting Rates of Minke Whale Around the United Kingdom (*DECC, 2009*)



Perenco is aware of the Management Units for marine mammals in UK waters data that was published in June 2013. However, due to the lack of area / density data, this data has not been included in this EIA. Instead, the SCANS-II (2008) data has been used in the density assessments.

In comparison to other areas of the UKCS, the Central North Sea (south) has a moderate to high density of marine mammals. It can be seen from Table 3.14 that by far the most abundant species in the Central North Sea (south) is the harbour porpoise. This cetacean has a density of 0.562 animals per square kilometre, significantly higher than the UK average. The abundance of minke whale is also higher than the UK average, at 0.0224 animals per square kilometre. White-beaked dolphin and white-sided dolphin are both present in densities lower than the UK average and bottlenose dolphin and common dolphin are not recorded to be present in the Central North Sea (south) (*SCANS-II, 2008*).

Table 3.14: Abundance and Corresponding Density of Cetaceans in SCANS-II Survey Area U (Central North Sea – South; *SCANS-II, 2008*)

Species	Survey Strata U - Central North Sea (South)[1]		Total (strata overlapping UK waters)[2]	
	Abundance[3]	Density[4]	Abundance	Density
Harbour porpoise	88,143	0.562	328,142	0.317
Minke whale	3,519	0.0224	13,818	0.0133
White-beaked dolphin	493	0.0031	22,398	0.0289
White-sided dolphin	405	0.0026	27,228	0.0263

[1] Total area of the Central North Sea - south = 156,972 square kilometres; [2] Total area of strata overlapping UK waters = 1,036,077 square kilometres; [3] Abundance is the total number of animals; [4] Density is the number of animals per square kilometre.

It should be noted, however, that the SCANS-II survey area encompasses a relatively large geographical area and, as such, is unlikely to accurately reflect the abundance and densities of cetaceans which may be present within the vicinity of the Blocks of Interest. Data taken from the JNCC Atlas of Cetacean Distribution in North-West European Waters, as summarised in Table 3.15 below, has therefore been used to give a more localised indication of the seasonal distribution of cetaceans.

According to Reid *et al.* (*2003*) three species have been previously been sighted in the area around the Blocks of Interest. Harbour porpoise have previously been recorded in moderate numbers (1-10 individuals sighted per hour of effort) from June to July and in low numbers (0.01-1 individuals sighted per hour of effort) throughout the remainder of the year, with the exception of October and November when they are absent (Table 3.15). White-beaked dolphins have been observed in the vicinity of the Blocks of Interest in moderate numbers during April and low numbers in March and May. Low sightings of minke whale were recorded during June.

It is estimated that the proposed Thames Decommissioning Programme will take up to 60 months (not concurrently), commencing in Q3 2014. Therefore, there is the potential for decommissioning activities to take place during any month of the year. Therefore, there is a possibility of all of the three cetacean species, displayed in Table 3.15, being present in the vicinity of the Blocks of Interest, during decommissioning activities.

Table 3.15: Cetacean Sightings within the Vicinity of the Blocks of Interest (*Reid et al., 2003*)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Harbour Porpoise	Low	Low	Low	Low	Low	Medium	Medium	Low	Low	No sightings	No sightings	Low
Minke Whale	No sightings	No sightings	No sightings	No sightings	No sightings	Low	No sightings	No sightings	No sightings	No sightings	No sightings	No sightings
White-Beaked Dolphin	No sightings	No sightings	Low	Medium	Low	No sightings	No sightings	No sightings	No sightings	No sightings	No sightings	No sightings

Key (Number of Individuals sighted per hour of effort)

High (>10)	Medium (1-10)	Low (0.01-1)	V. Low (0-0.01)	No sightings (0)

Note: The red box indicated the proposed decommissioning period.

Pinnipeds

Two species of Pinnipeds (or seals) are found around the English coast:

- Grey seal (*Halichoerus grypus*); and
- The harbour (or common) seal (*Phoca vitulina*).

Both the common seal and the grey seal are listed under Annex II of the EC Habitats and Species Directive as species whose conservation requires the designation of Special Areas of Conservation (SACs). In the UK, there are currently eight SACs primarily designated for their grey seal population and nine SACs primarily designated for their harbour seal populations (*JNCC, 2013a; JNCC, 2013b*). In addition, both common and grey seals are protected under the Conservation of Seals Act 1970.

Grey Seals (*Halichoerus grypus*)

Grey seals are large marine predators and this species is abundant in parts of the North Sea. Studies on their diet have indicated that it is highly seasonally dependent. During summer their diet is dominated by sandeels and cod.

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 (*DECC, 2009*). Densities at sea are likely to be lower during this period than at other times of the year. They also haul-out and rest throughout the year between foraging trips to sea (*DECC, 2009*).

Studies have indicated that breeding females tend to faithfully return to their natal breeding colony for most of their lives (*Pomeroy et al., 2000*). Mature females give birth to a single pup which is nursed for about three weeks before it is weaned and moults into its sea-going adult coat.

Some information on the distribution and movements of grey seals comes from using numbered tags attached to the flippers of pups. These indicate that young seals disperse widely in the first few months of life. Pups marked in the UK have, for example, been recaptured or recovered along the North Sea coasts of Norway, France and The Netherlands, mostly during their first year (*Wiig, 1986*).

Grey seal foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to discrete offshore areas (*McConnell et al., 1999*). The large distances travelled indicate that grey seals in the North Sea are not ecologically isolated and can thus be considered as coming from a single ecological population.

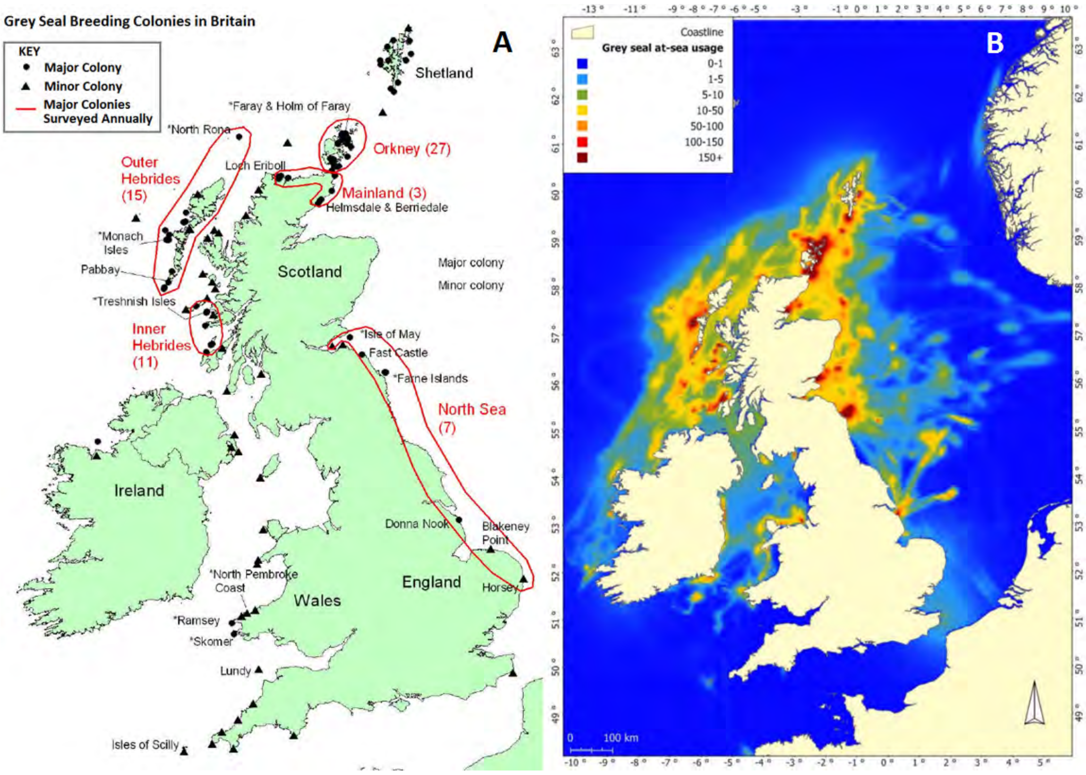
Along the adjacent coastline to the proposed Thames Decommissioning Programme area, a long established colony of breeding grey seals exists at Donna Nook (Figure 3.14 (A)). Smaller surveyed colonies are present further south at Blakeney Point on the north Norfolk coast, and also at Horsey on the east Norfolk coast. Amongst these three colonies, 2,566 newborn pups were counted in 2010 (*SCOS, 2011*). Breeding grey seals are also recorded at Flamborough Head and The Wash. Small numbers of grey seals occur along the European continental coast of the southern North Sea, the majority of which are recorded in the Dutch Wadden Sea; pup production in this area was 400 in 2008 (*SCOS, 2011*).

Models of marine usage by grey seals show a generally low density of activity in the southern North Sea, with greatest activity within The Wash and off the coast of Flamborough Head (*Matthiopoulos et al., 2004*). Grey seals from the Donna Nook colony are known to regularly travel 230 kilometres out to sea from their haul-out site (*SCOS, 2012*).

Figure 3.14 (B) shows the estimated area usage (at-sea and hauled out) distribution of grey seas in UK waters in a 5 square kilometre resolution grid. This map is based on over 20 years of telemetry and survey count data and indicates that (as a worst case) in the vicinity of the proposed Thames Decommissioning Programme area, on average, Block 52/3 may have 1 – 5 grey seals present at any time while the remaining Blocks have background levels, at 0 – 1 individuals present at any time (*SCOS, 2012*).

Given the above, and taking into account that the proposed decommissioning works will take place during any month of the year, grey seals could be present in the vicinity of the Thames decommissioning area.

Figure 3.14: (A) Locations of Grey Seal Breeding Colonies in Britain (source: *SMRU in SCOS, 2012*) and (B) Estimated At-Sea and Hauled –Out Density of Grey Seals around the UK (Source: *SCOS, 2012*)



Note: (A) Major and minor grey seal breeding colonies, those circled in red are surveyed annually. (B) Warmer colours represent areas of higher densities of grey seals (data resolution is to 5 square kilometres).

<u>Common seals (*Phoca vitulina*)</u>

The common seal (also known as harbour seal) is the smaller of the two species of pinniped that breed in Britain and is also an important predator in this area of the North Sea. Their diet is composed of a wide variety of prey, particularly pelagic and benthic species including whiting, saithe and a seasonal intake of sandeels. Their diet varies seasonally and from region to region depending on the abundance of schooling pelagic prey (*DECC, 2009*).

Several common seal colonies and haul-out sites are present on the east coast of England, with numbers estimated to be approximately 4,000 animals. The distribution of seals at haul-out sites around the UK is shown in Figure 3.15 (A). The largest concentrations are found in Scotland, primarily on Orkney, Shetland and the Inner and Outer Hebrides. Large numbers also occur on the English east coast at The Wash and adjacent coastline. Many other haul-out sites supporting lower numbers are present around the UK coast, the largest of which are found in the Moray Firth, east coast of Northern Ireland, the Firths of Tay and Forth, the greater Thames area and southwest Scotland (*DECC, 2009*).

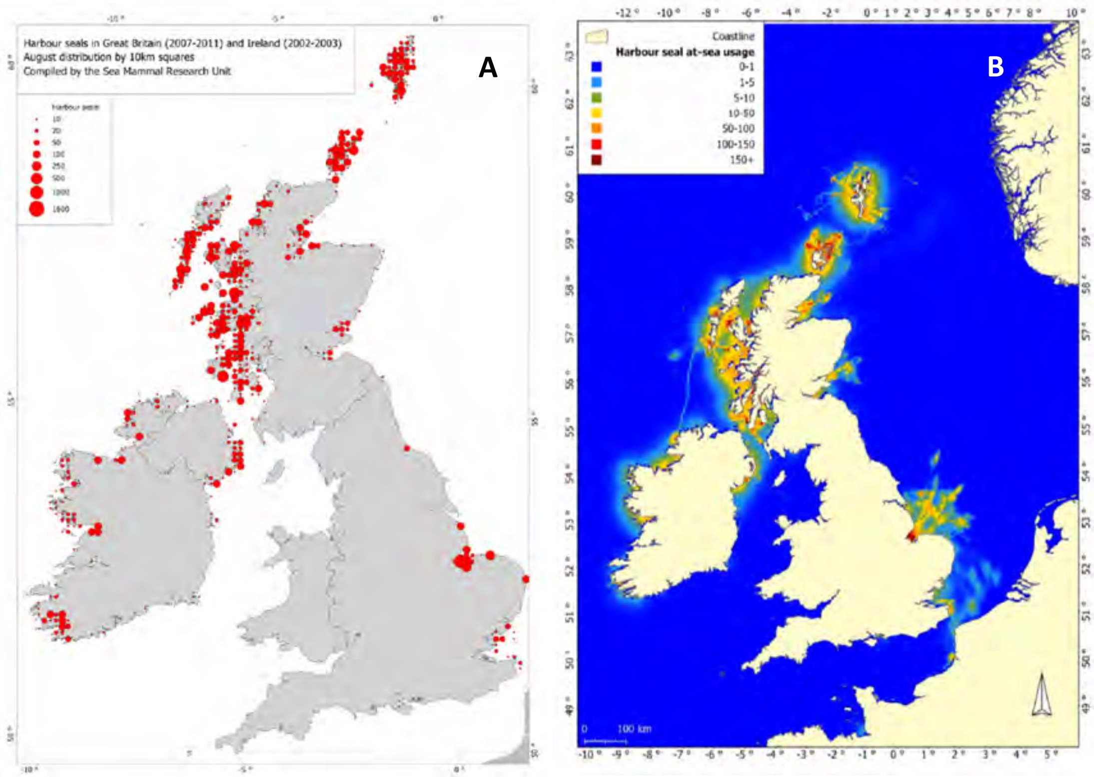
Approximately half of the English east coast population are recorded in The Wash, with Blakeney Point the second largest English colony, then Donna Nook (*DECC, 2009*). Colonies are also present at Scroby Sands off the east Norfolk coast and in the greater Thames area. The English east coast population has fluctuated considerably since the late 1980s in response to phocine distemper virus epidemics in 1988 and 2002, causing 50 percent and 22 percent declines in population size respectively (*DECC, 2009*).

Common seals haul out on tidally exposed areas of rock, sandbanks or mud. Pupping occurs on land from June to July, while the moult is centred around August and extends into September.

Common seals in The Wash, south of Donna Nook have been observed to regularly travel 165 kilometres out to sea (*SCOS, 2012*). Figure 3.15 (B) shows the estimated habitat use (at-sea and hauled out) distribution of harbour seas in UK waters. This map is based on over 20 years of telemetry and survey count data and indicates that in the vicinity of the proposed Thames Decommissioning Programme area (as a worst case) there may be 10 – 50 individuals present at any time within Blocks 49/26 and 49/27. While, Blocks 48/28-30 may have 5 – 10 individuals present at any time and Blocks 52/3 and 53/2 may have 1-5 seals present at any time. The remaining Blocks have background levels, with 0 - 1 individuals present at any time (*SCOS, 2012*).

It is therefore possible, given the above and the distance to shore of the Thames platform (approximately 66 kilometres), that common seals could be seen in the vicinity of the Blocks of Interest during the proposed Thames Decommissioning Programme works.

Figure 3.15: (A) Common Seal Numbers (source: *SMRU in SCOS, 2012*) and (B) Estimated At-Sea and Hauled-Out Density of Harbour Seals Around the UK (source: *SCOS, 2012*)



Note: (A) The August distribution of harbour seals in Great Britain and Ireland (data resolution to 10 square kilometres). These data are from surveys carried out between 2007 and 2011 (*SCOS, 2012*). (B) Warmer colours represent areas of higher densities of harbour seals (data resolution is to 5 square kilometres).

Marine Reptiles

Although not indigenous to the United Kingdom, sea turtles (family *Cheloniidae*) represent the only marine reptiles to be found in UK waters (*DECC, 2009*). There are seven species of marine turtle, five of which have been recorded in UK waters.

These are:

- The leatherback turtle (*Dermochelys coriacea*);
- The loggerhead turtle (*Caretta caretta*);
- Kemp's ridley turtle (*Lepidochelys kempii*);
- The green turtle (*Chelonia mydas*); and
- The hawksbill turtle (*Eretmochelys imbricata*).

Of the five species recorded in UK waters, the vast majority of records (ca. 80 percent) are of the leatherback turtle (*DECC, 2009*). This species exhibits physiological adaptations which allow it to function in temperate waters, and is the only species of marine reptile to be considered a regular member of the UK marine fauna (*DECC, 2009*). The appearance of most turtle species in UK waters is thought to be accidental, but the movement of leatherbacks is mostly regarded as a deliberate migration in response to food distribution, notably jellyfish (*Houghton et al., 2006*). This species may be at the extreme (northern) limit of its range in UK waters.

Sightings of leatherback turtle in the central North Sea are low, with the majority of sightings occurring in November (*Pierpoint, 2000*), in addition only eight sightings or strandings were recorded in the southern North Sea during 2001-2007 (*DECC, 2009*).

3.3.6 Marine Protected Areas

The UK is committed to contributing to a well-managed network of Marine Protected Areas (MPAs) by 2016 in order to protect marine life while allowing sustainable and legitimate use of our seas to continue. The network of MPAs will ensure the UK meets their commitments under the Convention on Biological Diversity and contributes to measures aimed at achieving Good Environmental Status across Europe's seas by 2020 under the EU Marine Strategy Framework Directive.

The main types of MPAs in English waters are:

- **Marine Conservation Zones (MCZs)** and **Sites of Special Scientific Interest (SSSIs)** with marine components giving protection to species and habitats of national importance; and
- **European Marine Sites** giving legal protection to species and habitats of European importance.

To date 27 MCZs have been designated in English waters, with two further tranches of MCZs planned over the next three years to complete the contribution to the ecologically coherent network (*JNCC, 2014c*).

European Marine Sites or 'Natura 2000' sites consist of:

- **Special Areas of Conservation (SACs)** to protect habitats and species listed under the EU Habitats Directives. In the UK there are 108 SACs with marine components and based on current available evidence, the SAC network in UK waters is now considered to be complete (*JNCC, 2014c*);
- **Special Protection Areas (SPAs)** to protect birds under the EU Wild Birds Directive. In the UK there are 108 SPAs with marine components (*JNCC, 2014c*). DEFRA is working with Natural England and JNCC to finish identifying and, where possible, classifying, more marine SPAs by the end of 2015.

In addition, Ramsar sites also contribute to the existing UK MPA network. These sites were established under the 1971 Convention of Wetlands of International Importance to promote the conservation and wise-use of wetlands of international importance and their resources.

Table 3.16 lists the protected areas with 40 kilometres of the Thames infrastructure and Figure 3.16 shows the location of the Thames infrastructure in relation to the protected areas around it.

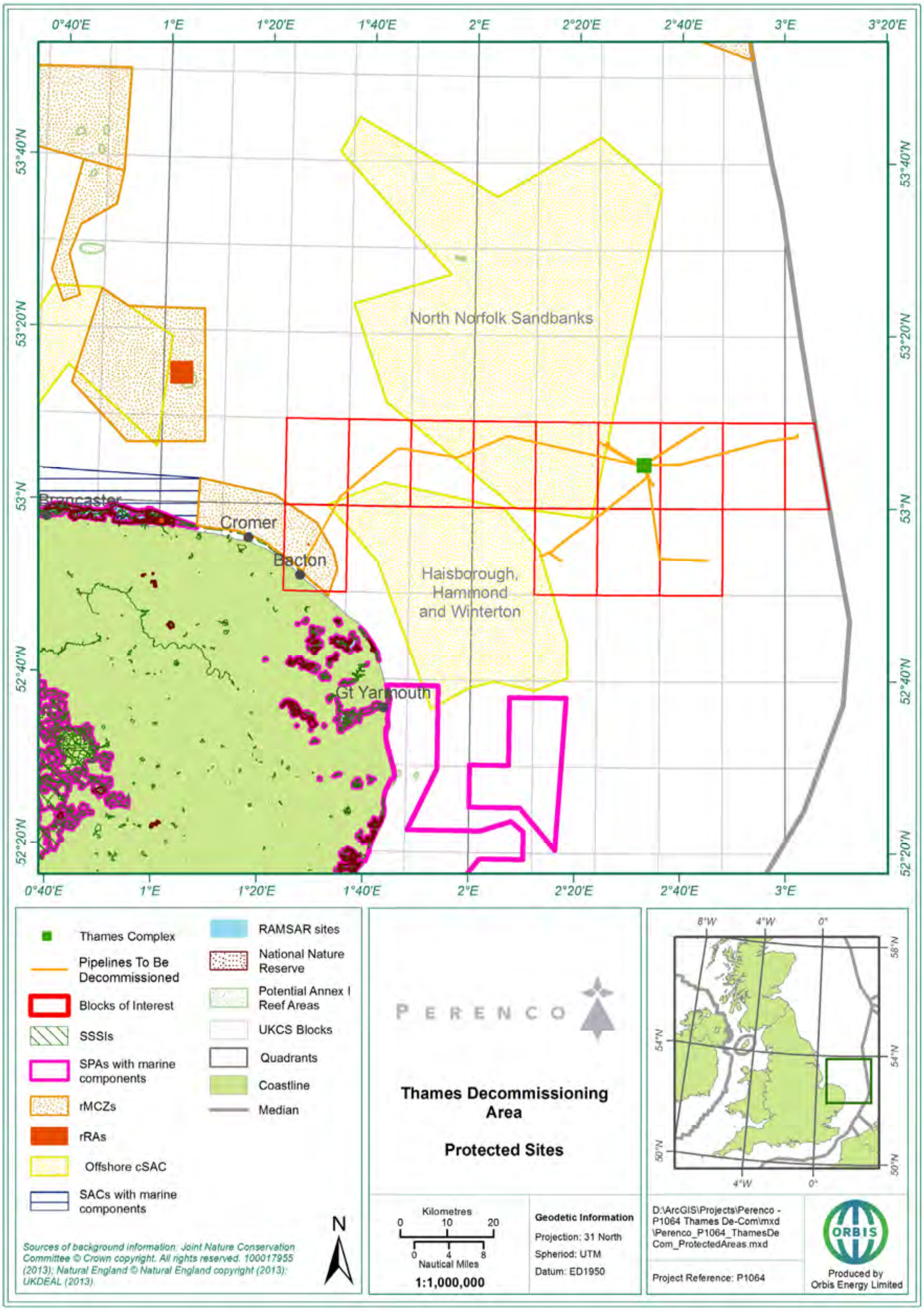
Table 3.16: Marine Protected Areas within 40 kilometres of the Proposed Thames Decommissioning Programme Area (*Net Gain, 2011; Natural England, 2013; JNCC, 2013a; JNCC, 2013b)*

Site Name	Designation	Distance From Thames Infrastructure	Site Description
Cromer Shoal Chalk Beds (NG2)	rMCZ	Overlaps	The site is recommended for designation due to the presence of the three broadscale habitats 'high energy infralittoral rock', 'moderate energy infralittoral rock' and 'moderate energy circalittoral rock' as well as the habitat of conservation importance, subtidal chalk.
Haisborough, Hammond and Winterton	cSAC	Overlaps	This site is designated for the presence of Annex I habitats 'Sandbanks which are slightly covered by sea water all the time' (1110) and 'Reefs' (1170).
North Norfolk Sandbanks and Saturn Reef	cSAC	Overlaps	This site is designated for the presence of Annex I habitats 'Sandbanks which are slightly covered by sea water all the time' (1110) and 'Reefs' (1170).
North Norfolk Blue Mussel Beds (RA1)	rRA	1km W	This site is primarily being recommended for designation for the presence of blue mussel (*Mytilus edulis*) beds. In addition three other features are recommended for designation, moderate energy infralittoral rock, subtidal chalk (modelled) and subtidal sands and gravels (modelled).
Mundesley Cliffs	SSSI	1.5km NW	A nationally important site for its extensive geological Pleistocene sequence.
Sidestrand & Trimingham Cliffs	SSSI	4km NW	Site is of geological importance. This is probably the best soft rock cliff site for invertebrates in East Anglia.
Happisburgh Cliffs	SSSI	6km SE	An important site for dating the Pleistocene succession of East Anglia.
Overstrand Cliffs	SSSI	10km NW	Some of the best example of soft cliff habitat in East Anglia. A diverse range of submaritime habitats of considerable botanical, entomological and ecological importance.
East Runton Cliffs	SSSI	15km NW	Geological importance.
West Runton Cliffs	SSSI	16km NW	Geological importance.
Winterton-Horsey Dunes	SSSI	16.5km SE	An extensive dune system. A wide range of both breeding and overwintering birds occur, including Little Terns on the foreshore, while the areas of scrub attract passage migrants. A rare amphibian breeds in shallow pools behind the main dune ridge, and the site is the only Norfolk locality for a rare butterfly.

Site Name	Designation	Distance From Thames Infrastructure	Site Description
Beeston Cliffs	SSSI	18km NW	A nationally important Pleistocene reference site.
Weybourne Cliffs	SSSI	19.5km NW	Geologically significant. Additional biological interest is provided by colonies of sand martins in the cliff-face and of fulmars (73 pairs in 1982) on the cliff ledges.
North Norfolk Coast	SSSI, Ramsar, SPA	25.5km NW	The area consists primarily of intertidal sands and muds, saltmarshes, shingle banks and sand dunes. There are extensive areas of brackish lagoons, reedbeds and grazing marshes. A wide range of coastal plant communities is represented and many rare or local species occur. The whole coast is of great ornithological interest with nationally and internationally important breeding colonies of several species. It is especially valuable for migratory birds and wintering waterfowl, particularly brent and pink-footed geese. Very large numbers of waterbirds occur throughout the year.
Seahorse Lagoon and Arnold's Marsh (RA2a and 2b)	rRA	29km W	These sites are being recommended for designation for the presence of starlet sea anemones (*Nematostella vectensis*) in the saline lagoons.
Outer Thames Estuary	SPA	29km S (Arthur)	This site it protected because of its use by over wintering Red Throated Divers (*Gavia stellata*), an Annex I species, which represented 38% of the population in Great Britain.
Glaven Reedbed (RA3)	rRA	30km W	The site is recommended for the protection of the broad-scale habitat saline reedbeds which provides habitat for birdlife and a variety of algae and invertebrates.
Great Yarmouth North Denes	SSSI	30.5km SE	This site supports a full successional sequence of vegetation from pioneer to mature types. The largest UK breeding colony of the rare Little Tern is located on the foreshore.
Wash Approach (NG4)	rMCZ	31km WNW	This site is recommended for designation for the following broadscale habitat types and Habitats of Conservation Interest; subtidal sand, subtidal mixed sediments and subtidal sands and gravels.
Blakeney Marsh (RA4)	rRA	32km W	This site is being proposed to protect the broad-scale habitat 'coastal saltmarshes and saline reedbeds'.

Site Name	Designation	Distance From Thames Infrastructure	Site Description
Blakeney Seagrass (RA5)	rRA	35km W	This site is being recommended for designation for the presence of seagrass beds (*Zostera* species).
Morston Cliff	SSSI	35km WNW	Geological importance.
Wash Approach (RA8)	rRA	39.5km NW	This site is recommended for designation for the following broadscale habitat types and Habitats of Conservation Interest; subtidal sand, subtidal mixed sediments and subtidal sands and gravels.
Inner Dowsing, Race Bank and North Ridge	cSAC	40km NW	This site is designated for the presence of Annex I habitats 'Sandbanks which are slightly covered by sea water all the time' (1110) and 'Reefs' (1170). In addition, this site is also designated for the presence of Annex II species harbour porpoise (*Phocoena phocoena*) and grey seals (*Halichoerus grypus*)

Figure 3.16: Marine and Coastal Protected Areas in the Vicinity of the Thames Decommissioning Programme Area



It can be seen from Table 3.16 and Figure 3.16 that the Thames Infrastructure overlaps with the boundaries of three MPAs described below.

Cromer Shoal Chalk Beds rMCZ (NG2)

The Cromer Shoal Chalk Beds rMCZ is an inshore site measuring 316 square kilometres. It has been recommended for designation as a MCZ for the presence of five features. These features comprise of three broad scale habitats (high energy infralittoral rock, moderate energy infralittoral rock and moderate circalittoral rock), one Habitat Features of Conservation Importance (FOCI), subtidal chalk, and one geological feature; North Norfolk coast (subtidal).

Of particular interest within this site is the subtidal chalk feature which represents one of the best examples of subtidal chalk in the Net Gain region and is the only example of this feature within the southern North Sea.

Circalittoral rock habitat communities are important secondary producers through growth of epibiotic organisms (which live on the body of another organism) including sponges and tunicates. This habitat is characterised by high species diversity supporting a range of fauna including polychaetes, sponges, soft and hard corals, bryozoans as well as mobile species in more sheltered areas.

The site, is also an important fish spawning ground, and provides a good foraging area for seabirds. Small cetaceans and seals are also recorded in the site.

This is an important site for benthic biodiversity. The site also provides good foraging areas for seabirds (*RSPB, 2010*), frequent sightings of small cetaceans and pinnipeds (whales, dolphins, porpoises and seals) (*Clark et al., 2010*) and unusual sightings of species such as sunfish and basking shark (*Spray, 2011 pers. comm*.).

Haisborough, Hammond and Winterton cSAC

The Haisborough, Hammond and Winterton site lies off the north east coast of Norfolk, and is designated as a cSAC due to the presence of a series of sandbanks which meet the Annex I habitat description 'Sandbanks slightly covered by sea water all the time'. The site also contains areas of the Annex I habitat biogenic reef.

The sandy sediments within the site are very mobile due to the strong tidal currents which characterise the area (*HR Wallingford et al., 2002*). Infaunal communities of the sandy bank tops are consequently of low biodiversity, characterised by mobile polychaetes (catworms) and amphipods (shrimp-like crustaceans) which are able to rapidly re-bury themselves into the dynamic sediment environments. Along the flanks of the banks, and towards the troughs between the banks, the sediments tend to be slightly more stable with exposed gravels in areas. In these regions of the site, infaunal and epifaunal communities are much more diverse. There are a number of areas where sediment movements are reduced and these areas support an abundance of attached bryozoans, hydroids and sea anemones. Other tube-building worms such as keel worms *Pomatoceros* sp. and sand mason worms *Lanice conchilega* are also found in these areas, along with bivalves and crustaceans.

Sabellaria spinulosa reefs are located at Haisborough Tail, Haisborough Gat and between Winterton Ridge and Hewett Ridge. They arise from the surrounding coarse sandy seabed to heights of between five centimetres to 10 centimetres. The reefs are consolidated structures of sand tubes showing seafloor coverage of between 30 per cent to areas where reef occupies 100 per cent of the sediment. Some parts of the reefs appear to be acting as sediment traps, with exposed tube height accordingly reduced within the core parts of reefs (*JNCC, 2010*).

North Norfolk Sandbanks and Saturn Reef cSAC

The North Norfolk Sandbanks and Saturn Reef site is a cSAC due to the presence of two Annex I habitats:

i) a series of ten main sandbanks and associated fragmented smaller banks formed as a result of tidal processes ('Sandbanks which are slightly covered by sea water all the time); and

ii) areas of *Sabellaria spinulosa* biogenic reef.

The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters (*Graham et al., 2001*). They are subject to a range of current strengths which are strongest on the banks closest to shore and which reduce offshore (*Collins et al., 1995*). 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 (*Collins et al., 1995*). 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 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 (*BMT Cordah, 2003*). Reefs formed by *Sabellaria* allow the settlement of other species not found in adjacent habitats leading to a diverse community of epifaunal and infaunal species (*JNCC, 2008*).

The Thames infrastructure that lies within these three MPAs includes approximately 51 kilometres of pipeline (see Table 3.17) and the three wellheads: West Bure, Bure 'O' and Arthur 3.

Table 3.17: Distances Over Which Thames Pipelines Cross MPAs

MPA	Pipeline Number	Pipeline Diameter (Inches)	Distance (Metres)
North Norfolk Sandbanks cSAC	PL370	24	34,000
	PL371	8	270
	PL374	0.5	590
	PL1635	8	1,940
	PL1636	0.75	1,940
		Subtotal	*38,740*
Haisborough, Hammond & Winterton Sandbanks cSAC	PL370	24	2,350
	PLU2048JP3	3	250
	PL2047JP3	8	250
		Subtotal	*2,850*
Cromer Shoal Chalk Beds rMCZ	PL370	24	9,500
		Subtotal	*9,500*
		Total	**51,090**

3.3.7 Potential Annex I Habitats

Based on the side scan sonar, multibeam bathymetry, sub-bottom profile, video footage and high-resolution still image data collected during the Thames Decommissioning Programme area site survey, Annex I shallow sandbanks may be present along some of the pipeline routes along with discrete populations of *S. spinulosa* identified in the side scan sonar mosaic and using seabed imagery. No herring spawning grounds were identified in the survey area (*GEMS, 2012; CMACS, 2013*).

Sabellaria spinulosa Biogenic Reefs

An analysis of 'reefiness' was undertaken during the site survey, whereby qualifying that a *S. spinulosa* reef is present depends on the extent, patchiness and height of *S. spinulosa* at a specific site (Table 3.19; *Gubbay, 2007; CMACS, 2013*).

Areas of high reflectivity and high relief identified on the side scan sonar were ground-truthed using the camera stills. The assessment of 'reefiness' was therefore undertaken using both the geophysical and photographic information.

Table 3.18: 'Reefiness' Classification Criteria for *S. spinulosa* (*Gubbay, 2007*)

Measure of 'reefiness'	Not a reef	Low	Medium	High
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m^2)	<25	25-10,000	10,000-1,000,000	>1,000,000
Patchiness (% cover)	<10%	10-20	20-30	>30

Aggregations of *S. spinulosa* were recorded from three parts of the survey area; near the Bure well, on the export pipeline from Arthur to the central hub and on the export pipeline to shore. Colonies from the Arthur and Bure areas were found to cover large areas of the seabed but were classified as 'low reefiness' due to the sparseness of cover and the low elevation of the aggregations (Tables 3.19a - 3.19b and Figures 3.17 – 3.18). Camera stills indicated that the aggregations had been damaged by unknown means (*CMACS, 2013*).

Along the export pipeline, there were areas of 'low' to 'medium reefiness' and two stations which were classified as 'not a reef' based on the presence of many loose single tubes and unstable aggregations on the sediment surface (Figures 3.19a – 3.19f). The areas of 'medium reefiness' were at the eastern end of the export pipeline with some healthy aggregations at station 42 but damaged aggregations at stations 25 and 31. At these stations there were several other associated epifaunal species including hydroids and the edible crab *Cancer pagurus* and velvet swimming crab (*Necora puber*) (*CMACS, 2013*).

Overall the site survey identified some areas of 'low' to 'moderate reefiness' but no areas of high reefiness which has previously been found at the Saturn Reef to the north of the Thames field (outside of the current working area). The assessments of reefiness are shown in Table 3.19a – 3.19c.

Table 3.19a: *Sabellaria spinulosa* 'Reefiness' Assessment at the Arthur Area (*CMACS, 2013*)

Station	Area (m^2)*	Per cent cover	Elevation (cm)	Reefiness	Notes
27	1,200	<10	<2	Not a reef	-
	200	≤20	1-5	Low	-
30	2,700	10-20	1-5	Low	-
	3,100	<10	<2	Not a reef	No images for these areas, assessment based on side scan mosaic of areas adjacent to station 30.
	4,700				

Table 3.19b: *Sabellaria spinulosa* 'Reefiness' Assessment at the Bure Area (*CMACS, 2013*)

Station	Area (m²)*	Per cent cover	Elevation (cm)	Reefiness	Notes
35 & 36	15,400	≈20	1-5	Low	Damaged reef, broken aggregations on sediment surface.
	4,400	<10	<5	Low	-
37	64,700	<10	<5	Low	Appears to be remains of a reef that has been damaged some time ago, extant aggregations are worn smooth at the edges.
38	800	<10	<5	Low	-
39	3,500	<5	<5	Low	-

Table 3.19c: *Sabellaria spinulosa* 'Reefiness' Assessment along the Thames Export Pipeline Route (*CMACS, 2013*)

Station	Area (m²)*	Per cent cover	Elevation (cm)	Reefiness	Notes
4	9,500	5-20	1-5	Low	
	15,700	5-20	1-5	Low	No images of this area, assessment based on similarity of reflectivity in side scan sonar mosaic to that around station 4
5	2,400	5-20	1-5	Low	
	3,400	5-20	1-5	Low	No images of these areas, assessment based on similarity of reflectivity in side scan sonar mosaic to that around station 5
	3,500	5-20	1-5	Low	
	3,800	5-20	1-5	Low	
	3,500	5-20	1-5	Low	
	8,100	5-20	1-5	Low	
	1,500	5-20	1-5	Low	
13, 14 & 15	184,400	10-30	<2	Low	Mainly a crust of worm tubes binding together gravel and pebble.
16	900	<10	2-5	Low	Worn remnant aggregations.
17	3,300	<10	<2	Not a reef	Scattered tubes and unattached aggregations.
18	5,200	≈10	<2	Not a reef	Scattered tubes and unattached aggregations.
22	2,600	20	<2	Low	Many broken tubes on sediment surface
24	3,300	<20	<5	Low	Scattered aggregations, possibly remnant reef

Station	Area (m²)*	Per cent cover	Elevation (cm)	Reefiness	Notes
25	5,100	0-50	0-5	Medium	Damaged/worn aggregations supporting hydroids
26	5,500	≈20	<5	Low	Damaged/worn aggregations supporting hydroids
28 & 29	30,100	≤20	<2	Low	Very broken up, hard to distinguish between unattached debris and attached aggregations.
31	2,300	>50	1-10	Medium	
	400	>50	1-10	Medium	No images of these areas, assessment based on similarity of reflectivity in side scan sonar mosaic to that around station 31
	1000	>50	1-10	Medium	
42	28,300	50-100	1-10	Medium	Actual area may be larger but constrained to north and south by limit of side scan sonar coverage.

*Areas are rounded to the nearest 100 km²

Figure 3.17: Assessment of 'Reefiness' on the Pipeline Route from the Arthur Well.

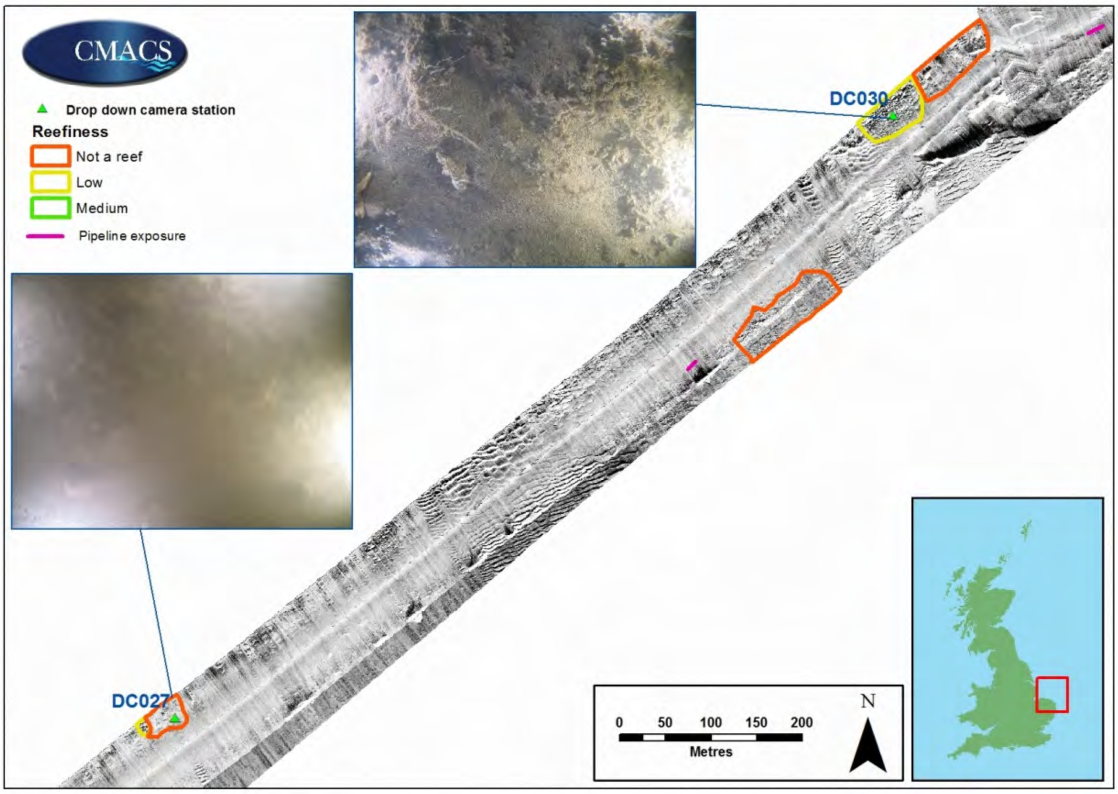


Figure 3.18: Assessment of 'Reefiness' on the Pipeline Route from the Bure Well

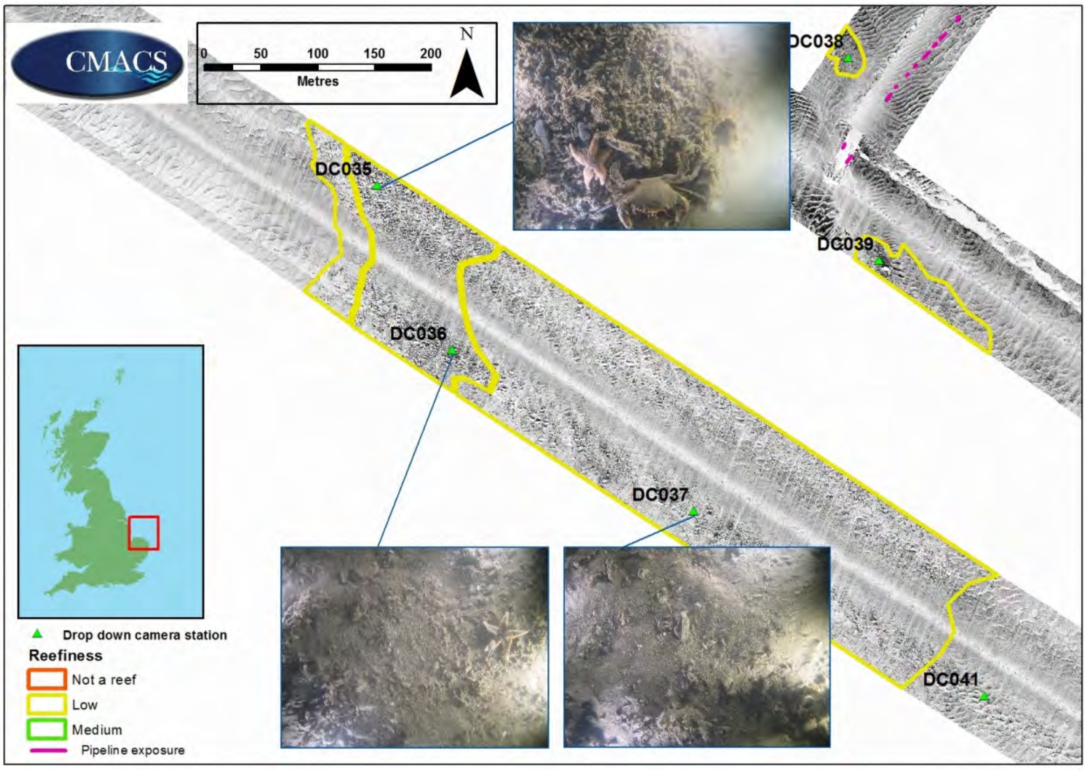


Figure 3.19a: Assessment of 'Reefiness' along the Export Pipeline Route

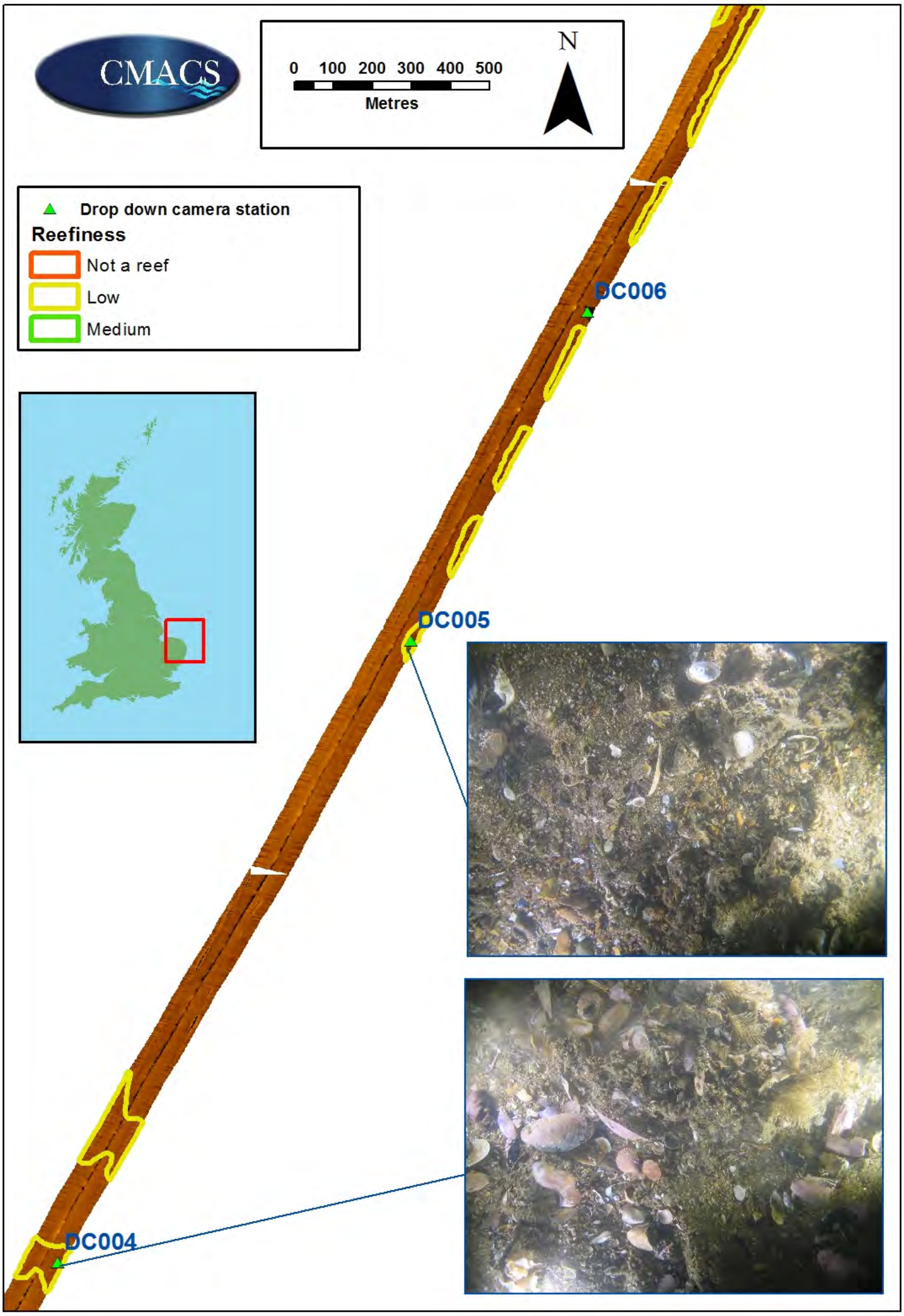


Figure 3.19b: Assessment of 'Reefiness' along the Export Pipeline Route

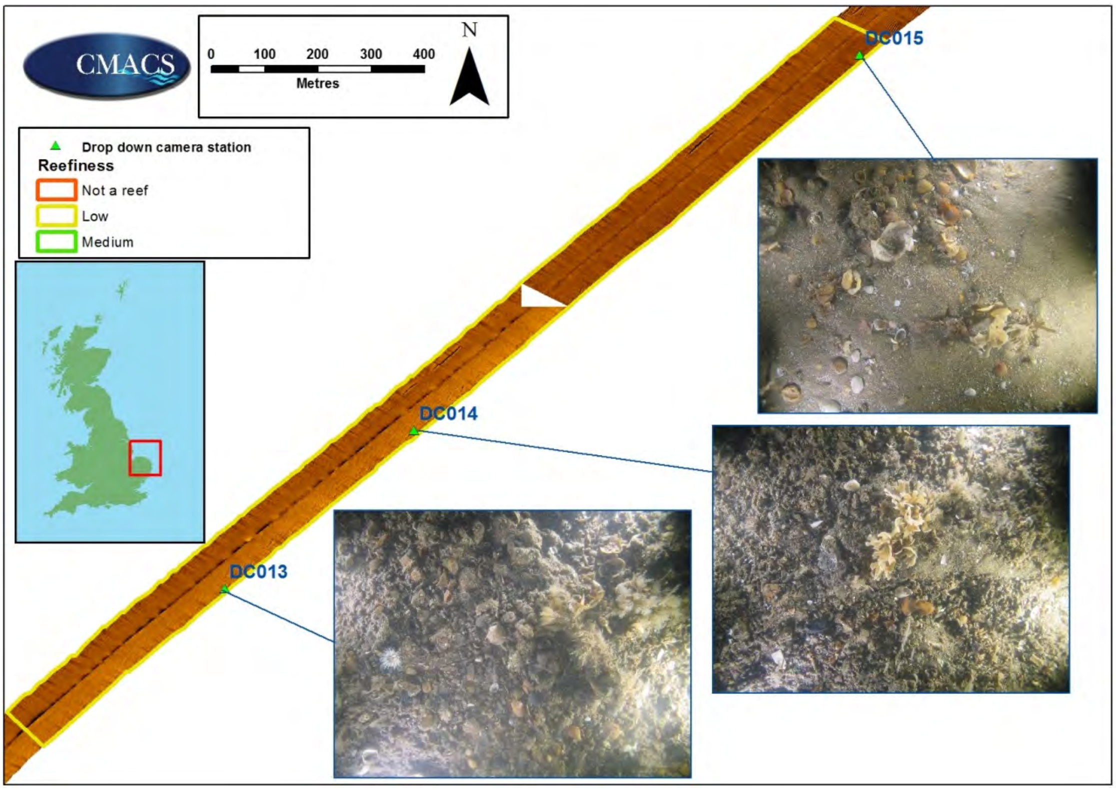


Figure 3.19c: Assessment of 'Reefiness' along the Export Pipeline Route

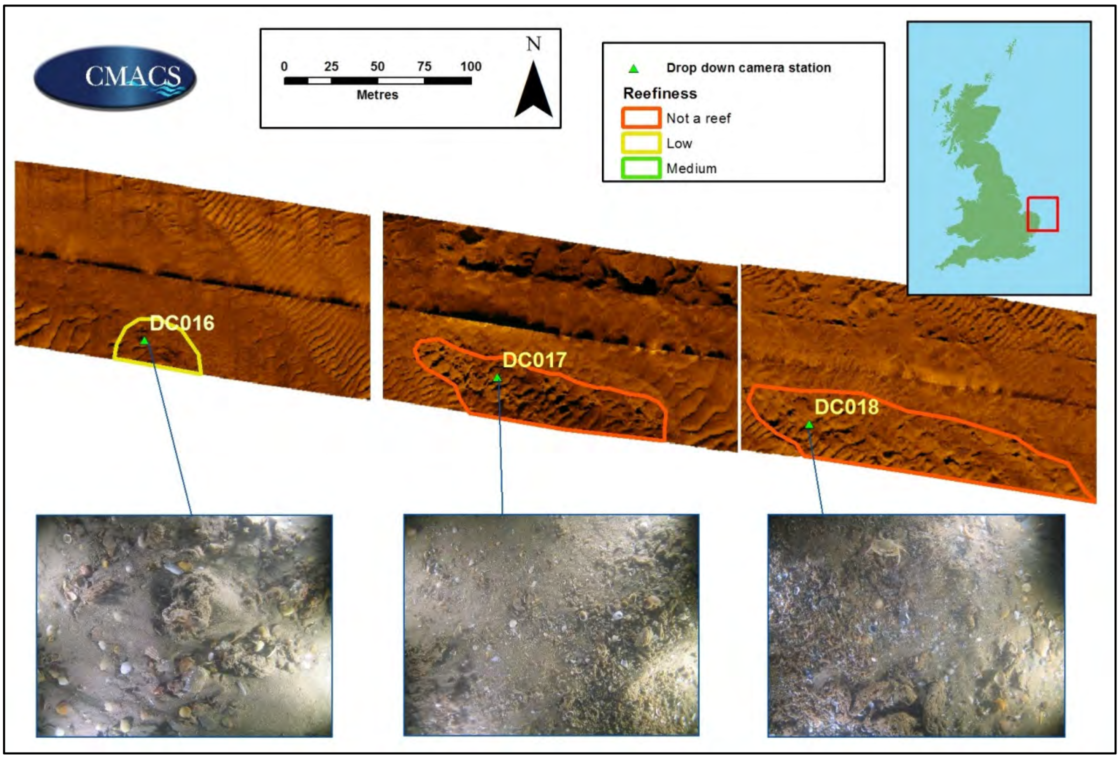


Figure 3.19d: Assessment of 'Reefiness' along the Export Pipeline Route

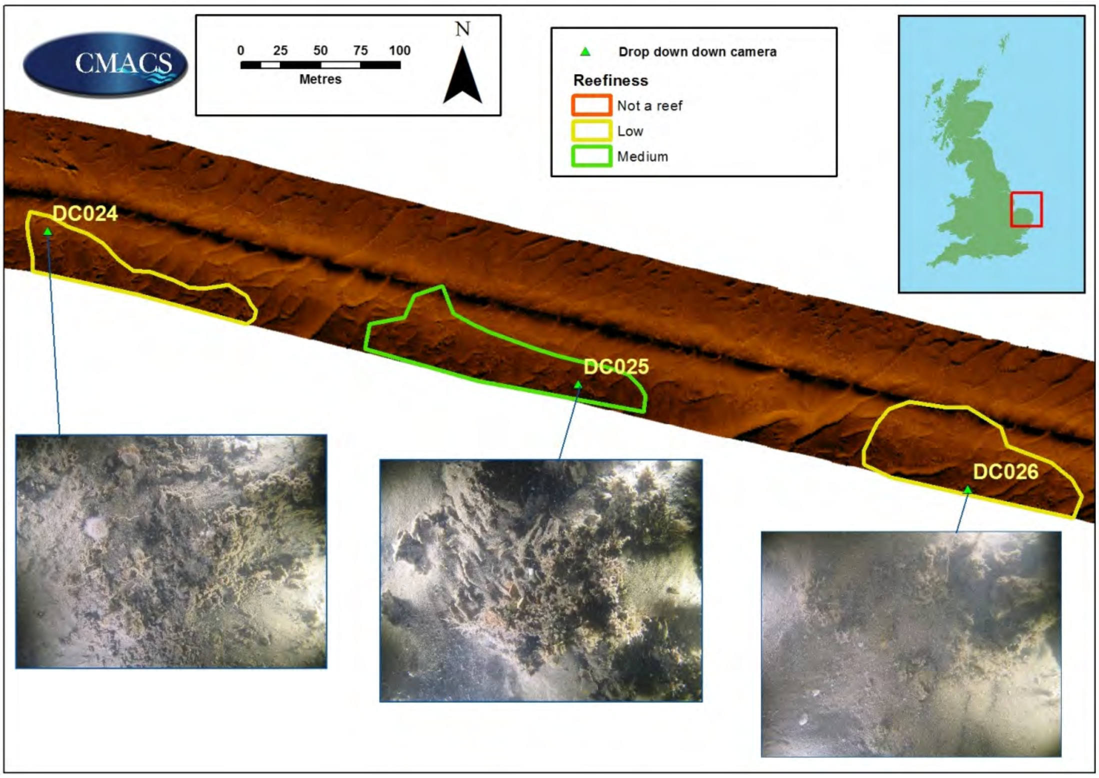


Figure 3.19e: Assessment of 'Reefiness' along the Export Pipeline Route

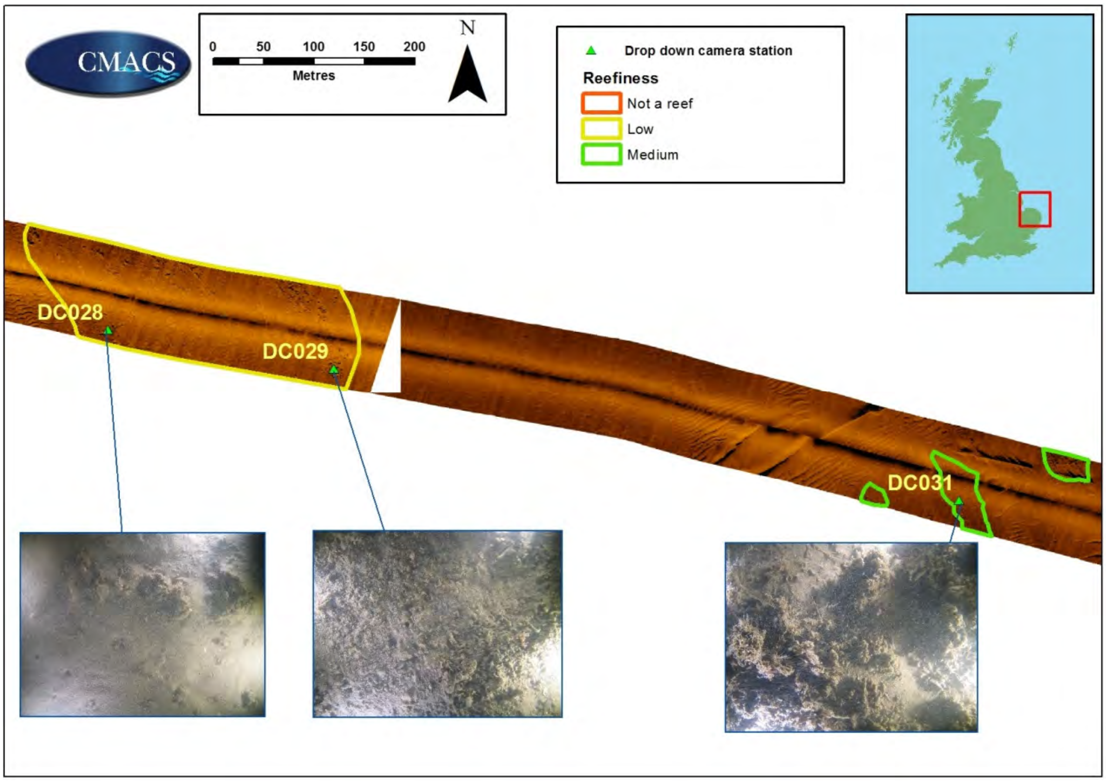
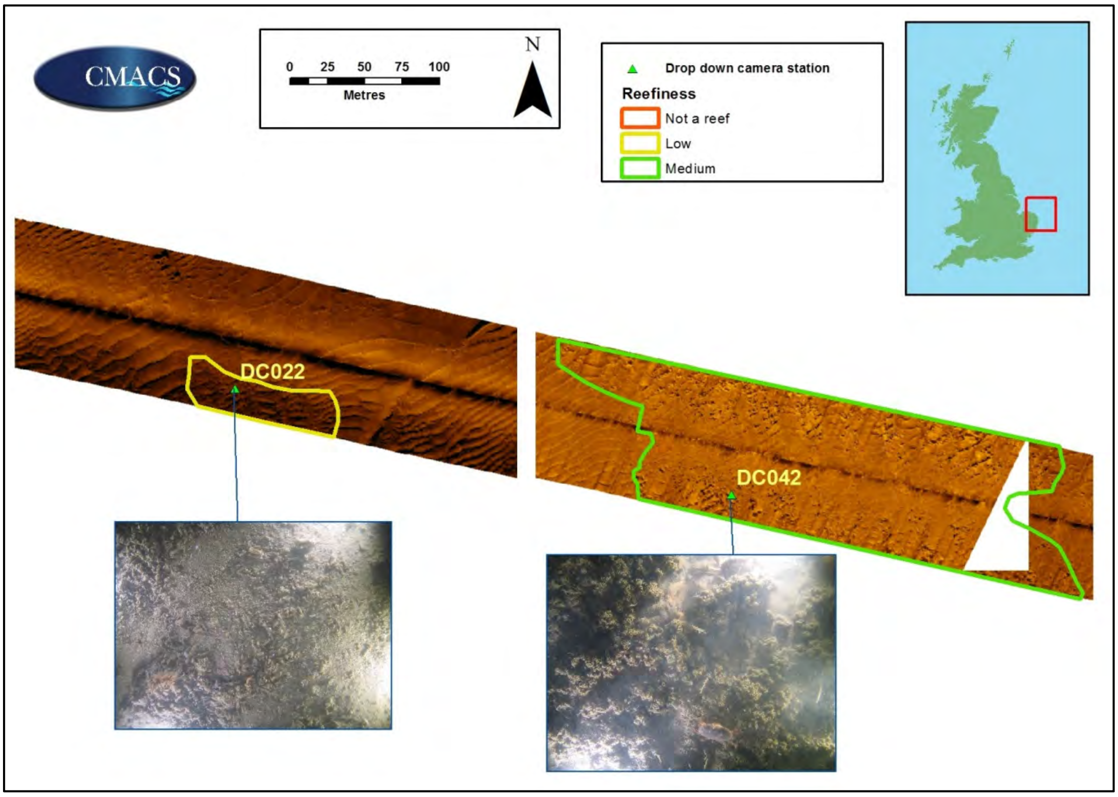


Figure 3.19f: Assessment of 'Reefiness' along the Export Pipeline Route



Shallow Sandbank Habitat

The export pipeline also passes through two cSACs which are designated due to the presence of Annex I shallow sandbank habitat; the North Norfolk Sandbanks and the Haisborough, Hammond and Winterton cSACs (refer to Section 3.3.6). Sandbanks are generally very large seabed features (i.e. several kilometres in length), therefore discrete site surveys may not always cover an entire sandbank feature, thus making them difficult to confirm their presence using bathymetry data. However bathymetric data from the inter-well pipeline routes indicates that there are points of shallower water and therefore raised seabed at two points along the Arthur pipeline, two points along the Orwell pipeline and another that is less well defined along the Gawain pipeline. These areas were found to contain sand waves and are interspersed with areas of deeper water which suggests that Annex I sandbank habitat is present (*CMACS, 2013*).

Bathymetric data were not available for the export pipeline however the side scan sonar data of the export pipeline shows large areas of sand waves that suggests that there is at least some Annex I habitat present. This is also consistent with the findings that much of the fauna identified is typical of mobile sandy sediments (*CMACS, 2013*).

3.4 Socio-Economic Environment

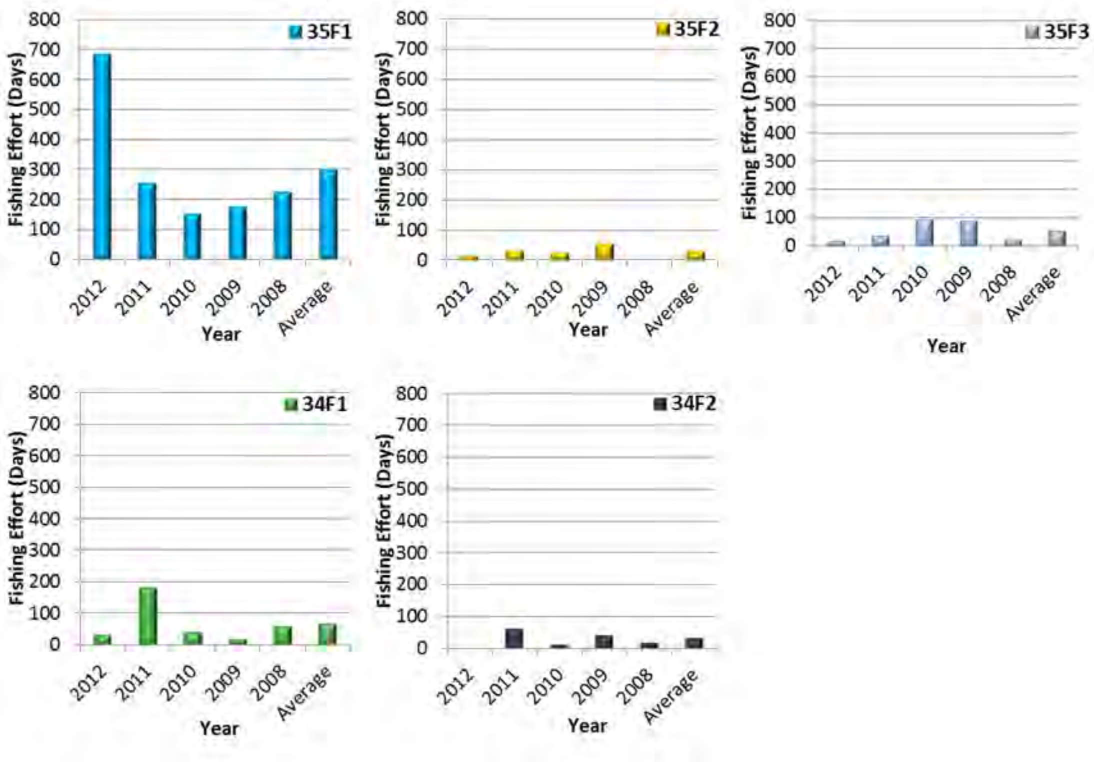
3.4.1 Commercial Fishing

Decommissioning operations can potentially interfere with commercial fishing activities. The North Sea is one of the world's most important fishing grounds and major UK and international fishing fleets operate in the southern North Sea, including vessels from England, Scotland, Belgium, Holland, Denmark and France (*DECC, 2009*).

UK fisheries may be broken down simply into the following sectors: demersal, pelagic and shellfish. The shellfish sector is typically the most valuable in the UK, with crabs, lobsters, *Nephrops* and scallops all of a high value. Pelagic fish are usually caught in large numbers but at low values. The average annual price per tonne (live weight) for shellfish species landed in the UK in 2010 was £1,758, compared with £1,767 for demersal species and £629 for pelagic species (*MMO, 2010*).

The Blocks of Interest lie within ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3. Between 2008 and 2012, ICES Rectangle 35F1 had the highest average total yearly fishing effort of 302 days fished (Figure 3.20), which is considered low and consistent with fishing efforts for large areas of the southern. The remaining ICES Rectangles have an average total yearly fishing effort of less than 100 days.

Figure 3.20: Total Fishing Effort in Days within ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 between 2008 and 2012 (*Marine Scotland, 2013*)

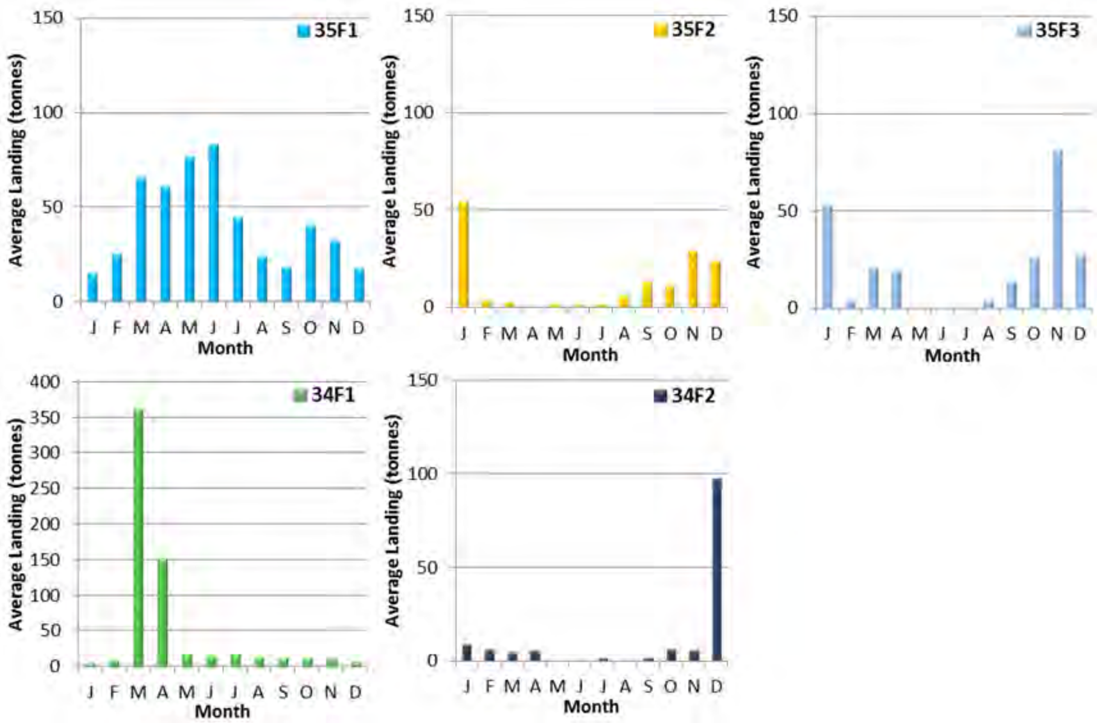


Specific fishing effort and landings data for ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 were obtained from Marine Scotland for the years 2008 to 2012. Data indicated that annual fish landings were greatest in 2010 for ICES Rectangle 35F3 (328.5 tonnes), 2011 for ICES Rectangles 34F1 (2,527.3 tonnes), 34F2 (411.1 tonnes), and 35F2 (217.8 tonnes) and in 2012 for ICES Rectangles 35F1 (886.8 tonnes). Conversely, annual fishing catches by tonnage were lowest during 2009 in ICES Rectangles 34F1 (93.3 tonnes) and 35F1 (326.6 tonnes), during 2008 in ICES Rectangle 34F2 (35.4 tonnes) and during 2012 in ICES Rectangles 35F2 (36.4 tonnes) and 35F3 (53.7 tonnes) (*Marine Scotland, 2013*).

On the whole, fishing activity for this area is low throughout the year. When averaged, catches by weight (tonnes) between 2008 and 2012 were highest during March and April in ICES Rectangle

34F1, December in ICES Rectangle 34F2, March to July in ICES Rectangle 35F1, January in ICES Rectangle 35F2 and January and November in ICES Rectangle 35F3 (Figure 3.21).

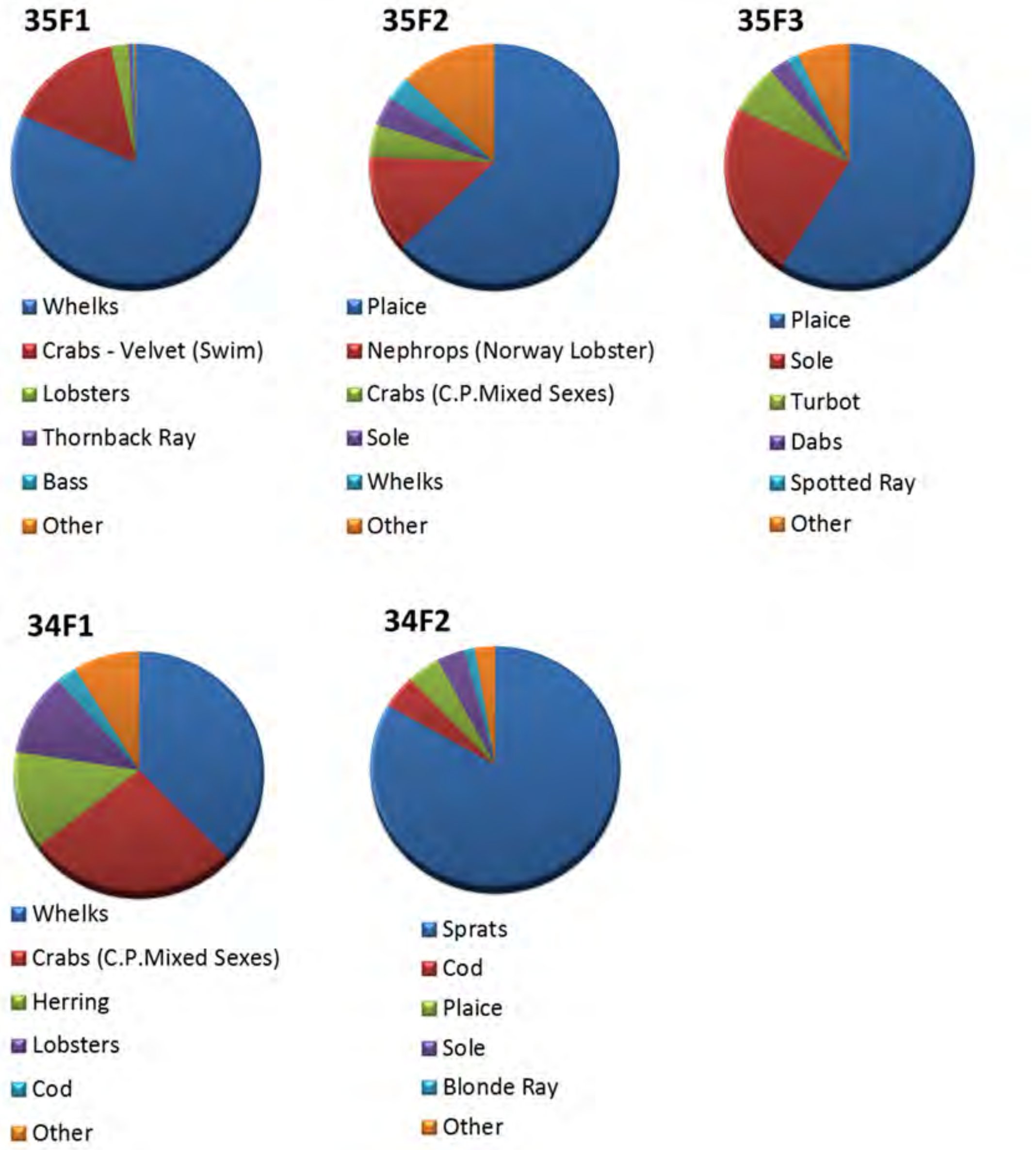
Figure 3.21: Average Monthly Total Fishery Landings by Weight within ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 for All Species between 2008 and 2012 (*Marine Scotland, 2013*).



The fish species landed from the commercial fishing operations in ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 correlate with those reported to have been landed in wide areas of the southern North Sea (*DECC, 2009*). Species which were routinely caught in higher quantities (tonnes) during 2012 in ICES Rectangle 34F1 were whelks (38%) and crabs (C.P. mixed sexes; 27%), in ICES Rectangle 34F2 were sprats (83%), in ICES Rectangle 35F1 were whelks (81%), in ICES Rectangle 35F2 were plaice (63%) and in ICES Rectangle 35F3 were plaice (59%) and sole (23%) (Figure 3.22).

It is important to note that in addition to UK registered vessels, vessels registered to other European countries e.g. The Netherlands, may also target fisheries within the vicinity of the Thames Decommissioning Programme area.

Figure 3.22: Highest Caught Species Within ICES Rectangles 34F1, 34F2, 35F1, 35F2 and 35F3 During 2012 (*Marine Scotland, 2013*).



3.4.2 Shipping and Ports

The southern North Sea is a busy sea way with ships following reasonably clearly defined shipping lanes. Major ports include, Grimsby and Immingham the UK's busiest port, London, Felixstowe and Dover with vessels mainly trading between ports on either side of the North Sea and supporting the oil and gas industry (*DECC, 2009*).

According to DECC (*2014*), shipping density within the Blocks of Interest is as follows:

- 'very high' in Blocks 48/28-29;
- 'high' in Blocks 48/30, 49/26-29, 53/2 & 53/3-4;
- 'moderate' in Blocks 49/30 & 50/26;
- There is no data available for Block 52/3.

In addition, Blocks 49/29, 49/30 and 53/4 are also listed as 'Deep Water Route' areas. Blocks with 'very high', 'high' and 'moderate' shipping density or that are listed under 'deep water route' require a vessel traffic survey and collision risk assessment. While those with 'low' shipping density or with no data require a vessel traffic survey unless there are routes that pass within 2 nautical miles of the site, which will lead to the requirement for a Collision Risk Assessment. Also of note, is that DECC will give special consideration to applications for consent to locate within 'Deep Water Route' areas.

Perenco is aware that, in addition to sections of seven pipelines, the Gawain and Wissey subsea wells and the Horne and Wren Platform lie within Blocks listed as 'deep water route' areas. The discussion of which will be detailed in a Shipping Hazard Assessment Study and Consent to Locate (if required, i.e. for drilling rig use). The results the shipping hazard assessment will be presented, along with a collision risk assessment, in the appropriate consent to locate application.

3.4.3 Oil and Gas Infrastructure and Submarine Cables

The oil and gas activity in and surrounding the Blocks of Interest is generally high. The Thames infrastructure that has been designated for decommissioning is crossed by a number of pipelines (Figure 3.23; *UK DEAL, 2013*).

The Bacton to Thames pipeline (PL370) is crossed:

- in Block 48/29 by the ENI operated 8" '48/29-9 to 48/29C' Gas Export gas pipeline (PL1173; not in use) and the ENI operated 0.5" '48/29C – 48/29-9' MEG Injection pipeline (PL1174; not in use); and
- in Block 49/27 by the Shell operated 4.5" 'Corvette to Leman AP' methanol pipeline (PL1611), the Shell operated 20" 'Corvette A to Leman A' gas pipeline (PL1610) and the Perenco operated 30" 'Indefatigable Joint 49/23 AT to 49/27 BT' gas pipeline (PL22);

The Orwell to Thames RA (PL931), Thames RA to Orwell MEG (PL932) and Thames RA to Orwell Control Umbilical (PL933) are crossed:

- in Block 49/28 by the Shell operated 30" 'Sean PP to Bacton' gas pipeline (PL311);
- in Block 49/30 by the Perenco operated 16" 'Davy to Inde-AT' gas pipeline (PL1053/PL1054).

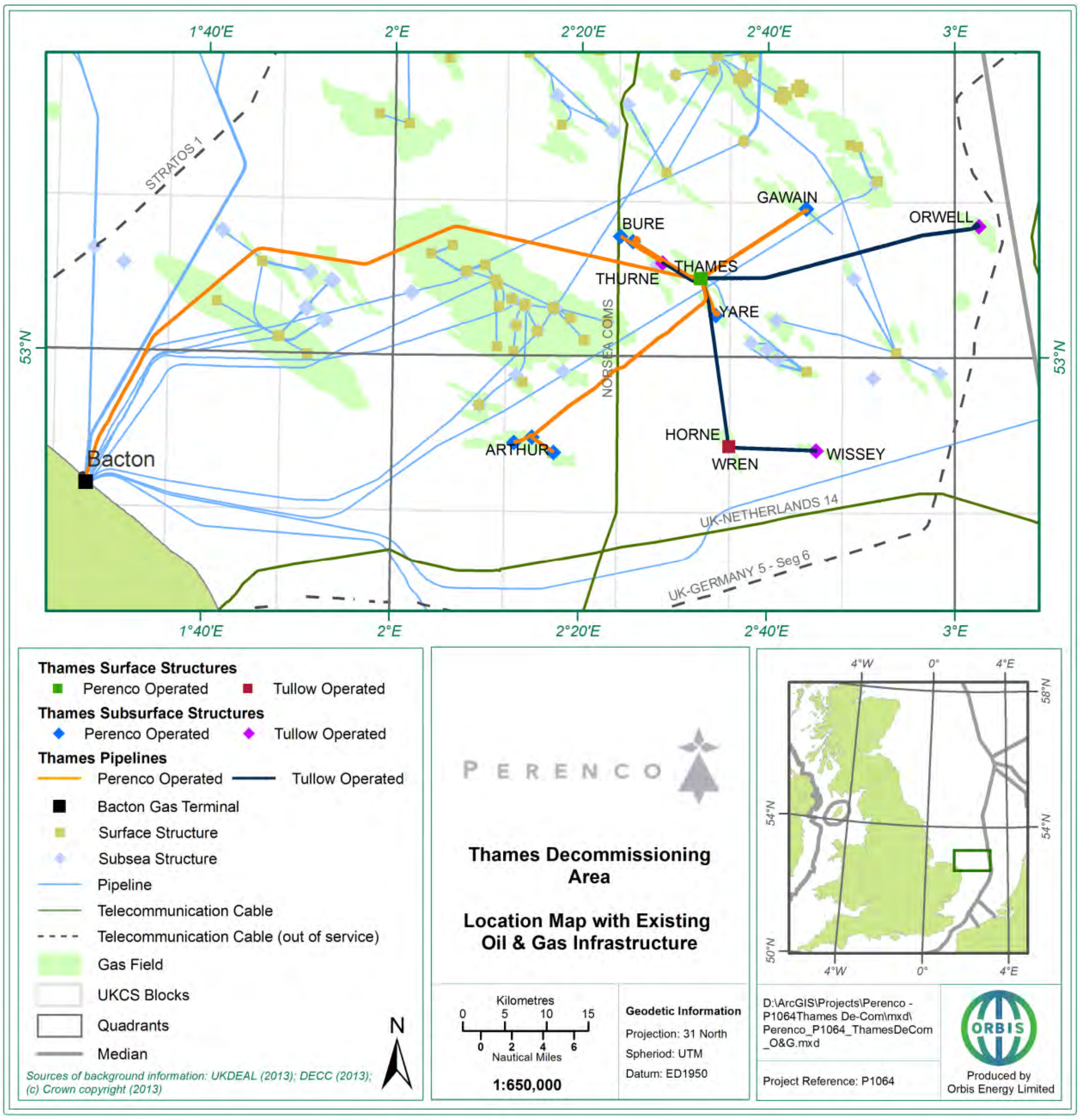
The Thames infrastructure that has been designated for decommissioning is crossed by the NORSEA COMS telecommunications cable twice, this cable also lies approximately 0.2 kilometres to the west of the Bure wellhead (Figure 3.23; *KIS-OCRA, 2013*). The pipelines that are crossed by the NORSEA COMs cable are:

- Thames to Bacton (PL370) along the boundary between Block 49/27 and 49/28;
- Thames to Arthur (PLU2048) and Arthur to Thames (PL2047) along the boundary between Blocks 53/2 and 53/3.

In addition, the following cables pass within 20 kilometres of the Thames infrastructure that has been designated for decommissioning:

- The UK-GERMANY 5 - Seg 6 (out of service) telecommunications cable, at its closest point, lies approximately 2.5 kilometres to the east of the Orwell wellhead;
- The UK-NETHERLANDS 14 telecommunications cable, at its closest point, lies 7 kilometres to the south of the Wissey wellhead; and
- The STRATOS 1 (out of service) telecommunications cable, at its closest point, lies approximately 13 kilometres to the north-west of the Thames to Bacton (PL370) export pipeline.

Figure 3.23: Oil and Gas Infrastructure in the Vicinity of the Thames Decommissioning Programme Area



3.4.4 Military Activity

The Blocks of Interest do not lie within any marine military exercise areas (*DECC, 2009*). However, part of the pipeline PL370 does within a military low flying zone.

3.4.5 Dredging and Dumping Activity

There are no offshore dredging sites within the Blocks of Interest. The nearest offshore dredging site is the Lowestoft Extension Aggregates Application site approximately 31 kilometres to the southwest of the Arthur 2 wellhead.

3.4.6 Wind Farms

There are no active windfarms in close proximity to the Blocks of Interest, however the Arthur P1 wellhead, Arthur 2 wellhead, Arthur manifold, Horne and Wren platform, Wissey wellhead and Orwell wellhead lie within the Round 3 Wind Farm Zone Search Area, East Anglia (which is in the Concept/Early Planning phase; *Crown Estates, 2013; 4COffshore, 2013*).

The nearest active wind farm site is the Round 2, Dudgeon East site approximately 32 kilometres to the north west of the Thames to Bacton (PL370) pipeline (*Crown Estates, 2013*). This site is in the consent/authorisation phase (*4COffshore, 2013*).

3.4.7 Archaeology

There are two charted wreck sites located within the Blocks of Interest (*Hydrographer of the Navy, 2008).* During the Thames Decommissioning Programme area site survey, one of the sampling stations (located in UKCS Block 52/03, approximately 13 metres from the Thames export pipeline route) was recorded directly over a shipwreck, which supported a dense turf of anemones, hydroids and soft corals (Figure 3.24). The shipwreck is not expected to be disturbed during the decommissioning activities.

Figure 3.24: An image recorded at sampling station (DC006_2) showing a shipwreck (*Osiris, 2013*)

Station	DC006_2
Seabed description	Shipwreck
Fauna & flora	Dense faunal turf that includes the hydroids *Nemertesia ramosa* and *Tubularia* sp., dead man's fingers *Alcyonium digitatum*, the bryozoan *Flustra foliacea* and the anemone *Sagartia elegans* (orange and white colour morphs).
Features of interest (including Annex 1 Habitat)	None

3.4.8 Tourism and Leisure

Leisure based and tourist activities are fairly widespread along the east coast of England. The north Norfolk coast is an important area for water-based activities, particularly dinghy sailing and wind-surfing. Bridlington and Great Yarmouth are both popular embarkation points for sea angling trips. The wildlife in the area is also a significant attraction and during the summer there are regular seal watching trips to Blakeney Point (*Smith, 1998*).

The tourism industry is not expected to be impacted significantly by the Thames Decommissioning Programme operations, however, leisure activities could be threatened in the event of a major accidental spill approaching the coast.

The risks associated with loss of well control and the subsequent condensate spill (as the wells are gas, no oil is expected) are detailed in Section 10. The proposed development is over 66 kilometres from the nearest landfall on the east English coast. However, the Thames Decommissioning Programme oil spill modelling calculated that in the event of a spill, he worst case condensate spill (5 kilometres from the MLWM) released over a period of 4 days, will beach after 3 hours, with a 55 percent probability.

3.5 East Inshore and Offshore Marine Plans

Through the Marine and Coastal Access Act 2009 (MCAA), the UK Government introduced a number of measures to deliver its vision of "clean, healthy, safe, productive and biologically diverse oceans and seas". These measures included introducing a marine planning system. MMO were designated marine planning functions by the Secretary of State (the marine plan authority) in April 2010. Marine plans, together with the Marine Policy Statement (MPS), underpin this new planning system for English seas (*MMO, 2013*).

The Thames infrastructure that has been designated for decommissioning lies within both the East Inshore and East Offshore Marine plan areas, which the MMO recently published draft plans for. In terms of seascape the Thames Decommissioning Programme project lies within the 'East Anglian Shipping Waters' area (Character Area 4), the 'Norfolk Coastal Waters' area (Character Area 9) and the 'East Midlands Offshore Gas Fields' area (Character Area 3; *Natural England, 2012*).

The plans aim to provide a clear spatial approach to the East Inshore and East Offshore areas, their resources, and the activities and interactions that take place within them. It is intended that these marine plans will help ensure the sustainable development of the marine area (*MMO, 2013*).

The vision for the East Inshore and East Offshore marine areas is that "By 2033 the East Inshore and East Offshore marine areas are providing a substantial part of the electricity generated from offshore wind in the UK as a result of collaboration and integration between sectors. Sustainable, effective and efficient use of our marine area has been achieved, resulting in economic development whilst protecting the marine ecosystem, and offering local communities new jobs, wealth, improved health and well-being" (*MMO, 2013*).

3.6 Key Environmental Sensitivities

A summary of key environmental sensitivities in the vicinity of the Thames Decommissioning Programme area include (Table 3.20):

- Potential Annex I shallow sandbank habitat was identified along part of the Thames export pipeline and also along Arthur and Orwell pipelines (*CMACS, 2013*);
- Discrete patches of *Sabellaria spinulosa* of low or moderate reefiness were identified during the site survey, however no high reefiness areas, which constitute Annex I biogenic reef, were identified (*CMACS, 2013*);
- Annual fishing effort is regarded as low compared to other areas of the North Sea. Monthly catches by weight are generally low, with peaks occurring at different times throughout the year between the four ICES rectangles. Of the five ICES Rectangles that the Thames Decommissioning Programme area falls into, ICES Rectangle 35F1 generally has the highest annual effort and fisheries landings by weight;
- Shipping movements in the vicinity of the Blocks of Interest are regarded as very high to low throughout the year. Blocks 49/29, 49/30 and 53/4 lie within a deep water route;
- Previously, there has been significant oil and gas activity within and around the Blocks of Interest;
- The Blocks of Interest are a spawning area for cod, herring, lemon sole, mackerel, *Nephrops*, plaice, sandeels, sole, sprat and whiting;
- The Blocks of Interest are also a fish nursery area for cod, herring, horse mackerel, mackerel, *Nephrops*, plaice, sole, sprat, thornback ray, tope shark and whiting;

- Seabird vulnerability is considered moderate / low for the majority of the year (3/4 out of 4 on the JNCC scale). Peak vulnerability occurs in different Blocks during February, March, August and October to December (1/2 out of 4 on the JNCC scale);
- Cetacean numbers overall are generally low;
- There are 24 protected areas with marine components within 40 kilometres of the Thames infrastructure. The Thames infrastructure crosses the boundaries of three of these areas.

Table 3.20: Seasonal Environmental Sensitivities

Activity in the Blocks of Interest, surrounding waters and adjacent coastline													
Component	**Abundance/Activity**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Plankton	Phytoplankton and zooplankton												
Benthic Fauna	Benthic faunal communities												
Fish	Cod			N	N	N	N						
	Herring										N	N	N
	Horse Mackerel					N	N	N	N	N	N		
	Lemon Sole						N	N	N	N	N	N	
	Mackerel							N	N	N	N		
	Nephrops	N	N	N	N	N	N	N	N	N	N	N	N
	Plaice												
	Sandeels	N	N	N	N								
	Sole					N	N	N					
	Sprat							N	N	N	N		
	Thornback Ray				N	N	N	N	N	N	N	N	
	Tope Shark	N	N	N	N	N	N	N	N	N	N	N	N
	Whiting				N	N	N	N	N				
Seabirds	Block 48/28 Offshore Vulnerability	4	3	4	4	4	4	4	3	4	1	2	2
	Block 48/29 Offshore Vulnerability	4	3	4	4	4	4	4	3	4	2	2	2
	Block 48/30 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	2	2	2
	Block 49/26 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	3	4	2
	Block 49/27 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	3	4	2
	Block 49/28 Offshore Vulnerability	4	3	2	4	3	4	4	3	4	3	4	2
	Block 49/29 Offshore Vulnerability	4	3	2	4	3	4	4	3	4	4	4	2
	Block 49/30 Offshore Vulnerability	4	2	2	4	3	4	4	3	4	4	4	2
	Block 50/26 Offshore Vulnerability	4	2	2	4	3	4	4	4	4	4	4	3
	Block 52/03 Offshore Vulnerability	4	3	4	4	4	4	4	2	3	1	2	2
	Block 53/02 Offshore Vulnerability	4	3	3	4	3	4	4	3	4	3	4	2
	Block 53/03 Offshore Vulnerability	3	2	2	4	3	4	4	3	4	3	4	2
	Block 53/04 Offshore Vulnerability	3	2	2	4	3	4	4	3	4	4	4	2
Cetaceans	Harbour porpoise												
	Minke whale												

Activity in the Blocks of Interest, surrounding waters and adjacent coastline													
Component	**Abundance/Activity**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
	White-beaked Dolphin												
Resource Users	Commercial fishing (ICES rectangle 34F1)												
	Commercial fishing (ICES rectangle 34F2)												
	Commercial fishing (ICES rectangle 35F1)												
	Commercial fishing (ICES rectangle 35F2)												
	Commercial fishing (ICES rectangle 35F3)												
	Shipping and ports												
	Military Activity												
	Oil and gas activity (including pipelines / cables)												
	Dredging and dumping												
	Offshore windfarms												
	Marine protected areas												
	Coastal protected sites												
	Tourism, recreation & leisure activities												

Key:

	High /Peak		Medium		Low		Very low		No Activity

1 = High Sensitivity, 4 = Low Sensitivity, blank = no data (*JNCC, 1999*);
N = Nursery Area (high intensity), N = Nursery Area (low intensity).
Note: The red box indicated the proposed decommissioning period.

4 Environmental Assessment Methodology

4.1 Introduction

This section describes the assessment methodology that has been used to identify, describe and assess the likely significant impacts of the proposed Thames Area Decommissioning project on the environment.

The impact assessment process which has been followed is illustrated in Figure 4.1.

Figure 4.1: Identification, Evaluation and Mitigation of Impacts

The key objectives of this process are to:

- Identify how the project may interact with the baseline environment in order to define, predict and evaluate the likely extent and significance of environmental impacts that may be caused by the project;
- Define mitigation measures in order to avoid, reduce, control or compensate for adverse impacts or enhance positive benefits;
- Evaluate the residual impacts of the project (i.e. the impact that is predicted to remain once mitigation measures have been designed into the intended activity);
- Develop a Register of Commitments in order that the proposed mitigation measures can be incorporated into an overall Environmental Management Plan for the project.

4.2 Impact Identification

4.2.1 Environmental Aspects and Impacts

The ISO (International Organization for Standardization) Standard for Environmental Management Systems, ISO 14001, defines an **environmental aspect** as:

'An element of an organization's activities, products, or services that can interact with the environment.'

ISO 14001 defines an **environmental impact** as:

'Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services.'

An environmental impact may result from any of the identified environmental aspects and can arise from planned or unplanned events.

Environmental impacts from a planned event are those caused as a natural consequence of project decommissioning activities (e.g. platform removal, flushing of pipelines etc.) and waste disposal operations (e.g. emissions to atmosphere through waste processing etc.). They may occur continuously, intermittently or on a temporary basis.

Environmental impacts from an unplanned event are those that occur as a result of mishaps or failures (e.g. failure of equipment, procedures not being followed, unforeseen non-routine events, or process equipment not performing as per design parameters). Typical examples of impacts occurring from accidental events include (but are not limited to) spills, leaks, fires and explosions.

Impacts may be adverse (i.e. have a detrimental or negative effect to an environmental resource or receptor) or positive (i.e. have an advantageous or positive effect to an environmental resource or receptor).

To identify the potential environmental impacts associated with the proposed Thames Area Decommissioning project, all activities associated with the decommissioning (as outlined in Section 2) have been considered in terms of their direct or indirect potential to interact with the baseline environment including its physical, biological and socio-economic elements (as detailed in Section 3).

Cumulative impacts (i.e. impacts that result from incremental changes caused by other past, present or reasonably foreseeable activities or projects in the local area, in combination with the proposed development) and transboundary impacts (i.e. impacts experienced in one country as a result of activities in another) have also been considered.

4.3 Evaluation of Significance

Once identified, the predicted environmental impacts are assessed to define the level of potential risk they present to the environment. If these risks are deemed significant, they should be removed or reduced through design or the adoption of operational mitigation measures.

ISO 14001 defines a **significant environmental aspect** as:

'An environmental aspect that has or can have a significant environmental impact.'

In order to determine the significance of the predicted environmental impacts for the proposed Thames Area Decommissioning project a risk assessment approach has been used, whereby:

Risk = Likelihood of Occurrence x Magnitude of Impact (Consequence)

The following sections describe the criteria which have been used to assess the significance of potential impacts.

4.3.1 Likelihood of Occurrence

For every environmental impact identified for the proposed Thames Area Decommissioning project the likelihood of occurrence has been scored (from 1 to 5) based on the definitions provided in Table 4.1.

Table 4.1: Likelihood of Occurrence

Likelihood	Likelihood of Occurrence of the Impact
5	**Definite:** could be expected to occur more than once during project delivery, part of normal and expected activities
4	**Likely:** could easily be incurred and has generally occurred in similar projects
3	**Possible:** occurred in a minority of similar projects
2	**Unlikely**: known to happen, but only rarely
1	**Remote:** hasn't occurred in similar projects, but is foreseeable

4.3.2 Magnitude of Impact (Consequence)

The magnitude of impact (consequence) on the environment has also been scored (from 0 to 6) based on the definitions provided in Table 4.2. A high score means the impact is of greatest severity. Where magnitude appears to fall within two different categories, the higher category is selected to provide a worst case scenario for the purposes of assessment.

Table 4.2: Definition of Consequence Categories

Consequence Category	Environmental Impact	Regulatory Compliance	Stakeholder Concern
6 Catastrophic	Catastrophic direct, indirect and/or cumulative impact on the ecosystem at an international level (major transboundary effects expected). The impact is likely to be permanent or of long-term duration and may include: • Major contribution, at a global level, to a known air pollution problem; • Long-term deterioration of water quality and the marine environment at an international level; • Irreparable effect on the ecosystem involving change in abundance or distribution of the population, or size of genetic pool over an extensive area (> 100 km^2); • Widespread and long term damage to international fisheries; • Significant damage and permanent loss to archaeological, cultural or natural resources of international importance.	Major breach of regulatory requirements, which is very likely to result in prosecution	International public concerns and extensive international media interest likely, resulting in complete loss of public confidence in company.
5 Severe	Severe direct, indirect and/or cumulative impact on the ecosystem at a national. The impact is likely to be of long-term duration and may include: • Major contribution, at a national level (and possible minor transboundary effects), to a known air pollution problem; • Long-term deterioration of water quality and the marine environment at an national level (and possible minor transboundary effects); • Change in abundance or distribution of the population, or size of genetic pool extending over a wide area (10 - 100 km^2); • Widespread and long term damage to national fisheries (and possible minor transboundary effects); • Significant damage and permanent loss to archaeological, cultural or natural resources of national importance.	Likely major breach of regulatory requirements resulting in potential prosecution or significant project approval delays.	National public concerns and extensive national media interest likely, resulting in major loss of public confidence in company.

Consequence Category	Environmental Impact	Regulatory Compliance	Stakeholder Concern
4 Major	Serious direct, indirect and/or cumulative impact on the ecosystem at a regional level. The impact is likely to lead to observable and measurable medium to long-term changes and may include: • Medium to long-term, regional deterioration of air quality; • Medium to long-term deterioration of water quality and the marine environment at a regional level; • Change in abundance or distribution of the population, or size of genetic pool extending over an area of approximately 10 km^2; • Medium to long-term impact to regional fisheries; • Major damage to archaeological, cultural or natural resources of regional importance.	Possible moderate to major breach of specific regulatory consent limits resulting in non-compliance.	Regional concerns at the community or broad interest group level, resulting in possible loss of public confidence in company.
3 Moderate	Moderate direct, indirect and/or cumulative impact on ecosystem on a local level, leading to observable and measurable medium-term changes. These impacts may include: • Medium-term deterioration of local air quality; • Medium-term deterioration of water quality and the marine environment; • Change in abundance or distribution of the population extending over an area of approximately 1 km^2; • Medium-term impact to local fisheries; • Moderate level of damage to archaeological, cultural or natural resources.	Possible minor breach of specific regulatory consent limits resulting in non-compliance.	Local concerns at the community or broad interest group level.
2 Minor	Limited direct and/or indirect impact on ecosystem on a local level, leading to observable and measurable short-term changes. These impacts may include: • Short-term deterioration of local air quality; • Short-term deterioration of water quality and the marine environment; • Change in abundance or distribution of the population similar in effect to small random changes in the ecosystem due to ambient environmental conditions, extending over an area of approximately 0.01 km^2; • Short-term impact to local fisheries; • Limited impact to archaeological, cultural or natural resources.	Very unlikely to result in a breach of regulatory or company EHS goals.	Issues that might affect individual people or businesses or single interests at a local level.
1 Negligible	Insignificant direct or indirect impact on the ecosystem, confined within the immediate vicinity of the site, unlikely to be observable or measurable above small random changes due to ambient environmental conditions. Such impacts would have no discernible effect on the local ambient air quality, water quality, marine environment, fisheries, archaeological, cultural or natural resources.	No likelihood of breach of regulatory or company EHS goals.	No noticeable stakeholder concern.
0 Positive	An enhancement of some ecosystem or socio-economic parameter.	N/A	Possible positive public support.

4.3.3 Impact Significance

The significance of the potential impacts is then determined by combining their likelihood and consequence scores as illustrated in the Risk Assessment Matrix below (Table 4.3).

Table 4.3: Risk Assessment Matrix

			Likelihood				
			1	2	3	4	5
			Remote	Unlikely	Possible	Likely	Certain
Consequence	6	Catastrophic					
	5	Severe					
	4	Major					
	3	Moderate					
	2	Minor					
	1	Negligible					
	0	Positive					

Overall Significance Definitions:	
Major	**Considered to be a significant risk:** the level of risk is unacceptable. Risk and control measures are required to move the risk figure to the lower risk categories, e.g. design out the risk, put plans and procedures in place.
Moderate	**Considered to be a significant risk:** the level of risk is tolerable, but extra control and reduction measures are required. This may be location or activity specific to minimise the risk as much as possible.
Minor	**Not considered to be a significant risk:** the level of risk is considered to be broadly acceptable and generic control and reduction measures are already part of the project design process. Continuous improvement is still a requirement.
Negligible	**No risk:** no action required.
Positive	**Positive impact:** to be encouraged.

4.4 Mitigation Measures and Residual Impacts

Where potentially significant impacts have been identified (i.e. those impacts which are considered to pose a major or moderate risk to the environment), mitigation measures have been considered in order to remove, reduce or manage the potential impacts so that they are not significant.

Once appropriate mitigation measures have been applied, the potential impacts are then reassessed to determine if the overall impact significance has been reduced. These remaining impacts are referred to as **residual impacts** (i.e. the impact that is predicted to remain once mitigation measures have been designed into the intended activity).

4.5 Results of the Assessment

The results of the environmental impact assessment for the proposed Thames Area Decommissioning project are summarised in the Environmental Aspects Tables in Appendix B.

Impacts associated with the Thames Area Decommissioning project have been grouped under the following headings:

- Physical Presence;

- Seabed Impacts;
- Noise;
- Atmospheric Emissions;
- Marine Discharges;
- Unplanned Releases;
- Solid Wastes;
- Transboundary Impacts;
- Cumulative Impacts.

Any relevant social-economic issues have been assessed within these sections.

Those environmental aspects given a significance ranking of minor or negligible before the application of mitigation measures are considered insignificant and have therefore been scoped out from further assessment in this ES (all of the environmental aspects are provided in Appendix B).

Those environmental aspects which are considered to be significant (or positive) are assessed further within Sections 5 – 13 of the ES and suitable mitigation measures are determined to demonstrate that the residual impact is as low as reasonably practicable (ALARP).

All mitigation measures identified within Sections 5-13 of the ES are listed in a Register of Commitments (refer to Table 14.1 in Section 14) and will be incorporated into Perenco's overall Environmental Management Plan for the Thames Area Decommissioning project to ensure that potential environmental impacts are minimised. A summary of the residual risk assessment of the significant impacts are shown in Table 4.4.

Table 4.4: A summary of the Residual Risk Assessment conducted for significant impacts

Thames Area Decommissioning Project	Residual Risk									
	Positive		Negligible		Minor		Moderate		Major	
	Planned	Unplanned	Planned	Unplanned	Planned	Unplanned	Planned	Unplanned	Planned	Unplanned
Decommissioning Activities	**1**	**0**	**2**	0	**20**	**0**	0	**1**	0	0

5 Physical Presence of the Drilling Rig, Super Heavy Lift Vessel and other Decommissioning Vessels

5.1 Assessment of Potentially Significant Impacts

The physical presence of the drilling rig, SHLV and other decommissioning vessels can result in some interference impacts to:

- General shipping vessels (cargo and passenger ferries);
- Fishing vessels;
- Pleasure craft.

5.1.1 Regulatory Regime

The positioning of drilling rigs and other fixed vessel / installations is covered by a Consent to Locate (CtL) application, which for decommissioning activities falls under the Marine and Coastal Access Act 2009 and The Energy Act 2008.

5.1.2 Decommissioning Activities Using a Drilling Rig

A jack up drilling rig will be used to plug and abandon all of the subsea wells and the Horne & Wren platform wells as part of the Thames Area Decommissioning Project. Shipping activity within the Thames Decommissioning area is variable. In Blocks 48/28 and 48/29 shipping is described as 'very high' (*DECC, 2014*), however no wells are located in these blocks, therefore no rig activity will be undertaken here. Blocks 49/29 and 53/4, where the Orwell and Wissey wells are located respectively, are located within Deep Water Routes. The majority of the wells to be decommissioned are located within Blocks 49/28 (Bure, Thurne, Thames and Yare wells) and 53/2 (Arthur wells), both of these blocks are described as having a 'high' shipping activity (*DECC, 2014*). The shipping density in the areas of rig activity is therefore generally high (refer to Section 3.5.2).

During the decommissioning of the subsea wells, there will be a restriction to all vessels (shipping, fishing and pleasure craft), limited to a radial area of 500 metres around the drilling rig (equalling a total area of 0.8 square kilometres). This exclusion zone will be maintained for the duration of the decommissioning activities using a jack up drilling rig (anticipated to be a maximum of 480 days for all locations). Vessels using the area may be disrupted by the presence of the exclusion zones around the drilling rig whilst in place due to the high level of shipping in these target blocks (refer to Section 3.5.2). However the impacts are not expected to be significant given that the rig will only be a temporary obstruction, there is adequate sea room, particularly to the north of the blocks, for vessels to re-route if necessary and the relatively small area to be impacted. Fishing vessels will also be excluded from fishing or trawling in the exclusion zone, which will lead to a temporary loss of fishing grounds.

When decommissioning the Thames and the Horne & Wren platform wells, there will be little change to the availability of fishing/shipping grounds as the drilling rig will be alongside the platform. The drilling rig will therefore will be within the existing 500 metre exclusion zone around the platforms.

Effective planning is one of the key factors that can mitigate potential conflicts with fishing and shipping interests. Therefore, consultations with the Fisheries and Maritime Agencies will be held by either Perenco or their representatives to try and address any potential conflicts and optimise the schedule. Communications with these agencies will be maintained, as necessary, throughout the decommissioning programmes. A Fisheries Liaison Officer (FLO) will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.

Prior to the decommissioning activities using the drilling rig, a shipping hazard assessment will be undertaken as part of the Consent to Locate permit. This report will detail the types of vessels used in the area, the available sea room (through shipping routes) and an assessment of the shipping frequency. The results and potential impacts of which, will be presented in the relevant chemical permit application (formally known as a PON 15F), for each specific well.

Mitigation Measures

The final mitigation measures (from a shipping hazard assessment) will be presented in the relevant Consent to Locate permit and chemical permit application (formally known as a PON 15F), however likely mitigation measures include:

- A 500 metre exclusion zone will be maintained around the drilling rig for the duration of the decommissioning activities;
- The main operators of ships passing in proximity to the site should be provided with advanced notice of the decommissioning operations. This will allow vessels to revise their passage to take account of the drilling rig at the sites, should they consider it necessary;
- Reporting of the rig move should take place in line with the requirements of the Coast Protection Act and HSE Operations Notice 6 guidance. This includes informing the MoD Hydrographer and Maritime and Coastguard Agency (MCA). This will ensure details of the drilling rig location are distributed via Notices to Mariners, Navtex and NAVAREA warnings, as well as to the appropriate Maritime Rescue Co-ordination Centre (MRCC);
- The crew of the Emergency Response and Rescue Vessel (ERRV) attending the rig should be experienced in traffic monitoring duties and should be briefed on the main routes of concern in the area;
- A collision risk management plan should be developed for the decommissioning operations to record the pre-planning measures taken to minimise the risk of ship collision, and to define the guarding role of the ERRV whilst on location.

Conclusions

The impact from the physical presence of the drilling rig is expected to be minor, if the above mitigation measures are implemented. It is also important to note that the overall impact of the presence of the drilling rig may be reduced, depending on the outcome of the collision risk assessment that will be undertaken prior to decommissioning operations beginning.

Providing the above mitigation measures are met from the future shipping hazard assessment study, the residual impact of the physical presence of the drilling rig, on other marine vessels, is considered to be Minor

5.1.3 Decommissioning Activities Using a Super Heavy Lift Vessel

For the purposes of this EIA, a worst case scenario of using the SHLV has been conducted. For the decommissioning of the platforms and platform wells, a SHLV will be used and therefore there will be a restriction to all vessels (shipping, fishing and pleasure craft), limited to a radial area of 500 metres around the SHLV (equalling a total area of 0.8 square kilometres). This exclusion zone will be maintained for the duration that the SHLV is on location next to the platforms (anticipated to be a maximum of 112 days for all locations). However, the impacts are not expected to be significant given that the SHLV will only be located within an already existing 500 metre exclusion zone (Thames and Horne & Wren). Therefore, shipping and fishing vessels will already be excluded from the safety zones.

Nevertheless, effective planning is one of the key factors that can mitigate potential conflicts with fishing and shipping interests. Therefore, consultations with the Fisheries and Maritime Agencies will still be held by either Perenco or their representatives to try and address any potential conflicts and optimise the schedule. Communications with these agencies will be maintained, as necessary, throughout the decommissioning programmes. An FLO will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.

Prior to the decommissioning activities using the SHLV, a shipping hazard assessment (or an addendum to an existing one) will be undertaken as part of the Consent to Locate permit (the need will be dependent on specific vessel used). This report will detail the types of vessels used in the area, the available sea room (through shipping routes) and an assessment of the shipping frequency. The results and potential impacts of which, will be presented in the relevant chemical permit application, for the Thames wells.

Mitigation Measures

- The SHLV will remaining within the existing exclusion zones of the Thames and Horne & Wren platforms.

Conclusions

The impact from the physical presence of the SHLV is expected to be lower (when compared to the presence of the drilling rig), as the SHLV will only be positioned in already established exclusion zones.

The residual impact of the physical presence of the SHLV, on other marine vessels, is considered to be Minor

5.1.4 Decommissioning Activities Using Other Decommissioning Vessels

In addition to the SHLV and drilling rig, there will also be different types of vessels required for decommissioning activities at the Thames Area. These include a DSV, support vessels, supply vessels for the drilling rig and SHLV, a heavy lift barge and tugs (refer to Section 2.11.1). These will be required for all aspects of decommissioning, including pipeline decommissioning.

Whilst these vessels are smaller and therefore do not have a statutory exclusion zone placed around them while working, they will provide an additional obstacle to other sea users (shipping, fishing and leisure craft), particularly the DSV during diving operations.

The number of days each of these vessels is likely to be present is provided in Section 2.11.1. Although there will be overlap of timings between vessels, each of the vessels is not expected to be on location for a significant period of time (the longest duration being 480 days for the supply and standby vessels). Vessels will all meet national and international legislation with regards to navigation aids and warning signals for other sea users. Other sea users will also be informed of the decommissioning activities, and therefore the presence of additional vessel traffic in the area, through Notices to Mariners to enable early warning and planning of proposed activities.

Effective planning is one of the key factors that can mitigate potential conflicts with fishing and shipping interests. Therefore, consultations with the Fisheries and Maritime Agencies will be held by either Perenco or their representatives to try and address any potential conflicts and optimise the schedule. Communications with these agencies will be maintained, as necessary, throughout the decommissioning programmes. An FLO will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.

Mitigation Measures

- Consultations with the Fisheries and Maritime Agencies will be undertaken;
- An FLO will be in place and will be responsible for the distribution of all key information to fishermen;

- A shipping hazard assessment (or addendum to the existing one) will be undertaken.

Conclusions

The impact from the physical presence of other decommissioning vessels is expected to be minor, if the above mitigation measures are implemented.

Providing the above mitigation measures are met from the future shipping hazard assessment study, and recommendations for other vessels are taken into account, the residual impact of the physical presence of other decommissioning vessels on other sea users, is considered to be Minor

5.1.5 Removal of Thames and Horne & Wren Platforms

The Thames platform and the Horne & Wren NUI infrastructure will be removed by the use of a SHLV and additional support vessels.

Both platform jackets will be removed from the seabed piles and the jacket legs will be cut just below the seabed (usually three metres below) where they will remain. Infrastructure on the seabed can pose an obstacle to fishing vessels, particularly benthic trawlers as their gears may become snagged or trapped on items left on the seabed. The jacket legs will remain *in situ* below the seabed, however given that these will remain below the mudline, they should not pose an obstacle for other sea users.

The final severance methodology is yet to be defined. If explosives are required, other sea users which may be affected by this will be informed in advance and communications maintained throughout the decommissioning programme.

Once the removal of the Thames and Horne & Wren platforms is complete, the existing exclusion zones around each platform will be removed. This will free up an area of approximately 1.6 square kilometres to other sea user and is expected to have a minor positive impact to fishermen who regularly already fish in the area.

Conclusions

There will be a minor impact from decommissioning vessels while in transit to and from the Thames and Horne & Wren locations. However, once the platforms are safely removed, the residual impact is expected to be a positive one, as there will be more available sea room for other sea users.

Once the Thames and Horne & Wren platforms are removed, the residual impact of the physical presence on other sea users, is considered to be Positive

5.2 Summary of Mitigation Measures

- A 500 metre exclusion zone will be maintained around the drilling rig for the duration of the decommissioning activities;
- The main operators of ships passing in proximity to the site should be provided with advanced notice of the decommissioning operations. This will allow vessels to revise their passage to take account of the drilling rig at the sites, should they consider it necessary;
- Reporting of the rig move should take place in line with the requirements of the Coast Protection Act and HSE Operations Notice 6 guidance. This includes informing the MoD Hydrographer and Maritime and Coastguard Agency (MCA). This will ensure details of the drilling rig location are distributed via Notices to Mariners, Navtex and NAVAREA warnings, as well as to the appropriate Maritime Rescue Co-ordination Centre (MRCC);

- The crew of the Emergency Response and Rescue Vessel (ERRV) attending the rig should be experienced in traffic monitoring duties and should be briefed on the main routes of concern in the area;
- A collision risk management plan should be developed for the decommissioning operations to record the pre-planning measures taken to minimise the risk of ship collision, and to define the guarding role of the ERRV whilst on location;
- The SHLV will remaining within the existing exclusion zones of the Thames and Horne & Wren platforms;
- A shipping hazard assessment (or addendum to the existing one) will be undertaken for the decommissioning operations;
- Consultations with the Fisheries and Maritime Agencies will be undertaken;
- A Fisheries Liaison Officer (FLO) will be assigned, who will be responsible for the distribution of all key information to fishermen.

6 Disturbance to the Seabed

6.1 Assessment of Potentially Significant Impacts

During the Thames Area decommissioning project, the main causes of seabed disturbance will be from:

- Removal of subsea infrastructure (wellheads, WPS and other subsea structures);
- Removal of concrete mattresses;
- Disturbance of wellbore muds / cuttings;
- The deployment of drilling rig legs (spud cans);
- Drilling rig and pipeline stabilisation (rock dumping).

6.1.1 Regulatory Regime

The removal subsea infrastructure, seabed disturbance and the placement of additional stabilisation / protective materials are all covered by the Marine and Coastal Access Act 2009 (MCAA). The deployment of drilling rig spud cans and drilling rig leg stabilisation materials (rock dumping) are covered under the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended).

6.1.2 The Removal of Subsea Infrastructure

The subsea infrastructure that will need to be removed is summarised in Table 6.1 below (also refer to Section 2.4). Note that pipelines, MEG lines and umbilicals have not been included as they will remain *in situ*.

Table 6.1: Summary of the Subsea Structures to be removed for each Decommissioning Programme (DP)

Subsea Structure	Thames (DP1)	Gawain (DP2)	Arthur (DP3)	Horne & Wren (DP4)	Orwell (DP5)	Wissey (DP6)	Thurne
Jackets	3	-	-	1	-	-	
Platform Wells	5	-	-	2	-	-	-
Subsea Wells	4	3	3	-	3	1	1
Wellheads	4	3	3	-	3	1	1
Wellhead Protection Structure (WPS)	4	1	4	-	1	1	-
Other	16 Platform piles, plus 1 template	1 Manifold and Template	1 Manifold	3 Platform piles	1 Template	-	-

The removal of subsea infrastructure (jacket piles and WPS) will be undertaken by metal cutting techniques. As the platform jacket legs and the WPS have been piled into the seabed, grit cutters or explosives may be used to cut the piles to below the seabed in order to remove them as a hazard to shipping/fishing vessels. Removal of these structures by high energy methods may disturb sediments and lead to an increase in sedimentation, potential destabilisation of the surrounding sediments (if the explosives are placed below the seabed) and a localised increase in turbidity. This can have an impact on water quality, plankton, fish and benthic suspension feeders.

The removal of the wellheads and other subsea structures such as templates and/or manifolds will be undertaken through the use of the SHLV. The structures will be recovered and transported to shore for disposal or recycling. The disturbance of sediments using these methods is not considered to have a significant impact.

The scope of the well decommissioning is described in Section 2.10. It is not expected that the plugging and abandoning of the wells will cause significant seabed disturbance.

Seabed sediments across the Thames area were found to be granular sediments with a lower proportion of muds and fine sediments (*CMACS, 2013*). Such sediments are less likely to remain re-suspended and carried over long distances, compared to fine muds and clays. It is more likely that they will resettle into the immediate vicinity following disturbance. Conversely, fine sediments would be more unstable and more likely to cause an increase in turbidity and sedimentation because of their relative ease of re-suspension.

Of particular sensitivity to localised increases in turbidity are; shellfish beds and fish spawning grounds (*OSPAR, 2008*). Due to the large areal extent of operations, several fish spawning grounds were identified (Section 3.3.3), of the species identified, only herring spawning grounds are of particular conservation importance. Based on the results of the site survey, no seabed sediments suitable for herring spawning were identified. No commercial shellfish beds were identified in the area of operations.

Benthic species are vulnerable to the effects of sediment loading. However, given the strong water column and seabed current regime in the area, species which are tolerant to a natural variability to sedimentation are present in the southern North Sea in general and also in the Thames area, as corroborated during the site survey where the benthic community was found to be dominated by polychaete worms and crustacean species (amphipods and cumaceans) (Section 3.3.2; *CMACS, 2013*). In addition, no notable or species of conservation importance were identified during the Thames site survey or other site surveys in the area. Discrete patches of *S. spinulosa* biogenic reef were identified during the site survey, however the majority of these were characterised as low 'reefiness' (*Gubbay, 2007; CMACS, 2013*). Areas which were characterised as moderate 'reefiness' were along the Thames export pipeline (PL370) route and are therefore not located in the vicinity of severance operations which may lead to an increase in turbidity. In addition, *S. spinulosa* requires a supply of sediment grains in order to build their tubes and are therefore tolerant to a degree of sedimentation (*JNCC, 2008b*). Therefore, the benthic communities are not anticipated to be significantly impacted by the removal of these structures from below the seabed (mudline).

There is also the potential for small extents of seabed, within the protected areas (refer to Section 3.3.6), to be impacted by the removal of subsea infrastructure. However, as the above demonstrates, it is not expected that any Annex I habitats will be significantly impacted by the removal and any impacts will be highly localised in nature.

Mitigation Measures

- Subsea infrastructure removal methods will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed;
- Post-decommissioning a debris survey will be undertaken to remove any objects remaining on the seabed.

Conclusions

The removal of the seabed infrastructure will pose an impact to the localised seabed, through disturbance and increased sedimentation. However, the residual impact is expected to be minor, as any seabed impacts will be highly localised and temporary in nature. In addition, the areas of impact are expected to recover quickly due to the nature of the local currents and sediment type.

The residual impact of the removal of seabed infrastructure is considered to be Minor

6.1.3 The Removal of Concrete Mattresses

As a 'worst-case' assessment, this section will assess the impact of removing all of the concrete mattresses at the Thames decommissioning area. There are approximately 426 concrete mattresses that would need to be removed from the seabed.

The exact methodology for removal for the concrete mattresses has yet to be decided / investigated (and therefore no impacts other than sediment disturbance is assessed), however it will likely involve the use of divers and shipboard cranes. The removal of these mattresses may disturb sediments and lead to an increase in sedimentation, potential destabilisation of the surrounding sediments and a localised increase in turbidity. This can have an impact on water quality, plankton, fish and benthic suspension feeders.

The concrete mattresses will be recovered and transported to shore for disposal or recycling. It is expected that the removal of all of the concrete mattresses will cause seabed disturbance, due to the potential size of the area of disturbance. The maximum area of disturbance from the removal of 426 mattresses is expected to be in excess of 15,336 square metres (this is based on a single mattress having an area of 18 square metres and doubling the area for working room during removal).

Seabed sediments across the Thames area were found to be granular sediments with a lower proportion of muds and fine sediments (*CMACS, 2013*). Such sediments are less likely to remain re-suspended and carried over long distances, compared to fine muds and clays. It is more likely that they will resettle into the immediate vicinity following disturbance.

Of particular sensitivity to localised increases in turbidity are; shellfish beds and fish spawning grounds (*OSPAR, 2008*). Due to the large areal extent of operations, several fish spawning grounds were identified (Section 3.3.3), of the species identified, only herring spawning grounds are of particular conservation importance. Based on the results of the site survey, no seabed sediments suitable for herring spawning were identified. No commercial shellfish beds were identified in the area of operations.

As described in Section 6.1.2, benthic species are vulnerable to the effects of sediment loading. However, given the strong water column and seabed current regime in the area, species which are tolerant to a natural variability to sedimentation are present in the southern North Sea in general and also in the Thames area, as corroborated during the site survey where the benthic community was found to be dominated by polychaete worms and crustacean species (amphipods and cumaceans) (Section 3.3.2; *CMACS, 2013*). Discrete patches of *S. spinulosa* biogenic reef were identified during the site survey, however the majority of these were characterised as low 'reefiness' (*Gubbay, 2007; CMACS, 2013*). Areas which were characterised as moderate 'reefiness' were along the Thames export pipeline (PL370) route and may be lopcated in areas of concrete mattress removal. However, *S. spinulosa* does require a supply of sediment grains in order to build their tubes and are therefore tolerant to a degree of sedimentation (*JNCC, 2008b*). Therefore, the benthic communities are not anticipated to be significantly impacted by the removal of concrete mattresses from the seabed.

There is also the potential for small / moderate extents of seabed, within the protected areas (refer to Section 3.3.6), to be impacted by the removal of concrete mattresses. However, as the above demonstrates, it is not expected that any Annex I habitats will be significantly impacted by the removal and any impacts will be highly localised in nature.

Mitigation Measures

- Concrete mattress removal methods will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed;
- Post-decommissioning a debris survey will be undertaken to remove any concrete mattresses remaining on the seabed.

Conclusions

The removal of all of the concrete mattresses will pose an impact to the localised seabed, through disturbance and increased sedimentation. However, the residual impact is expected to be minor, as the seabed impacts will be highly localised and temporary in nature. In addition, the areas of impact are expected to recover quickly due to the nature of the local currents and sediment type.

The residual impact of the removal of concrete mattresses is considered to be Minor

6.1.4 Disturbance of existing Wellbore Muds / Cuttings

No evidence of historical drill cuttings piles were identified during the most recent site survey (*CMACS, 2013*). Drill cuttings piles that were generated during previous drilling activity at the Thames area are considered to have been widely distributed in the local area over time, due to the high currents associated with this area of the North Sea. In addition, cuttings piles do not form generally within the southern North Sea due to the greater current strengths, and for the purposes of this study this has been assumed to be the case within the Thames area.

This is further supported by low barium levels detected at all stations (*Osiris, 2013*). There are no advisory contamination levels for barium, which is a relatively inert metal that is widely used in drilling muds to add weight, and can therefore be used as an indicator for possible contamination by drilling activities (including cuttings piles). However, the distribution of barium at between 6 and 36 ppm suggests that there are no 'hot spots' and likely results from wider drilling activities followed by natural dispersal in the southern North Sea region (*Osiris, 2013*).

Conclusions

Due to the high energy environment at the Thames Area, no cuttings piles are expected at any of the decommissioning locations. Therefore, the residual impact to the seabed from cuttings piles disturbance is expected to be negligible.

The residual impact of the disturbance of any drill cuttings is considered to be Negligible

6.1.5 The Deployment of Drilling Rig Spud Cans

As discussed in Section 2.10, all of the wells will be plugged and abandoned in accordance with Oil and Gas UK (OGUK) Guidelines. The decommissioning of all but five wells will be undertaken by using a jack-up drilling rig. The final rig selection process is yet to take place, however it is anticipated that a rig such as the Ensco 80 will be used (refer to Section 2.10.1).

Prior to drilling activities starting, the drilling rig legs need to be jacked down onto the seabed with the hull raised on the legs above the water, providing a stable platform. Excessive penetration by the legs into a soft seabed is prevented by large round feet called spud cans, at the bottom of the legs.

As the legs are pulled out they may leave scars and / or sediment mounds. Seabed disturbance caused by the penetration of these legs into the seabed will be influenced by:

- The nature of the seabed sediments; and
- The prevailing sediment transport system in the vicinity of the well locations.

The depth of penetration of the legs will be dependent on the shear strength and load bearing capacity of the seabed soils; a firm seabed will result in less depth of penetration than a soft seabed. Post-disturbance recovery of the seabed is dependent both on the strength of the seabed soils and the ability of the hydrological regime to rework disrupted sediments and return the seabed to its original contours. Physical disturbance as a result of leg penetration can cause mortality or displacement of benthic species in the impacted zone, direct loss of habitat and direct mortality of sessile seabed organisms that cannot move away from the contact area at seabed contact points. Several factors minimise these impacts:

- Biological communities are in a continual state of flux and are able to either adjust to disturbed conditions or rapidly recolonise areas that have been disturbed;
- The area has already been exposed to oil and gas exploitation of the seabed as well as being subjected to historical benthic trawling, therefore historic disturbance has already taken place;
- No sensitive species or Annex I habitats of conservation importance were identified around the proposed drilling rig locations;
- The mobile nature of the seabed sediments in the southern North Sea area will aid the rapid recovery of the disturbed areas, although some seabed scars may persist in the medium term.

Spud-cans typically have a diameter of 18 metres and therefore three spud-cans will disturb an area of seabed of approximately 775 square metres to a depth of 0.5 metres, directly below the rig. Once the rig has moved off station, it is expected that the indentations of the spud cans will naturally fill in with sediment.

Mitigation Measures

- Perenco will actively seek to position the drilling rig in as few separate locations as is possible during decommissioning. This will reduce the number of instances that jack-up spud cans will be deployed on the seabed.

Conclusions

The deployment of jack-up spud cans will pose an impact to the localised seabed, through disturbance and smothering. However, the residual impact is expected to be minor, as the area has already been exposed to oil and gas exploitation of the seabed; there are no sensitive species or Annex I habitats of conservation importance identified around the proposed drilling rig locations and the mobile nature of the seabed sediments in the southern North Sea area will aid the rapid recovery of the disturbed areas.

The residual impact of the drilling rig spud cans on benthic communities and the seabed sediments is considered to be Minor

6.1.6 Drilling Rig Stabilisation (Rock Dumping)

The seabed currents in the southern North Sea have been known to cause scouring (displacement of sediments) around structures placed on the seabed (*DECC, 2009*). This sediment movement can cause destabilisation of the sediments and the structures in place. Once the drilling rig is on location, there may be a requirement for the jack-up legs and spud cans to be stabilised by the placement of rock to maintain the integrity of the legs in place and prevent scouring. This may be required at each of the field hubs (depending on the nature of the seabed in those areas). If rock dumping is required, it is estimated that a maximum of 1,000 tonnes of rock would be needed per leg / spud can (totalling 3,000 tonnes of rock) at each of the proposed well decommissioning locations. It is estimated by Perenco that there could be a maximum of 12 (twelve) separate well decommissioning locations where the rig would need to be sited. Although unlikely, if rock dumping was required at every location that the rig was sited at, this would equate to a maximum of 36,000 tonnes of rock required.

Once the rock is deposited, it will become an integral component of the seabed around the decommissioned well locations. Over time, the bare rock will be colonised with benthic organisms that favour a hard substratum. The rock dumping operations will have a localised impact on the local sediment faunal communities, potentially smothering any flora and fauna directly beneath it. Once *in situ*, the area beneath the rock would therefore become unavailable for recolonisation by soft sediment inhabiting infauna, and over time a new rocky habitat would become established. Taxa likely to colonise such a hard substratum could include tunicates, sponges, sessile tube-dwelling polychaetes (*Sabella* spp. (fanworms)) and encrusting organisms such as bryozoans. The recolonisation of such substratum is likely to be rapid given the coarse sediments in the area and the presence of other epifaunal organisms found during the site survey (*CMACS, 2013*). Other seabed structures and stabilisation materials placed on the seabed within the Thames complex have been found to be buried over time, with some buried and exposed areas being colonised by epifaunal species (*CMACS, 2013*).

The use of rock for scour prevention measures is considered unlikely, particularly given that during previous well interventions using a jack up drilling rig, no stabilisation material was required. However, if it is required, the amount of rock placed on the seabed will be minimised as far as practicable and it will be placed as close to the spud cans as possible to reduce the area of seabed to be impacted.

Mitigation Measures

- Perenco will actively seek to minimise the amount of rock required for rig stabilisation.

Conclusions

In conclusion, although the placement of rocks on the seabed will impact the benthic organisms, these effects will be highly localised in nature and therefore will only have a minimal impact on the wider marine environment in the area. In addition to this, no stabilisation material was required for the more recent well intervention activities at the Thames complex and therefore it is not an expected requirement.

The residual impact of rock dumping around the drilling rig spud cans on benthic communities and the seabed is considered to be Minor

6.1.7 Remedial Actions to Address Pipeline Exposures

Based on the outcomes of the Comparative Assessment workshop, it was decided that the most economical, technically feasible and the option with least environmental disturbance, would be to leave the pipelines, MEG lines, umbilicals and stabilisation material *in situ* (*Perenco, 2014*). As discussed in Section 2.4, some of the lengths of the pipelines, MEG lines and umbilicals have become exposed over time (*Osiris, 2013*). Therefore, some areas of the lines may require additional remediation in the future. This can be achieved by one of three methods, using rock dumping material in order to prevent further scouring around free spans, reburial using jetting or removal of the exposure sections. All three methods will impact the seabed to varying degrees. However, it is considered highly unlikely that any free spans will develop in flooded pipelines.

The total length of pipelines, flowlines and umbilicals that are exposed within the Thames decommissioning area equates to approximately 10 kilometres in length, all of which may require stabilisation material, reburial or removal.

At the time of writing this EIA, the exact method of remediation for any exposed parts of the pipelines is not known. If rock dumping is chosen as the remedial method, the amount of stabilisation / protection materials that may be required to be deployed over the pipeline is unknown. Therefore, the specific amounts will be detailed in a deposit of materials on the seabed consent (DEPCON) application.

The rock placement operations will have a localised impact on the local sediment faunal communities, potentially smothering any flora and fauna directly beneath it. Once *in situ*, the area beneath the rock would therefore become unavailable for recolonisation by soft sediment inhabiting infauna, and over time a new rocky substrate habitat would become established. Taxa likely to colonise such a hard substrate could include tunicates, sponges, sessile tube-dwelling polychaetes (*Sabella* spp. (fanworms)) and encrusting organisms such as bryozoans.

Mitigation Measures

- Perenco will actively seek to minimise the amount of rock required for pipeline stabilisation.

Conclusions

In conclusion, although the placement of concrete mattresses and spot rock dump material on the seabed will impact the benthic organisms, these effects will be highly localised in nature and therefore will only have a minimal impact on the local marine environment.

The residual impact of concrete mattress activities on benthic communities and the seabed is considered to be Minor

6.2 Summary of Mitigation Measures

- Subsea infrastructure removal methods (including the removal of concrete mattresses) will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed;
- Perenco will actively seek to minimise the amount of rock required for rig stabilisation;
- Perenco will actively seek to minimise the amount of mattresses and grout bags required for pipeline stabilisation.

7 The Impact from Noise and Vibration

7.1 Assessment of Potentially Significant Impacts

7.1.1 Overview

Sound is used by many marine organisms to perceive information about their surrounding environment and it can play a vital part in their survival (*Richardson et al., 1995; OSPAR, 2009*).

Anthropogenic sound sources in the marine environment are of particular concern, especially where exposure thresholds and pressure thresholds for marine organisms are exceeded and the frequencies generated overlap within their hearing range (*OSPAR, 2009*).

Noise and vibration generated by offshore activities can impact some groups of marine organisms. Some of the extreme affects include physical injury and hearing impairment (when marine organisms are in close proximity to the sound source), masking, and various levels of behavioural disturbance (both direct and indirect) (*LGL, 2009*). For individual animals, such effects and their secondary consequences may vary in significance from negligible to fatal (the worst outcome being documented in a small number of cases (*MMC, 2007*)).

The decommissioning activities associated with the Thames Area Project generate noise both above and below the sea surface. Section 3.3.5 identities the marine organisms likely to be present in the vicinity of the Thames area and therefore these identified organisms could be impacted by the noise generated from the planned operations. The potential for effects on marine fauna is dependent upon the magnitude and frequency of the generated sound.

7.1.2 Regulatory Regime

Offshore Marine Regulations

Under regulations 41(1)(a) and (b) of the Conservation (Natural Habitats & c.) Regulations 1994 (as amended) and 39(1) (a) and (b) in the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (Amended 2010) (referred to as the Offshore Marine Regulations, OMR), is an offence to:

a) Deliberately capture, injure or kill any wild animal of a European Protected Species (EPS); and

b) Deliberately disturb wild animals of any EPSs in such a way that is likely to:

    i. Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or in the case the case of animals of a hibernating or migratory species, to hibernate or migrate;

    ii. Affect significantly the local distribution or abundance of the species to which they belong.

Consequently, the JNCC released a guidance document entitled The Protection of Marine European Protected Species from Injury and Disturbance (*JNCC, 2010c*) to enable operators to conform to the requirements of the Natural Habitats and OMR regulations. The JNCC guidance defines precautionary noise exposure thresholds for injury and behavioural responses based on the work by Southall *et al.* (*2007*).

The EPS include all cetaceans, turtles and sturgeon. In UK waters turtles and sturgeon are at the limits of their global distributions (which are centred elsewhere in the west Atlantic or Europe) and only occur in extremely low numbers around the UK. It is extremely unlikely that these animals would be present, or that their local abundance or distribution could be significantly affected by marine impacts (*JNCC, 2008c*).

European Marine Strategy Framework Directive

European Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC) includes measures to assess underwater sound in their qualitative descriptors for determining good environmental status (GES).

As part of the proposed requirements of this Directive, Member States may have to report on the occurrence and distribution of activities within their jurisdictions that generate 'loud, low and mid' frequency impulsive sounds that exceed levels capable of causing significant impact to marine animals. However, current EC guidance does not provide any specific levels of sound that are deemed capable of causing a 'significant impact' to marine animals, so there remains considerable flexibility in how this can be interpreted by Member States.

In the absence of any clear guidance as to the peak sound and exposure levels that are considered capable of causing significant impact to marine life, it was recommended in a study by Genesis Oil and Gas Consultants (2011) to DECC that oil and gas activities that produced sound in excess of the levels deemed capable of inducing a Temporary Threshold Shift (TTS) in hearing of cetaceans using the Southall *et al*. (2007) impact exposure criteria, were likely to qualify for reporting requirements (*Genesis, 2011*).

7.1.3 Sound Transmission

In general, sound can be characterised with reference to two features, the frequency at which it is emitted, measured in hertz (Hz), and the strength or intensity of the sound, measured in decibels (dB).

Not all sounds move through the ocean in the same way, high frequency sounds generally attenuate more quickly than low frequency sounds: a 100 Hz sound may be detectable after travelling hundreds or even thousands of kilometres, whereas a 100 kilohertz (kHz) sound may travel for only a few kilometres (*Swan et al., 1994; MMC 2007*).

The magnitude of the sound manifests itself as pressure, i.e. force acting over a given area. It is expressed in terms of 'sound pressure levels' (expressed as decibels relative to 1 micro-Pascal (dB re. 1µPa)), which use a logarithmic scale of the ratio of the measured pressure to a reference pressure. The logarithmic nature of the scale means that a reduction of 6 decibels is equivalent to the halving of the physical sound pressure received (*OSPAR, 2009*).

The spherical spreading of sound waves from a source with limited energy results in a logarithmic decline in noise due to the sound wave being distributed over a larger area at greater distances (*OSPAR, 2009*).

However, attenuation losses, resulting from physical processes in the ocean (e.g. sound absorption or scattering by organisms in the water column, reflection or scattering at the seabed and sea surface, and the effects of temperature, pressure, stratification and salinity), can distort mathematical spreading laws. This is more prevalent in shallow water (<200 metres deep), where sound can be reflected by the sea floor and/or water surface, therefore sound transmission is far more complex (*OSPAR, 2009*). Consequently, actual sound transmission has considerable temporal and spatial variability that is difficult to quantify. Various models have been identified which best fit the attenuation of sound with distance from its source for different conditions Swan *et al.* (*1994*) suggest that, depending on the propagation conditions, the attenuation is between 3-6 dB per doubling of distance from the source.

A simple sound propagation model has been used to estimate the sound attenuation at the Thames Decommissioning Area Project. The model has been generated from the following sound attenuation equation from Richardson *et al*. (1995):

$$\textbf{Transmission Loss} = 20\text{Log}(R/R_0)\ \text{dB}$$

Spherical spreading is assumed.
R_0 = the reference range, usually 1 metre, and R = the distance from the reference range.

This provides a measure of sound given to a reference distance, usually one metre. This method provides a conservative estimate of sound propagation with distance as it struggles to extrapolate sound attenuation in the near field (within tens of metres of the noise source due to interference between sound waves and reverberation which the model does not incorporate) and therefore generally overestimates transmission of sound from the source. This is sufficient to examine a 'worst case' scenario for noise impacts on marine fauna.

7.1.4 Thames Area Decommissioning Noise and Vibration Sources

The proposed Thames Decommissioning activities will generate noise below the sea surface, as the equipment on board the jack-up drilling rig is used. This noise will be generated from machinery vibrations, power generators and from the propeller movements of vessels associated with the proposed decommissioning operations. Cutting techniques will be required to sever the platform jackets from the legs and will also be required to remove other piled structures from the seabed, including the WPS and templates.

Noise will also be generated as equipment is removed from the seabed and as seabed stabilisation material (rock dumping) is placed on the seabed. The noise generated from these sources is likely to be negligible compared to the noise sources assessed in the following sections (*Nedwell & Edwards, 2004*).

Decommissioning Activities using both a Drilling Rig and Super Heavy Lift Vessel (SHLV)

The drilling rig and the SHLV will provide the greatest noise sources from vessels. Noise from drilling will arise as the drill bit penetrates the wellhead and also as various plugs and equipment are pulled from the well. Jack-up drilling rigs generally produce less noise than semi-submersible drilling rigs (*LGL, 2009*), which have their hull in constant contact with the water. Therefore, the noise generated on board the vessel from machinery, hydraulic pumps, power generation etc. is transmitted directly into the water.

Typical subsea noise levels from offshore decommissioning operations and expected natural attenuation are shown in Table 7.1.

Table 7.1: Typical Noise Levels Associated with Offshore Operations and Their Natural Attenuation (adapted from: *Evans & Nice, 1996; Richardson et al, 1995*)

Activity	Frequency range (kHz)	Average source level (dB re 1µPa @ 1m)	Estimated received level at different ranges by spherical spreading (dB re 1µPa-1m)			
			0.1 km	1 km	10 km	100 km
High resolution geophysical survey; pingers, side-scan	10 to 200	<230	190	169	144	69
Low resolution geophysical seismic survey; seismic air gun	0.008 - 0.2	248	210	144	118	102
			208	187	162	87
Vertical Seismic Profiling	0.005 - 0.1	190	150	129	104	29
Production drilling	0.25	163	123	102	77	2
Jack-up drilling rig	0.005 - 1.2	85 - 127	45 - 87	24 - 66	<41	0
Semi-submersible rig	0.016 - 0.2	167 - 171	127 - 131	106 - 110	81 - 85	6 - 10
Drill ship	0.01 - 10	175 - 191	139 - 151	118 - 130	93 - 105	18 - 30

Activity	Frequency range (kHz)	Average source level (dB re 1μPa @ 1m)	Estimated received level at different ranges by spherical spreading (dB re 1μPa-1m)			
			0.1 km	1 km	10 km	100 km
Large merchant vessel	0.005 - 0.9	160 - 190	120 - 150	99 - 129	74 - 104	<29
Super tanker	0.02 - 0.1	187 - 232	147 - 192	126 - 171	101 - 146	26 - 71

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

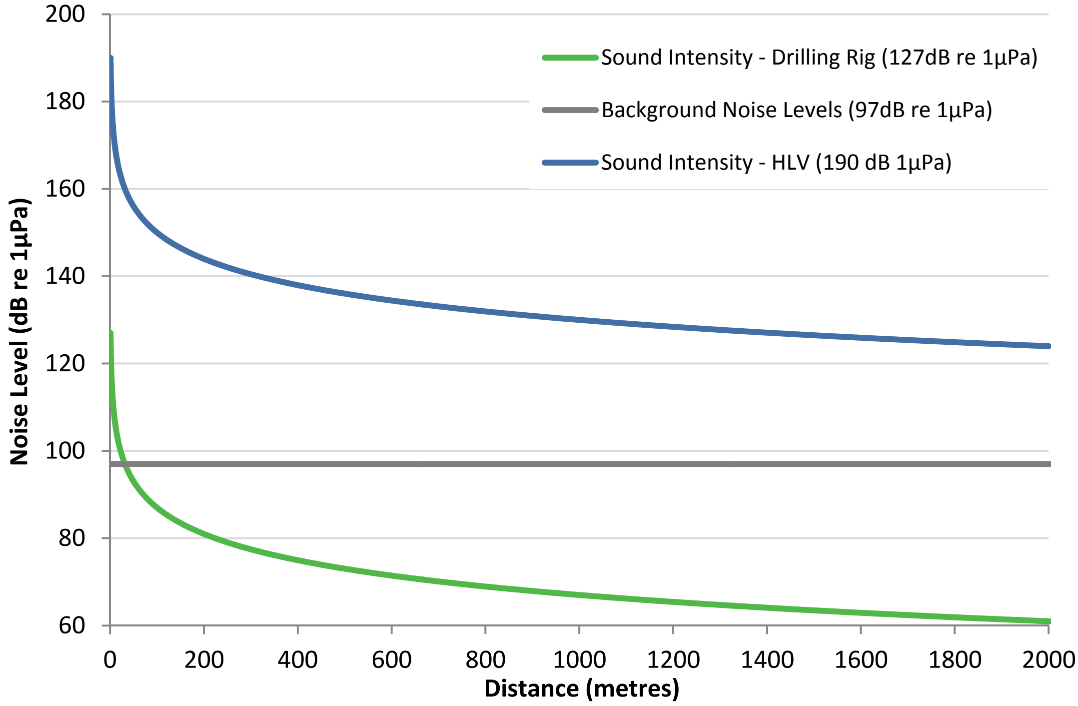
Average sound levels produced from a typical jack-up drilling rig are between 85-127 dB re. 1μPa @ 1 metre (*Richardson et al., 1995*). As a 'worst case' assessment, a source noise level of 127 dB re. 1μPa was used to represent the noise energy generated from a Jack-up drilling rig (*Richardson et al., 1995*) for sound attenuation during the Thames Decommissioning operations (Figure 7.1). Ship noise is generated through; propeller cavitation (*Richardson et al., 1995*) as bubbles generated on the propeller collapse as the propeller spins (*Genesis, 2011*), vibration of machinery and engines and from other machinery. The drilling rig will be on location for an estimated 480 days and therefore there will be a prolonged period of impact from the noise produced. However, the drilling rig will move to different well locations during this 480 day period and therefore the prolonged impact from noise will not be localised on one area. The maximum duration that the drilling rig will be in one location will be 78 days.

The size of the vessel has an influence on the type of noise generated. Larger vessels require larger propulsion systems and have a greater area of the hull in contact with the surface water and therefore noise transmitted through the water column is greater compared to smaller vessels. Larger vessels also tend to emit lower frequency noises which travel further in the water column (*Genesis, 2011*). In addition, some of the vessels that will be used to support the decommissioning operations (including the SHLV) will maintain their position by using thrusters when carrying out operations (known as Dynamically Positioned (DP) vessels), particularly when close to the platforms. Typically these vessels tend to generate more noise and of a higher frequency than a vessel's main engines (up to 170 dB). The SHLV will be used to remove the Thames and the Horne & Wren platform, jackets, topsides, the WPS and other subsea structures across the Thames area. It is anticipated that the SHLV will be on location for 112 days and may require the use of DP thrusters throughout. Noise levels of 190 dB re 1μPa have been used as an estimate of the expected noise levels from a SHLV, based on the characteristics of a large merchant vessel in Table 7.1 (*Richardson et al., 1995*). This value also coincides with noise levels from vessels described by Genesis (2011) and is also greater than the levels produced by DP vessels. It is important to note however, that these noise levels are taken for a SHLV in transit, which is when the greatest noise levels are emitted. Noise levels throughout the majority of the operations are likely to be lower and more in line with those of DP vessels, however this modelling therefore represents a 'worst case' scenario.

Routine helicopter trips may be required for crew transfer on the drill rig and on the SHLV. However, noise from routine helicopter flights will have little impact underwater, with studies indicating that noise levels from helicopters are generally below those significant for marine mammals (*Richardson et al., 1995*).

Modelling of the noise produced by the SHLV and drilling rig was conducted using a simple spherical noise spreading model. The results demonstrated that at 100 metres, noise levels from the jack-up drilling rig will be attenuated to approximately 87 dB re. 1μPa (assuming spherical spreading) and will reach background noise levels (97 dB re. 1μPa) within 30 metres of the source (Figure 7.1). Noise levels from the SHLV will be attenuated to approximately 150 dB re. 1μPa at 100 metres but will not reach background levels within two kilometres.

Figure 7.1: Sound Propagation in Water for a Typical Jack-up Drilling Rig and SHLV (assuming spherical spreading)



Noise Generated by Cutting and Explosive Techniques

In order to sever the piles of the Thames (DP1) and Horne & Wren (DP2) platforms from their jackets and remove the WPS and templates from the seabed, cutting techniques will be employed. Piles will be cut to three metres below the seabed. The final methodology detailing the cutting techniques is yet to be defined, however there are two main severance techniques; using a cutting tool such as a grit cutter, or by the use of explosives. One or both of these methods may be employed during the Thames area decommissioning activities. Explosives are often included as a contingency in the event that other mechanical severance methods are unsuccessful as they provide a quick and reliable way to detach structures that are firmly anchored or are difficult to access (*Genesis, 2011*).

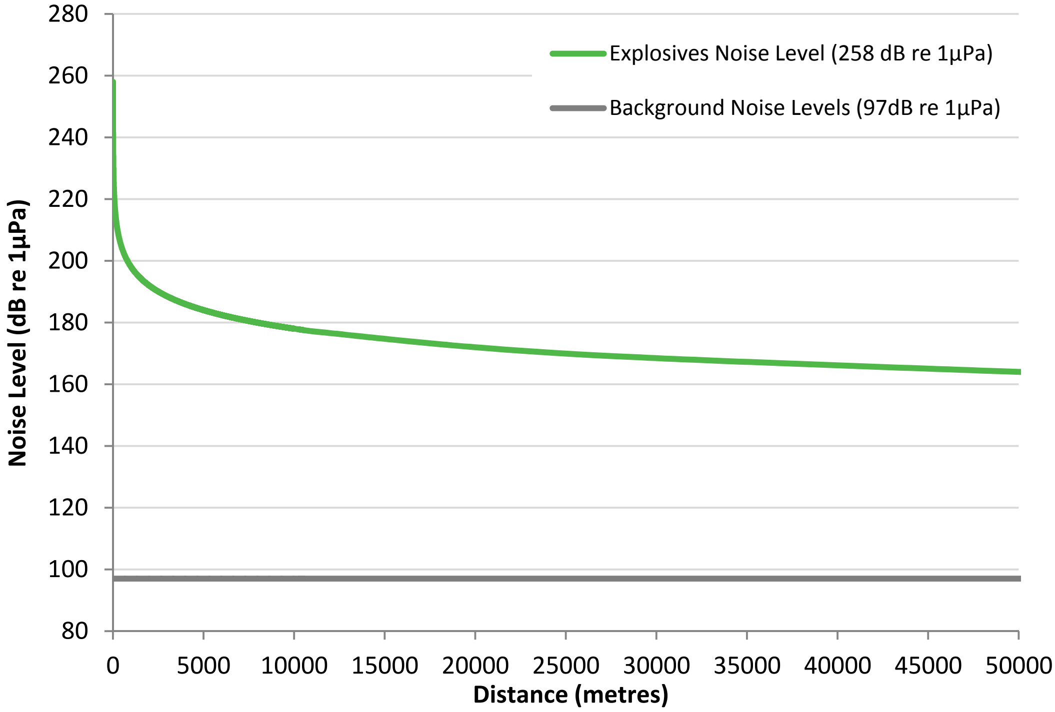
Cutting explosive charges include linear shaped charges which use high velocity energy to accelerate a v-shaped band of cutting material, usually a metal such as copper, in a high velocity jet that penetrates through the material (*Genesis, 2011*), in this case, the piles. Explosive sources produce broadband frequencies with very high peak source levels. In general, explosives are placed within or resting on the structure that is to be decommissioned and this is often below the seabed. This changes the pressure wave and therefore the way the sound is transmitted. The noise source levels from explosive detonations are some of the largest sounds generated by anthropogenic activities. Underwater explosions have the capacity to cause injury and, in extreme cases, death to marine fauna. This arises not only from the high peak pressure sound levels, but also from the initial shock wave that is emitted when charges are detonated (*Genesis, 2011*).

The decommissioning of wellheads in the North Sea has provided information on the acoustic signatures of explosives used. The highest recorded sound pressure level was 232 dB (0-peak) re 1µPa recorded at 300 metres for a 45 kilogram charge detonation (*Nedwell, 2001* In *Genesis, 2011*). The low frequency energy emitted has the ability to travel considerable distances where it may continue to have an impact on marine fauna with detection ranges likely to be beyond 50 kilometres (*Thomsen & Schack, 2013*).

No recorded noise levels from cutting equipment are available in the literature. The closest available noise values to subsea cutting equipment are available for a cutter suction dredger (CSD) which uses a rotating cutter head to loosen material in the seabed and then uses a suction mouth to remove material from the seabed. These vessels are estimated to produce noise levels of approximately 140 dB re 1µPa at 200 metres (*Genesis, 2011*). Therefore the noise emissions from explosives have been used as a 'worst case'.

Noise levels associated with the detonation of explosives have been estimated at 258 dB re. 1µPa at 1 metre based on previous decommissioning activities undertaken by Perenco at the Welland field. Based on the sound propagation method in Section 7.1.3, the noise levels will attenuate to 218 dB re. 1µPa within 100 metres of the source and 204 dB re. 1µPa within 500 metres from the source. Noise levels remain above 190 dB re. 1µPa within 2.3 kilometres of the noise source (Figure 7.2). It is therefore evident that noise levels of this magnitude have the capacity to travel long distances through the water column.

Figure 7.2: Sound Propagation in Water for an Explosive Charge (assuming spherical spreading)



The use of explosives is subject to EIA and noise modelling as well as requiring prior approval from DECC, therefore both methods of severance have been assessed here as a contingency. In addition, if it is likely that explosives will be used, a separate Decommissioning Explosives Noise Assessment for a Marine License will be produced, which will describe the type, weight and location of the charges, the proposed timings of operations and a full impact assessment for the use of explosives.

7.1.5 Potential Noise Impacts on Plankton

Fish eggs and invertebrate larvae are considered part of the plankton (meroplankton; species which spend a portion of their life cycle, usually the juvenile stage, passively drifting in the water column). Studies on the effects of noise on larval fish and invertebrate populations indicate that any effect is very small when compared to total population sizes, mortality rates or events such as storms, cyclones or shifts in normal oceanographic patterns (*Swan et al., 1994*). Due to the potential noise sources from explosives, there will be mortality of plankton species within the vicinity of the explosives. However, any removal of plankton from an area due to noise will be short-term with any animals removed quickly replaced due to the rapid turnover and short generations of this group of organisms.

7.1.6 Potential Impacts on Fish

Fish have a lateral line (acoustico-lateralis) system which can detect sound, vibrations and other displacements of the water in the fishes' environment (*Moyle & Cech, 2004*). Fish are highly sensitive to the particle motion of the sound wave, at low frequencies (<100 Hz) this is the component that fish are most sensitive to (*Thomsen & Schack, 2013*). At higher frequencies the pressure wave colliding with the gas filled spaces, such as the swimbladder, causes an increase in the particle motion stimulating the inner ear. Therefore species with a connection between the swimbladder and the inner ear, such as clupeid fish (herring), are most sensitive to the pressure component of the noise.

Many fish use sound for communication and predator avoidance, and therefore also have the capacity to detect sounds themselves. Disruption to the noise generating and hearing organs may therefore impact species communication and survival.

Explosive activities have been linked to the death of fish during the decommissioning of oil and gas platforms, with injuries to fish documented to distances of 100 metres from the blast site (*Thomsen & Schack, 2013*).

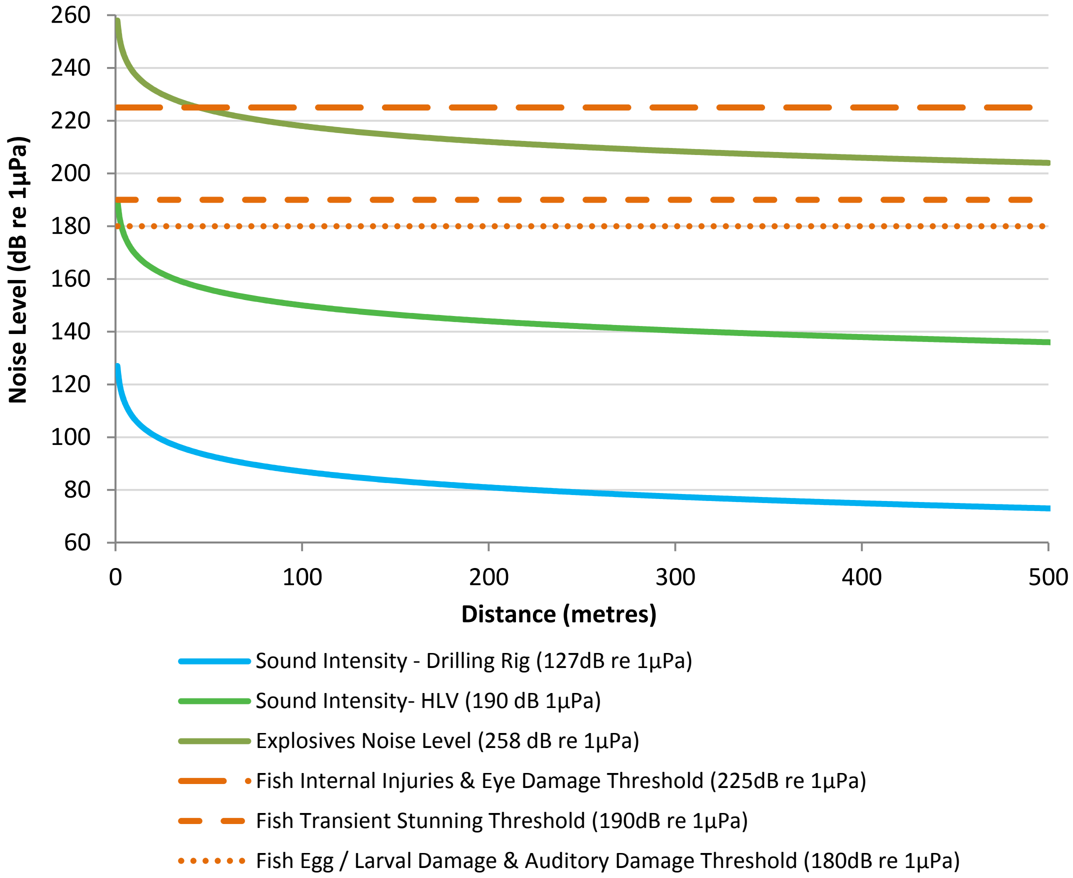
Turnpenny & Nedwell (1994) established a set of injury and behavioural thresholds for fish which are shown alongside the expected noise sources for the proposed decommissioning operations in Figure 7.3. This shows that noise levels from the explosives will exceed thresholds for internal injuries and eye damage to fish (225 dB re. 1µPa) within 47 metres of the noise source. Thresholds for transient stunning (190 dB re. 1µPa) and egg/larval and auditory damage (180 dB re. 1µPa) will be exceeded out to a distance of 2.4 kilometres and 7.5 kilometres from the noise source respectively. Therefore the use of explosives has the potential to cause physical injury to fish and fish eggs/larvae out to a significant distance from the charge location.

Due to the large range that the Thames decommissioning area covers, several species of fish have been identified as utilising the area as spawning and nursery grounds (refer to Section 3.3.3). Disturbance and injury to fish aggregations during spawning events can have an impact on the population dynamics and can lead to a loss of habitat due to the disturbance. However, the noise from explosives is a short term impact, which is usually over in a matter of seconds.

The period of lowest spawning activity is between September and November (refer to Table 3.10). Therefore by undertaking operations which may require the use of explosives within this period, the potential impact on fish populations may be reduced.

If explosives are not used, the greatest noise source will be from the SHLV. Noise levels from the SHLV movements will exceed thresholds for fish egg/larval damage and auditory damage (180 dB re. 1µPa) within three metres of the noise source. However the vessel will not be in transit during the majority of operations, therefore these noise levels represent a 'worst case scenario'. The noise may initiate a startle response from fish species but evidence has shown that fish will habituate to this type of sound from vessels and drilling rigs (*Westerberg, 1999*). Noise from the jack-up drilling rig will is not expected to exceed any injury criteria for fish, even at the source (Figure 7.3). Therefore the movements of the SHLV, including the use of DP thrusters, and the drilling activities are not expected to have a significant impact on local fish populations.

Figure 7.3: Sound Pressure Level Thresholds for the Onset of Fish Injuries from the Proposed Decommissioning Activities (after *Turnpenny & Nedwell, 1994*)



7.1.7 Potential Impacts on Marine Mammals

Marine mammals are especially sensitive to noise in the marine environment. Their extensive use of sound for communication, prey capture, predator avoidance and navigation, and the possession of large gas-filled organs, make them vulnerable to both disturbance and physiological damage from underwater noise of a sufficient magnitude. Identifying these effects, and the levels of sound which may induce them, has been the subject of considerable research; extensive reviews are provided by Richardson *et al*. (*1995*), Nowacek *et al*. (*2007*), Southall *et al*. (*2007*) and Weilgart (*2007*). Additionally, reviews of marine mammals in UK waters in contribution to previous SEA document have addressed the issue of noise (e.g. *Hammond et al. 2006, 2008*).

Research conducted by Southall *et al*. in 2007 has produced a comprehensive review of the impacts of underwater noise on marine mammals and proposed criteria for preventing injury based on both peak sound levels and Sound Exposure Level (SEL).

The noise exposure thresholds proposed by Southall *et al.* (*2007*) are segregated according to the functional hearing capabilities of different marine mammal groups, and the different categories and features of the typical anthropogenic sounds in the ocean.

Based on current knowledge of functional hearing in marine mammals, *Southall et al*. (*2007*) defined five distinct, functional hearing categories:

1. low-frequency cetaceans (i.e., mysticetes – baleen whales);
2. mid-frequency cetaceans (i.e., most odontocetes – toothed whales);
3. high-frequency cetaceans (e,g., harbour porpoises);

4. pinnipeds in water; and
5. pinnipeds in air.

Table 7.2 categorises the cetaceans identified in Section 3.3.7, which may be present within the Thames decommissioning area, into the functional hearing categories proposed by Southall *et al*. (*2007*).

Table 7.2: Functional Marine Mammal Hearing Categories of Marine Mammal Species Which May Be Present in the Vicinity of the Thames Decommissioning Area (*Reid et al., 2003*) and their Associated Auditory Bandwidth and Group-Specific (M) Frequency-Weightings (*Southall et al., 2007*)

Functional Hearing Categories	Estimated Auditory Bandwidth[1]	Species Which May Be Present	Frequency-Weighting Network
Low-frequency cetaceans	7 Hz to 22 kHz	Minke whale	M_{lf}
Mid-frequency cetaceans	150 Hz to 160 kHz	White-beaked dolphin	M_{mf}
High-frequency cetaceans	200 Hz to 180 kHz	Harbour porpoise	M_{hf}
Pinnipeds in water	75 Hz to 75 kHz	Grey seal, Common seal	M_{pw}
Pinnipeds in air	75 Hz to 30 kHz	Grey seal, Common seal	M_{pa}

[1] Estimated Lower to Upper Frequency Hearing Cut-Off
Note: Lf: low-frequency cetacean; mf: mid-frequency cetaceans; hf: high-frequency cetaceans; pw: pinnipeds in water; pa: pinnipeds in air.

In terms of the different categories and metrics of anthropogenic sounds in the ocean, Southall *et al.,* (*2007*) identified three types of sound, single pulse, multiple pulse and non-pulse. Table 7.3 describes the acoustic characteristics of each of these sound types and also indicates the types of activities that may generate each of these sounds.

The activities associated with the jack-up drilling rig, which will be used during the well decommissioning, and also the noise from the SHLV operations will be classified as non-pulse noise. The use of explosives is categorised as single pulse or multiple pulse noise, depending on whether it is a single explosion or sequential explosions within a short period, based on the criteria set out by Southall *et al.* (2007) (Table 7.3).

Table 7.3: Sound Types, Acoustic Characteristics and Examples of Anthropogenic Sound Sources (*Southall et al., 2007*)

Sound Type	Acoustic characteristics (at source)	Examples
Single pulse	Single acoustic event; > 3-dB difference between received level using impulse vs equivalent continuous time constant	Single explosion; sonic boom; single airgun, watergun, pile strike, or sparker pulse; single ping of certain sonars, depth sounders, and pingers
Multiple pulses	Multiple discrete acoustic events within 24 h; > 3-dB difference between received level using impulse vs equivalent continuous time constant	Serial explosions; sequential airgun, watergun, pile strikes, or sparker pulses; certain active sonar (IMAPS); some depth sounder signals
Non-pulses	Single or multiple discrete acoustic events within 24 h; <3-dB difference between received level using impulse vs equivalent continuous time constant	Vessel/aircraft passes; offshore drilling; many construction or other industrial operations; certain sonar systems (LFA, tactical mid-frequency); acoustic harassment/deterrent devices; acoustic tomography sources (ATOC); some depth sounder signals.

7.1.8 Marine Mammals Injury Thresholds

Southall *et al.* (2007) define the minimum exposure criterion for injury as the level at which a single exposure is estimated to cause the onset of permanent hearing loss (Permanent Threshold Shift; PTS).

The injury Sound Pressure Level (SPL) threshold for all three cetacean frequency groups to the three sound types (Table 7.4) is 230 dB re. 1µPa (0-peak), however beaked whale species may require special injury criterion. While, the injury Sound Pressure Level threshold for pinnipeds in water is lower at 218 dB re. 1µPa (0-peak) (Table 7.4).

Table 7.4: Injury Criteria for Cetaceans and Pinnipeds exposed to "discrete" Noise Events (Either Single or Multiple Exposures within a 24 Hour Period) (*Southall et al., 2007*)

Marine Mammal Group	Sound Measure[1]	Sound type		
		Single pulse	Multiple pulse	Non-pulse
Low-frequency cetaceans	Sound Pressure Level	230	230	230
	Sound Exposure Level	198	198	215
Mid-frequency cetaceans	Sound Pressure Level	230	230	230
	Sound Exposure Level	198	198	215
High-frequency cetaceans	Sound Pressure Level	230	230	230
	Sound Exposure Level	198	198	215
Pinnipeds (in water)	Sound Pressure Level	218	218	218
	Sound Exposure Level	186	186	203

[1] Sound Pressure Level in dB re. 1µPa (0-peak); Sound Exposure Level in dB re. 1µPa^2-s (species weighted)
Note: All criteria in the "Sound pressure level" lines are based on the peak pressure known or assumed to elicit TTS-onset, plus 6 dB. Criteria in the "Sound exposure level" lines are based on the SEL eliciting TTS-onset plus (1) 15 dB for any type of marine mammal exposed to single or multiple pulses, (2) 20 dB for cetaceans or pinnipeds in

water exposed to non-pulses, or (3) 13.5 dB for pinnipeds in air exposed to non-pulses. See text for details and derivation.

7.1.9 Marine Mammals Behavioural Response Thresholds

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. This is because behavioural responses to anthropogenic sound are dependent upon operational and environmental variables, and on the physiological, sensory, and psychological characteristics of exposed animals. It is important to note that the animal variables may differ (greatly in some cases) among species and even within individuals depending on various factors (e.g., sex, age, previous history of exposure, season). However, within certain similar conditions, there appears to be some relationship between the exposure Received Level and the magnitude of behavioural response. Southall *et al.* (2007) graded the severity of context-specific behavioural responses to noise exposure, as follows (Southall *et al.,* 2007 for full response descriptions):

- No observable response to a relatively minor and/or brief response, score 0-3;
- A higher potential to affect feeding, reproduction, or survival, score 4-6; and
- Considered likely to affect their life functions, with the potential to cause panic and avoidance behaviour, score 7-9.

Non-trivial disturbance, as in regulation 39(1A)(a) of the OMR, is interpreted for the purposes of this report as the sustained or chronic disruption of behaviour scoring 5 or more in the Southall *et al.* (2007) behavioural response severity scale. Table 7.5 details the sound levels which induce behavioural reactions in cetaceans that score 5 or more on the Southall *et al.* (2007) behavioural response scale.

Table 7.5: Proposed Behavioural Response Criteria for Cetaceans and Pinnipeds Exposed to Different Sound Types (*Southall et al., 2007*)

Marine Mammal Group	Sound Measure[1]	Sound Type		
		Single Pulses	Multiple Pulses[2]	Non-pulses[2]
Low-Frequency Cetaceans	Sound Pressure Level	224	110-180 (BRS = 5-7)	90-150 (BRS = 6-7)
	Sound Exposure Level	183	n/a	n/a
Mid-Frequency Cetaceans	Sound Pressure Level	224	120-180 (BRS = 6)	90-200 (BRS = 5-8)
	Sound Exposure Level	183	n/a	n/a
High-Frequency Cetaceans	Sound Pressure Level	224	80-170 (BRS = 6)	80-170 (BRS = 6)
	Sound Exposure Level	183	n/a	n/a
Pinnipeds (in Water)	Sound Pressure Level	212	160-200 (BRS = 6)	100-110 (BRS = 6)
	Sound Exposure Level	171	n/a	n/a

[1] peak Sound Pressure Level in dB re. 1µPa (0-peak); Sound Exposure Level in dB re. 1µPa^2-s (species weighted)
[2] BRS is the Behavioural Response Score, on the Southall *et al.* (2007) behavioural response severity scale, for the given Sound Pressure Level

7.1.10 Marine Mammal Response to Source Level (i.e. 'Worst Case') and Received Level

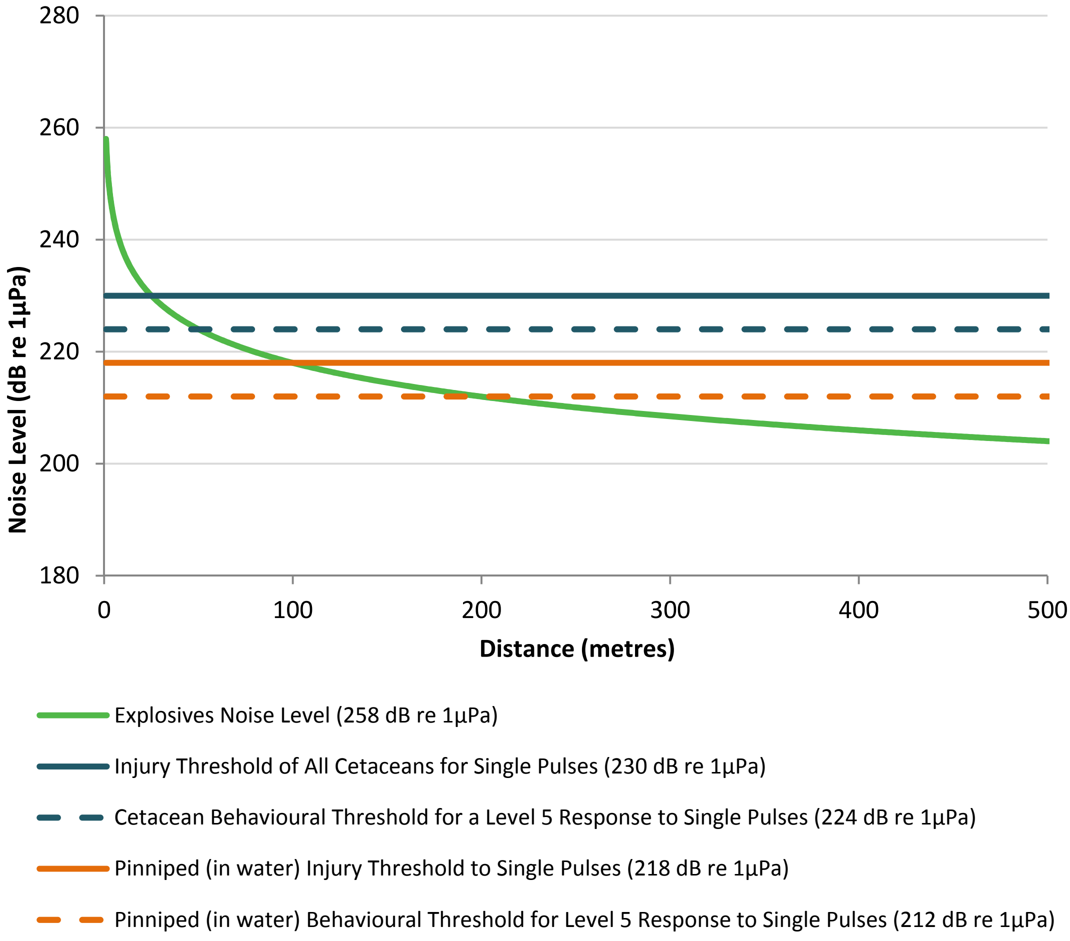
If explosives are used to sever the subsea piles, these will provide the greatest noise energy from the proposed decommissioning operations, with noise levels up to 258 dB re. 1µPa at 1 metre (refer to Section 7.1.4). This has therefore been considered as the 'worst case' scenario in terms of the sound that may be generated. The use of explosives may be required.

As the final decommissioning programme is yet to be defined, explosives may not be required. In this case the greatest noise levels would arise from the movement of the SHLV at around 190 dB re. 1µPa. Therefore the potential impact on marine mammals from the use of explosives, the movement of the SHLV and use of the jack-up drilling rig, have all been assessed. As discussed in Section 7.1.4, if explosives are required for the Thames decommissioning activities, a separate EIA will be undertaken to determine the impact of the use of explosive on the marine environment and submitted in support of a Marine Licence application.

Explosive noise will be the dominant pulsed noise source associated with the proposed decommissioning activities with noise levels of up to 258 dB at source. This will therefore exceed cetacean injury thresholds within 24 metres of the noise source and injury thresholds to pinnipeds in water within 95 metres of the noise source (Figure 7.4). Behavioural response to this noise may be elicited by cetaceans within 50 metres of the noise source and by pinnipeds within approximately 200 metres of the noise source (Figure 7.4).

There will therefore be a danger to marine mammals within these radii from the noise source. In the event that explosives are not required, the dominant noise sources from decommissioning will be of a lower intensity and will be classified as non-pulsed (Figure 7.4).

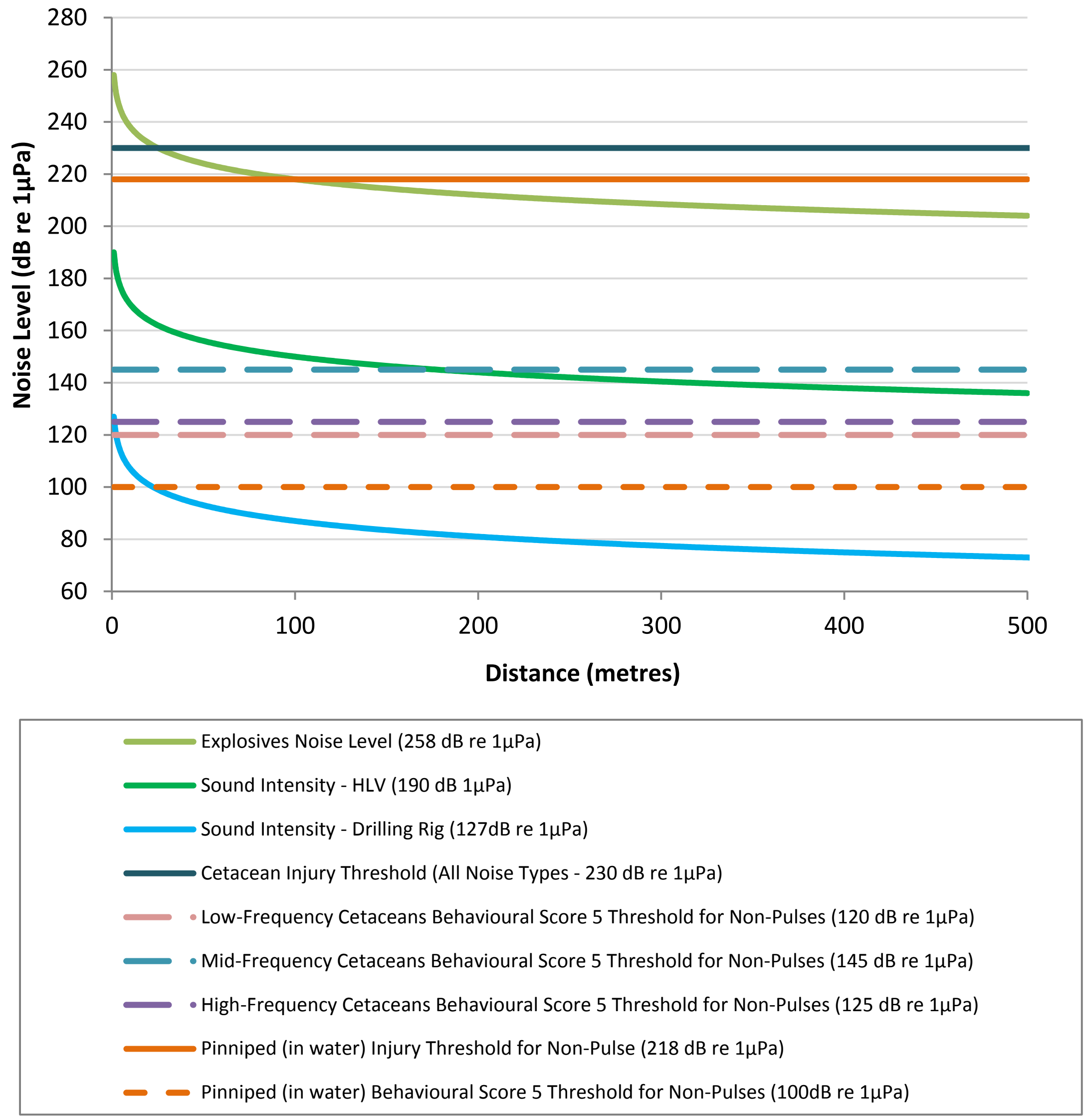
Figure 7.4: Average Sound Pressure Level Thresholds for Injury and Behavioural Response Scores of 5 or more in Cetaceans Exposed to Different Noise Types (after *Southall et al., 2007*) and the Sound Propagation in Water (assuming spherical spreading).



It is anticipated that the SHLV will be the dominant non-pulse sound source associated with the Thames decommissioning operations and will generate approximately 190 dB at source (worst case noise). The jack-up drilling rig will also produce non-pulse sound of a lower magnitude (127 dB) In addition the drilling noise generated by large vessels such as this, and also drilling rigs, is generally of low frequency (*Nedwell & Edwards, 2004*).

Therefore, it is unlikely that the noise produced at source by the SHLV / jack-up drilling rig will exceed the non-pulse injury sound pressure level threshold for cetaceans (230 dB re. 1µPa (0-peak)) or pinnipeds in water (218 dB re. 1µPa (0-peak)), which may be present in the vicinity (Figure 7.5).

Figure 7.5: Average Sound Pressure Level Thresholds for Injury and Behavioural Response Scores of 5 or more in Cetaceans Exposed to Non-Pulsed Noise (after *Southall et al., 2007*) and the Sound Propagation in Water (assuming spherical spreading).



Note: Cetacean behavioural thresholds for a response scoring 6 on the Southall *et al.* (*2007*) severity scale are an average of the lowest Sound Pressure Level range for each sound type in Table 7.5. Therefore rough indications of the decibel level at which these thresholds occur and will vary between marine mammal groups.

It is likely that noise generated from drilling and SHLV activity will exceed the behavioural Sound Pressure Level response thresholds for a grade 5 response for cetaceans and Pinnipeds, which may be present in the vicinity (Table 7.2). It is of note that dolphins and other odontocetes have been reported to show considerable tolerance of drilling rigs and support vessels (*Richardson et al., 1995*).

Examples of behaviour displayed by free-ranging subjects listed under a grade 5-6 response are (*Southall et al., 2007*):

- Minor or moderate individual and/or group avoidance of sound source;
- Brief or minor separation of females and dependent offspring;
- Aggressive behaviour related to noise exposure (e.g. tail/flipper slapping, fluke display, jaw clapping/gnashing teeth, abrupt directed movement, bubble clouds);
- Extended cessation or modification of vocal behaviour;
- Visible startle response;
- Brief cessation of reproductive behaviour.

Table 7.6 provides a summary of which sound pressure thresholds are expected to be exceeded by the proposed decommissioning operations.

Table 7.6: Summary of Cetacean and Pinniped Sound Pressure Level Threshold Exceedance by the Noise Generated at Source by the Proposed Decommissioning Activities at source

Marine Mammal Group	Threshold[1]	Activity		
		Explosives	SHLV	Drilling
Low-Frequency Cetaceans	Behavioural (BRS 5+)	Exceeds	Exceeds	Exceeds
	Injury	Exceeds	Never exceeds	Never exceeds
Mid-Frequency Cetaceans	Behavioural (BRS 5+)	Exceeds	Exceeds	Never exceeds
	Injury	Exceeds	Never exceeds	Never exceeds
High-Frequency Cetaceans	Behavioural (BRS 5+)	Exceeds	Exceeds	Exceeds
	Injury	Exceeds	Never exceeds	Never exceeds
Pinnipeds (in water)	Behavioural (BRS 5+)	Exceeds	Exceeds	Exceeds
	Injury	Exceeds	Never exceeds	Never exceeds

[1] 'BRS +5' = Behavioural Response Score of 5 or more, on the Southall *et al.* (2007) behavioural response severity scale. According to the JNCC a noise inducing a response score of 5 or more in marine mammals constitutes a 'non-trivial' disturbance.

Behavioural changes are expected to occur several kilometres from the source of explosives. However, for the other noise sources, the impacts will not be as significant. Behavioural effects may be observed in some species due to the movements of the SHLV, however injury criteria are not exceeded. The drilling and SHLV activities are considered to be sources of 'non-trivial' disturbance because they are likely to induce a behavioural response scoring 5 or more, on the Southall *et al.* (*2007*) behavioural response severity scale.

However, it is important to note that, source levels are measured at or calculated to 1 metre distance from the sound source and that due to the physics of how sound travels through water (spherical spreading assumed) and the resulting transmission losses, the area which will experience sound pressure levels above the threshold for a behavioural response scoring 5 or more in marine mammals will be relatively small and therefore very few individuals are likely to be adversely affected. This is particularly true for explosives which are often placed at or within the seabed where attenuation is likely to be greater than what is modelled.

Marine mammal abundance is generally lower within the Thames decommissioning area compared to other areas of the North Sea. The most abundant and frequently sighted cetacean in the North Sea, the harbour porpoise is generally a coastal species with a strong affinity for shallow waters and therefore could spend time in the vicinity of the Thames decommissioning operations. However this species is more likely to be found closer to the coast.

Currently, decommissioning activities are likely to occur throughout the year. Based on observations by Reid *et al*. (2003), no species have been recorded in the area in October and November and the density of harbour porpoises is low from December to February. Harbour porpoise abundance is greatest during June and July, the minke whale has only been recorded during June and white beaked dolphins have been recorded between March and May, with peak observations during April (*Reid et al., 2003*). If at all possible, Perenco will strive to avoid the use of explosives during these periods.

Table 7.7 estimates the numbers of cetaceans which could potentially experience 'non-trivial' behavioural disturbance (scoring 5 or more, on the Southall *et al.* (*2007*) scale) as a result of the decommissioning activities.

Table 7.7: Estimated Number of Cetaceans That Could Potentially Experience 'Non-Trivial' Behavioural Disturbance (Scoring 5 or more on the *Southall et al., 2007* Scale) as a Result of the Decommissioning Activities (assumes spherical spreading)

Species	Estimated Density in the Thames Area (animals/km^2)[1]	Marine Mammal Hearing Group	Numbers of Animals That May Experience Behavioural Disturbance[2]		
			Explosives	SHLV	Drilling
Harbour porpoise	0.562	High-frequency	0.0041	3.9340	0
Minke whale	0.0224	Low-frequency	0.00016	0.6274	0
White-beaked dolphin	0.0031	Mid-frequency	0.00002	0.00027	0
White-sided dolphin	0.0026	Mid-frequency	0.00002	0.00023	0

[1] Source: SCANS II (*2008*) data – Survey area U – Central North Sea South.
Note that no white-sided dolphin were recorded based on Reid *et al*. (2003)
[2] Calculation method based on Southall *et al.* (2007), as recommended by JNCC (*2010*): Area around the activity with potential to injure or disturb marine mammals multiplied by the individual species density for that area of the UKCS.

In summary, the use of explosives may have the capacity to cause injury to marine mammals and it is also likely that the use of explosives may elicit a behavioural response in marine mammals within a considerable distance from the noise source. Therefore fish and mammals may experience some noise induced effects during the Thames decommissioning activities. If explosives are not used, the impacts on marine fauna are likely to be reduced and the radius of impact for all species will be lower.

As previously discussed, if explosives are required a separate EIA will be produced, once their use has been more sufficiently designed. This will help determine the time of year, the expected noise levels, the number of charges required and the locations to fully assess the impact of the use of explosives on marine organisms.

7.2 Summary of Mitigation Measures

- In order to minimise any potential impact on marine cetaceans from the proposed Thames Area Decommissioning operations (excluding the use of explosives), Perenco will seek to conform to the JNCC protocol for minimising the risk of disturbance and injury to marine mammals from underwater noise throughout operations;
- Vessel movements and the use of DP thrusters will be minimised where possible to reduce the potential impacts on marine mammals;
- Vessel movements will be minimised;
- Perenco will also adhere to the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives at all times and where appropriate;
- Strive to avoid undertaking explosive activity during periods of known peak cetacean abundance;
- Use of trained Marine Mammal Observers (MMOs) to identify if there are any vulnerable cetaceans in the vicinity of the explosive source. It is recommended that a one kilometre radius mitigation zone be set up around the explosion source. If marine mammals are sighted within this area, operations should be ceased / halted until they have left the area at a safe distance;
- Use of Passive Acoustic Monitoring (PAM), in conjunction with MMOs, to determine the presence of cetaceans in high sea states, poor visibility, during low light conditions and to identify those which may not surface regularly enough to be sighted;
- Use the minimum amount of explosive required to achieve the task based on sound planning and engineering;
- Implement a 'soft start' procedure whereby small amounts of explosives are used to scare fish and marine mammals from the vicinity.

7.3 Conclusions

Although there could be significant impacts from the noise generated during the Thames Area Decommissioning activities, it is expected that these impacts could be minimised by implementing the above mitigation measures.

In summary, it is likely that all marine mammals and fish present in the immediate vicinity of the Thames Area Decommissioning location (during operations) will be subject to some sound induced effects, however it is unlikely that these effects will result in injury unless they are within very close proximity of the noise source.

The residual impact of noise generated from the Thames Area Decommissioning activities is considered to be Minor

8 The Impact of Atmospheric Emissions and Energy Balance

8.1 Assessment of Potentially Significant Impacts

8.1.1 Decommissioning Emissions from Operations

Atmospheric emissions will be generated during the decommissioning activities and waste processing of the Thames area infrastructure. These mainly will be from:

- Power generation for the drilling rig and associated support vessels (including helicopter trips);
- Power generation from the SHLV and associated support vessels; and
- Power generation from the DSV and associated support vessels.

The emissions give rise to polluting gases including carbon dioxide (CO_2), oxides of nitrogen (NOx), sulphur dioxide (SO_2) and unburned hydrocarbons. Please note that all calculations have been based on the maximum period that the vessels will be on location. Table 8.1 shows the estimated atmospheric emissions generated during the Thames area decommissioning activities.

8.1.2 Regulatory Regime

Atmospheric emissions generated by decommissioning activities are covered by the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended).

Table 8.1: Predicted Atmospheric Emissions Generated During the Thames Area Operational Decommissioning Activities

Gas[1]	Drilling Rig Use				SHLV				DSV (tonnes)[8]	Rock Dumping Vessel (tonnes)[9]	Total (tonnes)
	Drill Rig[2] (tonnes)	Standby Vessel[2] (tonnes)	Supply Vessel[2] (tonnes)	Helicopter Trips[3] (tonnes)	SHLV[4] (tonnes)	Supply Vessel[5] (tonnes)	Guard Vessel[6] (tonnes)	Heavy Barge (tonnes)[7]			
Carbon dioxide	15,360.0	15,360.0	15,360.0	574.08	10,752.0	3,584.0	1,075.2	3,584.0	18,240.0	640.00	**84,529.3**
Carbon monoxide	75.4	75.4	75.4	0.93	52.8	17.6	5.3	17.6	89.5	3.14	**413.1**
Oxides of nitrogen	285.1	285.1	285.1	2.24	199.6	66.5	20.0	66.5	338.6	11.88	**1,560.6**
Nitrous oxide	1.1	1.1	1.1	0.039	0.7	0.2	0.1	0.2	1.3	0.04	**5.9**
Sulphur dioxide	19.2	19.2	19.2	0.72	13.4	4.5	1.3	4.5	22.8	0.80	**105.6**
Methane	0.9	0.9	0.9	0.0156	0.6	0.2	0.1	0.2	1.0	0.04	**4.9**
Volatile organic chemicals	9.6	9.6	9.6	0.144	6.7	2.2	0.7	2.2	11.4	0.40	**52.5**

Notes:
[1] Emission factors used from EEMS Atmospheric Emissions Calculations (*DECC, 2008*)
[2] Rig is estimated to consume at 10 tonnes fuel/day, standby / supply vessel at 10 tonnes fuel/day, all for 480 days duration
[3] Based on 2 helicopter trips per week over 480 days (ca. 68 weeks) at 1.3 tonnes of fuel per return trip
[4] SHLV is estimated to consume at 30 tonnes fuel/day for 112 days in duration
[5] SHLV supply vessel estimated to consume 10 tonnes fuel/day for 112 days duration
[6] SHLV Guard vessel estimated to consume 3 tonnes fuel/day for 112 days
[7] Heavy barge estimated to consume 10 tonnes fuel/day for 112 days
[8] DSV estimated to consume 30 tonnes fuel/day for 190 days
[9] Rock dumping vessel estimated to consume 10 tonnes fuel/day for 20 days

It is anticipated that these types of emissions will disperse rapidly under most conditions to levels approaching background within a few tens of metres of their source.

This is shown by a simple dispersion model to predict the concentration of some of the key gases in the air at various distances from the Thames area decommissioning project (Table 8.2). The model assumes spherical spreading of atmospheric gases, under calm atmospheric conditions.

Table 8.2: Contribution of Predicted Combustion Gases to Atmospheric Concentrations (µg / m³) spreading during Thames Area Decommissioning Operational Activities

Gas[1]	1 km	2 km	5 km	10 km	20 km	50 km
Carbon dioxide	2,732.2	1,934.9	658.44	252.76	85.615	27.937
Carbon monoxide	13.4	9.5	3.23	1.24	0.420	0.137
Oxides of nitrogen	50.7	35.9	12.22	4.69	1.589	0.519
Sulphur dioxide	3.4	2.4	0.82	0.32	0.107	0.035
Methane	0.2	0.1	0.04	0.01	0.005	0.002
Volatile organic chemicals	1.7	1.2	0.41	0.16	0.054	0.017

Notes:
[1] Emission factors used from EEMS Atmospheric Emissions Calculations (*DECC, 2008*)

8.1.3 Decommissioning Emissions and Energy Balance from Processing of Materials

Power generation and energy will be required to recycle and / or process the decommissioned materials that will be removed from the Thames decommissioning area.

Table 8.3 gives an estimation of the energy required to recycle the materials against the production of new materials.

Table 8.3: Estimated energy use (GJ) required during recycling and manufacture from new common materials that will be recovered during the Thames Area Decommissioning Project

Material	Total Tonnage Note 1	Recycling		Manufacture from New	
		Energy Required (GJ / tonne)	Total Energy Required (GJ)	Energy Required (GJ / tonne)	Total Energy Required (GJ)
Steel	14,664	9	131,976	25	366,600
Copper	62	25	1,550	100	6,200
Plastic	50	20	1,000	105	5,250
Concrete / Cement	4,629 Note 2	N/A	-	1	4,629
Total			**138,291**		**382,679**

Note:
[1] Only materials that will be removed and taken to shore have been included
[2] Based on a 'worst-case' impact assessment scenario of removal of all 426 concrete mattresses

Table 8.4 shows the estimated gas emissions (CO_2, NO_x and SO_2) that would be generated from recycling and producing from new, the removed Thames area decommissioning materials.

The atmospheric calculations in Table 8.4 show that recycling the common decommissioning materials that will be removed from the Thames area, will result in reduced gas emissions (CO_2, NO_x and SO_2) being emitted to the atmosphere. This will therefore have a reduced impact to air quality and greenhouse gas emissions.

Table 8.4: Estimated gaseous emissions from recycling and manufacture from new common materials that will be recovered during the Thames Area Decommissioning Project (*IoP, 2000*)

Material	Total Tonnage Note 1	Recycling						Manufacture from New					
		Gas Emissions Ratio (tonne of gas emitted / tonne of material)			Total Gaseous Emissions (tonnes)			Gas Emissions Ratio (tonne of gas emitted / tonne of material)			Total Gaseous Emissions (tonnes)		
		CO_2	NO_x	SO_2	CO_2	NO_x	SO_2	CO_2	NO_x	SO_2	CO_2	NO_x	SO_2
Steel Note 2	14,664	0.96	0.0016	0.0038	14,077	23	55	1.889	0.0035	0.0055	27,700	51	80
Copper Note 2	62	0.3	-	0.12	19	-	7	7.175	0.02	0.2	445	1	12
Plastic Note 3	50	0.693	-	-	35	-	-	3.179	-	-	159	-	-
Concrete / Cement Note 2	4,629 Note 4	-	-	-	-	-	-	0.88	0.0054	0.0001	4,073	25	0.4
		Total (tonnes)			**14,131**	**23**	**62**	**Total (tones)**			**32,377**	**77**	**92**

Note:
[1] Only materials that will be removed and taken to shore have been included
[2] IoP (2000)
[3] Harvey (2010) & DEFRA/DECC (2011)
[4] Based on a 'worst-case' impact assessment scenario of removal of all 426 concrete mattresses
No data is represented by a dash

8.1.4 Global Warming Potential of Atmospheric Emissions

Global Warming Potential (GWP) represents how much a given mass of a chemical contributes to global warming over a given time period compared to the same mass of carbon dioxide. Carbon dioxide's GWP is defined as 1.0 (*USEPA, 2013*). For example, the 100 year GWP of methane is 21, which means that if the same mass of methane and carbon dioxide were introduced into the atmosphere, methane will trap 21 times more heat than the carbon dioxide over the next 100 years.

The total predicted emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) generated from the Thames Area Decommissioning activities are displayed in Table 8.5 as GWP CO_2 equivalents, using factors from the International Panel on Climate Change (IPCC) (*IPCC, 2007*).

Table 8.5: The Global Warming Potential (GWP) for the Atmospherics Emissions Associated With the Thames Area Decommissioning (*IPPC, 2007*)

GWP[1]	CO_2	N_2O	CH_4
Thames Area Decommissioning Operational Activities	84,529	1,829	102
Thames Area Decommissioning Material Recycling	14,131	n/a	n/a

[1]Global warming potentials are only available for CO_2, N_2O and CH_4 – Nitrous oxide has a greenhouse warming potential that is 310 times greater than carbon dioxide and methane has a greenhouse warming potential that is 21 times greater than carbon dioxide.

A quantitative comparison between the predicted CO_2 emissions produced from the Thames Area Decommissioning activities and the local, regional and UK total emissions of CO_2 has been made in Table 8.6. It can be seen from this that although there will be a short-term increase in CO_2 emissions in the vicinity of the proposed decommissioning activities, the amount of CO_2 produced is small relative to the predicted UKCS Offshore emissions (ca. 2 percent) and the total UK emissions (<0.02 percent) over the proposed decommissioning activity period.

Table 8.6: The Estimated Carbon Dioxide Emissions from Thames Area Decommissioning Operational Activities

Location	Estimated CO_2 emissions over 480 days (tonnes)
Thames Area Decommissioning Operational Activities[1]	84,529
UKCS Platform Atmospheric Emissions for 2010[2]	4,019,701
UK Total[3]	722,235,610

Emission factors used from EEMS Atmospheric Emissions Calculations (*DECC, 2008*)
[1] All vessels expected to consume fuel as detailed in Table 8.1, over a maximum of 480 days
[2] Based on 480 days of 2010 total UK Offshore Facility Emissions (*DECC, 2011a*)
[3] Based on 480 days of total UK Emissions from 2011 data (*DECC, 2013*)

8.2 Summary of Mitigation Measures

Practical steps to limit atmospheric emissions that will be adopted during the decommissioning activities include:

- Advanced planning to ensure efficient operations;
- Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels;
- Speed of vessels will be managed to minimise fuel consumption;

- Generators will be running on the minimum power for the job task to avoid unnecessary emissions;
- Well maintained and operated power generation equipment; and
- Regular monitoring of fuel consumption;
- Licensed waste processing contractors will be chosen for the recycling of decommissioning materials.

8.3 Conclusions

Although there will be increased atmospheric emissions from the Thames Area Decommissioning activities and materials processing, the residual impact on air quality is expected to be minor.

The increase in greenhouse gas emissions are expected to disperse within a few kilometres from source. Given the distance from shore to the decommissioning operations (approximately 41 kilometres at the closest point) the impact from the increased atmospheric emissions from the decommissioning vessels / drilling rig are expected to be minor.

However, the increase in atmospheric emission could impact nearby protected areas, as many of them overlap with the Thames Area infrastructure. In addition, given that the distance to the transboundary line, between the UK and Netherlands, is only approximately 4 kilometres (at the closest point) there could be minor increases of the atmospheric greenhouse concentrations over the median line. However, due to atmospheric dispersion, the concentrations are expected to be minute over a few kilometres from source and therefore the transboundary impact is expected to be minor.

Given the distance to other existing oil and gas field developments in the vicinity of the proposed Thames Area Decommissioning, it is likely that there would be cumulative impacts resulting from atmospheric emissions. However, these impacts will be localised and also temporary (the duration of the decommissioning operations) in nature.

There will also be a temporary increase in onshore atmospheric emissions at the waste treatment facility, where the Thames Area Decommissioning materials will be processed. However, these emissions would be within the 'normal' operational atmospheric emissions generated at the waste treatment facility, through normal working / treatment processes. Therefore, although Perenco recognise that the onshore processing of decommissioning materials will result in increased atmospheric emissions, the impact from these is expected to be minor. In addition, the recycling of the common materials requires less energy and produces less atmospheric emissions, when compared to producing the same weight of the new material.

The residual impact of atmospheric emissions from the Thames Area Decommissioning activities is considered to be Minor

9 The Impact of Marine Discharges

9.1 Assessment of Potentially Significant Impacts

9.1.1 Regulatory Regime

The discharge of cementing and other offshore chemicals is covered by the Offshore Chemicals Regulations 2002 (as Amended 2011). The planned discharge of any hydrocarbons is covered under the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).

9.1.2 Well Abandonment and Cementing Activities

All of the twenty two (22) wells that are to be decommissioned in the Thames Area will be plugged and abandoned in accordance with Oil and Gas UK Guidelines for the suspension and abandonment of wells.

The exact abandonment methodology, including chemical and cement programmes, is yet to be finalised. These will be fully detailed and risk assessed in a future chemical permit application for each individual well. Perenco is aware that the discharge of any of the chemicals used will be subject to a monitoring regime and will comply with the conditions stipulated on the chemical permit award.

All chemicals discharged will meet the requirements of the Offshore Chemicals (Amendment) Regulations 2011. In the UK this falls under the Offshore Chemical Notification Scheme (OCNS), which is administered by DECC using scientific and environmental advice from CEFAS and the Marine Scotland (MS) Marine Laboratory.

It is expected that the vast majority (by volume) of chemicals utilised in the cementing programs will have an OCNS category of either ‘Gold’ or ‘E’ (and will be naturally occurring products (e.g. barite and bentonite) that are either biologically inert or readily dispersible or biodegradable. Prior to cementing chemicals selection being finalised, a risk assessment is carried out on all cementing chemicals that are discharged and remain down-hole. The risk assessment takes into account a number of factors including environmental profile of the chemicals, chemical effectiveness and environmental, health and safety (EHS) risks. At the time of writing this EIA, it is not expected that large volumes of chemicals would be discharged when plug and abandoning the wells. For the purposes of this EIA assessment, it is assumed that all cementing chemicals will be discharged at a volume approximately equivalent to 10 percent of their use. The exception to this is for those chemicals used as spacers / dyes, where the only way to prepare the space is to pit-mix them.

Mitigation Measures

- Prior to well abandonment activities, Perenco will undertake a chemical risk assessment as part of the chemical permit applications for each well;
- The mixing of cement offshore as needed;
- Any chemicals identified to be high risk will be substituted for more environmentally friendly alternatives where practicable;
- Perenco will actively seek to minimise the amount of cementing chemicals required.

Conclusions

In conclusion, the abandonment of the Thames Area Decommissioning wells will require the use and possible discharge of chemicals and cement. However, Perenco will undertake a chemical risk assessment to lower the residual impact of the chemicals on the marine environment, to as low as reasonably possible. Therefore, the residual impact from well abandonment and cementing activities is expected to be minor.

The residual impact from well abandonment discharges during the Thames Area Decommissioning is considered to be Minor

9.1.3 Pipeline Chemicals and Residual Hydrocarbons

As discussed in Section 2.1.1, all flowlines and umbilicals will be flushed prior to disconnection. Estimates of residual hydrocarbons and chemicals that may be retained in the flowlines, post flushing are shown in Table 9.1. The data in Table 9.1 is taken from engineering modelling, which predicts residual concentrations as a function of flow rates and velocities during flushing operations. The data are also supported by the experience of flushing Welland flowlines, in 2009, when samples were analysed. Samples from Thames flushing operations will be taken where possible.

Table 9.1: The estimated residual chemicals and hydrocarbons found in the flowlines that will be discharged

Installation well / Pipeline	Fluid Type	Volume (m^3)	Concentration (ppm)
Wissey	Hydraulic Fluid (Castrol Transaqua HT2)	1.39	n/a
	Hydrocarbons	0.01	39
Bure ‘O’	Hydraulic fluid (portable water)	4.9	n/a
	Hydrocarbons	0.01	42
Yare C	Hydraulic fluid (portable water)	2.3	n/a
	Hydrocarbons	0.005	42
Bure West	Hydraulic fluid (Aqualink)	4.7	n/a
	Hydrocarbons	0.01	38
Gawain	Hydraulic fluid (Aqualink)	15	n/a
	Hydrocarbons	0.035	40
Arthur	Hydraulic fluid (Aqualink)	44.9	n/a
	Hydrocarbons	0.085	44
Arthur JP1	Hydrocarbons	0	-
Arthur JP2	Hydrocarbons	0.005	48
Arthur JP3	Hydrocarbons	0.004	48
Thurne	Hydraulic fluid (Aqualink)	3.6	n/a
	Hydrocarbons	0.005	38
Orwell	Hydraulic fluid (Aqualink)	17.1	n/a
	Hydrocarbons	0.165	43
Horne & Wren	Hydrocarbons	0.034	43
Total Volume (m^3)		**94.2**	

On cutting the pipelines, there will be a release of chemicals and hydrocarbons to the environment.

The environmental risk of these chemicals being discharged is expected to be minor due to the low volumes expected and that they are both classed as 'poses little or no risk' (PLONOR) to the environment.

It is anticipated that any discharged condensate will be dispersed rapidly with the turbidity of the water and broken down through biodegradation processes. High dispersion of produced waters means that significant toxicity in the receiving waters has rarely been demonstrated (*Stagg et al., 1996*). Seabirds may be impacted by oily water on the sea surface; however this volume of condensate is not expected to persist on the sea surface for any significant time.

A variation to Thames' chemical permit to enable the umbilical inventory of MEG and methanol to be displaced into the flowlines and subsequently injected into the subsea or platform wells, has been submitted for DECC approval.

Mitigation Measures

- Perenco will actively seek to aim for an oil in water concentration from pipeline flushing of less than 30 milligrams per litre.

Conclusions

In conclusion, the flushing of the Thames Area Decommissioning umbilicals and pipelines will result in the discharge of chemicals and residual hydrocarbons. However, as the volumes involved are relatively small, the residual impact from any of the flushing activities is expected to be minor.

The residual impact from pipeline / umbilical flushing discharges during the Thames Area Decommissioning is considered to be Minor

9.1.4 Drainage Water, Food Waste, Sewage and Grey Water

Water generated from rig washdown and rainfall from the open deck areas may contain trace amounts of mud, lubricants and residual chemicals from small onboard leaks derived from activities such as re-fuelling of power packs or the laying down of dirty hoses or dope brushes etc. It should be stressed, however, that these would be relatively low volume discharges containing small residual quantities of contaminant. Perenco will ensure that the rig / vessels are equipped with suitable containment, treatment and monitoring systems as part of the contract specification. In addition, the Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels to minimise the amount of hydrocarbons and other contaminants entering the drainage systems. Liquid storage areas and areas that might otherwise be contaminated with oil are generally segregated from other deck areas to ensure that any contaminated drainage water can be treated or accidental spills contained. All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons (<15 parts per million hydrocarbons in water) as required under the MARPOL Convention and discharged to sea. Residual hydrocarbons will be routed to transit tanks for processing onshore.

The discharge of food waste, grey water and sewage to sea will cause transient organic enrichment of the water column and an increase in biological oxygen demand (BOD). This could lead to a minor increase in plankton and fish populations. Food waste is normally macerated to increase rates of dispersion and biodegradation. Black (sewage) and grey water (usually domestic chemicals from washing and laundry facilities on the drilling rig, stand-by / supply and installation vessels) is also collected, treated to meet the requirements of the MARPOL Convention and discharged to sea.

In addition to this, each vessel (including the drilling rig) will have a Garbage Management Plan in place and good housekeeping standards will be ensured. Where possible, the household products selected for use will have a low environmental impact.

Mitigation Measures

- Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels;
- Each vessel (including the drilling rig) will have a Garbage Management Plan in place;
- All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons;
- As part of the HSE Plan, Perenco will ensure that the drilling contractor knows how to react to spills, that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.

Conclusions

In conclusion, the residual impact from discharges of drainage, sewage and grey water is expected to be minor.

The residual impact from discharges of drainage, sewage and grey water are considered to be Minor

9.2 Summary of Mitigation Measures

- Prior to well abandonment activities, Perenco will undertake a chemical risk assessment as part of the chemical permit applications for each well;
- The mixing of cement offshore as needed;
- Any chemicals identified to be high risk will be substituted for more environmentally friendly alternatives where practicable;
- Perenco will actively seek to minimise the amount of cementing chemicals required;
- Prior to flushing activities, Perenco will undertake an environmental risk assessment as part of the chemical permit application;
- Perenco will actively seek to aim for an oil in water concentration from pipeline flushing of less than 30 milligrams per litre;
- Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels;
- Each vessel (including the drilling rig) will have a Garbage Management Plan in place;
- All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons;
- As part of the HSE Plan, Perenco will ensure that the drilling contractor knows how to react to spills, that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.

10 The Impact of an Unplanned Hydrocarbon Release

10.1 Regulatory Framework

Prior to decommissioning activities commencing at the Thames Area, an approved Oil Pollution Emergency Plan (OPEP) will be in place. This will be covered under the Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation Convention) Regulations 1998 and The Offshore Installation (Emergency Pollution and Control) Regulations 2002.

10.2 Assessment of Potentially Significant Impacts

It is Perenco's policy that operations will be conducted in such a manner as to minimise the risk of oil spillage and pollution. Onshore efforts in operations planning are subjected to review to identify potential risks and to ensure that they are properly controlled. These include:

- Programme review meetings (involving all contractors);
- Pre-job meetings to review the final programme in detail; and
- Hazard and risk identification to test the programme for likelihood and severity of all identified risks.

Perenco will ensure that appropriate oil spill response training is undertaken by key personnel within Perenco and relevant contractors (this will be fully detailed in the forthcoming Perenco Thames Area Decommissioning OPEP). Perenco fully recognises that spills can and do occur and takes precautions, as outlined in the section below, to reduce the possibility of a spill occurring.

The main spill risk from decommissioning activities will be from the diesel inventory of the drilling rig and other decommissioning vessels (i.e. SHLV).

The most frequently expected type of spill would be a small (< 1 tonne) spill of diesel or chemical from the rig during bulk transfer to/from the rig, leakage, or during use or storage. A worst case scenario in these activities would be the entire loss of fuel inventory from the drilling rig or SHLV.

Worst case spill scenarios are determined by the inventory (fuel capacity) of the drilling rig and the reservoir characteristics. For the Thames Area Decommissioning activities this amounts to:

- 18,700 cubic metres of diesel (i.e. the loss of the entire inventory of the SHLV;
- 890 cubic metres of diesel (i.e. the loss of the entire inventory of the drilling rig (e.g. the Ensco 70));
- 151 cubic metres of condensate (48.1˚ API) from the Thames Export Pipeline (PL370).

It is noted that spills of diesel are the most frequent type of spill on the UKCS, comprising 14.5 percent of UKCS spills by number and 3.5 percent of the total amount of oil spilt. Gas condensate spills are the least frequent, comprising 1.9 percent of the number of spills on the UKCS and 0.3 percent of the total amount of oil spilt.

10.3 Oil Spill Modelling

Based on the potential spill scenarios from the proposed Thames Decommissioning Programme, trajectory and stochastic oil spill modelling has been run using the Oil Spill Contingency and Response (OSCAR) model (version 6.2) developed by SINTEF to illustrate the fate and movement of the diesel and condensate in the marine environment.

A summary of the scenarios run and the results (i.e. the fate of the spilt condensate) is provided in Table 10.3. The outputs of the modelling are illustrated in Scenarios 1 to 24.

Worst case spill scenarios are determined by the inventory (fuel capacity) of the heavy life vessel and the reservoir characteristics (found within the Thames export pipeline). The total hydrocarbon inventory during Thames Decommissioning Programme is shown in Table 10.1.

Table 10.1: The Super Heavy Lift Vessel, Thames Pipeline and Drilling Rig – Inventory of Hydrocarbons

Source	Type of Oil	Maximum Quantity	Comment
Drilling Rig (i.e. Ensco 70)	Diesel (fuel oil)	890 m^3	Fuel oil
Super Heavy Lift Vessel (SHLV)	Diesel (fuel oil)	18,700 m^3	Fuel oil
Thames Export Pipeline (PL370)	Condensate (48.1˚ API)	151 m^3	The worst case scenario would be a pipeline rupture 5 kilometres from the Mean Low Water Mark (i.e. 100% of the pipeline contents).
Reservoir hydrocarbons during P&A of wells [Note 1]	Condensate (48.1˚ API)	Ca.<200 m^3 (less than 2 m^3 per day for 90 days [Note 2])	This would be a 'blow-out scenario where the well flow would be uncontrolled.

Note 1: Due to the low volumes expected in the case of a 'blow-out' scenario, this was not modelled as the diesel release would be a significantly larger volume and a heavier API hydrocarbon.]

Note 2: This would be estimated maximum time to bring the well under control, by the drilling of a relief well.

The two scenarios that could result in a large spill from the decommissioning activities are:

- An incident, such as collision, resulting in loss of containment from a pontoon; or
- Damage to the Thames export pipeline, resulting in a loss of condensate.

Table 10.3 shows the modelling parameters used. All model runs were done with a surface release of hydrocarbons. Figure 10.1 shows the locations of the spill modelling scenarios.

Please note that the nearest condensate type to that contained by the Thames export pipeline (PL370), in the OSCAR modelling database, was LAVRANS with an API of 47.8˚.

Table 10.2: Model Parameters Used During OSCAR Modelling

Feature	Parameter value used
Offshore wind direction	270° (towards Dutch transboundary line)
Onshore wind direction	65° (towards nearest UK landfall – Norfolk coastline)
Stochastic wind rose	Korevaar (1990) for the proposed drilling period
Sea temperature	10°C
Air temperature	10°C
Current and wind data	Southern North Sea wind data from 1990 (UK Met Office - in model) Southern North Sea current data from 1990 (UK MET Office - in model)

Figure 10.1: The locations of the Thames Area Decommissioning Oil Spill Modelling Scenarios (see Table 10.3 for details)

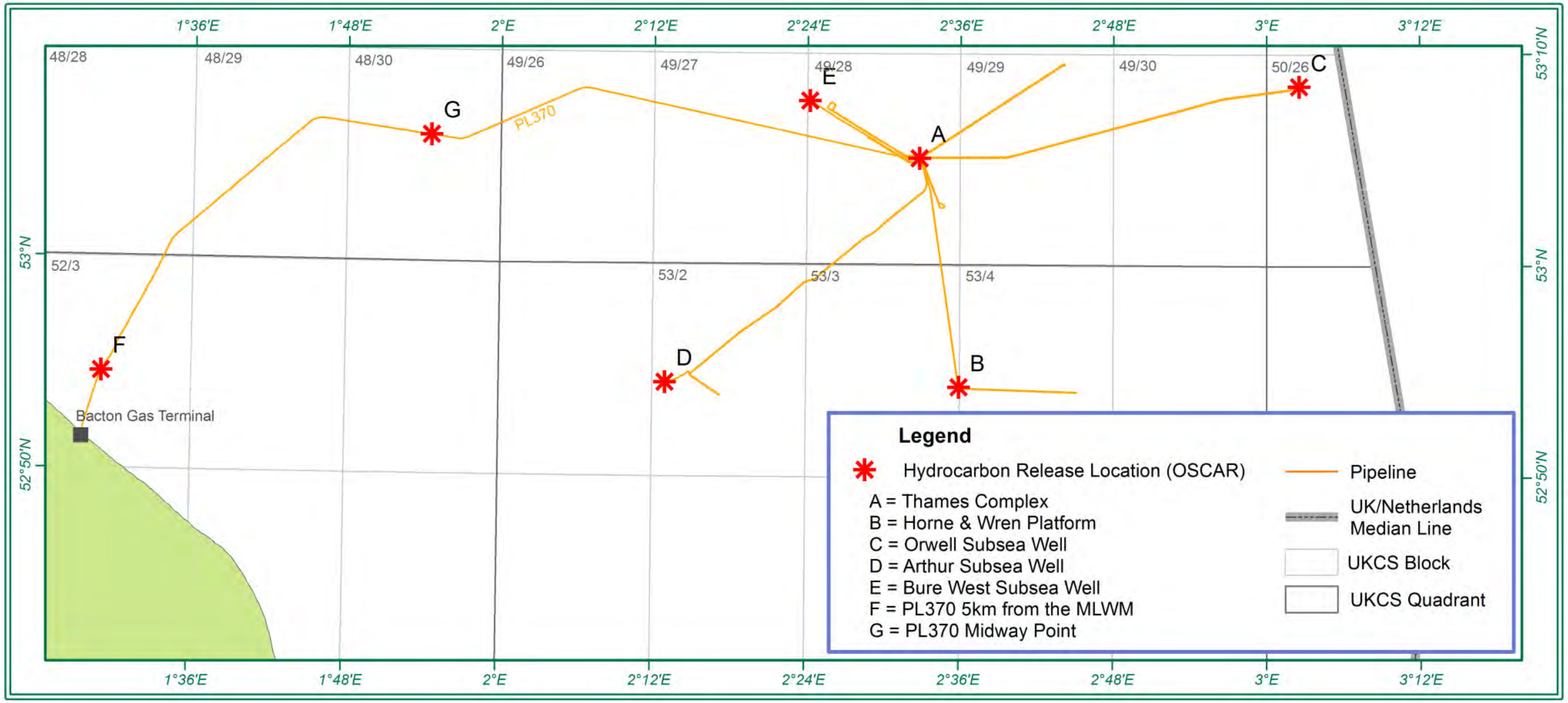


Table 10.3: Thames Decommissioning - Oil Spill Scenarios and Modelling Results Using OSCAR (version 6.2)

Scenario No	Location *	Oil Type	Spill Size	Model Duration (days)	Scenario	Wind Conditions	Fate of Spill Summary			
							Time to Disperse** (hours)	Potential to beach on a UK coastline	Potential to cross transboundary lines (TBL)	Potential to beach on an Int'l coastline
1	A	Diesel	18,700 m^3 (instantaneous)	10	SHLV Loss from fuel inventory	30 knot onshore wind	33	None	None	None
2						30 knot offshore wind	39	None	**UK/Netherlands TBL -** 33 hours after start of release.	None
3				20		Typical Conditions (Stochastic)	-	**England** - 5 % probability	**UK/Netherlands TBL** - 65 % probability	**Netherlands** - 5 % probability
4	B	Diesel	18,700 m^3 (instantaneous)	10	SHLV Loss from fuel inventory	30 knot onshore wind	33	None	None	None
5						30 knot offshore wind	36	None	**UK/Netherlands TBL** - 60 hours after start of release.	None
6				20		Typical Conditions (Stochastic)	-	**England** - 5 % probability	**UK/Netherlands TBL** - 60 % probability	**Netherlands** - 5 % probability
7	C	Diesel	890 m^3 (instantaneous)	10	Rig Loss from fuel inventory	30 knot onshore wind	30	None	**UK/Netherlands TBL** - 12 hours after start of release	None
8						30 knot offshore wind	21	None	**UK/Netherlands TBL** - 3 hours after start of release	None
9				20		Typical Conditions (Stochastic)	-	None	**UK/Netherlands TBL** - 43 % probability **Netherlands/Germany TBL -** <5 % probability	**Netherlands** - 5 % probability **Germany** – 0 % probability

Scenario No	Location *	Oil Type	Spill Size	Model Duration (days)	Scenario	Wind Conditions	Fate of Spill Summary			
							Time to Disperse** (hours)	Potential to beach on a UK coastline	Potential to cross transboundary lines (TBL)	Potential to beach on an Int'l coastline
10	D	Diesel	890 m^3 (instantaneous)	10	Rig Loss from fuel inventory	30 knot onshore wind	15	None	None	None
11						30 knot offshore wind	12	None	None	None
12				20		Typical Conditions (Stochastic)	-	None	**UK/Netherlands TBL** - 9 % probability	None
13	E	Diesel	890 m^3 (instantaneous)	10	Rig Loss from fuel inventory	30 knot onshore wind	15	None	None	None
14						30 knot offshore wind	24	None	None	None
15				20		Typical Conditions (Stochastic)	-	None	**UK/Netherlands TBL** - 15 % probability	None
16	F	Conde-nsate (47.8° API)	151 m^3 (1.57 m^3/hour for 4 days)	20	Release from PL370 5km from the MLWM	30 knot onshore wind	99	**England** – within 3 hours of the start of the release	None	None
17						30 knot offshore wind	99	**England -** 9 hours after of the start of the release	None	None
18						Typical Conditions (Stochastic)	-	**England** – 55% probability	**UK/Netherlands TBL** - 5 % probability	None

Scenario No	Location *	Oil Type	Spill Size	Model Duration (days)	Scenario	Wind Conditions	Fate of Spill Summary			
							Time to Disperse** (hours)	Potential to beach on a UK coastline	Potential to cross transboundary lines (TBL)	Potential to beach on an Int'l coastline
19	G	Conde-nsate (47.8° API)	76 m^3 (1.57 m^3/hour for 2 days)	20	Release from PL370 at midpoint	30 knot onshore wind	51	None	None	None
20						30 knot offshore wind	51	None	None	None
21						Typical Conditions (Stochastic)	-	None	**UK/Netherlands TBL** - 5 % probability	None
22	A	Conde-nsate (47.8° API)	15.1 m^3 (1.57 m^3/hour for 0.4 days)	20	Release from PL370 at the Thames Complex	30 knot onshore wind	33	None	None	None
23						30 knot offshore wind	12	None	None	None
24						Typical Conditions (Stochastic)	-	None	**UK/Netherlands TBL** - 13 % probability	None

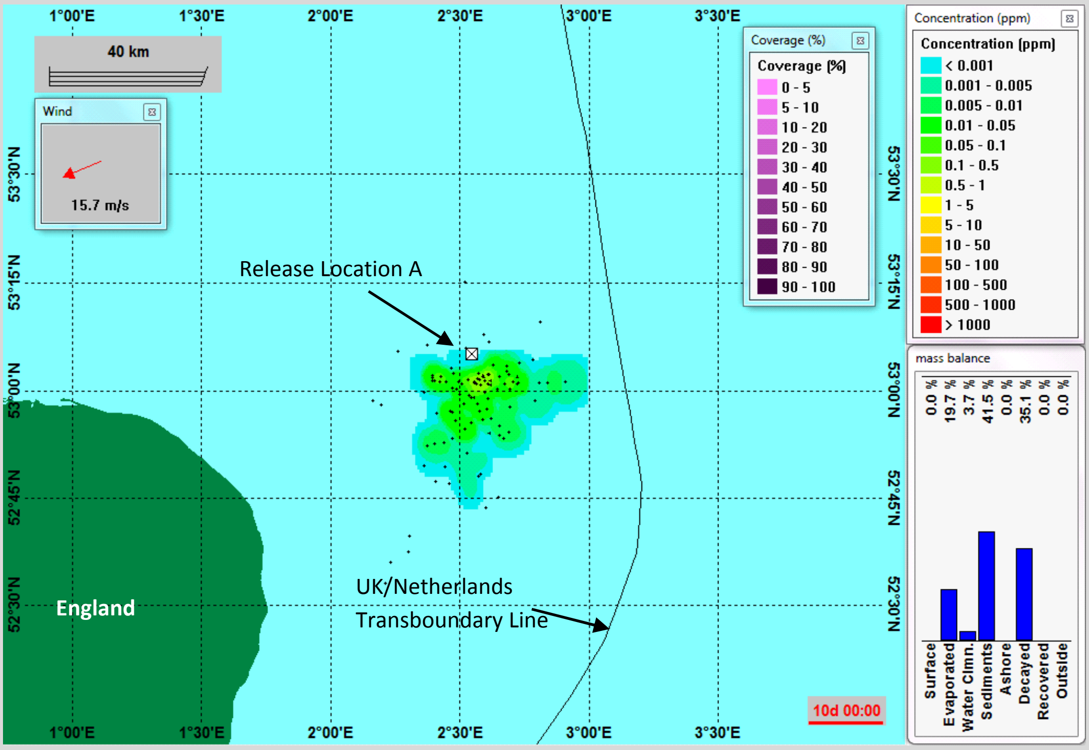
* Please refer to Figure 10.1 for Locations A-G.

** Please note, for the purposed of this assessment, when there is consistently less than 1 percent of the total released hydrocarbons present on the sea surface, the hydrocarbons are considered to be dispersed.

In the event of a real spill, the spill will be modelled by Perenco's onshore emergency response team in conjunction with the spill response contractor OSRL, using real time and actual characteristics to aid in effective response.

Scenario 1: The weathering of a worst case instantaneous 18,700 m³ diesel oil spill with a 30 knot onshore wind (trajectory) at the Thames Complex (release location A)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 5’ 3.995” N; Longitude: 02˚ 32’ 48.995” E
Total Spill Quantity	18,700 m³
Leak Rate	Instantaneous
Model Duration	10 Days
Wind Conditions	30 knot onshore wind
Water Depth	33 m

OSCAR Model Image Taken 10 Days After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling of an instantaneous inventory spill of 18,700 m³ of diesel oil (35˚API) released instantaneously from a SHLV location at the Thames Complex (release location A in Figure 10.1), using a constant 30 knot onshore wind, showed that the diesel slick predominantly remains centred around the release location.

The diesel does not beach on the UK coastline.

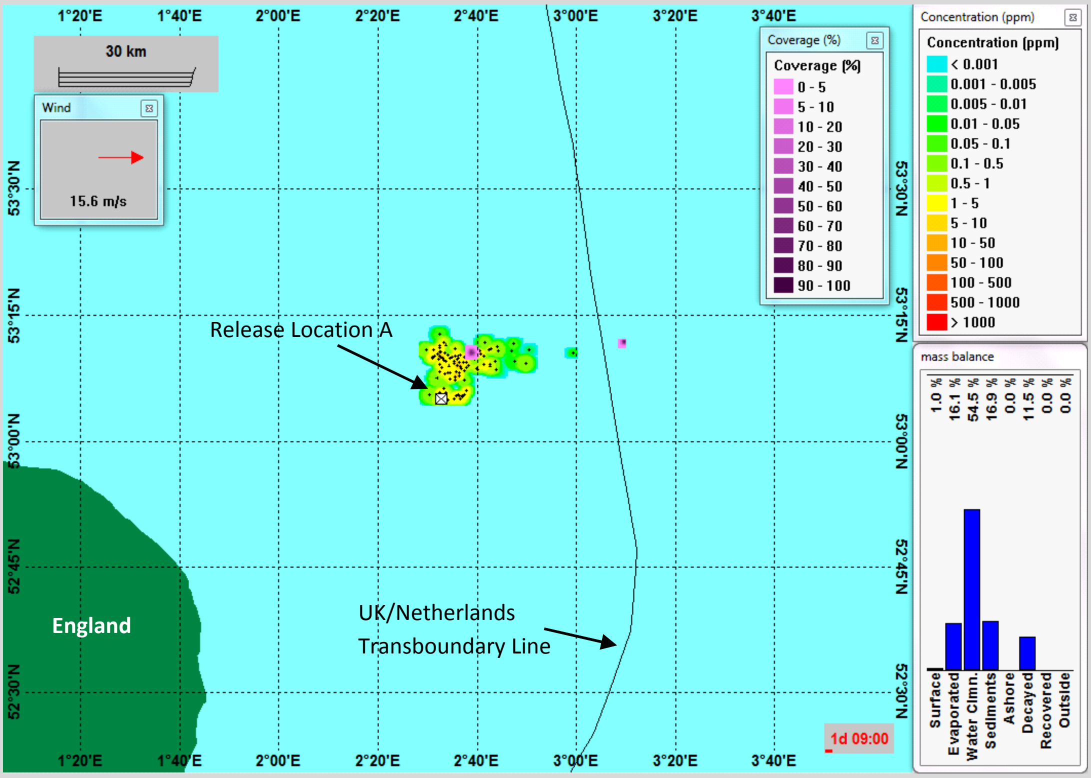
The diesel does not cross any transboundary lines.

The maximum area of the diesel slick at any time is 13.86 km² and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after hours 33 hours, approximately 48 kilometres from the UK coastline.

Scenario 2: The weathering of a worst case instantaneous 18,700 m^3 diesel oil spill with a 30 knot offshore wind (trajectory) at the Thames Complex (release location A)

Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 5’ 3.995” N; Longitude: 02˚ 32’ 48.995” E
Total Spill Quantity	18,700 m^3
Leak Rate	Instantaneous
Model Duration	10 Days
Wind Conditions	30 knot offshore wind
Water Depth	33 m

OSCAR Model Image Taken 1 Day and 9 hours After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling of an instantaneous inventory spill of 18,700 m^3 of diesel oil (35˚API) released instantaneously from a SHLV location at the Thames Complex (release location A in Figure 10.1), using a constant 30 knot offshore wind, shows that the diesel slick is predominantly pushed to the east of the release location.

The diesel does not beach on the UK coastline

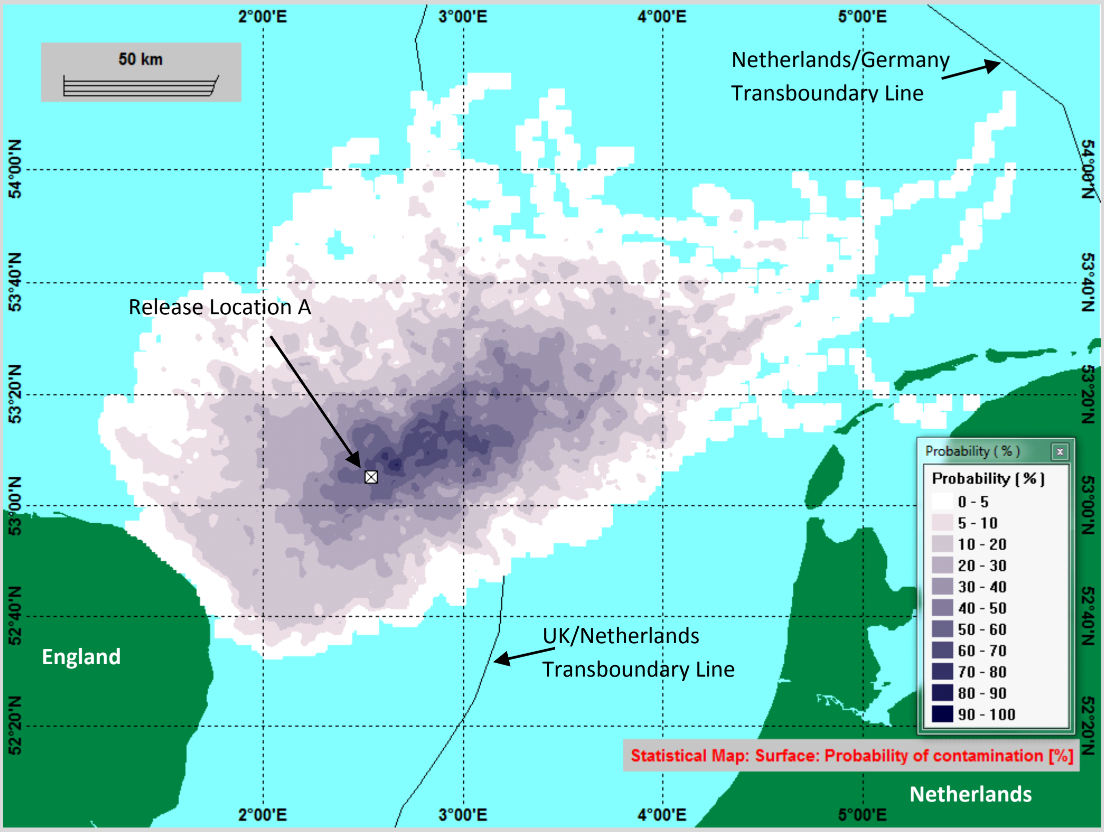
The diesel slick crosses the UK/Netherlands transboundary line after 33 hours.

The diesel slick does not beach on the Dutch coastline.

The maximum area of the diesel slick at any time is 31.8 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 39 hours, approximately 100 kilometres from the UK coastline.

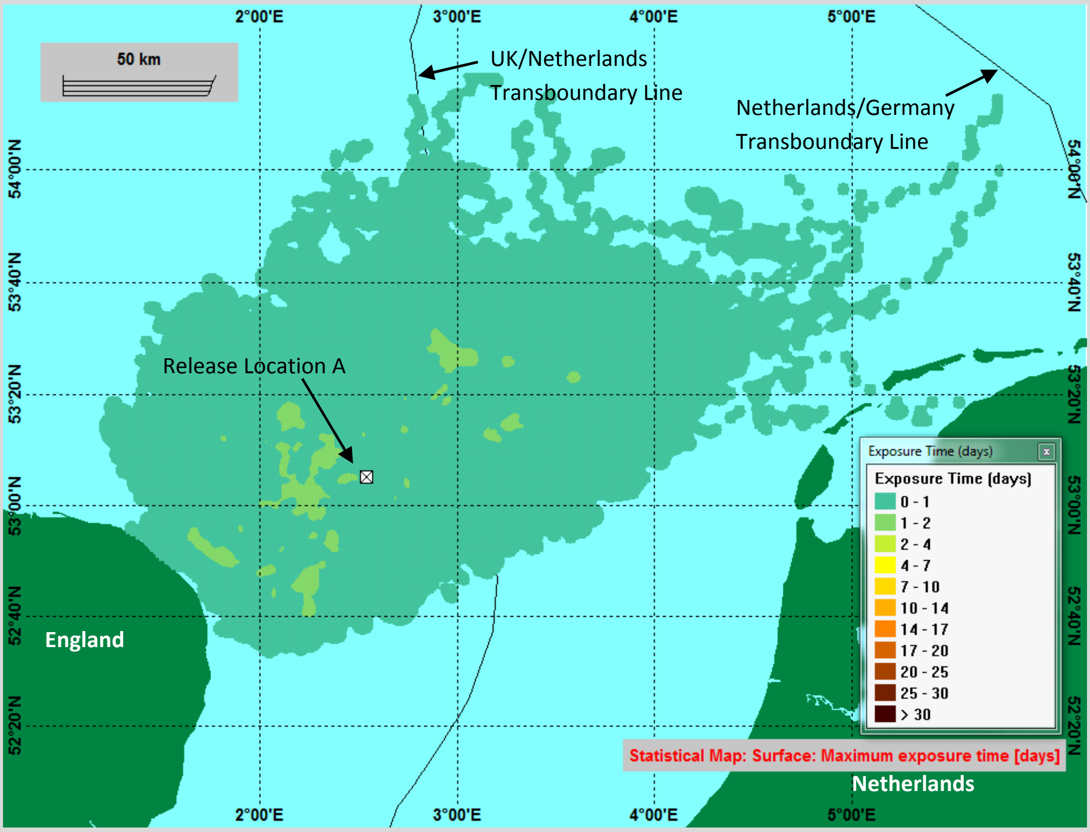
Scenario 3: The weathering of a release of 18,700 m³ of diesel oil under 'typical' conditions (stochastic) at the Thames Complex (release location A)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 5' 3.995" N; Longitude: 02˚ 32' 48.995" E
Total Spill Quantity	18,700 m³
Spill Duration	Instantaneous
Model Duration	20 days
Wind Conditions	Typical
Water Depth	35 m (rounded to nearest 5 m)

6a. Probability (%) of Surface Hydrocarbons Being Present

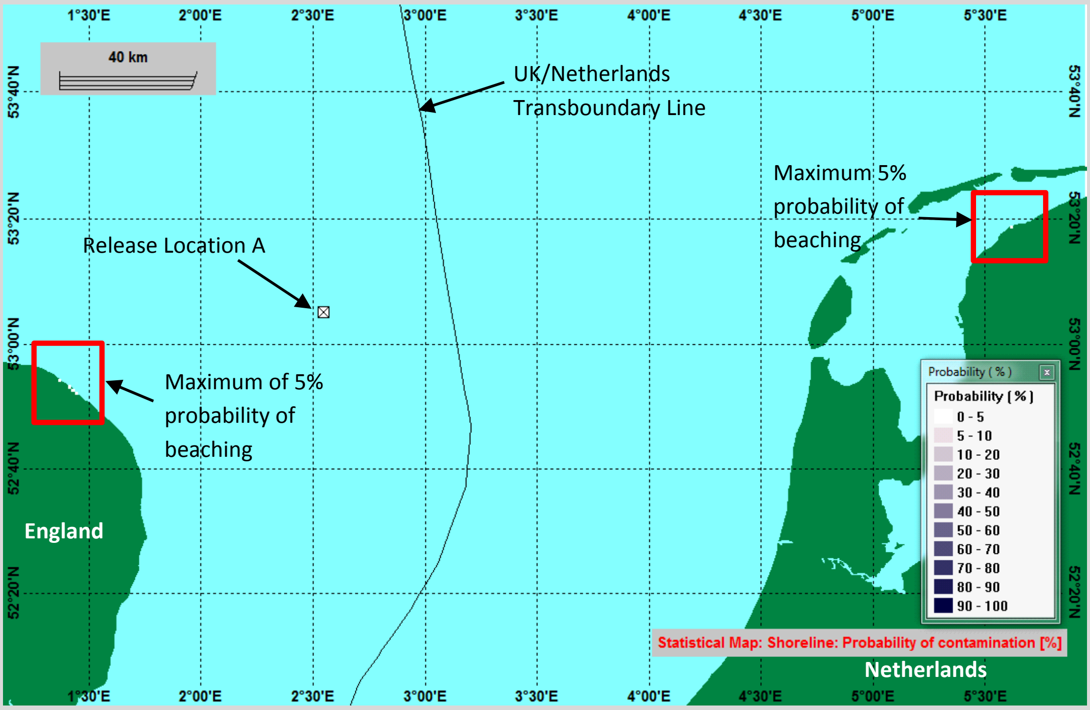


Scenario 3: The weathering of a release of 18,700 m^3 of diesel oil under 'typical' conditions (stochastic) at the Thames Complex (release location A)

3b. The Maximum Exposure Time (Days) of Surface Oil



3c. Probability of Shoreline Contamination (%)



Summary of Results:

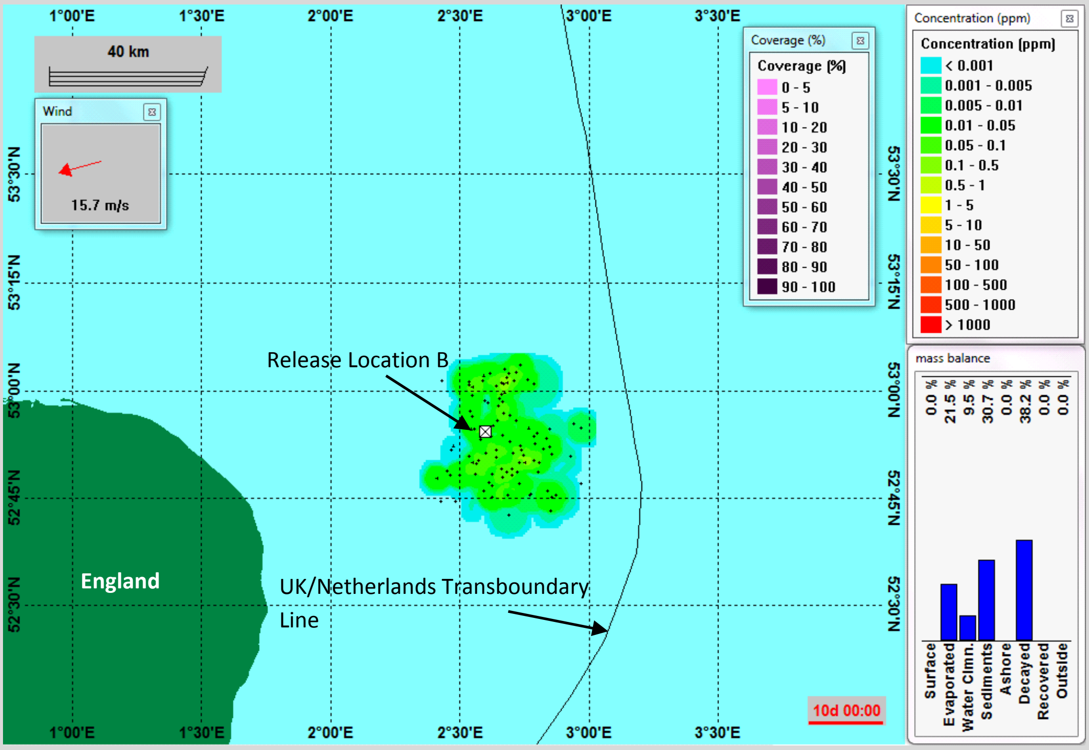
Scenario 3: The weathering of a release of 18,700 m^3 of diesel oil under 'typical' conditions (stochastic) at the Thames Complex (release location A)
Stochastic modelling for a worst case scenario of 18,700 m^3 of diesel oil (35˚API) released instantaneously from a SHLV location at the Thames Complex (release location A in Figure 10.1), under typical conditions, shows that the hydrocarbon slick is pushed slightly to the north east of the release location. There is a 5 % probability of the diesel beaching on the UK coastline (Figure 3c). There is a 65 % probability that the diesel slick will cross the UK/Netherlands transboundary line (Figure 3a) and a 5 % probability of the diesel beaching on the Dutch coastline (Figure 3c). The worst case maximum accumulation of diesel on any shoreline is 805.62 m^3. The shortest shoreline arrival time of the diesel is 71 hours. Due to the relative lightness of the diesel (35˚API) released from the SHLV, the hydrocarbons do not persist on the surface for any great length of time. The Figure 3b in Scenario 3 shows the maximum exposure time (in days) of surface hydrocarbons is 1-2 days on the sea surface.

Scenario 3: Beaching Locations

Country	Location Name	Maximum Probability of Beaching (%)	Shortest Arrival Time to Shore (Hours)
UK	Mundesley, Norfolk	5	71
Netherlands	Friesland Province	5	383

Scenario 4: The weathering of a worst case instantaneous 18,700 m³ diesel oil spill with a 30 knot onshore wind (trajectory) at the Horne & Wren Platform (release location B)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 52˚ 54’ 15.466” N; Longitude: 02˚ 35’ 57.790” E
Total Spill Quantity	18,700 m³
Leak Rate	Instantaneous
Model Duration	10 Days
Wind Conditions	30 knot onshore wind
Water Depth	41 m

OSCAR Model Image Taken 10 Days After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling of an instantaneous inventory spill of 18,700 m³ of diesel (35˚API) released instantaneously from a SHLV located at the Horne & Wren Platform (release location B in Figure 10.1), using a constant 30 knot onshore wind, shows that diesel slick predominantly remains centred around the release location.

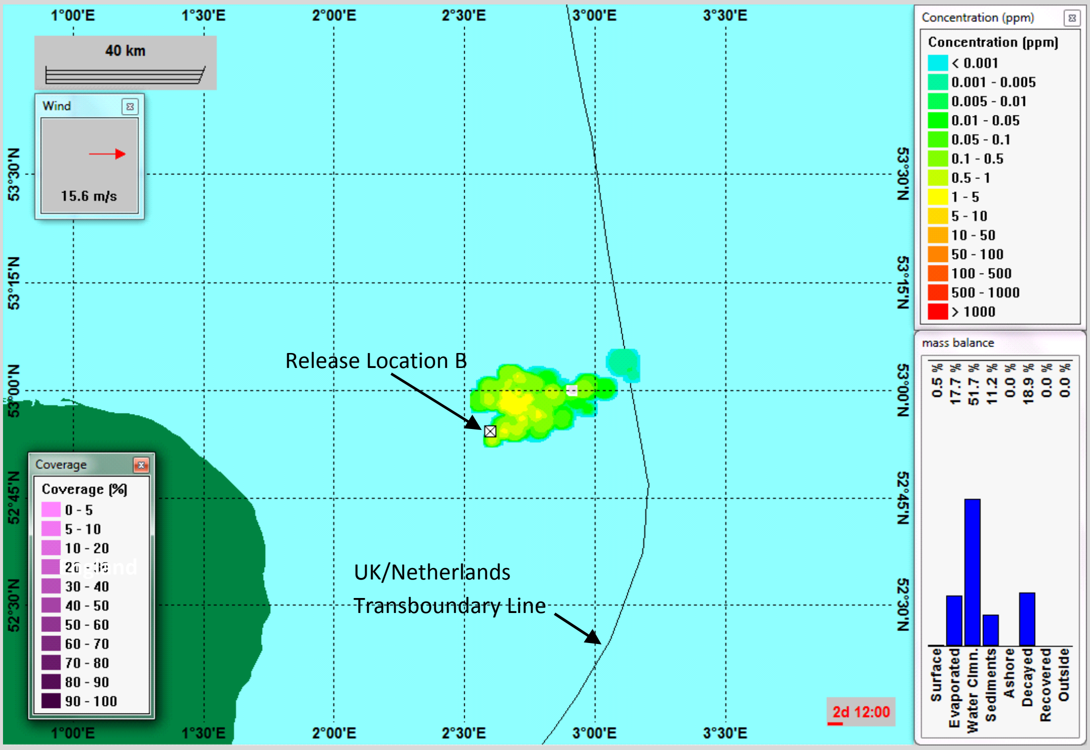
The diesel slick does not beach on the UK coastline.

The diesel slick does not cross any transboundary lines.

The maximum area of the diesel slick at any time is 30.29 km² and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 33 hours, approximately 70 kilometres from the UK coastline.

Scenario 5: The weathering of a worst case instantaneous 18,700 m³ diesel oil spill with a 30 knot offshore wind (trajectory) at the Horne & Wren Platform (release location B)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 52˚ 54' 15.466" N; Longitude: 02˚ 35' 57.790" E
Total Spill Quantity	18,700 m³
Leak Rate	Instantaneous
Model Duration	10 Days
Wind Conditions	30 knot offshore wind
Water Depth	41 m

OSCAR Model Image Taken 2 Days and 12 hours After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling of an instantaneous inventory spill of 18,700 m³ of diesel (35˚API) released instantaneously from a SHLV located at the Horne & Wren Platform (release location B in Figure 10.1), using a constant 30 knot offshore wind, shows that the diesel slick is predominantly pushed to the east of the release location.

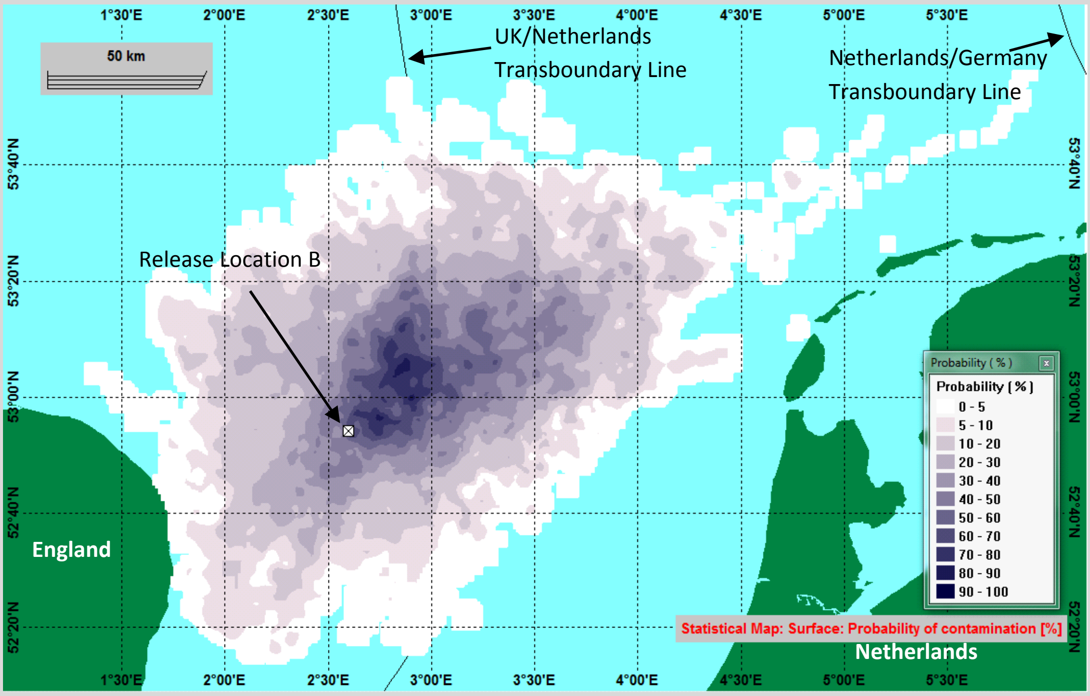
The diesel slick does not beach on the UK coastline.

The diesel slick crosses the UK/Netherlands transboundary line after 60 hours, however it does not beach on the Dutch coastline.

The maximum area of the diesel slick at any time is 47.99 km² and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after hours 36 hours, approximately 80 kilometres from the UK coastline.

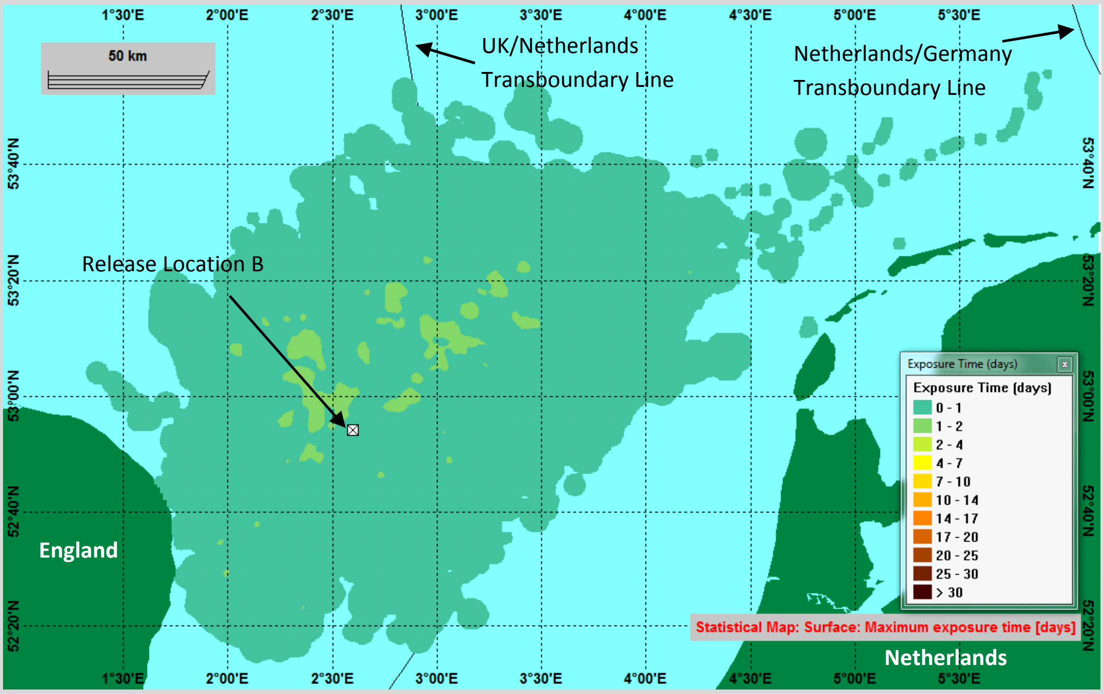
Scenario 6: The weathering of a release of 18,700 m^3 of diesel oil under 'typical' conditions (stochastic) at the Horne & Wren Location (release location B)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 52˚ 54' 15.466" N; Longitude: 02˚ 35' 57.790" E
Total Spill Quantity	18,700 m^3
Spill Duration	Instantaneous
Model Duration	20 days
Wind Conditions	Typical
Water Depth	40 m (rounded to nearest 5 m)

6a. Probability (%) of Surface Hydrocarbons Being Present

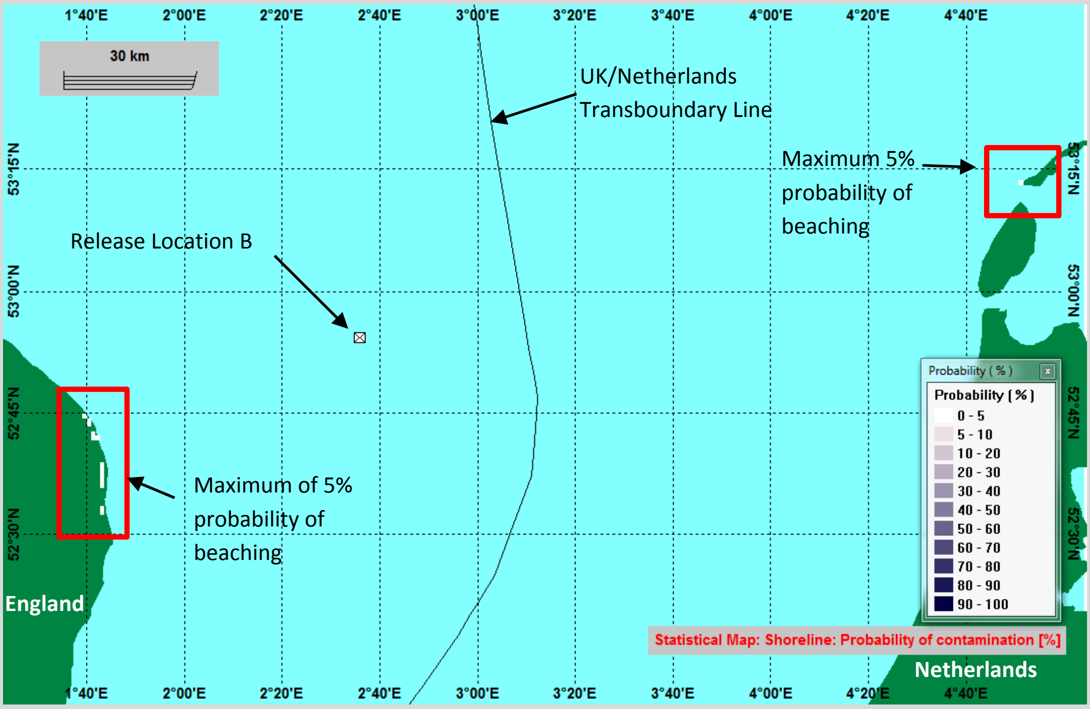


Scenario 6: The weathering of a release of 18,700 m³ of diesel oil under 'typical' conditions (stochastic) at the Horne & Wren Location (release location B)

6b. The Maximum Exposure Time (Days) of Surface Oil



6c. Probability of Shoreline Contamination (%)



Summary of Results:

Stochastic modelling for a worst case scenario of 18,700 m³ of diesel (35˚API) released instantaneously from a SHLV located at the Horne & Wren Platform (release location B in Figure 10.1), under typical conditions showed that the diesel slick is pushed slightly to the north east of the release location.

There is a 5 % probability that the diesel slick will beach on the UK coastline.

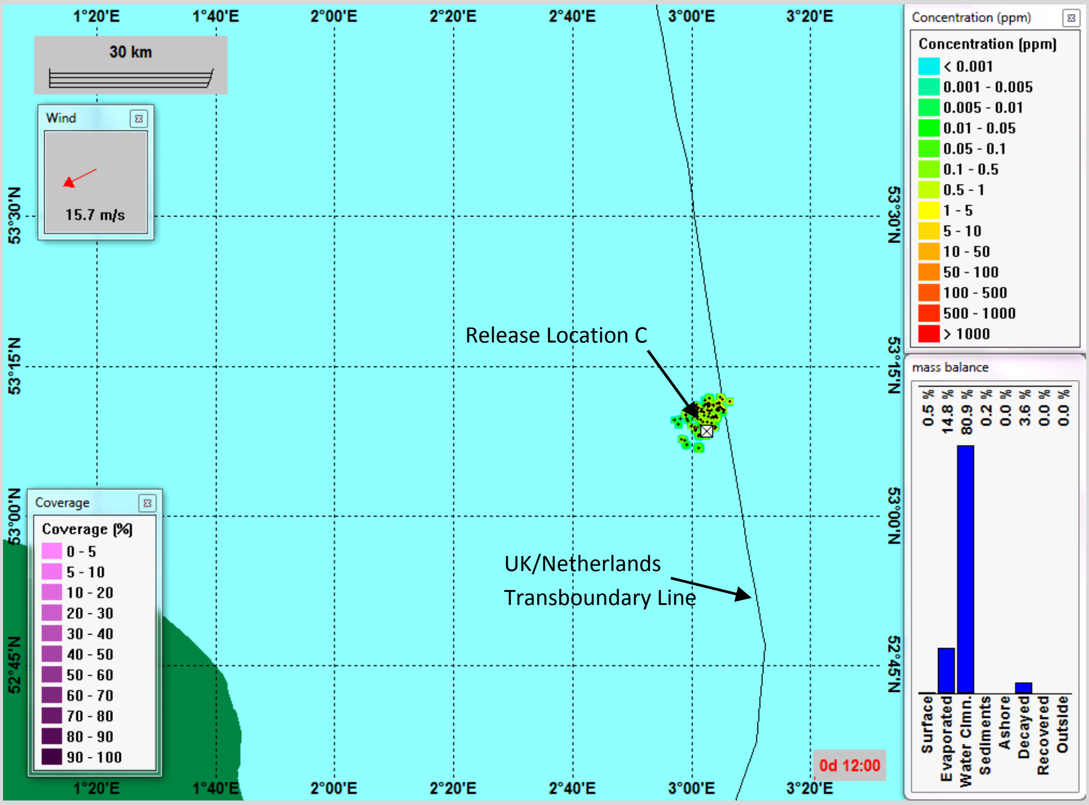
Scenario 6: The weathering of a release of 18,700 m^3 of diesel oil under 'typical' conditions (stochastic) at the Horne & Wren Location (release location B)
There is a 60 % probability that the diesel slick will cross the UK/Netherlands transboundary line (Figure 6a). There is a 5 % probability of the hydrocarbons beaching on the coastline of the Netherlands (Figure 6c). The worst case maximum accumulation of diesel on any coastline is 1,933.28 m^3. The shortest shoreline arrival time of the diesel is 1 day and 23 hours. Due to the relative lightness of the diesel (35˚API) released from the SHLV, the hydrocarbons do not persist on the surface for any great length of time. The Figure 6b in Scenario 6 shows the maximum exposure time (in days) of surface hydrocarbons is 1-2 days on the sea surface.

Scenario 6: Beaching Locations

Country	**Location Name**	**Maximum Probability of Beaching (%)**	**Shortest Arrival Time to Shore (Hours)**
UK	Scratby, Norfolk	5	47
UK	Great Yarmouth, Norfolk	5	48
UK	Corton, Norfolk	5	61
Netherlands	Vlieland, Friesland	5	428

Scenario 7: The weathering of a worst case 890 m^3 diesel oil spill with a 30 knot onshore wind (trajectory) at the Orwell subsea well location (release location C)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 8’ 27.899” N; Longitude: 03˚ 2’ 34.451” E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	10 days
Wind Conditions	30 knot onshore wind
Water Depth	32 m

OSCAR Model Image Taken 12 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

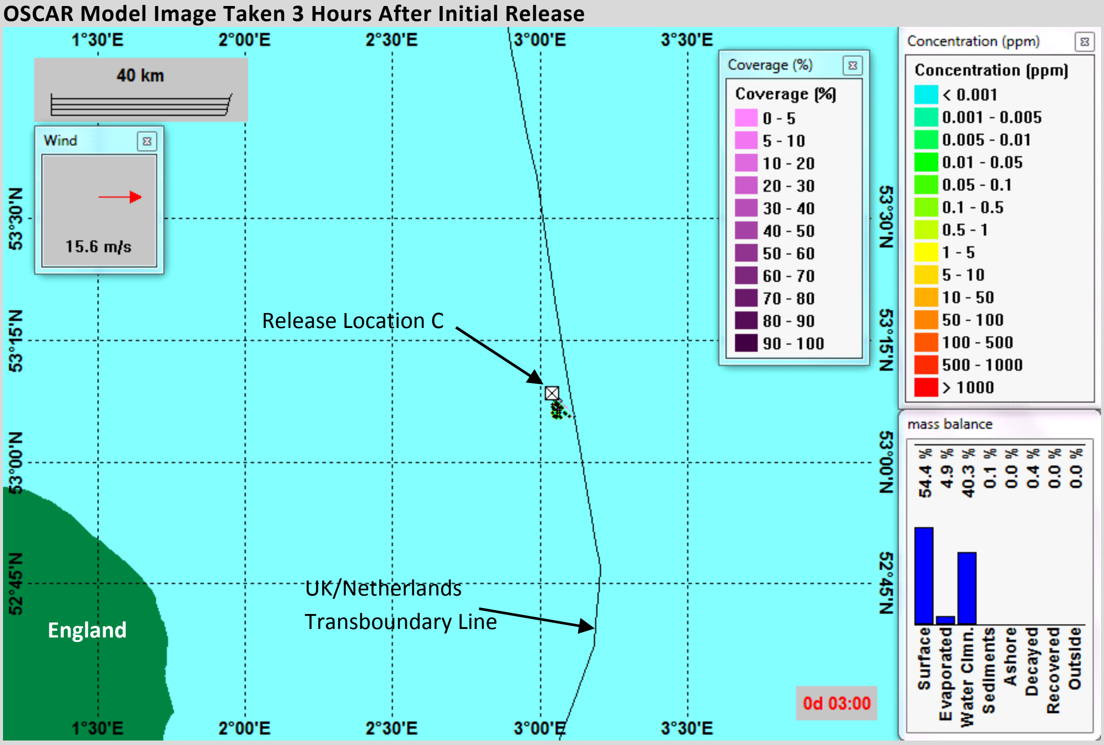
Trajectory modelling for a worst case scenario of 890 m^3 of condensate (35˚API) released instantaneously from a drilling rig located at the Orwell subsea well (release location C in Figure 10.1), under theoretical worst case conditions of a constant 30 knot onshore wind, showed that the diesel slick predominately remained centred around the release location

The diesel slick does not beach on the UK coastline.

The diesel slick crosses the UK/Netherlands transboundary line after 12 hours, however it did not beach on the Dutch coastline. The maximum area of the slick at any time is 4.69 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 30 hours, approximately 105 kilometres from the UK coastline.

Scenario 7: The weathering of a worst case 890 m³ diesel oil spill with a 30 knot onshore wind (trajectory) at the Orwell subsea well location (release location C)	
Scenario 8: The weathering of a worst case 890 m³ diesel oil spill with a 30 knot offshore wind (trajectory) at the Orwell subsea well (release location C)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 8’ 27.899” N; Longitude: 03˚ 2’ 34.451” E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	10 days
Wind Conditions	30 knot offshore wind
Water Depth	32 m

OSCAR Model Image Taken 3 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 890 m^3 of condensate (35˚API) released instantaneously from a drilling rig located at the Orwell subsea well (release location C in Figure 10.1), under theoretical worst case conditions of a constant 30 knot offshore wind, showed that the diesel slick moved predominately to the north east of the release location.

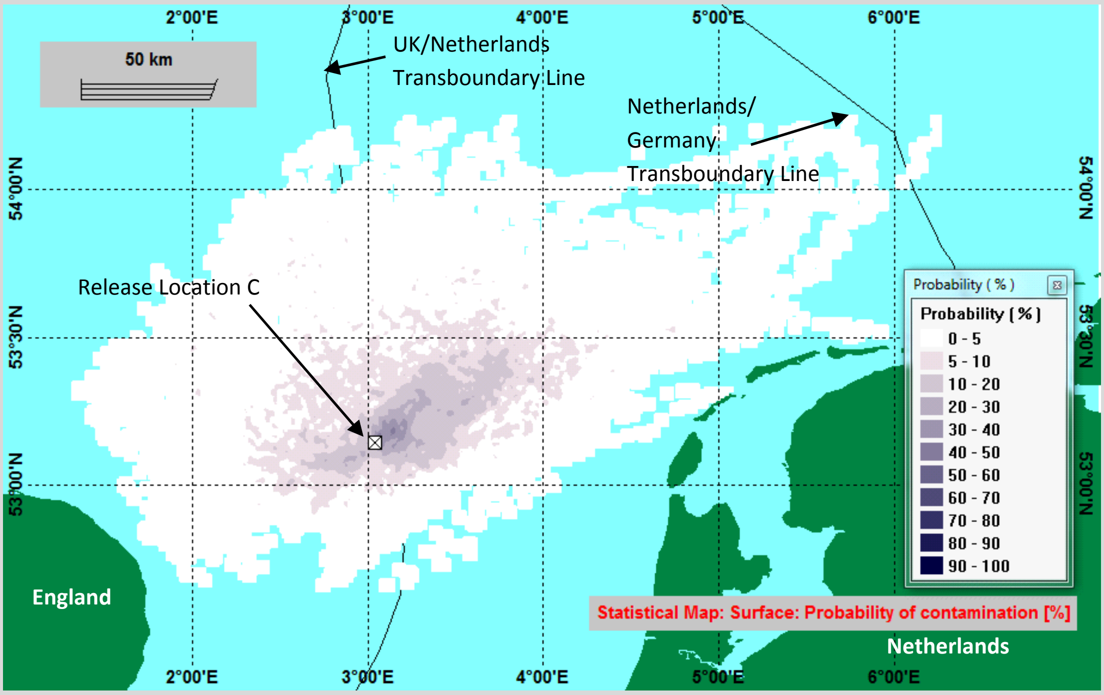
The diesel slick does not beach on the UK coastline.

The diesel slick crosses the UK/Netherlands transboundary line after 3 hours, however it does not beach on the Dutch coastline.

Scenario 7: The weathering of a worst case 890 m^3 diesel oil spill with a 30 knot onshore wind (trajectory) at the Orwell subsea well location (release location C)
The maximum area of the slick at any time is 5.02 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 21 hours, approximately 121 kilometres from the UK coastline.

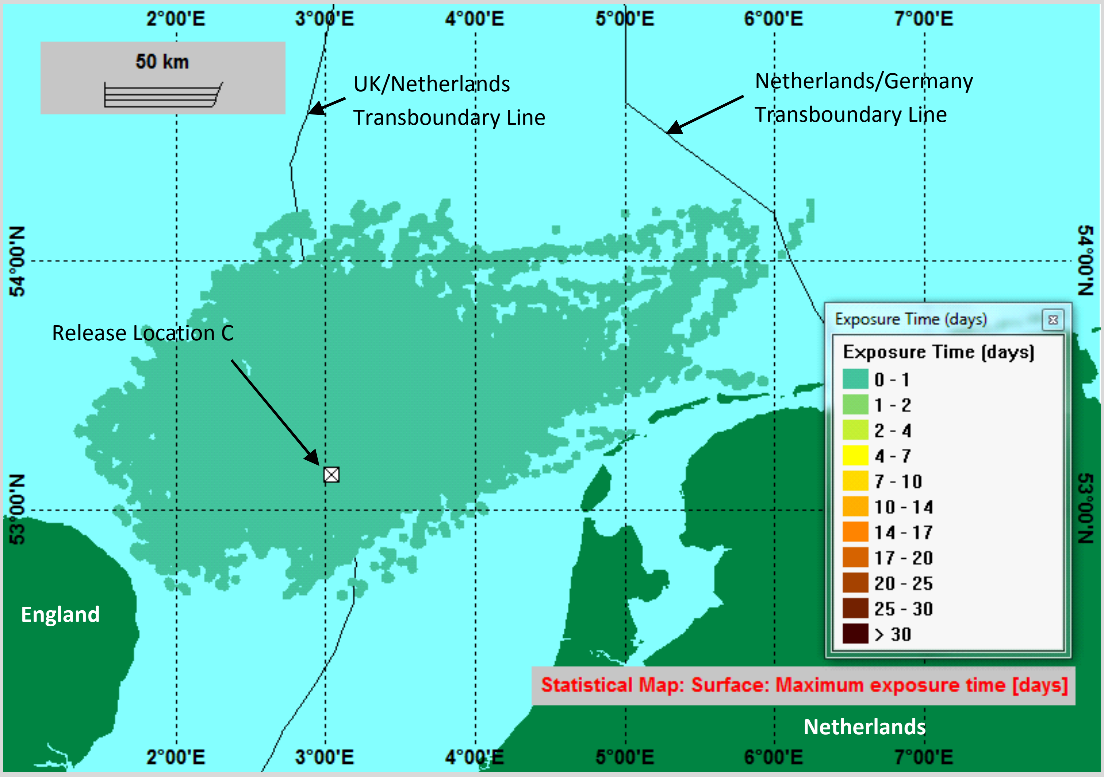
Scenario 9: The weathering of a release of 890 m³ of diesel oil under 'typical' conditions (stochastic) at the Orwell subsea well location (release location C)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 8' 27.899" N; Longitude: 03˚ 2' 34.451" E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	20 days
Wind Conditions	Typical
Water Depth	30 m (rounded to the nearest 5 m)

9a. Probability (%) of Surface Hydrocarbons Being Present



Scenario 9: The weathering of a release of 890 m³ of diesel oil under 'typical' conditions (stochastic) at the Orwell subsea well location (release location C)

9b. The Maximum Exposure Time (Days) of Surface Oil



Summary of Results:

Stochastic modelling for a worst case scenario of 890 m³ of condensate (35˚API) released instantaneously from a drilling rig located at the Orwell subsea well (release location C in Figure 10.1), under typical conditions showed that the diesel slick is predominantly pushed to the north east of the drilling location.

There is zero probability of the diesel slick beaching on the UK coastline.

There is a 43 % probability that the hydrocarbon slick will cross the UK/Netherlands transboundary line.

There is zero probability of the diesel slick beaching on the Dutch coastline.

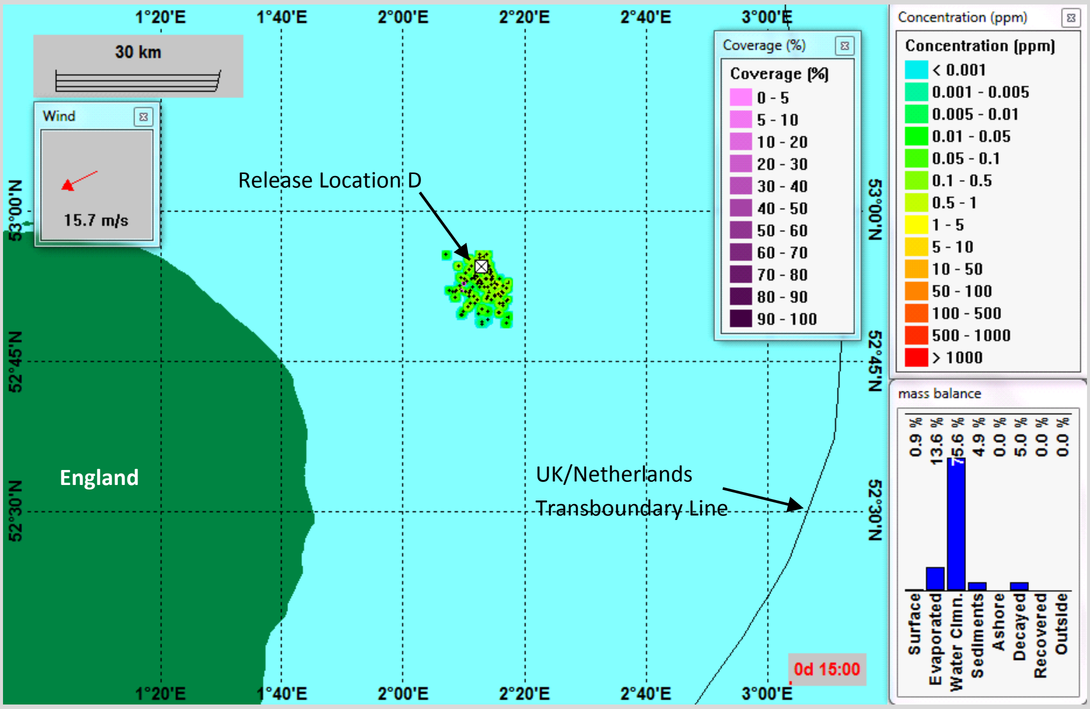
There is <5 % probability that the diesel slick will cross the Netherlands/Germany transboundary line (Figure 9a).

There is zero probability of the hydrocarbons beaching on the German coastline.

Due to the relative lightness of the diesel oil (35˚API) released from the Thames export pipeline, the hydrocarbons do not persist on the surface for any great length of time. The Figure 9b in Scenario 9 shows the maximum exposure time (in days) of surface hydrocarbons is 0-1 days on the sea surface.

Scenario 10: The weathering of a worst case 890 m³ diesel oil spill with a 30 knot onshore wind (trajectory) at the Arthur 3 subsea well location (release location D)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 52˚ 54’ 25.286” N; Longitude: 02˚ 13’ 0.426” E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	10 days
Wind Conditions	30 knot onshore wind
Water Depth	49 m

OSCAR Model Image Taken 15 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 890 m^3 of diesel oil (35˚API) released instantaneously from a drilling rig located at the Arthur 3 subsea well (release location D in Figure 10.1), under theoretical worst case conditions of a constant 30 knot onshore wind, showed that the diesel slick is predominately pushed to the south east of the release location.

The diesel slick does not beach on the UK coastline.

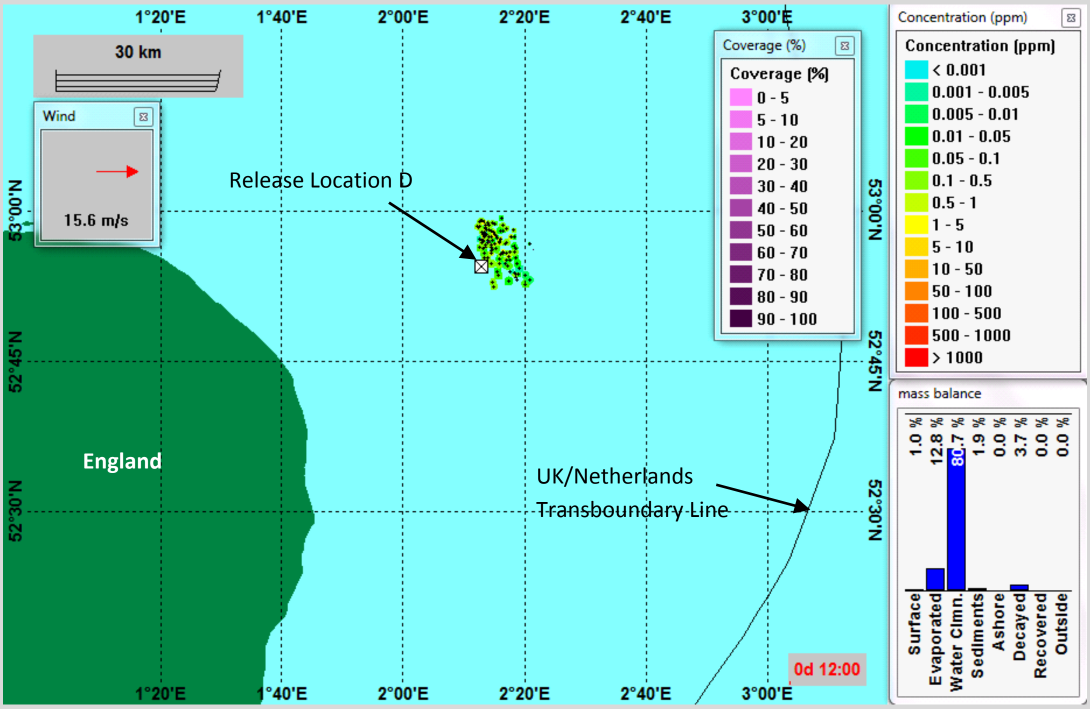
The diesel slick does not cross any transboundary lines.

The maximum area of the slick at any time is 2.87 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 15 hours, approximately 36 kilometres from the UK coastline.

Scenario 11: The weathering of a worst case 890 m³ diesel oil spill with a 30 knot offshore wind (trajectory) at the Arthur 3 subsea well (release location D)

Oil Type	Diesel (35˚ API)
Release Location	Latitude: 52˚ 54’ 25.286” N; Longitude: 02˚ 13’ 0.426” E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	10 days
Wind Conditions	30 knot offshore wind
Water Depth	49 m

OSCAR Model Image Taken 12 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 890 m^3 of diesel oil (35˚API) released instantaneously from a drilling rig located at the Arthur 3 subsea well (release location D in Figure 10.1), under theoretical worst case conditions of a constant 30 knot offshore wind, showed that the hydrocarbon slick moved predominately to the east and south east of the release location.

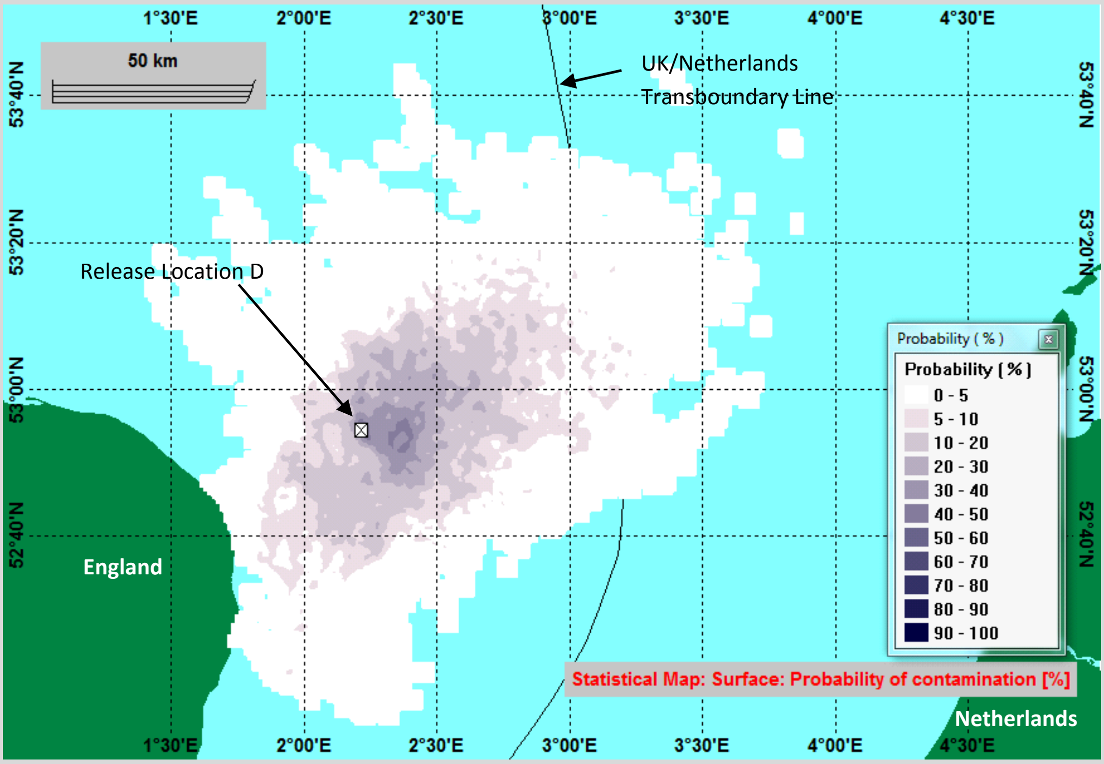
The diesel slick does beach on the UK coastline.

The diesel slick does not cross the any transboundary lines.

The maximum area of the slick at any time is 5.64 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 12 hours, approximately 45 kilometres from the UK coastline.

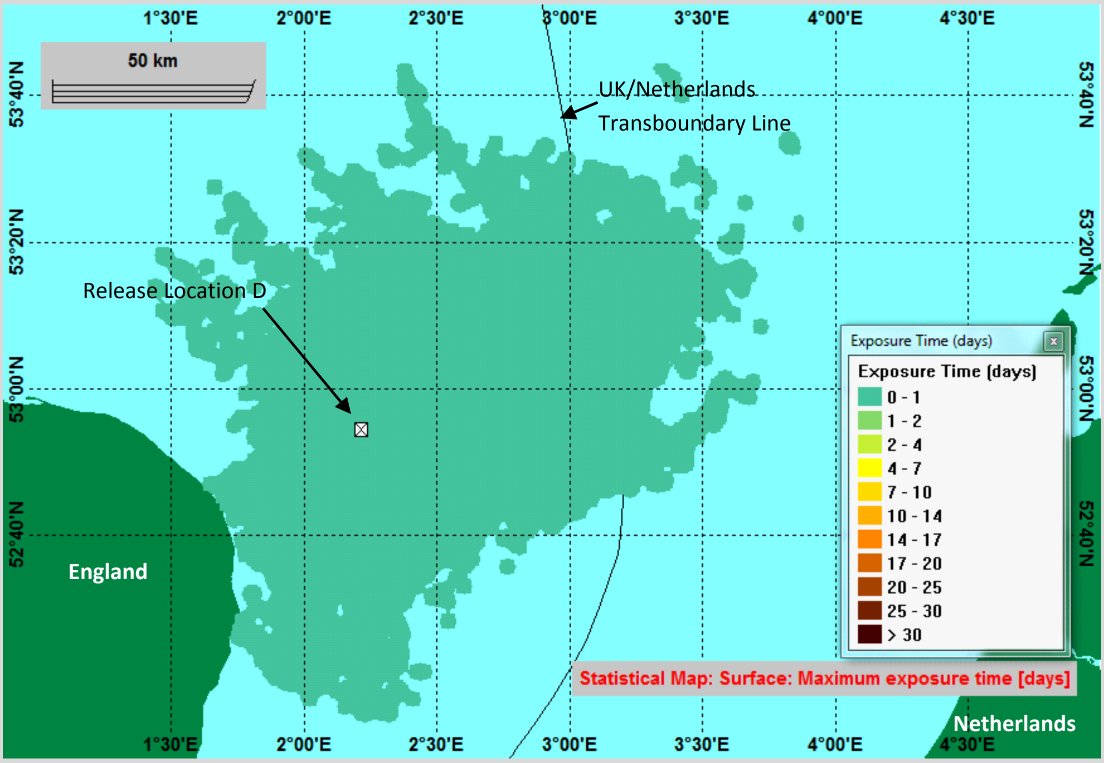
Scenario 12: The weathering of a release of 890 m³ of diesel oil under 'typical' conditions (stochastic) at the Arthur 3 subsea well location (release location D)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 52˚ 54' 25.286" N; Longitude: 02˚ 13' 0.426" E
Total Spill Quantity	890 m³
Leak Rate	Instantaneous
Model Duration	20 days
Wind Conditions	Typical
Water Depth	50 m (rounded to the nearest 5 m)

12a. Probability (%) of Surface Hydrocarbons being present

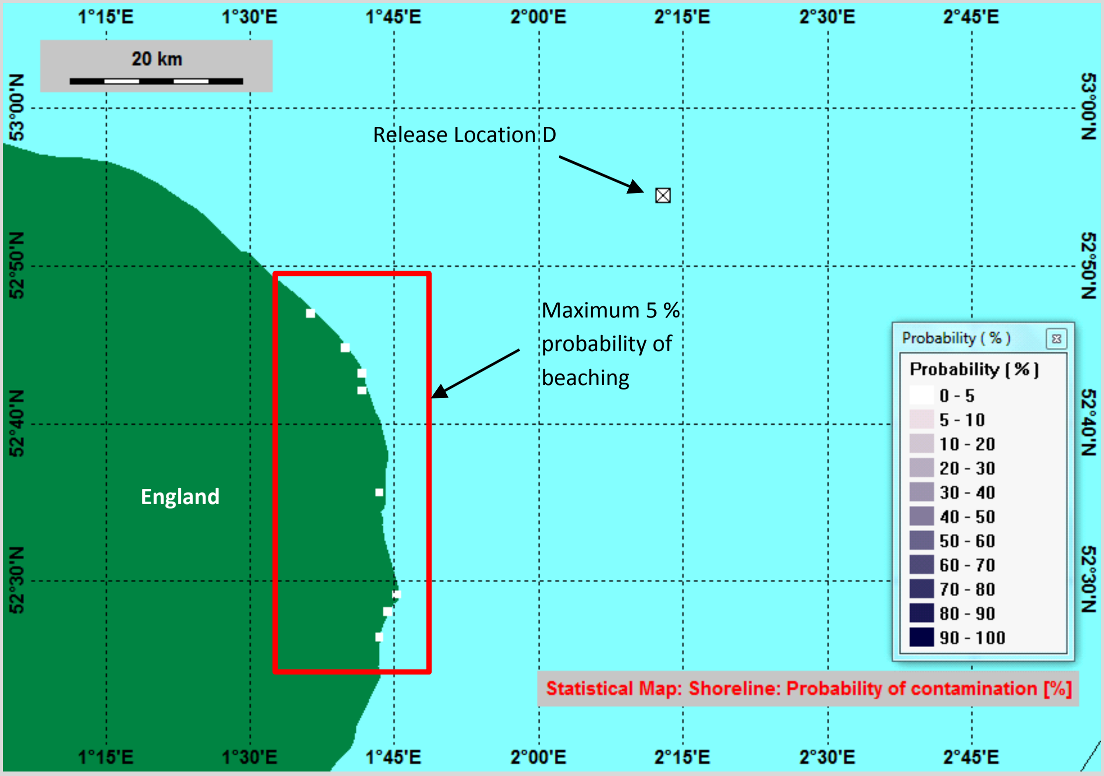


Scenario 12: The weathering of a release of 890 m³ of diesel oil under 'typical' conditions (stochastic) at the Arthur 3 subsea well location (release location D)

12b. The Maximum Exposure Time (Days) of Surface Oil



12c. The Probability of Shoreline Contamination (%)



Summary of Results:

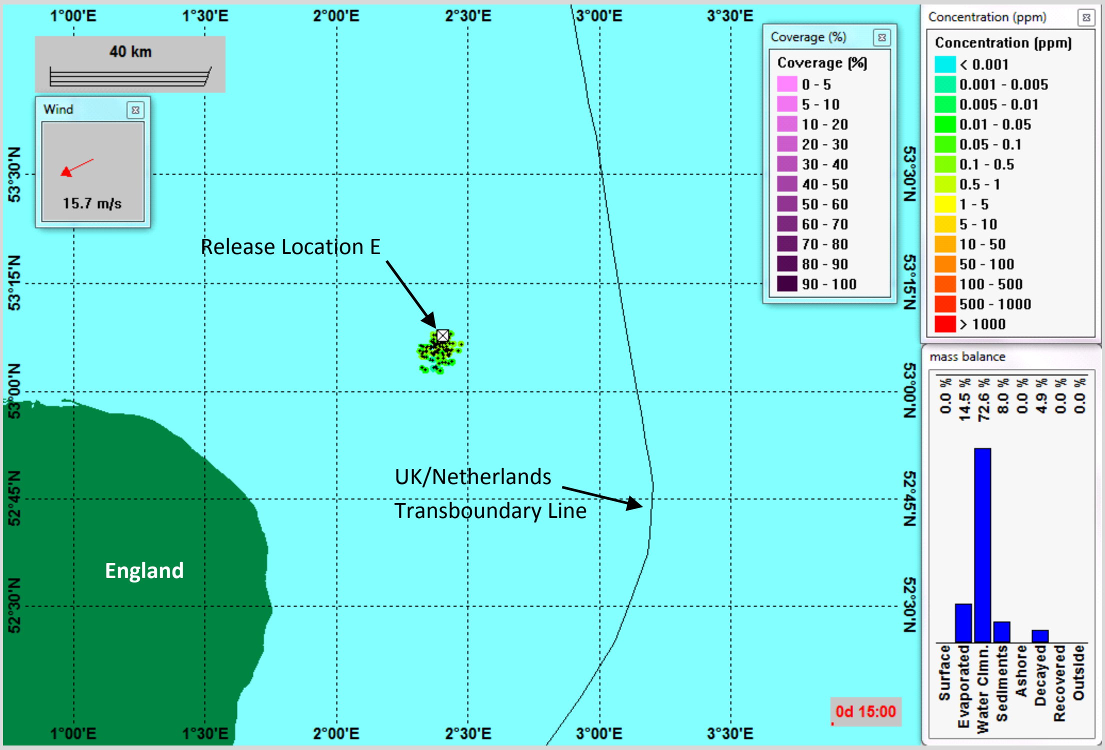
Scenario 12: The weathering of a release of 890 m^3 of diesel oil under 'typical' conditions (stochastic) at the Arthur 3 subsea well location (release location D)
Stochastic modelling for a worst case scenario of 890 m^3 of diesel oil (35˚API) released instantaneously from a drilling rig located at the Arthur 3 subsea well (release location D in Figure 10.1), under typical conditions showed that the diesel slick is predominantly pushed to the north east of the drilling location. There is a 5 % probability of the diesel beaching on the UK coastline. The worst case maximum accumulation of diesel on the UK's shoreline is 21.11 m^3 and the shortest shoreline arrival time is 29 hours. There is a 9 % probability that the diesel slick will cross the UK/Netherlands transboundary line (Figure 12a) but zero probability of the diesel beaching on the Dutch coastline. Due to the relative lightness of the diesel oil (35˚API) released from the SHLV, the hydrocarbons do not persist on the surface for any great length of time. The Figure 12b in Scenario 12 shows the maximum exposure time (in days) of surface hydrocarbons is 0-1 days on the sea surface.

Scenario 12: Beaching Locations

Country	Location Name	Maximum Probability of Beaching (%)	Shortest Arrival Time to Shore (Hours)
UK	Scratby, Norfolk	5	29
UK	Gorleston-on-Sea, Norfolk	5	300
UK	Lowestoft	5	283

Scenario 13: The weathering of a worst case 890 m^3 diesel oil spill with a 30 knot onshore wind (trajectory) at the Bure West subsea well location (release location E)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 7' 45.358" N; Longitude: 02˚ 24' 13.118" E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	10 days
Wind Conditions	30 knot onshore wind
Water Depth	34 m

OSCAR Model Image Taken 15 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 890 m^3 of diesel oil (35˚API) released instantaneously from a drilling rig located at the Bure West subsea well (release location E in Figure 10.1), under theoretical worst case conditions of a constant 30 knot onshore wind, showed that the hydrocarbon slick is pushed slightly to the south east of the release location.

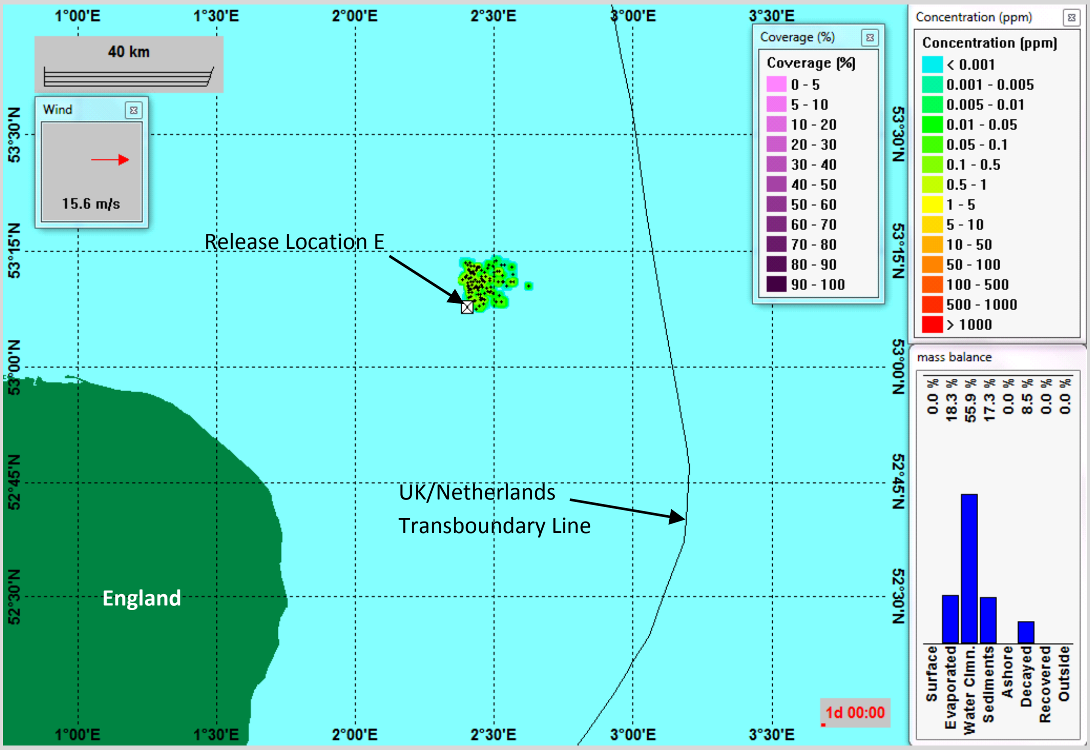
The diesel does not breach on the UK coastline.

The diesel slick does not cross any transboundary lines.

The maximum area of the slick at any time is 2.66 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 15 hours, approximately 61 kilometres from the UK coastline.

Scenario 14: The weathering of a worst case 890 m³ diesel oil spill with a 30 knot offshore wind (trajectory) at the Bure West subsea well (release location E)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 7' 45.358" N; Longitude: 02˚ 24' 13.118" E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	10 days
Wind Conditions	30 knot offshore wind
Water Depth	34 m

OSCAR Model Image Taken 1 Day After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 890 m^3 of diesel oil (35˚API) released instantaneously from a drilling rig located at the Bure West subsea well (release location E in Figure 10.1), under theoretical worst case conditions of a constant 30 knot offshore wind, showed that the hydrocarbon slick moved predominately to the east of the release location.

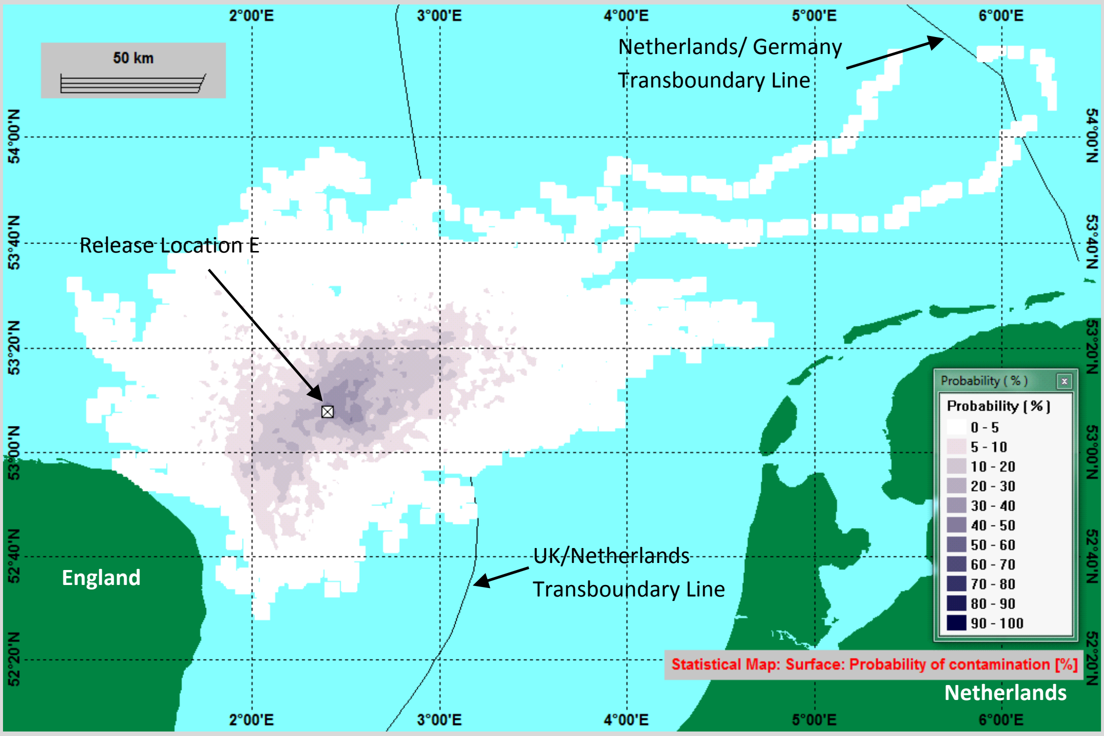
The diesel slick does not beach on the UK coastline.

The diesel slick does not cross any transboundary lines.

The maximum area of the slick at any time is 3.43 km^2 and it disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 24 hours, approximately 70 kilometres from the UK coastline.

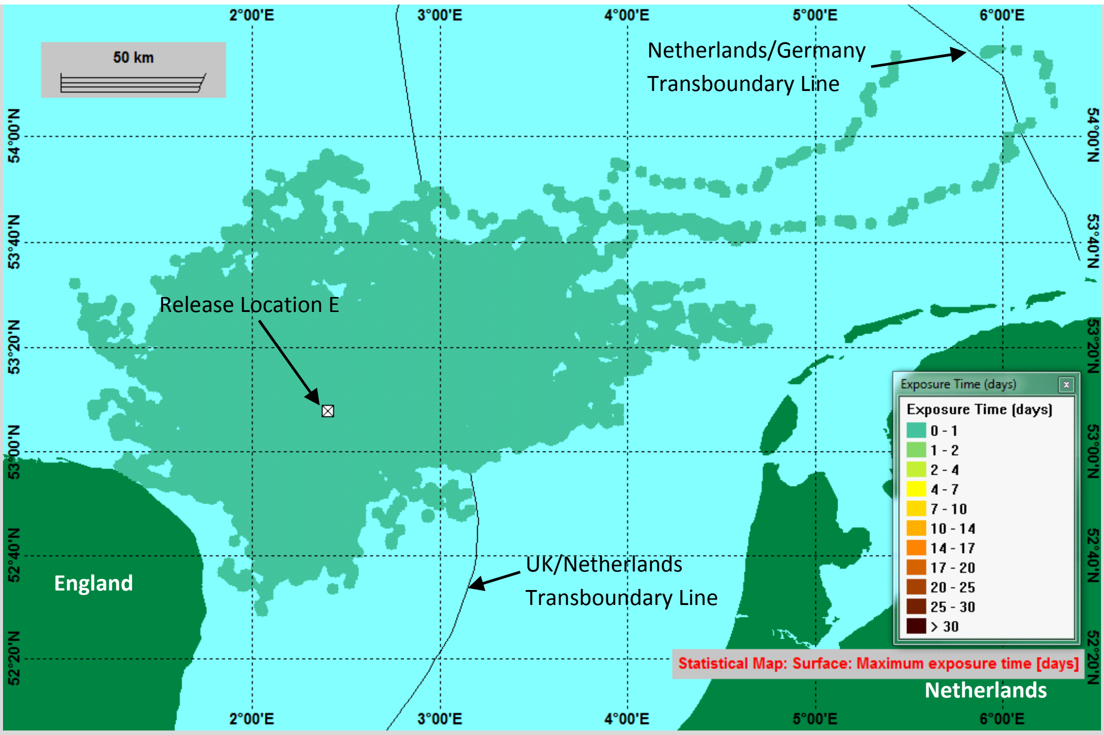
Scenario 15: The weathering of a release of 890 m³ of diesel oil under 'typical' conditions (stochastic) at the Bure West subsea well location (release location E)	
Oil Type	Diesel (35˚ API)
Release Location	Latitude: 53˚ 7' 45.358" N; Longitude: 02˚ 24' 13.118" E
Total Spill Quantity	890 m^3
Leak Rate	Instantaneous
Model Duration	20 days
Wind Conditions	Typical
Water Depth	35 m (rounded to the nearest 5 m)

15a. Probability (%) of Surface Hydrocarbons Being Present



15b. The Maximum Exposure Time (Days) of Surface Oil

Scenario 15: The weathering of a release of 890 m^3 of diesel oil under 'typical' conditions (stochastic) at the Bure West subsea well location (release location E)



Summary of Results:

Stochastic modelling for a worst case scenario of 890 m^3 of diesel oil (35˚API) released instantaneously from a drilling rig located at the Bure West subsea well (release location E in Figure 10.1), under typical conditions shows that the diesel slick is pushed slightly to the north east of the release location

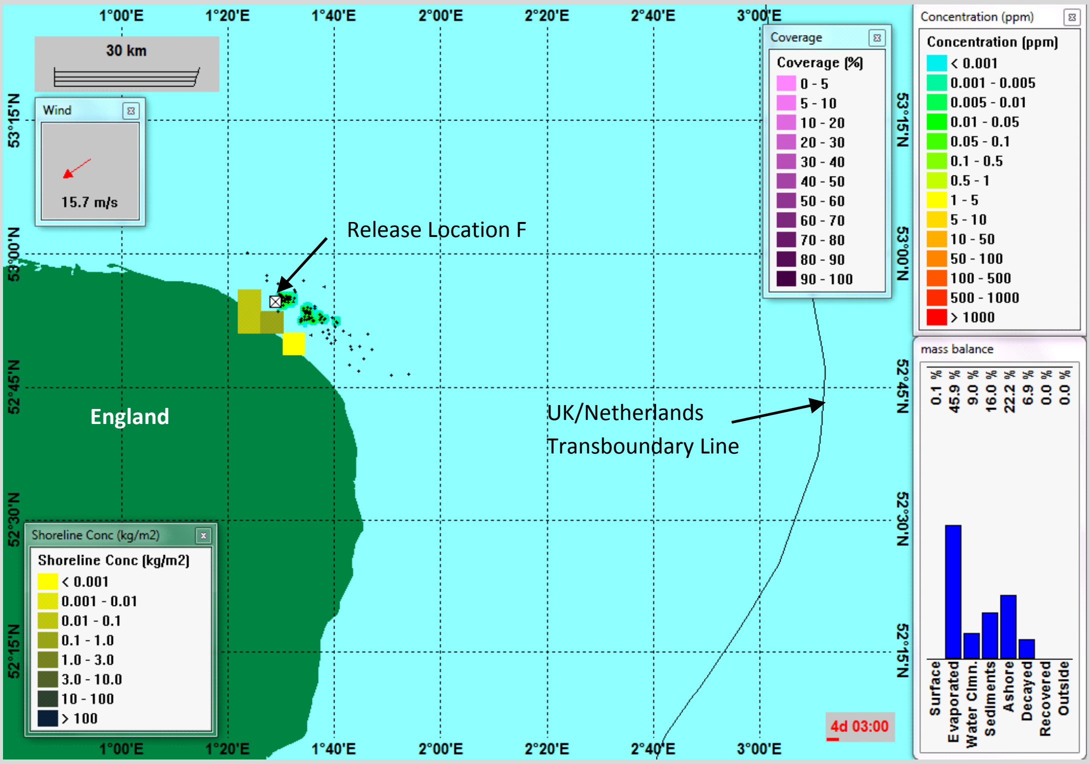
There is a zero probability of the diesel slick beaching on the UK coastline.

There is a 15 % probability that the hydrocarbon slick will cross the UK/Netherlands transboundary line (Figure 15a), however there is zero probability of the diesel beaching on Dutch coastline.

Due to the relative lightness of the diesel oil (35˚API) released from the Thames export pipeline, the hydrocarbons do not persist on the surface for any great length of time. The Figure 15b in Scenario 15 shows the maximum exposure time (in days) of surface hydrocarbons is 0-1 days on the sea surface.

Scenario 16: The weathering of a worst case 151 m³ condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release location F	
Condensate Type	47.8˚API (LAVRANS)
Release Location	Latitude: 52˚ 54' 35.068" N; Longitude: 01˚ 29' 0.208" E
Total Spill Quantity	151 m^3
Leak Rate	1.57 m^3/hour
Spill Duration	4 days
Model Duration	20 days
Wind Conditions	30 knot onshore wind
Water Depth	19 m

OSCAR Model Image Taken 4 Days and 3 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = Dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Dark yellow squares along shoreline = shoreline concentration of hydrocarbons (kg/m^2);
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 151 m^3 of condensate (47.8˚ API) released over 4 days from the Thames explore pipeline (PL370) 5 kilometres offshore from the MLWM (release location F in Figure 10.1), under theoretical worst case conditions of a constant 30 knot onshore wind, shows that the condensate slick predominately remains centred around the release location, close to shore.

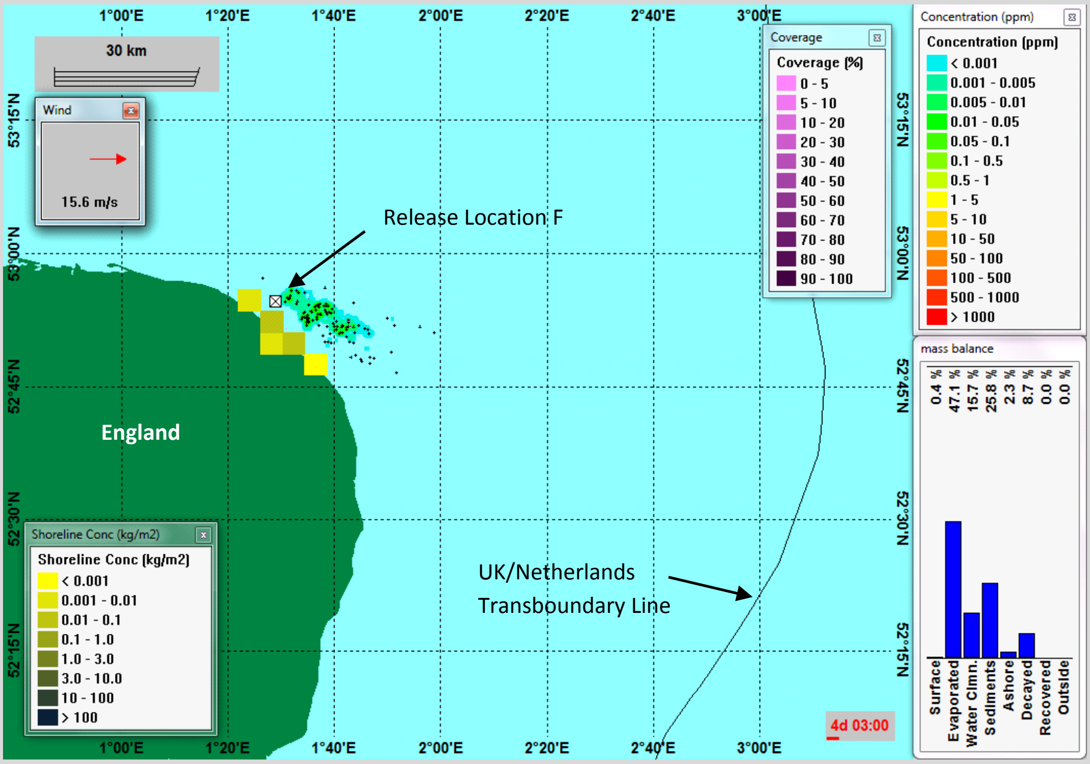
The condensate slick does beach on the UK shoreline (Norfolk), within approximately 3 hours of the initial release. The beached condensate has a worst case concentration of 308.711 g/m^2 which is relatively low. A maximum of 33.65 m^3 of condensate is stranded on the shoreline at any one time during the modelled scenario.

Scenario 16: The weathering of a worst case 151 m^3 condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release location F
The condensate slick does not cross any transboundary lines. After 4 days there is approximately 1.99 m^3 of condensate on the sea surface. The condensate disperses on the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 99 hours, approximately 3 kilometres from the UK coastline. The maximum area of the condensate slick during the release is 0.26 km^2.

Scenario 17: The weathering of a worst case 151 m³ condensate spill with a 30 knot offshore wind (trajectory) from the Thames export pipeline (PL370) at release location F

Condensate Type	47.8˚API (LAVRANS)
Release Location	Latitude: 52˚ 54’ 35.068” N; Longitude: 01˚ 29’ 0.208” E
Total Spill Quantity	151 m^3
Leak Rate	1.57 m^3/hour
Spill Duration	4 days
Model Duration	20 days
Wind Conditions	30 knot offshore wind
Water Depth	19 m

OSCAR Model Image Taken 4 Days and 3 Hours After Initial Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Purple coloured patches = surface hydrocarbon coverage;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Dark yellow squares along shoreline = shoreline concentration of hydrocarbons (kg/m²);
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 151 m³ of condensate (47.8˚ API) released over 4 days from the Thames explore pipeline (PL370) 5 kilometres offshore from the MLWM (release location F in Figure 10.1), under theoretical worst case conditions of a constant 30 knot offshore wind, shows that the hydrocarbon slick is predominately pushed to the east and south east of the release location

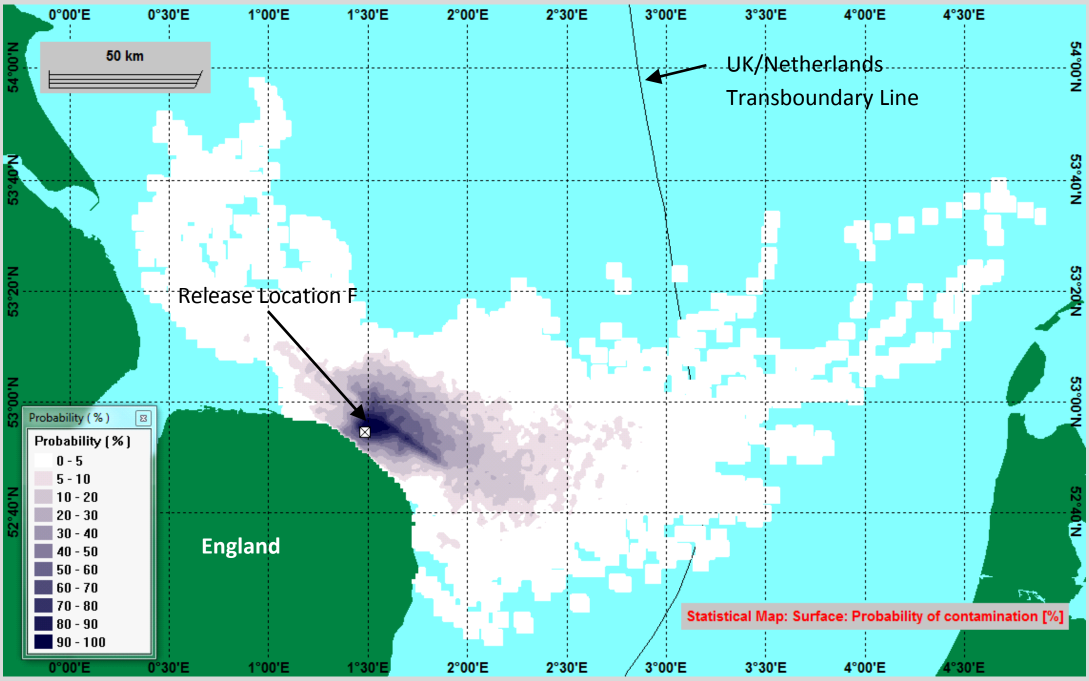
The condensate does beach on the UK shoreline (Norfolk), 9 hours after of the initial release. The worst case concentration of beach condensate is of 27.08g/m², which is relatively low. The maximum amount of condensate to be stranded on the shoreline at any one time is 3.8 m³.

The condensate slick does not cross any transboundary lines.

Scenario 17: The weathering of a worst case 151 m^3 condensate spill with a 30 knot offshore wind (trajectory) from the Thames export pipeline (PL370) at release location F
After 4 days there is approximately 1.59 m^3 of condensate on the sea surface. The maximum area of the slick during the release is 0.42 km^2 and the condensate disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 99 hours, approximately 3 kilometres from the UK coastline.

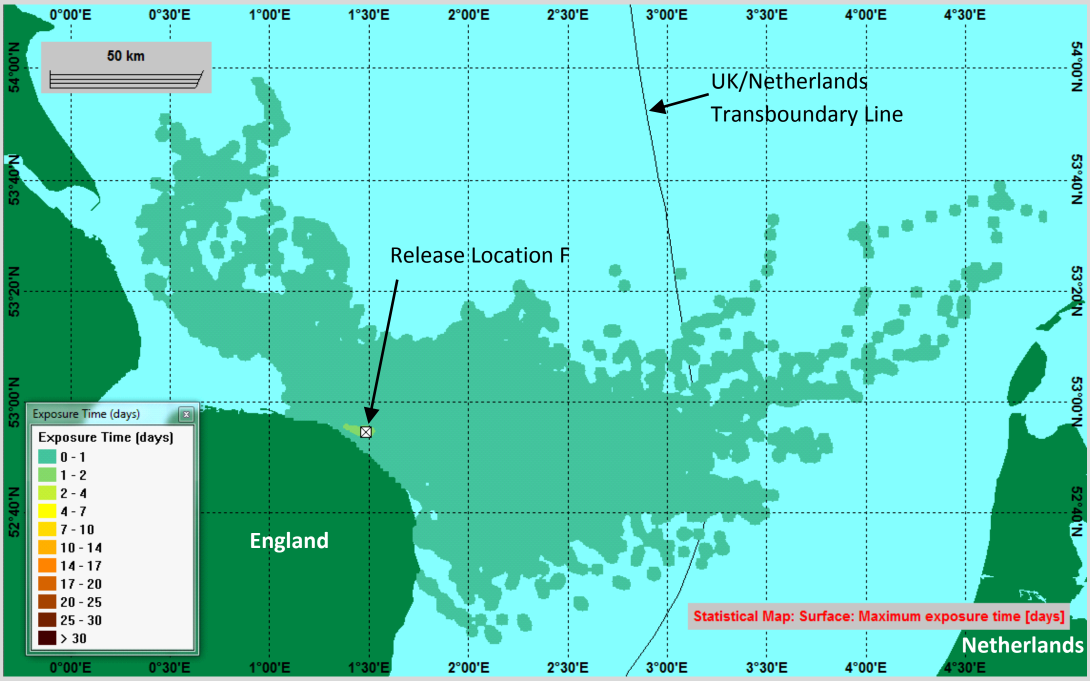
Scenario 18: The weathering of a release of 151 m³ of condensate under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location F	
Condensate Type	47.8˚API (LAVRANS)
Release Location	Latitude: 52˚ 54' 35.068" N; Longitude: 01˚ 29' 0.208" E
Total Spill Quantity	151 m^3
Leak Rate	1.57 m^3/hour
Spill Duration	4 days
Model Duration	20 days
Wind Conditions	Typical
Water Depth	20 m (rounded to the nearest 5 m)

18a. Probability (%) of Surface Hydrocarbons being present

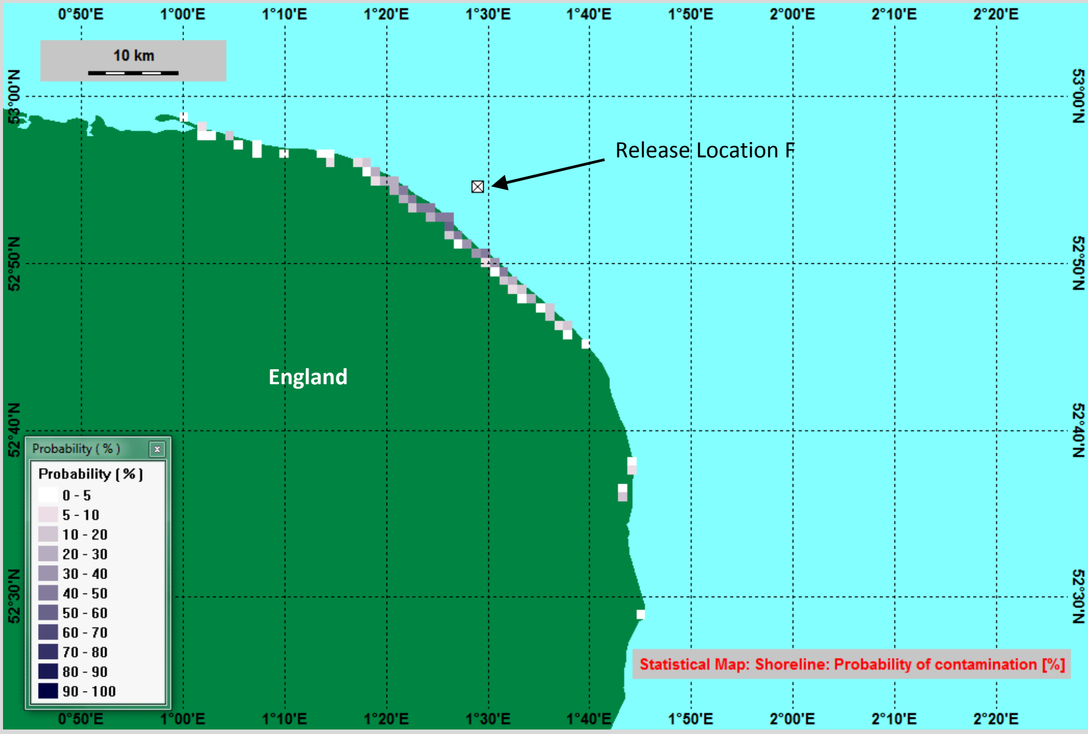


Scenario 18: The weathering of a release of 151 m³ of condensate under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location F

18b. The Maximum Exposure time (days) of surface oil



18c. Probability of Shoreline Contamination (%)



Summary of Results:

Stochastic modelling for a worst case scenario of 151 m³ of condensate (47.8˚API) released over 4 days from the Thames export pipeline (PL370) 5 kilometres offshore of the MLWM (release location F in Figure 10.1), under typical conditions showed that the condensate slick is predominantly pushed to the north west and east of the release location.

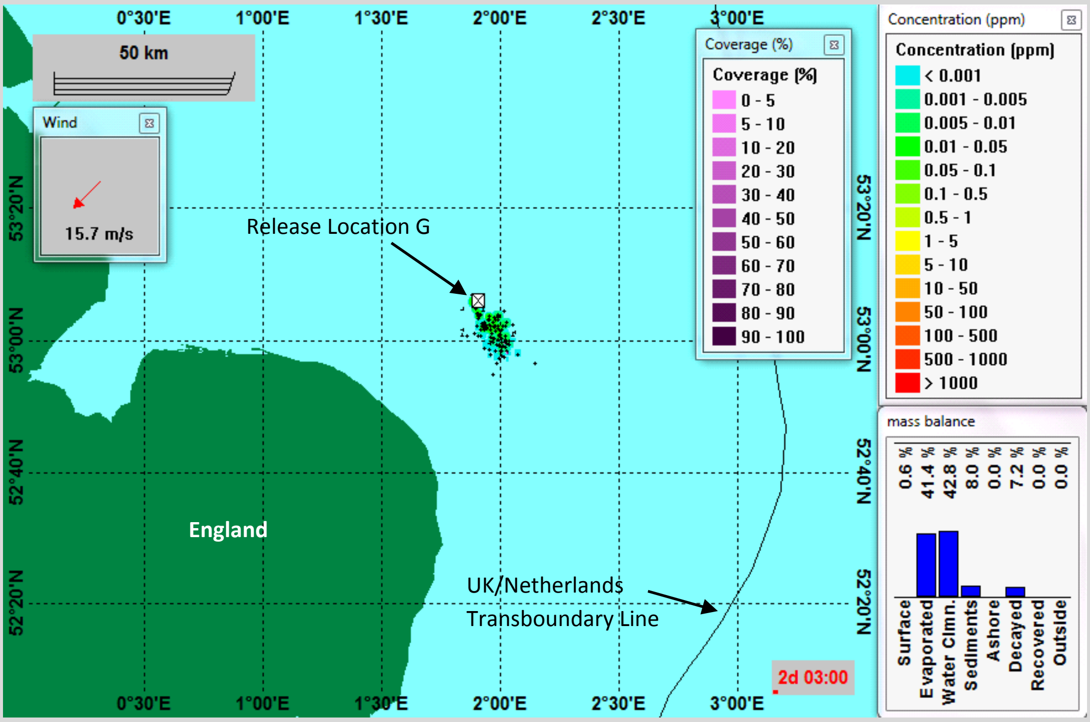
There is a 55% probability of the condensate beaching on the UK coastline (Figure 18a). The worst case maximum accumulation of condensate on the shore is 37.13 m³ and the shortest shoreline arrival time is

Scenario 18: The weathering of a release of 151 m^3 of condensate under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location F
5.7 hours. The model estimates that 29.28 km^2 of the coastline are at risk from more than a 5% probability of oiling (Figure 18c). There is a < 5 % probability that the hydrocarbon slick will cross the UK/Netherlands transboundary line (Figure 18a), however there is zero probability of the condensate beaching on the Dutch coastline. Due to the relative lightness of the condensate (47.8˚API) released from the Thames export pipeline (PL370) at 5 km offshore from the MLWM, the hydrocarbons do not persist on the surface for any great length of time. The Figure 18b in Scenario 18 shows the maximum exposure time (in days) of surface hydrocarbons is 2-4 days on the sea surface.

Scenario 19: The weathering of a worst case instantaneous 76 m^3 condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release location G

Condensate Type	Condensate (47.8˚ API)
Release Location	Latitude: 53˚ 5’ 58.423” N; Longitude: 01˚ 54’ 33.772” E
Total Spill Quantity	76 m^3
Leak Rate	1.57 m^3/hour
Spill Duration	2 days
Model Duration	20 Days
Wind Conditions	30 knot onshore wind
Water Depth	41 m

OSCAR Model Image Taken 2 Days and 3 Hours After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 76 m^3 of condensate (47.8˚ API) released over 2 days from the Thames export pipeline (PL370) at midway along its length (release location G in Figure 10.1), under theoretical worst case conditions of a constant 30 knot onshore wind, shows that the hydrocarbon slick is predominately pushed to the south east of the release location.

The condensate slick does not beach on the UK coastline.

The condensate slick does not cross any transboundary lines.

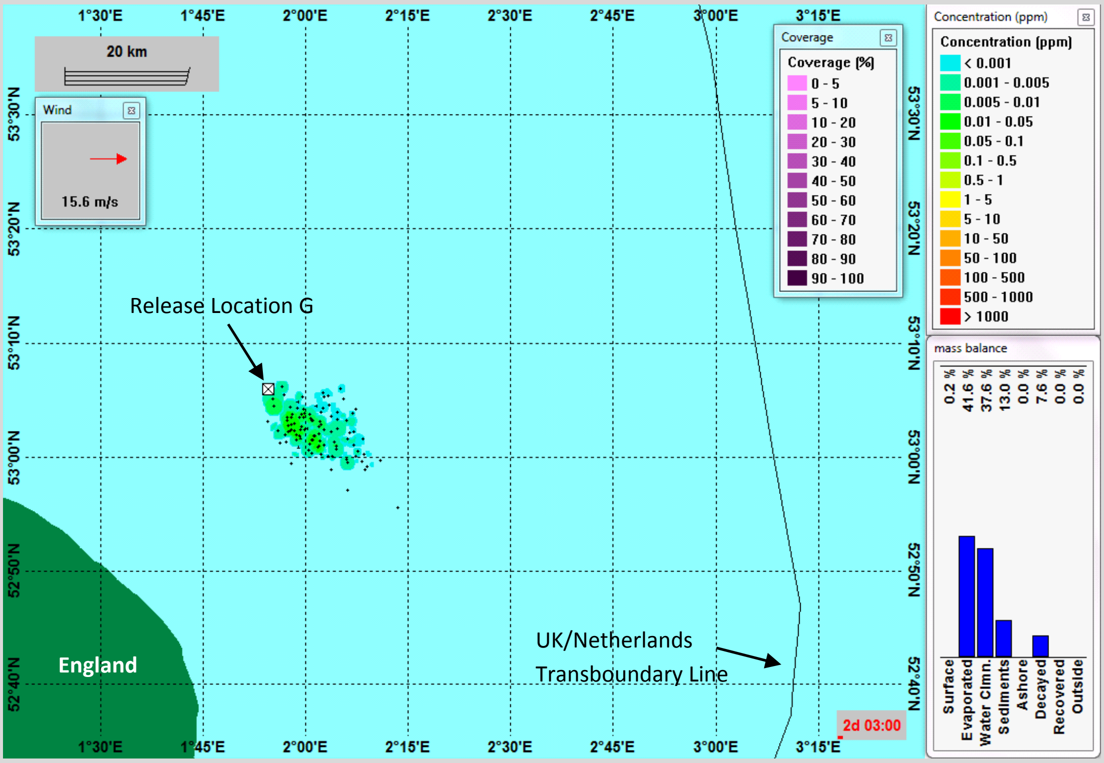
After 2 days there is approximately 1.33 m^3 of condensate on the sea surface. The maximum area of the slick during the release is 0.46 km^2 and the condensate disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 51 hours, approximately 36 kilometres from the UK coastline.

Scenario 19: The weathering of a worst case instantaneous 76 m³ condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release location G

Scenario 20: The weathering of a worst case instantaneous 76 m³ condensate spill with a 30 knot offshore wind (trajectory) from the Thames export pipeline (PL370), at release location G

Condensate Type	Condensate (47.8˚ API)
Release Location	Latitude: 53˚ 5' 58.423" N; Longitude: 01˚ 54' 33.772" E
Total Spill Quantity	76 m³
Leak Rate	1.57 m³/hour
Spill Duration	2 days
Model Duration	20 days
Wind Conditions	30 knot offshore wind
Water Depth	41 m

OSCAR Model Image Taken 2 Days and 3 Hours After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

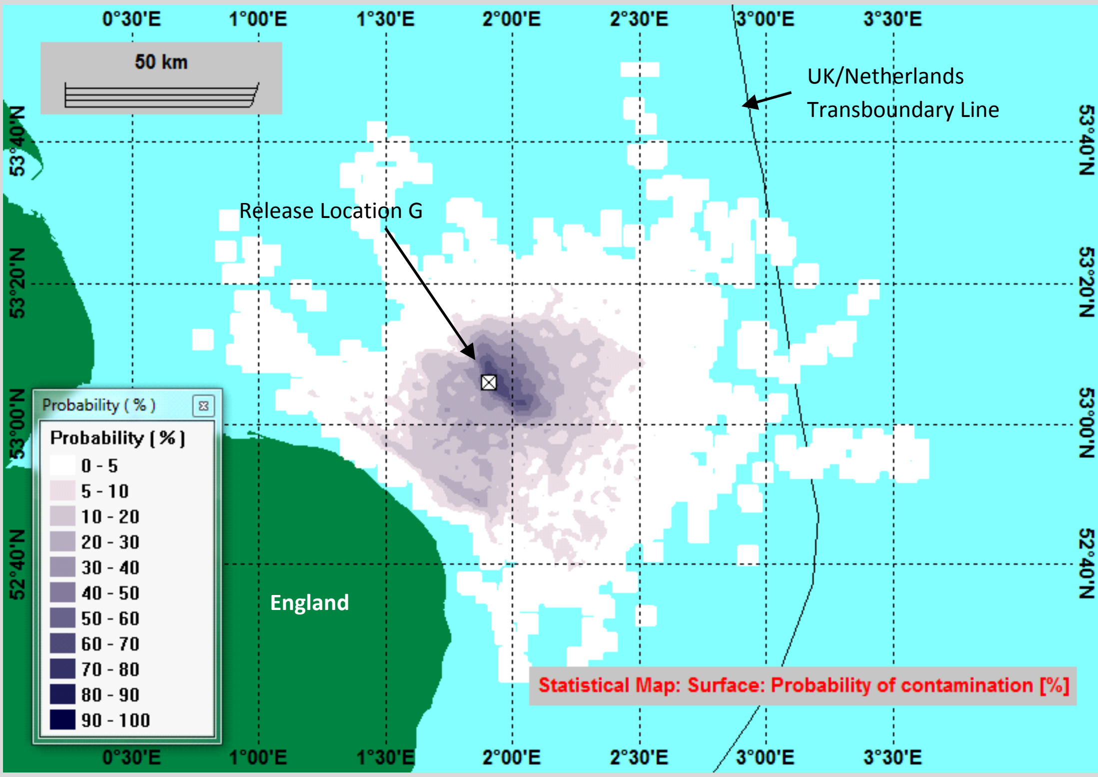
Trajectory modelling for a worst case scenario of 76 m³ of condensate (47.8˚ API) released over 2 days from the Thames export pipeline (PL370) at midway along its length (release location G in Figure 10.1), under theoretical worst case conditions of a constant 30 knot offshore wind, shows that the hydrocarbon slick is predominately pushed to the south east of the release location.

The condensate slick does not beach on the UK shoreline. The condensate slick does not cross any transboundary lines. After 2 days there is approximately 1.45 m³ of condensate on the sea surface. The maximum area of the slick during the release is 0.5 km² and the condensate disperses at the sea surface

Scenario 19: The weathering of a worst case instantaneous 76 m³ condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release location G
(i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 51 hours, approximately 42 kilometres from the UK coastline.

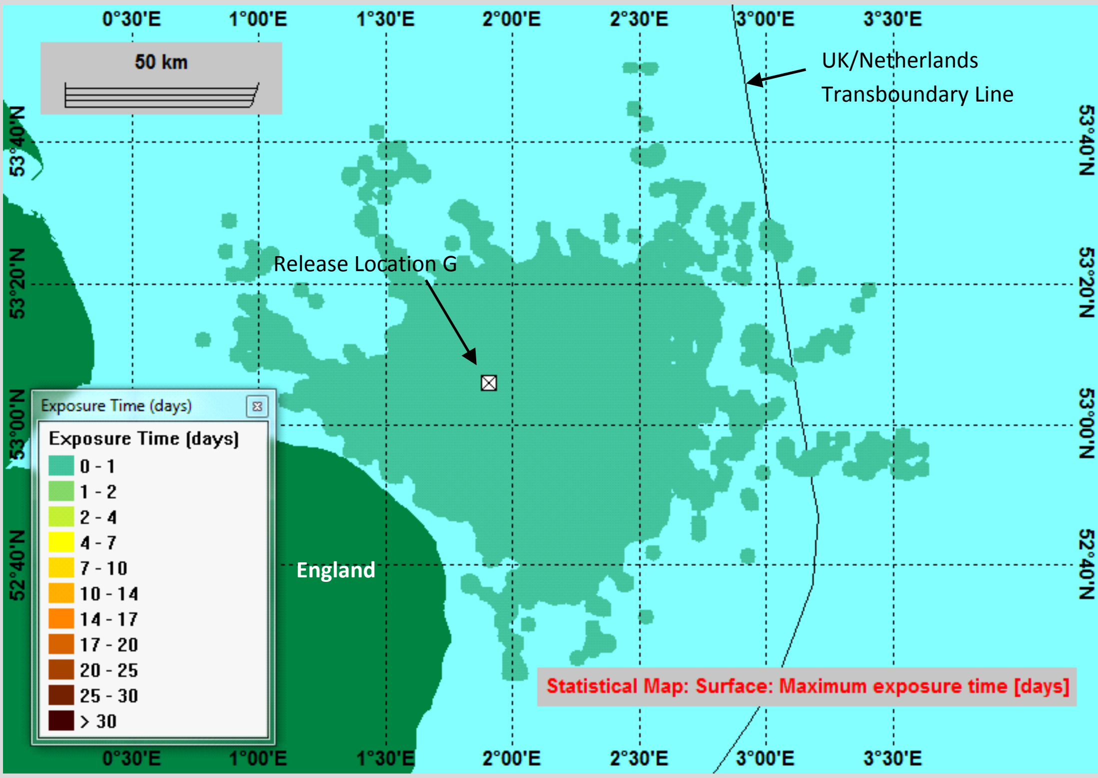
Scenario 21: The weathering of a release of 76 m³ of condensate under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location G	
Condensate Type	Condensate (47.8˚ API)
Release Location	Latitude: 53˚ 5' 58.423" N; Longitude: 01˚ 54' 33.772" E
Total Spill Quantity	76 m³
Spill Rate	1.57 m³/hour
Spill Duration	2 days
Model Duration	20 days
Wind Conditions	Typical
Water Depth	40 m (rounded to nearest 5 m)

21a. Probability (%) of Surface Hydrocarbons being present



Scenario 21: The weathering of a release of 76 m³ of condensate under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location G

21b. The Maximum Exposure time (days) of surface oil



Summary of Results:

Stochastic modelling for a worst case scenario of 76 m³ of condensate (47.8˚API) released over 2 days from the Thames export pipeline at midway along its length (release location G in Figure 10.1), under typical conditions shows that the condensate slick predominantly stays centred around the release location.

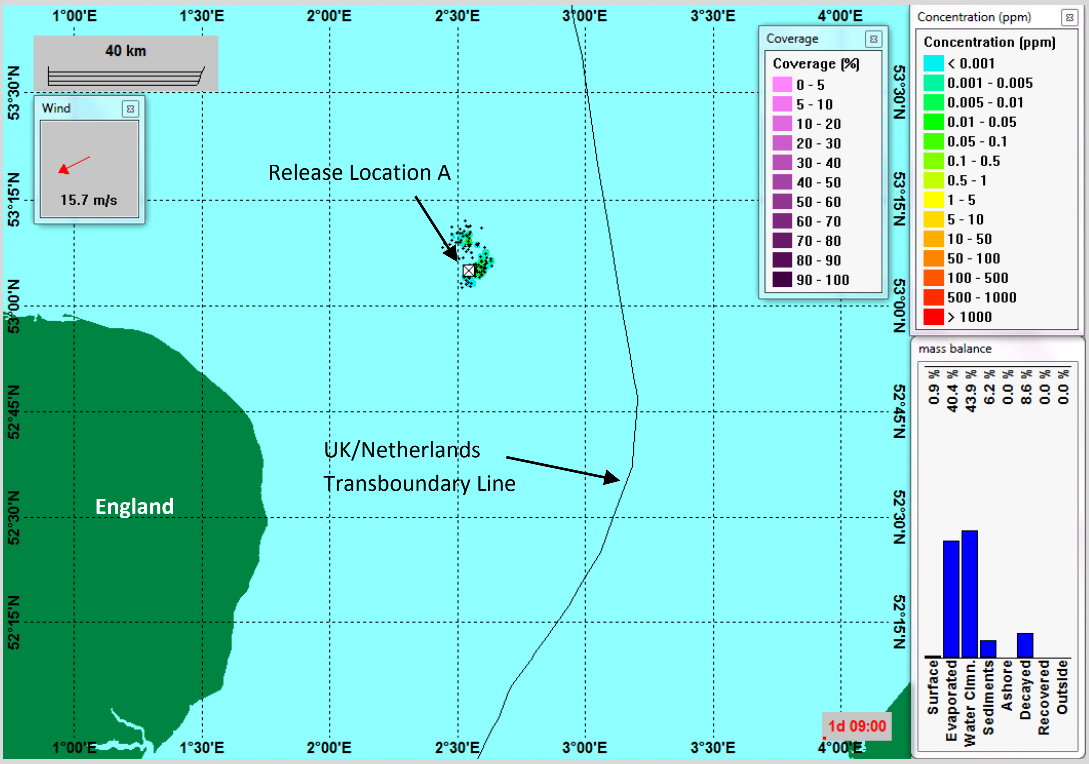
There is zero probability of the condensate beaching on the UK coastline (Figure 21a).

There is a 5 % probability that the condensate slick will cross the UK/Netherlands transboundary line (Figure 21a), however there is zero probability of the condensate beaching on the Dutch coastline.

Due to the relative lightness of the condensate (47.8˚API) released from the Thames export pipeline (PL370), the hydrocarbons do not persist on the surface for any great length of time. The Figure 21b in Scenario 21 shows the maximum exposure time (in days) of surface hydrocarbons is 1-2 days on the sea surface.

Scenario 22: The weathering of a worst case instantaneous 15.1 m³ condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release Location A	
Condensate Type	Condensate (47.8˚ API)
Release Location	Latitude: 53˚ 5' 3.995" N; Longitude: 02˚ 32' 48.995" E
Total Spill Quantity	15.1 m^3
Leak Rate	1.57 m^3/hour
Spill Duration	0.4 days
Model Duration	20 Days
Wind Conditions	30 knot onshore wind
Water Depth	33 m

OSCAR Model Image Taken 1 Day and 9 Hours After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

Trajectory modelling for a worst case scenario of 15.1 m^3 of condensate (47.8˚ API) released over 0.4 days from the Thames export pipeline (PL370) at the Thames Complex (release location A in Figure 10.1), under theoretical worst case conditions of a constant 30 knot onshore wind, shows that the hydrocarbon slick is predominately pushed to the east of the release location.

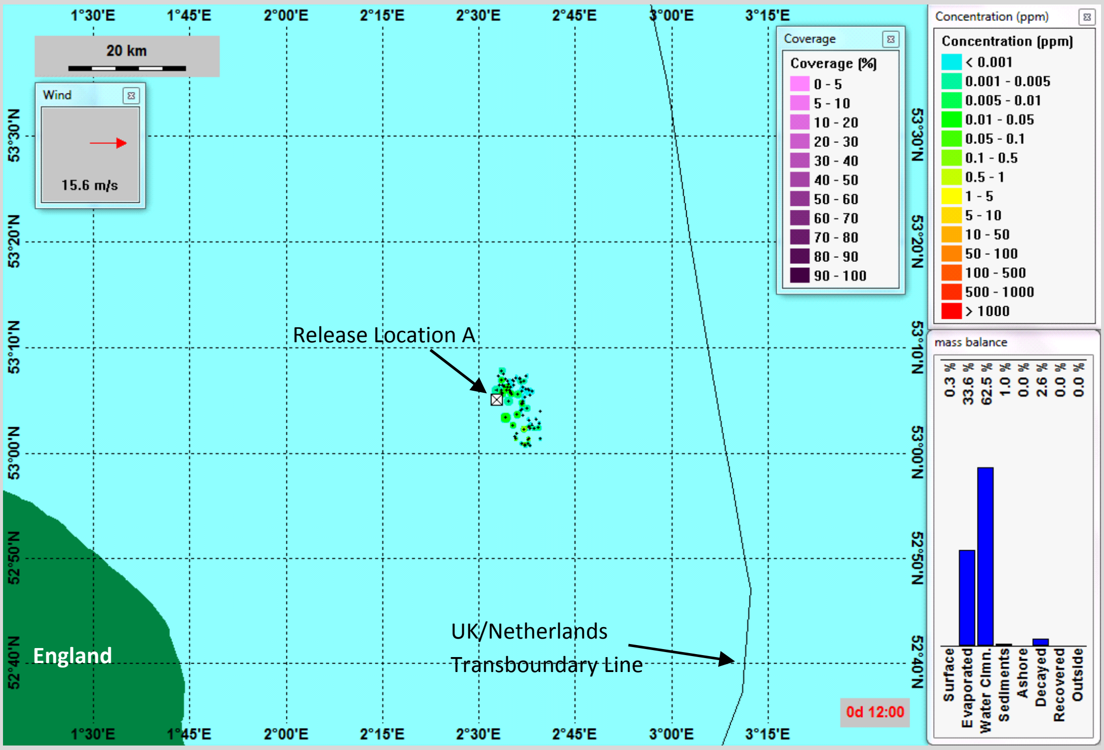
The condensate slick does not beach on the UK coastline. The condensate slick does not cross the UK/Netherlands transboundary line. After 0.4 days there is approximately 0.89 m^3 of condensate on the sea surface. The maximum area of the slick during the release is 0.23 km^2 and the condensate disperses at the sea surface (i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 33 hours, approximately 70 kilometres from the UK coastline.

Scenario 22: The weathering of a worst case instantaneous 15.1 m^3 condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release Location A

Scenario 23: The weathering of a worst case instantaneous 15.1 m^3 condensate spill with a 30 knot offshore wind (trajectory) from the Thames export pipeline (PL370), at release location A

Condensate Type	Condensate (47.8˚ API)
Release Location	Latitude: 53˚ 5' 3.995" N; Longitude: 02˚ 32' 48.995" E
Total Spill Quantity	15.1 m^3
Leak Rate	1.57 m^3/hour
Spill Duration	0.4 days
Model Duration	20 days
Wind Conditions	30 knot offshore wind
Water Depth	33 m

OSCAR Model Image Taken 12 Hours After Release



Key:

- Black dots = dissolved hydrocarbon particles;
- Multi-coloured areas = dissolved concentration of hydrocarbons (ppb);
- Purple coloured patches = surface hydrocarbon coverage;
- Mass balance box displays the fate of the oil over time.

Summary of Results:

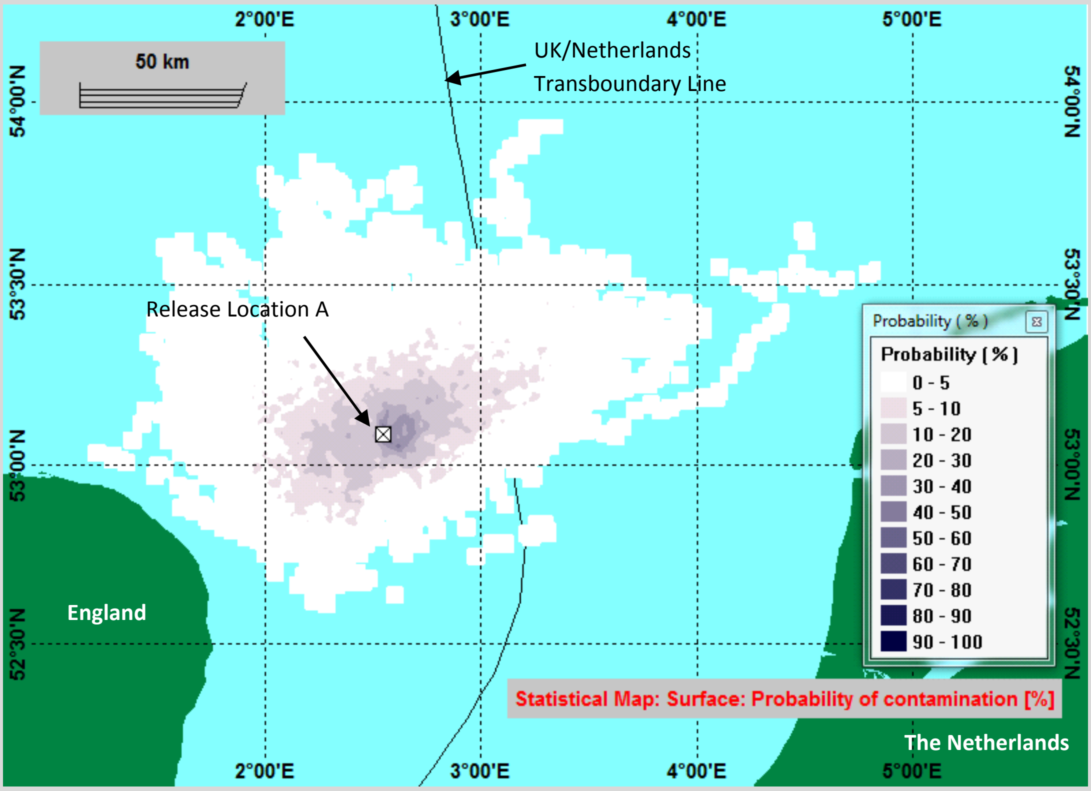
Trajectory modelling for a worst case scenario of 15.1 m^3 of condensate (47.8˚ API) released over 0.4 days from the Thames export pipeline (PL370) at the Thames Complex (release location A in Figure 10.1), under theoretical worst case conditions of a constant 30 knot offshore wind, shows that the hydrocarbon slick is predominately pushed to the east of the release location.

The condensate slick does not beach on the UK coastline. The condensate slick does not cross any transboundary lines. After 0.4 days there is approximately 0.05 m^3 of condensate on the sea surface. The maximum area of the slick during the release is 0.11 km^2 and the condensate disperses at the sea surface

Scenario 22: The weathering of a worst case instantaneous 15.1 m³ condensate spill with a 30 knot onshore wind (trajectory) from the Thames export pipeline (PL370), at release Location A
(i.e. there is less than 1 % of the total released hydrocarbons present on the sea surface) after 12 hours, approximately 73 kilometres from the UK coastline.

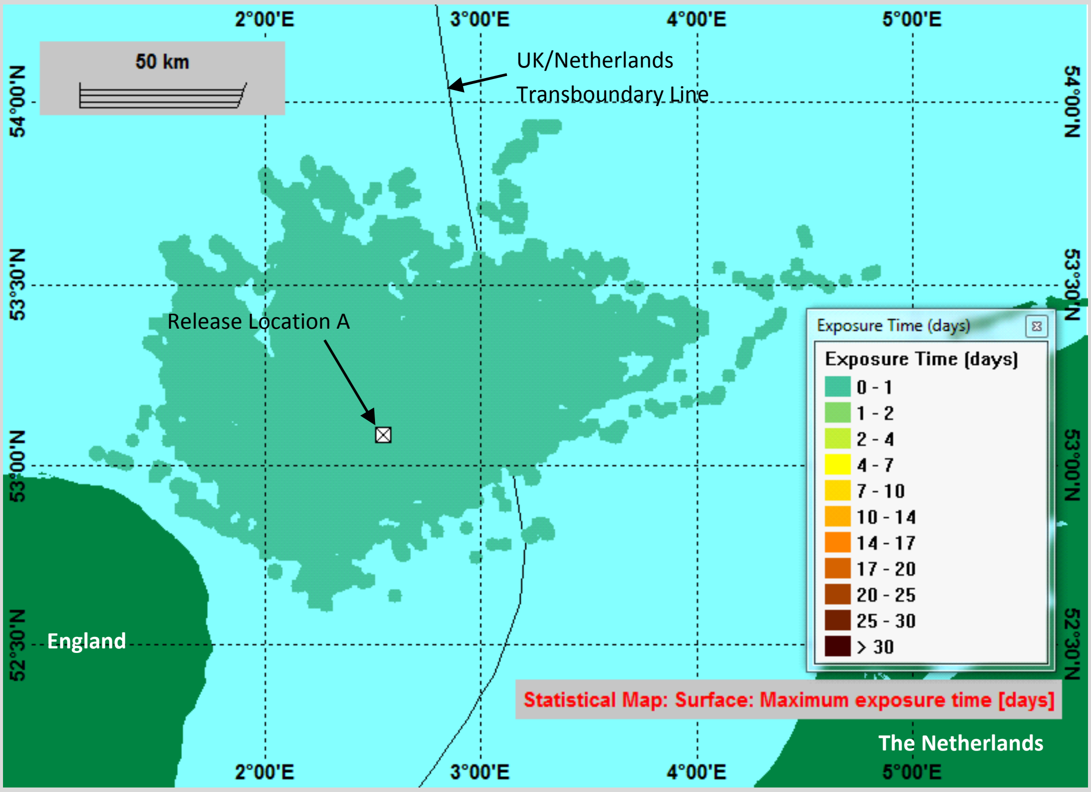
Scenario 24: The weathering of a release of 15.1 m³ of condensate oil under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location A	
Condensate Type	Condensate (47.8˚ API)
Release Location	Latitude: 53˚ 5' 3.995" N; Longitude: 02˚ 32' 48.995" E
Total Spill Quantity	15.1 m^3
Spill Rate	1.57 m^3/hour
Spill Duration	0.4 days
Model Duration	20 Days
Wind Conditions	Typical
Water Depth	30 m (rounded to nearest 5 m)

24a. Probability (%) of Surface Hydrocarbons Being Present



Scenario 24: The weathering of a release of 15.1 m^3 of condensate oil under 'typical' conditions (stochastic) from the Thames export pipeline (PL370), at release location A

24b. The Maximum Exposure Time (Days) of Surface Oil



Summary of Results:

Stochastic modelling for a worst case scenario of 15.1 m^3 of condensate (47.8˚API) released over 0.4 days from the Thames export pipeline, at the Thames Complex (release location A in Figure 10.1), under typical conditions showed that the condensate slick is pushed slightly to the north east of the release location.

There is a zero probability of the condensate slick beaching on the UK coastline (Figure 24a).

There is a 13 % probability that the condensate slick will cross the UK/Netherlands transboundary line, however there is a zero probability of the condensate slick beaching on the Dutch coastline (Figure 24a).

Due to the relative lightness of the condensate (47.8˚API) released from the Thames export pipeline, the hydrocarbons do not persist on the surface for any great length of time. The Figure 24b in Scenario 24 shows the maximum exposure time (in days) of surface hydrocarbons is 0-1 days on the sea surface.

10.4 Summary of Mitigation Measures

Mitigations measures to reduce the risk of an oil spill at the Thames Area Decommissioning include:

1. Loss of Rig Inventory

An incident, such as a collision, could potentially cause the entire inventory of hydrocarbons stored on the rig to be released to the sea. For Mobile Offshore Drilling Units (MODU) in the North Sea between 1980 and 1997 a total loss accident frequency of 3.75 occurrences per 1,000 unit years has been recorded (Worldwide Offshore Accident Databook – Statistical Report 1998, DET NORSKE VERITAS). In practice it is most likely that any release of oil would occur over a period of time. An immediate release could, however, occur in the unlikely event that all compartment/tanks containing oil were instantaneously fractured in some way.

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

2. *Fuel Transfer*

Small spills of hydrocarbons (< 1 tonne) can occur during re-fuelling of the rig (bunkering).

Before commencing operations, if practicable, Perenco will try to ensure the rig and vessels are fully bunkered prior to moving onto location. When fuel transfer is required the following precautions will be taken, whenever possible:

- Supervision or operations on both supply boat and drill rig / vessels;
- Transfers to take place during daylight hours and only in calm sea and weather conditions, whenever possible;
- Use of non-return valves on bulk transfer hoses;
- Transfer hoses are regularly maintained and inspected and a close visual inspection of them carried out prior to transfer to or from a supply vessel;
- Use of flotation collars on hoses;
- There is bunding around each of the loading stations and around the main fuel oil tank vents on the main deck.

Perenco will ensure that the rig / vessel crew have been trained and regularly hold exercises to contain and clean up deck spills and safely store contaminated material until its ultimate disposal on shore. Training records will be held on board.

3. *Deck Spills*

- The drilling area of the rig has plate decks and is protected by a bund. Bunds are fitted at all times except during heavy rain or washdown. Drainage within this area is to the closed drain system and all water is treated by the water treatment system prior to release to the sea. Outside this area, locations where inventories of utility oils and chemicals are stored are covered with bunded areas and drip tray/save-alls below spring loaded valves on fuel oil tanks.
- Special training is given to personnel with the responsibility for the operation of valves, particularly dump valves, to make them aware of the importance to the environment of preventing accidental oil spills in general and in the correct identification and utilisation of valves prior to their use.
- Clean-up equipment is available for deck spills and two containers of specialised equipment are sited on the main deck. Training is given in the control and clean-up of oil spills.

4. *General*

Perenco will also ensure that operations staff are fully aware of their responsibilities under the Oil Pollution Emergency Plan (OPEP), are trained in the appropriate response techniques and are involved in at least one response exercise per shift, per year, to ensure that the Plan can be implemented effectively. All personnel, both offshore and onshore, who are involved in the Thames Area Decommissioning, will be fully briefed as to the sensitivities in the area. This will be covered in the well programmes, pre-spud meetings and toolbox talks and in the Health, Safety, Environmental Management System (HSE MS).

10.5 Conclusions

The Thames Area Decommissioning is located in an area of the North Sea that has an active hydrological regime which will assist in the natural dispersion and dilution of pollutants. Although the area surrounding the Thames Area location is sensitive for both fish spawning and cetaceans, the main sensitivity from a spill is to seabirds, with predominantly very high / high seabird vulnerability (1 or 2 out of 4) occurring in Blocks 48/28-30, 49/26-30, 50/26, 52/3 and 53/2-4 at some time throughout the year. Seabirds could be affected by a diesel or condensate release as the hydrocarbons could affect the bird’s plumage, causing feathers to mat and separate, impairing waterproofing and exposing the animal's sensitive skin to extremes in temperature. In cases with heavy crude oils, this can result in hypothermia, meaning the birds can become cold, or hyperthermia, which results in overheating. Instinctively, the bird tries to get the oil off its feathers by preening, which results in the animal ingesting the oil and causing severe damage to its internal organs. However, as condensate and diesel are both light oils, the impact on seabirds is reduced when compared to crude oil spills (*bird-rescue.org, 2013*). In addition, the condensate and diesel do not persist in the marine environment for any great time (see Scenarios 1-24).

The modelling carried out for the planned operations allows the following conclusions to be drawn:

Diesel and condensate spills are more likely to affect the environment within the vicinity of the drilling rig and / or vessels. The maximum dispersion time for any of the diesel spills is 39 hours, with a 5 percent probability of beaching and a 65 percent probability of crossing the UK / Netherlands transboundary line. The worst case condensate spill (5 kilometres from the MLWM) released over a period of 4 days will beach after 3 hours, with a 55 percent probability. There is a small (13 percent) probability that the condensate spill could cross the median line, when released from the Thames platform location.

The residual impact from potential oil spill is considered to be Moderate

11 The Impact of Solid Wastes

11.1 Assessment of Potentially Significant Impacts

11.2 Regulatory Regime

The management and disposal of solid waste will be covered by The Environment Protection Act 1990 (EPA 90), the Control of Pollution (Amendment) Act 1989 (as amended), the Mercury Export and Data (Enforcement) Regulations 2010 and The Radioactive Substances Act (1993).

11.3 Operational Waste Management

Careful consideration is given to minimising the amount of waste generated and controlling its eventual disposal. Furthermore, there is a waste management plan in place for the drilling rig, which covers the entire decommissioning programme.

Typically, up to 8 tonnes of waste per month is generated from a drilling / decommissioning programme. Bulk wastes (e.g. garbage, scrap metals etc.) generated on the drilling rig will be segregated by type and back loaded to shore where they can be recycled or disposed of in a controlled manner. Perenco will ensure that an effective waste management programme is implemented to minimise the amounts generated and to ensure material such as scrap metal, waste oil and surplus chemicals are sent for recycle or re-use as far as practicable. Other waste will be sent to authorised landfills or incineration facilities, depending on its precise nature.

Mitigation Measures

- Perenco will ensure that an effective waste management plan is put in place prior to decommissioning activities commencing.

Conclusions

Providing the Perenco waste management plan is adhered to, there should be no significant impacts resulting from the generation and disposal of operational solid waste, during the Thames Area Decommissioning operations. Therefore, the residual impact from operational solid waste is expected to be minor.

The residual impact from operational solid waste is considered to be Minor

11.4 Decommissioning Materials

The Thames Area Decommissioning activities will result in the generation of decommissioning materials that will need to be brought to shore for appropriative disposal and processing. The expected material inventory, which will be recovered during the Thames Area Decommissioning, is shown in Section 2.7. The materials are defined as ‘controlled waste’ in Section 75(4) of the Environmental Protection Act 1990 as ‘household, industrial and commercial waste or any such waste’.

Any waste that arises from the decommissioning of the Thames Area will be treated and disposed of in accordance with all relevant legislation and company policy. Wastes will be categorised and handled in a manner that will minimise the threat to personnel and the environment. In order to maximise the reuse and recycle rate of decommissioning wastes, Perenco will minimise the volume of materials destined for incineration/landfall. Materials will be segregated for ease of handling and to reduce the energy used when transporting different materials to their respective recycling, reuse or disposal facilities. Each waste stream will be assessed individually in order to implement the most favourable option. The waste stream management methods are detailed in each individual Decommissioning Programme.

Any non-hazardous waste (i.e. steel, copper, plastics etc), which have not been contaminated with special waste (i.e. chemicals, NORM etc) will be removed and recovered for reuse, recycling or disposal in landfill. Any special waste (i.e. NORM, oil and chemicals) will require additional treatment from specialised waste contractors.

Prior to decommissioning activities commencing, Perenco will also compile a detailed waste management plan for dealing with all of decommissioning waste materials. It is expected that those recovered materials that can be recycled / re-used (i.e. steel) will be subject to processing and / or recycling. Materials that cannot be recycled / re-used (i.e., cement) will be treated, cleaned and then transported to appropriate disposal in landfill.

Any NORM-contaminated material returned to shore will be treated, recycled or disposed of as appropriate, in line with the Radioactive Substances Act 1993. The selected NORM contractor will have the experience and management procedures in place to handle and dispose of the NORM in a responsible way and in accordance with the Radioactive Substances Act 1993. Procedures for NORM LSA scale and radioactive components will be in accordance with company procedures.

Figure 11.1 details the breakdown of Thames Area materials that will be recovered and left in-situ. The figure shows that 86 percent of the total Thames Area Decommissioning materials will be left in-situ (this will be mainly attributed to pipelines and stabilisation materials). Approximately 14 percent of the total material inventory will be recovered for onshore disposal and processing (note this figure assumes that all of the concrete mattresses within the Thames Decommissioning Area are recovered).

Figure 11.1: Breakdown of the Thames Area materials between those expected to be recovered and those that will remain *in-situ*

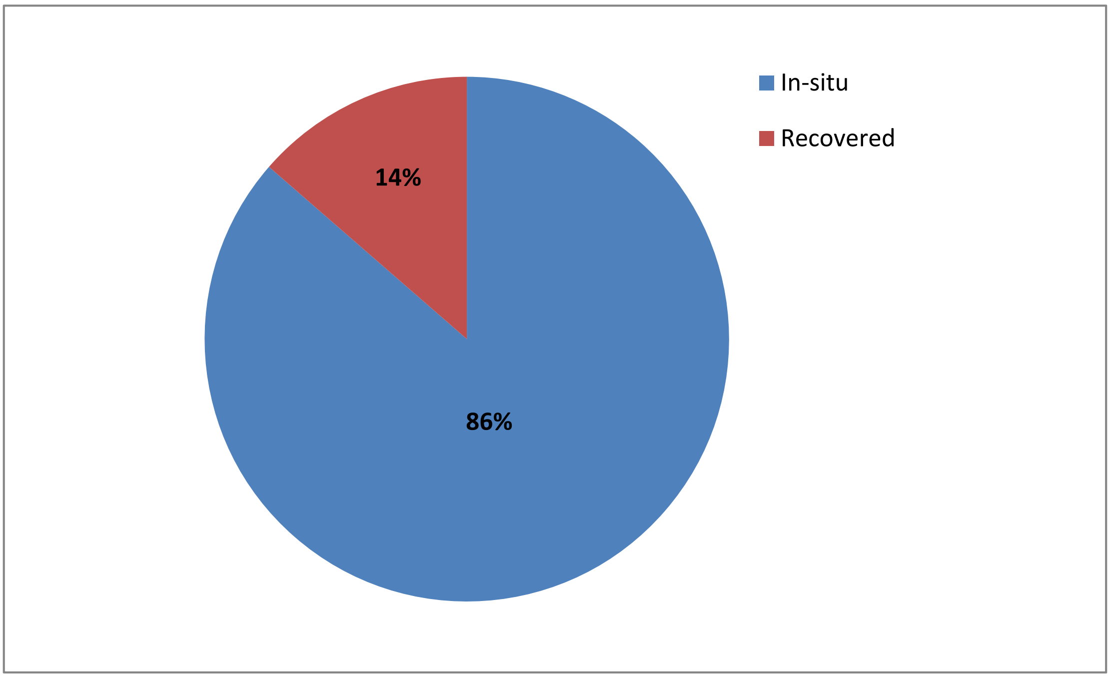


Figure 11.2 shows the breakdown of the recovered materials by type. The figure shows that over 73 percent of the recovered materials will be steel, which over 90 percent of this is expected to be recycled. The next largest material by weight will be cement and concrete (over 25 percent), which will be cleaned and disposed of in landfill (note this figure assumes that all of the concrete mattresses within the Thames Decommissioning Area are recovered).

Figure 11.2: Breakdown by material type of the Thames Area recoverable materials

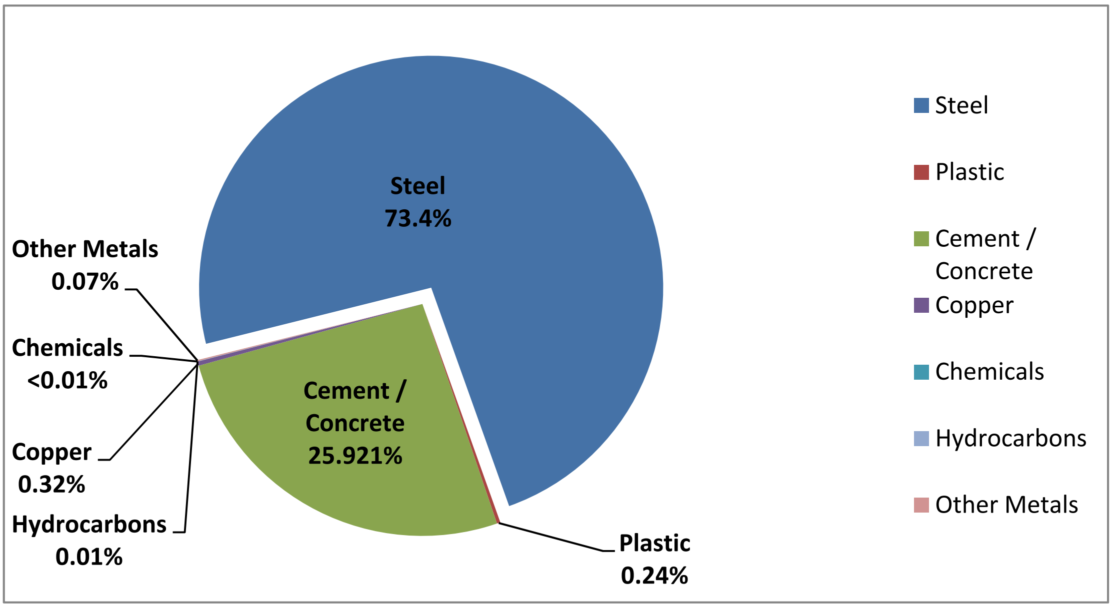
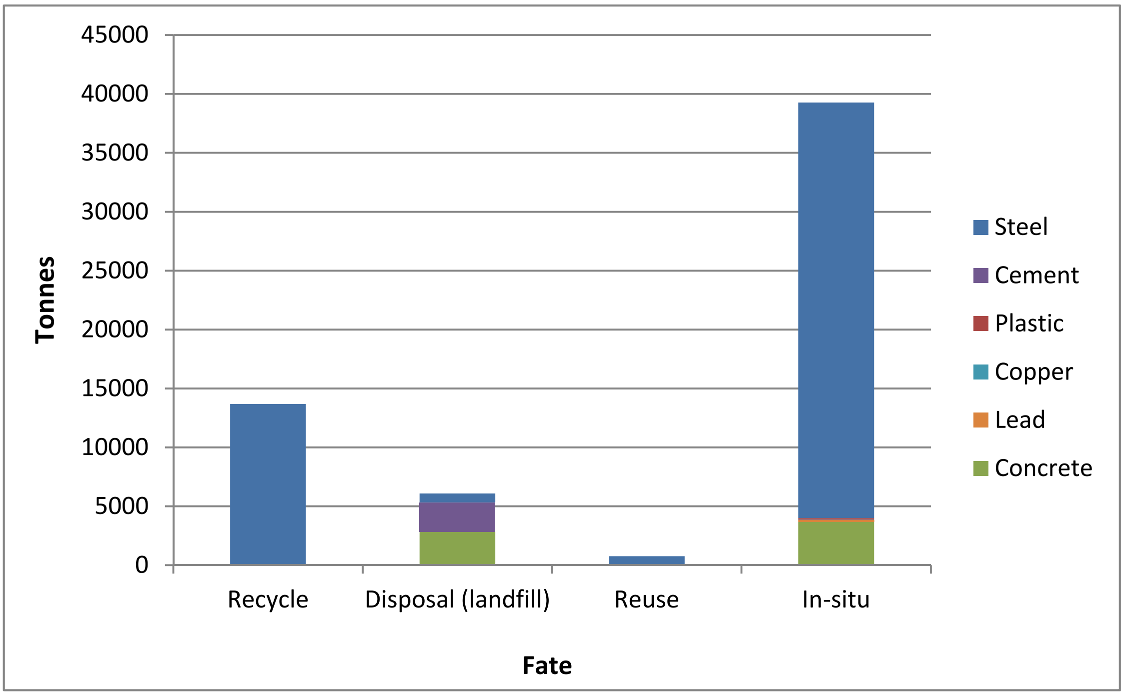


Figure 11.3 shows the breakdown of the tonnage of the Thames Area Decommissioning materials and the expected fate. The figure shows that the majority of the materials will be left in-situ, but of the recovered materials, the majority will be recycled. The materials that are destined for landfill are mainly attributed to concrete and cement.

Figure 11.3: Breakdown of the estimated tonnage and waste fates of material from the Thames Area Decommissioning



Mitigation Measures

- Perenco will ensure that an effective waste management plan is put in place prior to decommissioning activities commencing;
- Perenco will ensure all waste contractors are audited and meet relevant legislation;

- Perenco will actively seek to reduce the amount of recovered materials that are sent to landfill.

Conclusions

Providing the Perenco waste management plan is adhered to, there should be no significant impacts resulting from the generation and disposal of Thames Area Decommissioning waste materials. Therefore, the residual impact from the decommissioning waste materials is expected to be minor.

The residual impact from decommissioning waste materials is considered to be Minor

11.5 Summary of Mitigation Measures

- Perenco will ensure that an effective waste management plan is put in place prior to decommissioning activities commencing;
- Perenco will ensure all waste contractors are audited and meet relevant legislation;
- Perenco will actively seek to reduce the amount of recovered materials that are sent to landfill.

12 Transboundary Impacts

12.1 Assessment of Potentially Significant Impacts

12.2 Regulatory Regime

The main regulations relating to transboundary issues are those related to the OPEP (see Section 9).

12.3 Unplanned Hydrocarbon Releases

The Orwell subsea wells are the closest of the Thames Area Decommissioning infrastructure to a transboundary line. The wells are located approximately 4 kilometres to the west of the UK / Netherlands transboundary line.

Under the worst case wind conditions at the Orwell location (position C in Figure 10.1 and scenarios 7, 8 & 9) the diesel spill crossed the transboundary line after 3 hours (30 knot offshore wind) and under stochastic modelling (typical conditions) returned a probability of 43 percent that the diesel could cross the transboundary line. In addition, the stochastic modelling results also gave a 5 percent probability that the diesel could cross the Netherlands/Germany transboundary line.

In two instances (scenarios 3 and 9) the modelling results indicate that there would be a 5 percent probability of the diesel beaching on the Netherlands coastline.

For condensate releases, the modelling in scenario 24 indicated a 13 percent probability that the spill could also cross the UK/Netherlands transboundary line.

If a diesel or condensate spill did cross the transboundary line, then the Bonn agreement would be activated. In accordance with the Bonn Agreement for Co-operation in dealing with Pollution of the North Sea by Oil & Other Harmful Substances, 1983, all states bordering the North Sea notify each other of marine pollution or the threat of marine pollution and assist one another in dealing with incidents. Reporting of any incidents will be made to the UK authorities (which will be detailed in the Thames Area Decommissioning OPEP) who will, if appropriate, advise authorities in other jurisdictions.

Mitigation Measures

- Perenco will ensure that the Bonn agreement is fully detailed in the Thames Area Decommissioning OPEP.

Conclusions

Given the distance from the transboundary line to some of the Thames Area Decommissioning infrastructure (Orwell in particular) it is likely that should a spill occur the UK/Netherlands transboundary line would be crossed and foreign waters impacted. However, as the hydrocarbons involved are diesel and condensate, in the event of a spill neither would persist on the surface of the sea for a significant time. Even a complete fuel inventory loss from the SHLV (releasing 18,700 cubic metres), the diesel would only persist for a maximum of approximately 4 days (scenario 3). Therefore, the residual impact to transboundary areas from hydrocarbon releases would be minor.

The residual impact from potential unplanned hydrocarbon releases on transboundary areas is considered to be Minor

12.4 Atmospherics Emissions

Due to the distance of the Orwell subsea wells to the UK/Netherlands transboundary line (approximately 4 kilometres) there could be minor increases of the atmospheric greenhouse concentrations over the median line. However, due to atmospheric dispersion, the concentrations are expected to be minute over a few kilometres from source. In addition, the operations will be temporary in nature and therefore the transboundary impact from atmospheric emissions is expected to be minor.

Mitigation Measures

- Advanced planning to ensure efficient operations;
- Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels;
- Generators will be running on the minimum power for the job task to avoid unnecessary emissions;
- Well maintained and operated power generation equipment; and
- Regular monitoring of fuel consumption.

Conclusions

The impact to transboundary areas from atmospheric emissions is expected to be temporary in nature and therefore the residual impact is expected to be minor.

The residual impact from atmospheric emissions on transboundary areas is considered to be Minor

12.5 Chemical and Planned Hydrocarbon Discharges

Due to the planned volumes of chemicals and hydrocarbons to be discharged, and distances from the discharges to the transboundary line, no transboundary impacts are expected.

The residual impact from planned chemical and hydrocarbon discharges on transboundary areas is considered to be Negligible

12.6 Summary of Mitigation Measures

- Perenco will ensure that the Bonn agreement is fully detailed in the Thames Area Decommissioning OPEP;
- Advanced planning to ensure efficient operations;
- Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels;
- Generators will be running on the minimum power for the job task to avoid unnecessary emissions;
- Well maintained and operated power generation equipment; and
- Regular monitoring of fuel consumption.

13 Cumulative Impacts

13.1 Assessment of Potentially Significant Impacts

Given the distance to other existing oil and gas field developments in the vicinity of the proposed Thames Area Decommissioning location, it is likely that there would be cumulative impacts.

13.2 Regulatory Regime

There are no regulations directly relating to cumulative impacts, therefore please refer to the individual sections of the below impacts.

13.3 Physical Presence

The presence of the drilling rig and other decommissioning vessels may pose an additional hazard to navigation in the area and add to the over cumulative impact to shipping, fishing and other sea users. Perenco will undertake vessel traffic surveys to assess the available sea room and potential impact caused by these additional vessels / rig being location. However, any cumulative impacts will be temporary in nature and only last for the duration of the decommissioning operations.

Mitigation Measures

- Perenco will undertake vessel traffic surveys to assess the potential cumulative impact from the physical presence of the decommissioning vessels / rig.

Conclusions

The cumulative impact from the physical presence of the decommissioning vessels / rig is expected to be temporary in nature and therefore the residual impact is expected to be minor.

The residual cumulative impact from the physical presence of the decommissioning vessels / rig is considered to be Minor

13.4 Atmospheric Emissions

Atmospheric emissions from the decommissioning activities will also contribute to those from other nearby developments. However, the emissions from the Thames Area Decommissioning are only considered to represent a very small proportion of the regional and UK totals (Refer to Section 8). Decommissioning operations are anticipated to last for a maximum of 480 days and therefore the cumulative impacts associated with the rig and vessels being on location and atmospheric emissions are anticipated to occur throughout this period.

However, once the decommissioning operations are completed, there will be no on-going cumulative impacts from atmospheric emissions.

Mitigation Measures

- Advanced planning to ensure efficient operations;
- Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels;
- Generators will be running on the minimum power for the job task to avoid unnecessary emissions;
- Well maintained and operated power generation equipment; and
- Regular monitoring of fuel consumption.

Conclusions

Due to the temporary nature of the atmospheric emissions from the decommissioning activities and the dispersive capacity of the receiving environment, any cumulative impacts are anticipated to be minor. In addition to this, the atmospheric emissions will not originate from the same location throughout the decommissioning operations and therefore the cumulative will be varied during this period. The cumulative residual impact to from atmospheric emissions is expected to be minor.

The residual cumulative impact from atmospheric emissions is considered to be Minor

13.5 Chemical and Planned Hydrocarbon Discharges

Due to the planned volumes of chemicals and hydrocarbons to be discharged and distances from the discharges to other installations, no cumulative impacts are expected.

The residual cumulative impact from planned chemical and hydrocarbon discharges is considered to be Negligible

13.6 Noise

Cumulative impacts from noise and other ongoing decommissioning projects, as many fields near the end of their life, may cause habitat loss for noise sensitive North Sea species (such as marine mammals). However, the Thames Area Decommissioning operations are temporary in nature and therefore the cumulative impacts from noise are not expected to be significant (see Section 7).

Mitigation Measures

- In order to minimise any potential impact on marine cetaceans from the proposed Thames Area Decommissioning operations (excluding the use of explosives), Perenco will seek to conform to the JNCC protocol for minimising the risk of disturbance and injury to marine mammals from underwater noise throughout operations;
- Perenco will also adhere to the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives at all times and where appropriate. Strive to avoid undertaking explosive activity during periods of known peak cetacean abundance;
- Use of trained Marine Mammal Observers (MMOs) to identify if there are any vulnerable cetaceans in the vicinity of the explosive source. It is recommended that a one kilometre radius mitigation zone be set up around the explosion source. If marine mammals are sighted within this area, operations should be ceased / halted until they have left the area at a safe distance;
- Use of Passive Acoustic Monitoring (PAM), in conjunction with MMOs, to determine the presence of cetaceans in high sea states, poor visibility, during low light conditions and to identify those which may not surface regularly enough to be sighted;
- Prior to planning explosive operations, Perenco will consult with DECC as to whether other operations using explosives are being undertaken at a similar time and location.

Conclusions

Due to the temporary nature of the decommissioning activities, any cumulative impacts from noise are anticipated to be minor. In addition to this, the noise source will not originate from the same location throughout the decommissioning operations and therefore the cumulative will be varied during this period. The cumulative residual impact to from noise is expected to be minor.

The residual cumulative impact from noise is considered to be Minor

13.7 Summary of Mitigation Measures

- Perenco will undertake vessel traffic surveys to assess the potential cumulative impact from the physical presence of the decommissioning vessels / rig;
- Advanced planning to ensure efficient operations;
- Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels;
- Generators will be running on the minimum power for the job task to avoid unnecessary emissions;
- Well maintained and operated power generation equipment; and
- Regular monitoring of fuel consumption.

14 Environmental Management

14.1 Overview

The Environmental Management chapter is intended to provide an outline of the arrangements that will be put in place to ensure that the mitigation and other measures to control, reduce or eliminate predicted impacts are implemented and effective. These arrangements draw heavily on the environmental management system (EMS) operated by both Perenco UK Limited and Tullow Oil SK Limited and the control requirements emerging from the Environmental Statement (ES).

Both Perenco and Tullow are certified to ISO 14001 standard and therefore have relevant documentation in place to support the decommissioning process from an environmental standards perspective. Where there is a need for documents to be compiled to reflect joint operations during the decommissioning process then these will be jointly assessed and approved accordingly.

The following sections describe the key elements of Perenco / Tullow EMS, indicating how they will be applied to the Thames Area Decommissioning.

The Environmental Impact Assessment (EIA) is a key principle of the EMS of both companies. It allows the comparison of the environmental impacts of alternative solutions during the evolution of the project, from design through procurement and construction of plans to implementation and execution of the plans for the operation, and to seek mitigation and control measures that aim to prevent pollution and minimise waste.

In addition to providing the means to implement the identified mitigation and control measures, the EMS enables the monitoring of their effectiveness through checks on actual environmental performance.

Figure 14.1 illustrates the relationship between the ES and the different components of Perenco / Tullow EMS, which broadly follows the ISO 14001 structure. The EMS will allow Perenco / Tullow to control environmental impacts and will provide assurance that the environmental management is effective. The basis of the EMS is the Environmental Policy statement.

14.2 Scope

The EMS provides the framework for managing HSE issues within the business. This EMS is intended for application to all of Perenco / Tullow activities as directed under the OSPAR recommendation 2003/5 to promote the use and implementation of Environmental Management Systems by the Offshore Industry. Perenco / Tullow business is concentrated on oil and gas exploration activities both onshore and offshore and includes seismic and drilling operations. As a small operator, both Perenco and Tullow intend to resource such projects largely through the engagement of contractors should it not be available from in house functions.

It focuses on:

- Clear assignment of responsibilities;
- Excellence in HSE performance;
- Sound risk management and decision making;
- Efficient and cost effective planning and operations;
- Legal compliance throughout all operations;
- A systematic approach to HSE critical business activities; and
- Continual improvement.

14.3 Principle of the EMS

14.3.1 Improvement Programmes and the Management of Change

The purpose of improvement programmes is to:

- Drive the policy commitment through continuous improvement at the implementation stages; and
- Introduce changes that ensure the achievement of performance standards where current performance is below expectations.

The EMS also makes provision for the management of change. Change may occur for a number of reasons, and at a number of levels. A 'management of change' procedure specifies the circumstances when formal control of change is required to ensure that significant impacts remain under control and/or new impacts are identified, evaluated and controlled, for example the management of future decommissioning.

14.3.2 Roles and Responsibilities

Perenco / Tullow will review existing environmental roles and responsibilities for personnel and these will be amended and recorded in individual job descriptions where applicable to ensure that they take account of changes required for the management of the impacts identified in the ES.

14.3.3 Training and Competence

The competence of personnel with environmental responsibilities is a critical means of control. The EMS, in conjunction with Perenco / Tullow Human Resources allows for the appointment of suitably competent personnel. The development and implementation of training programmes facilitates understanding and application of environmental control requirements.

14.3.4 Communication

Internal environmental communication generally employs existing channels such as management meetings, minutes, presentations and regular reporting etc.

External communication with stakeholders and interested parties is controlled through a communication programme. This establishes links between each stakeholder, the issues that are of concern to them, and the information they require to assure them that their concerns and expectations are being addressed. This ES and the consultation process that informed its production will be used to design the on-going communication programme. Communication and reporting will employ information derived from the monitoring programme.

14.3.5 Document Control

The control of EMS documents is managed in Perenco's Document Control System (DCS) and Tullow's Document Control Centre.

14.3.6 Records

Records provide the evidence of conformance with the requirements of the EMS and of the achievement of the objectives and targets stated in the ES in the Improvement Programmes. The EMS of both companies specifies those records that are to be generated for these purposes, and controls their creation, storage, access and retention.

14.3.7 Monitoring & Audit

Checking techniques employed within Perenco / Tullow EMS is a combination of monitoring, inspection activities and periodic audits.

The requirement for monitoring and inspection stems from the need to provide information to a number of different stakeholders, but primarily regulators, and the management of Perenco and

Tullow Oil. As such, there is a requirement for the results of monitoring and inspection to be integrated within the internal and external communication programme.

Monitoring and inspection activities focus on:

- Checks that process parameters remain within design boundaries – process monitoring;
- Checks that emissions and discharges remain within specified performance standards – emissions monitoring; and
- Checks that the impacts of emissions and discharges are within acceptable limits – ambient monitoring.

14.3.8 Incident Reporting & Investigation

The EMS includes documented procedures to control the reporting and investigation of incidents pertaining to the environment (spills, uncontrolled releases) not just to personnel injury.

14.3.9 Non-conformance and Corrective Action

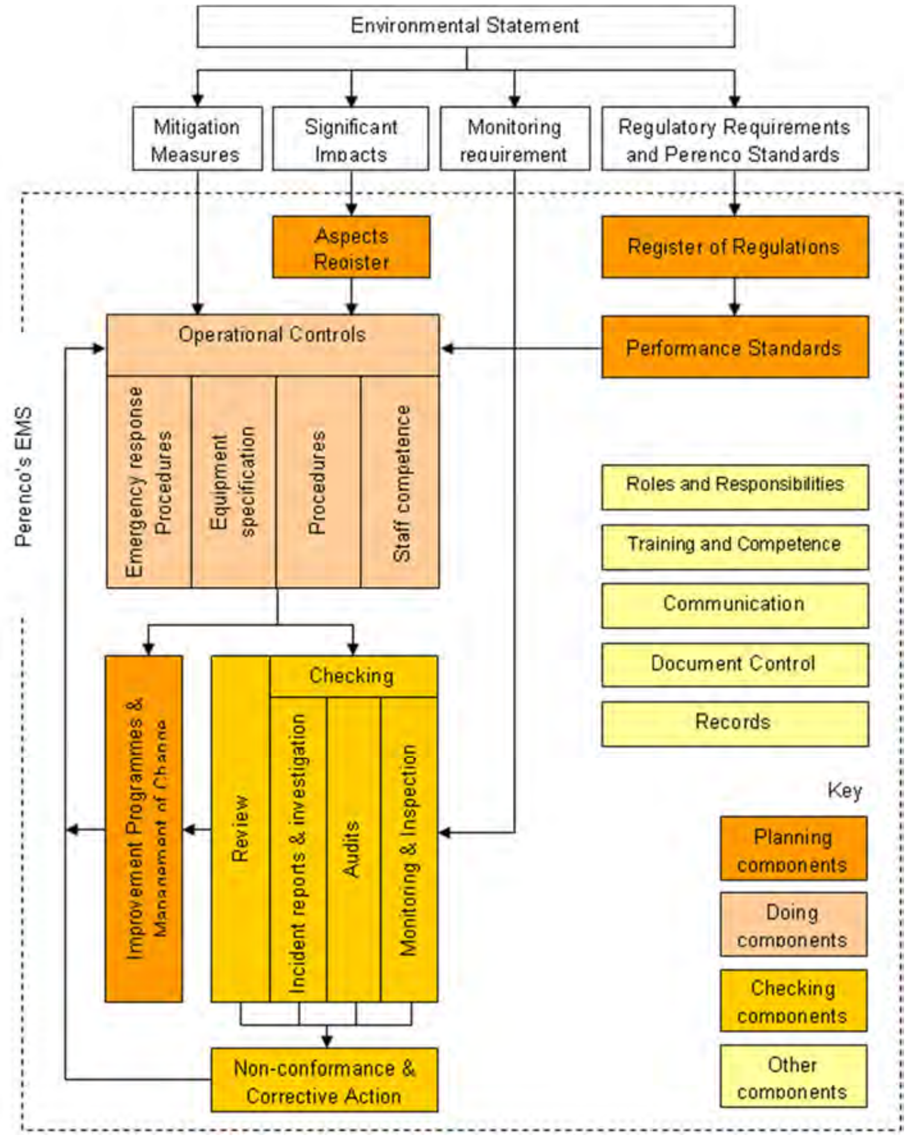
The checking techniques outlined above are the means of detecting non-conformances. Both Perenco's EMS and that of Tullow Oil EMS includes procedures for the formal recording and reporting of detected non-conformances, the definition of appropriate corrective action, the allocation of responsibilities and monitoring of close out. Once closed out the further check is to ensure that the close out is implemented and effective.

14.3.10 Review

The EMS includes arrangements for management review. This provides the means to ensure that the EMS remains an effective tool to control the environmental impacts of operations, and to re-configure the EMS in the light of internal or external change affecting the scope or significance of the impacts.

Of particular importance is the role management review plays in the definition and implementation of the improvement programme, and the management of change.

Figure 14.1: The Relationship between the ES and Perenco's Environmental Management System



14.4 Perenco / Tullow Thames Area Decommissioning ES Commitments

Perenco / Tullow has made a number of commitments within this ES in order to reduce the potential environmental and socio-economic impacts from the Thames Area Decommissioning, as far as practicable. These commitments, along with the personnel responsible for ensuring that they are implemented, are summarised in Table 14.1.

Table 14.1: Key Commitments from the Thames Area Decommissioning Environmental Statement

Commitment	Details	ES Section	Responsibility	Monitoring
Communications with fisheries and maritime agencies	Consultations with the Fisheries and Maritime Agencies will be held by either Perenco / Tullow or their representatives to try and address any potential conflicts and optimise the schedule. Communications with these agencies will be maintained, as necessary, throughout the Thames Area Decommissioning programme.	Section 5	Perenco / Tullow or their representative	N/A
Shipping	Perenco / Tullow will commit to undertaking a site specific shipping assessment for the Thames Area Decommissioning. The results of which will be included in the relevant Consent to Locate applications.	Section 5	Perenco / Tullow or their representative	Project meeting to ensure these commitments are implemented
Decommissioning Activities	Perenco / Tullow will inform fishermen and other sea users in the area in advance of all works. Appropriate charts and information on safety zones will accompany notification of these works and activities. Perenco / Tullow will also appoint a Fisheries Liaison Officer (FLO) if required, who will be responsible for the distribution of all key information.	Section 5	Perenco / Tullow or their representative	N/A
Rock Dumping	A maximum of 36,000 tonnes of rock will be used for the Thames Area Decommissioning for drilling rig stabilisation. Relevant notifications shall be lodged with DECC.	Section 6	Perenco / Tullow or their representative	Monitored during decommissioning operations
Noise from decommissioning activities	In order to minimise any potential impact on marine cetaceans from the proposed Thames Area Decommissioning operations, Perenco / Tullow will seek to conform to the JNCC protocol for minimising the risk of disturbance and injury to marine mammals from underwater noise throughout operations. Perenco / Tullow will also adhere to the JNCC guidelines for minimising the risk of injury to marine mammals from the use of explosives at all times and where appropriate; Strive to avoid undertaking explosive activity during periods of known peak cetacean abundance; Use of trained Marine Mammal Observers (MMOs) to identify if there are any vulnerable cetaceans in the vicinity of the explosive source. It is recommended that a one kilometre radius mitigation zone be set up around the explosion source. If	Section 7	Perenco or their representative	Monitored during the decommissioning activities

Commitment	Details	ES Section	Responsibility	Monitoring
	marine mammals are sighted within this area, operations should be ceased / halted until they have left the area to a safe distance; Use of Passive Acoustic Monitoring (PAM), in conjunction with MMOs, to determine the presence of cetaceans in high sea states, poor visibility, during low light conditions and to identify those which may not surface regularly enough to be sighted; Use the minimum amount of explosive required to achieve the task based on sound planning and engineering; Implement a 'soft start' procedure whereby small amounts of explosives are used to scare fish and marine mammals from the vicinity.			
Atmospheric emissions	Commitments to limit atmospheric emissions that will be adopted during the decommissioning programme include: • Advanced planning to ensure efficient operations; • Well maintained and operated power generation equipment and; • Regular monitoring of fuel consumption.	Section 8	Perenco / Tullow or their representative	Monitored during the decommissioning activities
Drainage water and sewage	The Perenco / Tullow Representative will also ensure good housekeeping standards are maintained onboard the rig to minimise the amount of hydrocarbons and other contaminants entering the drainage systems. All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons (<15 parts per million hydrocarbons in water) as required under the MARPOL Convention and discharged to sea. Residual hydrocarbons will be routed to transit tanks for processing onshore. Black (sewage) and grey water is also collected, treated to meet the requirements of the MARPOL Convention and discharged to sea. As part of the HSE Plan, Perenco / Tullow will ensure the contractor knows how to react to spills and that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.	Section 9	Perenco / Tullow or their representative	Regular monitoring of all discharges

Commitment	Details	ES Section	Responsibility	Monitoring
Accidental Hydrocarbon Spill	Perenco / Tullow will ensure that appropriate oil spill response training is undertaken by key personnel from within (details of which will be presented in the forthcoming Perenco / Tullow Thames Area Decommissioning Oil Pollution Emergency Plan (OPEP). Before commencing operations, if practicable, Perenco / Tullow will try to ensure the rig and vessels are fully bunkered prior to moving onto location. When fuel transfer is required the following precautions will be taken, whenever possible: • Supervision or operations on both supply boat and drill rig / vessels; • Transfers to take place during daylight hours and only in calm sea and weather conditions, whenever possible; • Use of non-return valves on bulk transfer hoses; • Transfer hoses are regularly maintained and inspected and a close visual inspection of them carried out prior to transfer to or from a supply vessel; • Use of flotation collars on hoses; • There is bunding around each of the loading stations and around the main fuel oil tank vents on the main deck. Perenco / Tullow will also ensure that operations staff are fully aware of their responsibilities under the Oil Pollution Emergency Plan (OPEP), are trained in the appropriate response techniques and are involved in at least one response exercise at the beginning of the programme to ensure that the Plan can be implemented effectively. All personnel, both offshore and onshore, who are involved in the Thames Area Decommissioning, will be fully briefed as to the sensitivities in the area. This will be covered in the well programmes, pre-spud meetings and toolbox talks and in the Health, Safety, Environmental Management System (HSE MS).	Section 10	Perenco / Tullow and their contractors	Regular monitoring as part of the ongoing operations

Commitment	Details	ES Section	Responsibility	Monitoring
Waste	Perenco / Tullow will ensure that an effective waste management plan is put in place prior to decommissioning activities commencing. Perenco / Tullow will ensure all waste contractors are audited and meet relevant legislation. Perenco will actively seek to reduce the amount of recovered materials that is sent to landfill.	Section 11	Perenco / Tullow and their contractors	Regular monitoring as part of the ongoing operations

15 Conclusions

In conclusion, all residual impacts are considered to be of minor significance, provided the proposed mitigation and management measures, as identified within the ES, are implemented during the Thames Area Decommissioning (refer to Table 15.1, Sections 5-13 and Appendix B).

The exception to this is in the event of an accidental spill, where there would be a release of condensate from the pipeline or diesel fuel loss from the drilling rig / SLV; here the residual impact has been assessed as moderate (Table 15.1).

In addition, the assessment of potential cumulative impacts indicated that there would be no significant impacts and no significant transboundary impacts are expected to occur as a result of the decommissioning operations.

Table 15.1: A summary of the Residual Risk Assessment conducted for significant impacts

Thames Area Decommissioning Project	Residual Risk									
	Positive		Negligible		Minor		Moderate		Major	
	Planned	Unplanned	Planned	Unplanned	Planned	Unplanned	Planned	Unplanned	Planned	Unplanned
Decommissioning Activities	**1**	**0**	**2**	0	**20**	**0**	0	**1**	0	0

16 References

4COffshore (2013) Hornsea Project One – Njord, Offshore Wind Farms, website: http://www.4coffshore.com/windfarms/hornsea-project-one---njord-united-kingdom-uk82.html (accessed July 2013).

Barne, J.H., Robson, C.F., Kaznowska, S.S. & Doody, J.P., (1995). Coasts and Seas of the United Kingdom. Region 6. Eastern England: Flamborough Head to Great Yarmouth

Baxter, J.M., Boyd, I.L., Cox, M., Donald, A.E., Malcolm, S.J., Miles, H.,Miller, B., Moffat, C.F., (Eds) (2011) Scotland's Marine Atlas: Information for the national marine plan. Marine Scotland, Edinburgh. pp. 191, website: http://www.scotland.gov.uk/Topics/marine/science/ assessment/atlas.

BMT CORDAH. 2003. Ross-worm non-technical report. Report to Subsea 7 as part of contract for ConocoPhillips. 8 pp.

CEFAS (2001) Contaminant status of the North Sea. Technical report produced for Strategic Environmental Assessment – SEA-2. https://www.gov.uk/government/publications/strategic-environmental-assessment-2-supporting-documents

CMACS (Centre for Marine and Coastal Studied Ltd) (2013) Thames Gas Field – Benthic survey technical report 2013. CMACS Ref: J3235. Prepared for OSIRIS Projects (on behalf of Perenco UK Ltd and Orbis Energy Ltd).

COLLINS, M.B., SHIMWELL, S.J., GAO, S., POWELL, H., HEWITSON, C. & TAYLOR, J.A. 1995. Water and sediment movement in the vicinity of linear sandbanks: the Norfolk Banks, southern North Sea. Marine Geology, 123, 125-142.

Conner D.W., Allen J.H., Golding N., Howell K.L., Lieberknecht L.M., Northen K.O. & Reker J.B. (2004) Marine Habitat Classification for Britain and Ireland Version 04.05. JNCC, Peterborough. www.jncc.gov.uk/MarineHabitatClassification

Coull, K. A., Johnstone, R., and S.I. Rogers (1998) Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.

Crown Estate (2014) Website: www.thecrownestate.co.uk.

DECC (2008) Atmospherics

DECC (2009) Offshore Energy SEA Environmental Report: Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage, Department of Energy and Climate Change (DECC), website: https://www.gov.uk/offshore-energy-strategic-environmental-assessment-sea-an-overview-of-the-sea-process

DECC (2011a) Guidance Notes – Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998. Version 6. March 2011

DECC, (2011b) https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/uk-greenhouse-gas-emissions

DECC (2013) Annual Statement of Emissions for 2011. https://www.gov.uk/government/organisations/department-of-energy-climate-change

DECC (2014) 28th Seaward Licensing Round. Information on the levels of shipping activity. https://www.gov.uk/oil-and-gas-licensing-rounds

DEFRA / DECC (2011) Guidelines for DERFA/DECC's Greenhouse Gas Conversion factors for Company Reporting. Produced by AEA for the Department of Energy and Climate Change (DECC) and the Department for Environment, Food and Rural Affairs (DEFRA).

Dobson, M. & Frid, C. (1998) Ecology of Aquatic Systems, Addison Wesley Longman Ltd.

DTI (2002) Strategic Environmental Assessment of Parts of the Central & Southern North Sea - SEA 3. Report to the Department of Trade and Industry.

DTI (2004) Source: Atlas of UK Marine Renewable Energy Resources: Technical Report, website: http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/energy/sources/renewables/explained/wind/page27741.html

Ellis, J.R., Cruz-Martínez, A., Rackham, B.D. and Roger, S.I. (2004) The Distribution of Chondrichthyan Fishes Around the British Isles and Implications for Conservation, Journal of Northwest Atlantic Fishery Science, Volume 25: 195-213.

Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. & Brown, M.J. (2012) Spawning and nursery grounds of selected fish species in UK waters, CEFAS, Science Series, Technical Report no. 147, website: http://www.cefas.defra.gov.uk/publications/techrep/TechRep147.pdf.

Genesis (2011) Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. 2011. Genesis Oil and Gas Consultants report for the Department of Energy and Climate Change.

GESAMP (1993) Impact of oil and related chemicals and wastes on the marine environment, Reports and Studies GESAMP 50, International Maritime Organization, London, U.K. 180p.

GRAHAM, C., CAMPBELL, E., CAVILL, J., GILLESPIE, E. & WILLIAMS, R. 2001.JNCC Marine Habitats GIS Version 3: its structure and content. British Geological Survey Commissioned Report, CR/01/238. UK: British Geological Survey

Gubbay, S. (2007) Defining and managing Sabellaria spinulosa reefs: report of an inter-agency workshop 1-2 May, 2007

Harvey, L. (2010) Energy Efficiency and Demand for Energy Services. Energy and the New Reality 1. Earthscan Ltd. Cromwell Press, London, UK. ISBN: 978-1- 84971-912-5

Houghton, J.D.R., Doyle, T.K., Wilson, M.W., Davenport, J. & Hays, G.C. (2006)Developing a simple rapid method for identifying and monitoring jellyfish aggregations from the air. Mar. Ecol. Prog. Ser. 314: 159-170

H R WALLINGFORD, CEFAS/UEA, POSFORD HASKONING & D‟OLIER B, 2002. Southern North Sea Sediment Transport Study. Report Produced for Great Yarmouth Borough Council.

Hydrographer of the Navy (2008) International Chart Series No. 2182A.

Institute of Petroleum (IoP) (2000) Guidelines for the calculation of estimates of energy use and gaseous emissions in the decommissioning of offshore structures. February 2000.

IPCC (2007) IPCC Fourth Assessment Report, Working Group I Report, Chapter 2, 2007. Intergovernmental Panel on Climate Change (IPCC), 2007.

IUCN (2014) International Union of the Conservation of Nature, website: http://www.iucnredlist.org/.

JNCC (1999) Seabird Vulnerability in UK Waters: Block Specific Vulnerability, 1999. Joint Nature Conservation Committee, Aberdeen.

JNCC (2008a) Onshore Special Area of Conservation: North Norfolk Sandbanks and Saturn Reef. SAC Selection Assessment. Version 4.0 July 2008

JNCC (2008b) UK Biodiversity Action Plan Priority Habitat Descriptions – Sabellaria spinulosa reef. http://jncc.defra.gov.uk/page-5706

JNCC (2008c) The deliberate disturbance of marine European Protected Species Guidance for English and Welsh territorial waters and the UK offshore marine area

JNCC (2010a) UKSEAMAP Project. http://jncc.defra.gov.uk/UKSeaMap

JNCC (2010b) Special Area of Conservation (SAC): Haisborough, Hammond & Winterton SAC Selection Assessment Version 6.0.

JNCC (2010c) JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys

JNCC (2013a) Annex II Species Account: 1365 Common seal, Joint Nature Conservation Committee, website: http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?FeatureIntCode=S1365

JNCC (2013b) Annex II Species Account: 1364 Grey seal, Joint Nature Conservation Committee, website: http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?featureintcode=s1364

JNCC (2013c) SPAs with Marine Components, Joint Nature Conservation Committee, website: http://jncc.defra.gov.uk/page-1414 (accessed July 2013).

JNCC (2013d) SACs with Marine Components, Joint Nature Conservation Committee, website: http://jncc.defra.gov.uk/page-1445 (accessed July 2013).

KIS-OCRA (2014) Kingfisher Information Systems – Offshore Cable and Renewables Awareness: Online Map. http://www.kis-orca.eu/map#.UxiOXfnV_O8

Korevaar, C.G. (1990) North Sea Climate based on observations from ships and lightvessels. Kluwer Academic Publishers.

Kunzlik, P.A. (1988) The Basking Shark. Scottish Fisheries Information Pamphlet Number 14, 1988

Law, R.J. and Fileman, T.W., 1985. The distribution of hydrocarbons in surficial sediments of the central North Sea. Mar. Pollut. Bull., 16: 335 – 337

Lawrence (2000) Hederson's Dictionary of Biological Terms. Prince Hall.

Leterme S.C., Seuront L. & Edwards M. (2006) Differential contribution of diatoms and dinoflagellates to phytoplankton biomass in the NE Atlantic and the North Sea, Mar. Ecol.-Prog. Ser. 312: 57–65.

LGL (2009) Cetacean Stock Assessment in Relation to Exploration and Production Industry Sound, LGL Limited, prepared on behalf of Joint Industry Programme by LGL Limited environmental research associates and LGL Alaska Research Associates Inc., LGL Report TA4582-1, Canada.

Marine Scotland (2013) Fishing Effort and Quantity and Value of Landings by ICES Rectangle, The Scottish Government, website: http://www.scotland.gov.uk/Topics/Statistics/Browse/-Agriculture-Fisheries/RectangleData (Accessed July 2013).

Matthiopoulos J, McConnell B, Duck C, Fedack M (2004) Using satellite telemetry and aerial counts to estimate space use by grey seals around the British Isles. Journal of Applied Ecology 41: 476-491.

McConnell BJ, Fedak MA, Lovell P, Hammond PS (1999) Movements and foraging areas of grey seals in the North Sea. Journal of Applied Ecology 36, 573-590.

MMC (2007) Marine Mammals and Noise: A Sound Approach to Research And Management, A Report to Congress from the Marine Mammal Commission.

MMO (2013) Seascape character area assessment East Inshore and East Offshore marine plan areas. http://www.marinemanagement.org.uk/marineplanning/areas/documents/east_seascape.pdf

Moyle, P.B. & Cech, J.J. (2004) Fishes: An introduction to Ichthyology. Pearson Prentice Hall.

Natural England (2012) Seascape characterisation around the English Coast (Marine Plan areas 3 and 4 and part of area 6 pilot study). Report NECR106. October 2012.

Natural England (2013) MCZ Factsheets – November 2013. http://publications.naturalengland.org.uk/category/1721481

Nedwell, J.R. & Edwards, B. (2004) A review of the measurement of underwater man made noise carried out by Subacoustech Ltd. Subacoustech Ltd. 2004

Net Gain (2011) Final recommendations – Submission to Natural England and JNCC. 31 August 2011. Version 1.2

Nowacek, D.P., Thorne, L.H., Johnston, D.W. & Tyack, P.L. (2007) Responses of cetaceans to anthropogenic noise. Mammal Review. 37 (2): 81-115

NSTF (1993) North Sea Quality Status Report 1993 - London (Oslo and Paris Commissions) & Fredensborg, North Sea Task Force, Denmark (Olsen & Olsen).

OGP (2008) Guidelines for the management of Naturally Occurring Radioactive Material (NORM) in the oil and gas industry. Report No. 412. September 2008.

Osiris Projects (2013) Thames & Welland Pipeline Surveys. Volume 2e – Results report. Environmental Survey. October 2013

OSPAR Commission, 2000. Quality Status Report 2000, Region II - Greater North Sea. OSPAR Commission, London, 136 +xiii pp.

OSPAR (2008) OSPAR guidance on environmental considerations for offshore wind farm development. Reference: 2008-3

OSPAR (2009) Overview of the impacts of anthropogenic underwater sound in the marine environment, Biodiversity Series, The Convention for the Protection of the Marine Environment of the

North-East Atlantic (the "OSPAR Convention"), [Available at: http://www.ospar.org/documents/dbase/publications/p00441_noise%20background%20document.pdf].

Perenco (2014) Comparative Assessment

Pierpoint, C. (2000) Bycatch of marine turtles in UK and Irish waters, JNCC Report No 310, website: http://jncc.defra.gov.uk/pdf/jncc_310.pdf.

Pomeroy, P.P., Twiss, S.D. & Duck, C.D., 2000. Expansion of a grey seal (Halichoerus grypus) breeding colony: changes in pupping site use at the Isle of May, Scotland. Journal of Zoology, London, 250, 1-12.

Reid, J., Evans, P.G.H. and Northridge, S. (Eds) (2003) An atlas of cetacean distribution on the Northwest European continental shelf. Joint Nature Conservation Committee, Peterborough.

Richardson, W.J., Greene, C.R. Jr., Malme, C.I. & Thomson, D.H. (1995) Marine mammals and noise. Academic Press, San Diego.

SCANS-II (2008) Small Cetaceans in the European Atlantic and North Sea. Final Report to the European Commission under project LIFE04NAT/GB/000245, Available from Sea Mammal Research Unit, University of St. Andrews, 54pp. plus appendices.

SCOC (2011) Scientific advice on matters related to the management of seal populations: 2011, Sea Mammal Research Unit (SMRU), website: http://www.smru.st-and.ac.uk/documents/678.pdf.

SCOS (2012) Scientific Advice on Matters Related to the Management of Seal Populations: 2012, SCOS Main Advice 2012, website: http://www.smru.st-andrews.ac.uk/documents/1199.pdf (accessed July 2013).

Smith, J. (1998) UKCS 18th Round Environmental Screening Report: Area IV Southern North Sea. Report to UKOOA. CORDAH, Neyland, Pembrokeshire. Report No. OPRU/6/98 65 pp. plus figures.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. & Tyack, P.L. (2007) Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33, 411–521.

Swan, J., Neff, J. & Young, P. (1994) Environmental implications of offshore oil and gas development in Australia: The findings of an independent scientific review, Australian Petroleum Exploration Association, Sydney.

Thomsen, F. & Schack, H.B. (2013) Danish sustainable offshore decommissioning: Decommissioning of an oil rig in the Ekofisk oil field – A risk assessment. Offshore Centre Danmark. 31 pp.

Tullow Oil Schooner & Ketch (TOSK) Limited (2013) Southern North Sea – Thames Area Decommissioning Project Execution Plan. Define Phase. Document Number: 02029-TLW-PM-PEP-0001

Turnpenny, A.W.H. & Nedwell, J.R. (1994) The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. FARL Report Reference: FCR 089/94, October 1994

UK Benthos (2012) Searchable database. Database tables for downloading inventory of monitoring survey results. United Kingdom Offshore Operators Association. Produced by Heriot-Watt University.

UKDEAL (2014) DEAL Data Registry for UK Offshore Oil and Gas, website: www.ukdeal.co.uk.

UKDMAP (1998) United Kingdom Digital Marine Atlas, Third Edition, July 1998, National Environmental Research Council.

Weilgart, L.S. (2007) The impacts of anthropogenic ocean noise on cetaceans and implications for management, Canada Journal of Zoology. 85: 1091 – 1116

Westerberg, H. (1999) Impact Studies of Sea-Based Windpower in Sweden. "Technische Eingriffe in marine Lebensraume". In: Vella, G. 2002. Offshore Wind: The Environmental Implications, [internet] available: <http://www.utilitiesproject.com/documents.asp?grID=117&d_ID=880>.

Wiig, Ø. (1986) The status of the grey seal Halichoerus grypus in Norway. Biol. Conserv. 38: 339-349.

Wildlife Trusts (2014) Cromer Shoal Chalk Beds Recommended Marine Conservation Zones (MCZ). http://www.wildlifetrusts.org/MCZ/cromer-shoal-chalk-beds

Xodus Group (2013) Thames Complex Decommissioning Concept Study

Appendix A: Legislation and Marine Policy

A.1 Key International and National Legislation

Table A.1 shows some of the key national and international legislation and policy which is applicable to the Thames Area Decommissioning Project.

Table A.1: Key Environmental Legislation of Relevance to the Proposed Thames Decommissioning Project

Legislation	Overview of Objectives	Relevance to the Thames Decommissioning Project
The Petroleum Act 1998	This Act sets out the requirements for undertaking the decommissioning of offshore installations and pipelines including preparation and submission of a Decommissioning Programme (DP). It also requires that decommissioning proposals for pipelines should be contained within a separate DP from that of installations unless within the same field.	Decommissioning Programmes will be submitted for approval alongside the ES.
Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended)	Requires environmental assessments to be carried out for certain types of offshore oil and gas activities throughout the European Union. A Decommissioning Programme must be supported by an EIA through the production of an ES. A Comparative Assessment will also be required in the case of OSPAR derogation cases where some (if not all) infrastructure is to be left in place, in this all of the disposal options must be assessed. The regulations were amended in 2007 by the Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) (Amendment) Regulations 2007 to implement Directive 2003/35/EC which provides for public participation in respect of the drawing up of certain plans and programmes relating to the environment.	An EIA has been undertaken along with a Comparative Assessment for the decommissioning of the pipelines (including umbilicals and MEG lines) and stabilisation materials.
The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)	Applies the Habitats Directive and the Wild Birds Directive in relation to oil and gas plans or projects wholly or partly on the United Kingdom's Continental Shelf and superjacent waters outside territorial waters ('the UKCS'). If explosives are used for abandonment, consultation must be undertaken with DECC and JNCC. Consideration must be given to the impact on offshore habitats and species.	The ES has considered the use of explosives in a 'worst case scenario'. Other potential impacts have been assessed in the ES. A separate Noise Assessment will be produced, as required

Legislation	Overview of Objectives	Relevance to the Thames Decommissioning Project
The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended)	Ensures that certain activities that have an effect on important species and habitats in the offshore marine environment, can be managed. The 2010 amendment makes it an offence to deliberately disturb wild animals of a European Protected Species (EPS) in such a way as to be likely (a) to impair their ability (i) to survive, breed, or rear or nurture their young; or (ii) in the case of animals of a hibernating or migratory species, to hibernate or migrate or b) to affect significantly the local distribution or abundance of that species. If explosives are used for abandonment, consultation must be undertaken with DECC and JNCC. Consideration must be given to the impact on offshore habitats and species.	The ES has considered the use of explosives in a 'worst case scenario'. Other potential impacts have been assessed in the ES. A separate Noise Assessment will be produced, as required A Wildlife (or EPS Disturbance) License will be obtained, if required.
Offshore Chemicals Regulations 2002 (As Amended 2011)	All activities, which use and/or discharge chemicals to the marine environment during well suspension/abandonment and used during decommissioning must be detailed on a Petroleum Operations Notice (PON5 and PON15E respectively). These permits require details of all the chemicals to be used and discharged and an assessment of their likely effects on the environment.	PON5 and Chemical permit applications (formally known as a PON15E) will be in place prior to offshore activities commencing if chemicals are used/discharged.
Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation Convention) Regulations 1998	Implements The Oil Pollution Preparedness, Response and Cooperation Convention (OPRC Convention) in the UK, which aims to facilitate international co-operation and mutual assistance in preparing for and responding to a major oil pollution incident and to encourage states to develop and maintain an adequate capability to deal with oil pollution emergencies. All offshore production installations must have an Oil Pollution Emergency Response Plan (OPEP) in place. It is expected that the existing OPEP for all of the facilities should cover activities relating to decommissioning and should be revised to include such activities or a separate decommissioning OPEP should be submitted.	All installations have an approved OPEP in place. However, a decommissioning OPEP Appendix will be compiled and submitted prior to decommissioning activities commencing.
The Offshore Installation (Emergency Pollution and Control) Regulations 2002	The Offshore Installations (Emergency Pollution Control) Regulations 2002 give the government powers to intervene in the event of an incident or accident involving an offshore installation where: • There is, or may be a risk of, significant pollution	All installations have an approved OPEP in place. However, a decommissioning OPEP Appendix will be compiled and submitted prior to decommissioning activities commencing.

Legislation	Overview of Objectives	Relevance to the Thames Decommissioning Project
	• An operator is failing or has failed to implement effective control and preventative operations DECC's role is to monitor, and if necessary intervene, to protect the environment in the event of a threatened or actual pollution incident in connection with an offshore installation.	
Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended)	Prohibits the discharge of oil to sea other than in accordance with the terms and conditions of a permit. Operators of offshore installations must identify all planned oil discharges to relevant waters and apply for the appropriate OPPC permits.	May be required for the discharge of residual hydrocarbons in the pipelines – Perenco will apply for OPPC applications, if applicable.
The Offshore Combustion Installations (Pollution Prevention and Control) Regulations 2001	Transpose the relevant provisions of the Industrial Emissions Directive 2010/75/EU in respect to specific atmospheric pollutants from combustion installations (with a thermal capacity rating ≥ 50 MW) on offshore platforms. Such permits would have been granted prior to decommissioning, if the power generation is below this threshold during the course of the decommissioning, the operator will be required to surrender the permit.	No action required – combustion installations are under the 50 MW threshold. Any relevant permits will be surrendered as required.
The Greenhouse Gas Emissions Trading Scheme (ETS) Regulations 2005 (as amended)	A permit would have been granted to cover the emission of greenhouse gases for facilities which have an aggregated thermal capacity from combustion equipment >20 MW(th) prior to decommissioning. Therefore when the thermal capacity falls below this threshold the permit must be surrendered. The installation(s) will be deemed closed and will fall out of the ETS.	Any relevant permits will be surrendered as required.
Marine and Coastal Access Act 2009 (MCAA)	Introduced a marine licensing system to cover those offshore energy activities that are the responsibility of DECC, and which are not excluded from the MCAA licensing provisions. The licensable activities are principally related to decommissioning and include: • Seabed disturbance (i.e. to access platform legs or relocate cuttings piles or carry out trenching work that is not covered by a Pipeline Works Authorisation (PWA)); • Temporary deposits during abandonment; • Deposits or removal of certain cables (not covered by PWA);	A single Marine License will be applied for to cover all of the proposed activities relevant to the Decommissioning Programme.

Legislation	Overview of Objectives	Relevance to the Thames Decommissioning Project
	• Deposits (including setting the provisions for marking objects on the seabed) or removal of objects e.g. rock dumping, mattress placement or burial operations not covered by a PWA, or to remove platforms or other structures from the seabed; • Deposit and use of explosives to remove structures. The legislation also makes provision for the designation of Marine Conservation Zones (MCZs) and the establishment of the Marine Management Organisation (MMO) who deal with aspects of licensing marine activities through the implementation of Marine Plans and Policy.	
The Energy Act 2008	Part 3 – Sets out provisions for the abandonment of wells including financial security provisions and enables the DECC Secretary of State (SoS) to make all relevant parties liable for the decommissioning of an installation or pipeline powers to protect the fund for decommissioning in case of insolvency of the owner parties. A written consent is required from the SoS if a relevant operation will result, or is likely to result, in an obstruction or danger to navigation (during or subsequent to the operation). The relevant operations will include the construction, alteration, maintenance, improvement, dismantling or abandonment of any works; and the deposit or removal of any substance or article.	Consent to locate will be applied for prior to applicable offshore activities commencing.
The Environment Protection Act 1990 (EPA 90)	Part 2 of the EPA 90 introduces the Operators Duty of Care, which obliges waste producers to manage their wastes responsibly	A Waste Management Plan will be in place for all waste streams which will place emphasis on the waste hierarchy principles.
Control of Pollution (Amendment) Act 1989 (as amended)	This is the principle legislation which requires all carriers of controlled waste (which includes waste arising from domestic, industrial and commercial premises as well as special/hazardous waste for which there are additional regulations) to be registered.	A Waste Management Plan will be in place with approved waste handing/disposal contractors used.
Mercury Export and Data (Enforcement) Regulations 2010	Puts in place the provisions for UK enforcement and management of directly applicable obligations under the EU Mercury Regulation, which implements the objectives of the Community Strategy Concerning Mercury (adopted in 2005),	Perenco will ensure that any mercury waste is sent to shore in-line with existing legislation for the containment/shipment of hazardous waste.

Legislation	Overview of Objectives	Relevance to the Thames Decommissioning Project
	namely to reduce the supply of, and demand for, mercury in order to protect human health and the environment.	
The Radioactive Substances Act (1993)	This Act prohibits the disposal and accumulation of radioactive waste except as authorised by the Environment Agency (EA). Registration for accumulation of radioactive substances is required under this Act, this includes LSA and NORM. Some accumulation and deposits are exempt from licensing due to the low levels of activity.	If levels of LSA/NORM are above the activity threshold, the required permits for storage and disposal will be obtained.
OSPAR Decision 98/3 on the disposal of Disused Offshore Installations	This decision prohibits the dumping and leaving wholly or partially in place of disused offshore installations with some exceptions for large structures (derogation cases).	The platforms will be wholly removed with the exception of the piles and legs which will be cut below the seabed
OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry	All operators controlling the operation of offshore installations on the UKCS are required to have in place an independently verified Environmental Management System designed to achieve: the environmental goals of the prevention and elimination of pollution from offshore sources and of the protection and conservation of the maritime area against other adverse effects of offshore activities and to demonstrate continual improvement in environmental performance. OSPAR recognises the ISO 14001: 2004 & EMAS International standards as containing the necessary elements to fulfil these requirements. All operators are also required to provide a public statement of their environmental performance on an annual basis.	Perenco operate under an EMS which is certified to ISO14001.
OSPAR Recommendation 2006/5 on a management scheme for offshore cuttings piles	This outlines the approach for the management of cuttings piles left on the seabed.	No action necessary – There no expected drill cuttings associated with the project. It is likely that cuttings will have been widely dispersed given the hydrodynamic regime in the area.

A.2 National Marine Policy – The Marine and Coastal Access Act (MCAA) 2009

Following the implementation of the MCAA, the UK government introduced a number of measures to manage and protect the seas around the UK. Many of the functions were delegated to the established Marine Management Organisation (MMO) in 2010. Draft marine plans were established for the east coast of England which are used to underpin a new offshore planning system designed to manage the resources, activities and interactions (natural and anthropogenic) which occur within them.

Table A.2 identifies the draft objectives of the East Inshore and East Offshore Marine Plans that are relevant to the Thames Area Decommissioning Project, along with their (directly) associated and contributing (i.e. indirectly associated) plan policies. Table A.3 lists the plan policies, identified in Table A.2, by sector and explains their relevance to the Thames Area Decommissioning Project.

Table A.2: Draft East Inshore and East Offshore Marine Plans – Objectives and Their Associated and Contributing Plan Policies that are Relevant to the Thames Area Decommissioning Project

Objectives	Plan Policy	
	Associated Policy	Contributing Policy
Objective 1: To promote the sustainable development of economically productive activities, while taking account of spatial requirements of other activities of importance to the East marine plan areas.	-	GOV2; GOV3; OG1; WIND1; PS1 PS2; FISH1; FISH2; TR1
Objective 2: To support activities that create employment at all skill levels, taking account of the spatial and other requirements of activities in the East marine plan areas.	**EC2**	BIO1; MPA1; DEF1; OG1; WIND1; PS1; PS2; FISH1; FISH2; TR1
Objective 5: To conserve heritage assets and ensure that decisions consider the character of the local area.	**SOC2; SOC3**	FISH1
Objective 6: To have a healthy, resilient and adaptable marine ecosystem in the East marine plan areas.	**ECO1; ECO2**	BIO1; MPA1; FISH2
Objective 7: To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas.	**BIO1**	ECO1; ECO2; MPA1; GOV2; GOV3 FISH2
Objective 8: To support the objectives of MPAs (and other designated sites around the coast that overlap, or are adjacent to the East marine plan areas), individually and as part of an ecologically coherent network.	**MPA1**	ECO1; ECO2; BIO1; GOV1; GOV2; FISH2
Objective 9: To facilitate action on climate change adaptation and mitigation in the East marine plan	**-**	WIND1
Objective 10: To ensure integration with other plans and regulation and management of key activities and issues in the East marine plan, and adjacent areas.	**GOV2; GOV3**	-

Table A.2: Draft East Inshore and East Offshore Marine Plans - Objectives and Policies of Relevance to the Thames Area Decommissioning Project

Sector	Policy	Relevance to the Thames Area Decommissioning Project
(BIO) Biodiversity	**BIO1:** Appropriate weight should be attached to biodiversity, taking account of the best available evidence including on habitats and species that are protected or of conservation concern in the East marine plan areas.	Refer to Section 3.3 of the ES.
(CC) Climate Change	**CC2:** Proposals for development should minimise as far as practicable emissions of greenhouse gases. Mitigation measures will also be encouraged. Consideration should also be given to: • Emissions from other activities or users affected by the proposal; • The impact upon mitigation measures that may be in place related to other activities.	Mitigation measures will be put in place to minimise greenhouse gas emissions. Refer to Section 8 of the ES.
(DEF) Defence	**DEF1:** Proposals in or affecting MOD danger and exercise areas should not be authorised without agreement from the MOD.	There are no MoD training or exercise areas located in the proposed area (Refer to Section 3.4.4)
(EC) Economic	**EC2:** Proposals that provide additional sustainable employment benefits should be supported, particularly where these benefits have the potential to meet employment needs in localities close to the marine plan areas.	Project will create employment for contractors offshore as well as sites handling the decommissioned material onshore.
(ECO) Ecosystem	**ECO1:** Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be taken into account in decision-making and plan implementation.	No significant cumulative impacts have been identified. Refer to Section 13 of the ES.
	ECO2: The risk of release of hazardous substances as a result of any increased collision risk should be taken account of in proposals that require an authorisation.	Oil spill modelling has been undertaken for the project. Refer to Section 10 of the ES.
(FISH) Fisheries	**FISH1:** Within areas of fishing activity, proposals should demonstrate in order of preference: a) That they will not prevent fishing activities on, or access to, fishing grounds; b) How, if there are impacts on the ability to undertake fishing activities and access to fishing grounds, they will minimise or mitigate these; c) The case for proceeding with their proposal if it is not possible to minimise or mitigate the impacts.	There will be a temporary loss of access to fishing grounds during the decommissioning operations, particularly during well abandonment and removal of the platforms. However, following removal, there will be no restrictions on fishing that were in place around the platforms. Perenco will inform fishermen who use the area in advance of offshore activities commencing

Sector	Policy	Relevance to the Thames Area Decommissioning Project
		allowing fishing vessels to plan alternative deployment. Refer to Section 5.1 of the ES.
	FISH2: Within and adjacent to spawning and nursery areas and their associated habitat, applications for proposals should demonstrate, in order of preference: a) That they will not have an impact upon spawning and nursery areas and the associated habitat; b) How, if there are impacts upon the spawning and nursery areas and the associated habitat, they will minimise or mitigate these; c) The case for proceeding with their proposals if it is not possible to minimise or mitigate the impacts.	Some seabed disturbance may occur from the removal of seabed infrastructure, however the effects are likely to be temporary (Refer to Section 6 of the ES).
(GOV) Governance	**GOV2:** Opportunities for co-existence should be maximised wherever possible.	The closest infrastructure (Orwell) located 4 km from the transboundary line (UK/Netherlands). Refer to section 3.2.1.
	GOV3: Proposals should demonstrate in order of preference: a) That they will avoid displacement of other existing or authorised but yet to be implemented activities; b) How, if there are impacts resulting in displacement by the proposed activity, they will minimise or mitigate these impacts; c) The case for proceeding with the proposal if it is not possible to minimise or mitigate the impacts of displacement.	The decommissioning area is located in varied areas of shipping and oil and gas activity (Refer to Section 3.4.2)
(MPAs) Marine Protected Areas	**MPA1:** Any impacts on the overall MPA network must be taken account of in strategic level measures and assessments, with due regard given to any current agreed advice on an ecologically coherent network.	The proposed decommissioning area lies partly within two cSACs and in the nearshore section, through a recommended MCZ. Current changes to the integrity of these sites are not expected to be significantly impacted by the proposed operations (Refer to Section 3.3.6)
(OG) Oil and Gas	**OG1:** Proposals within areas with existing oil and gas production should not be authorised except where compatibility with oil and gas production and infrastructure can be satisfactorily demonstrated.	The project is compatible with oil and gas production and infrastructure.

Sector	Policy	Relevance to the Thames Area Decommissioning Project
(PS) Ports and Shipping	**PS1:** Proposals that require static, sea surface infrastructure or that significantly reduce under-keel clearance will not be authorised in International Maritime Organisation (IMO) designated routes.	Static infrastructure will not be required. All decommissioning operations will be temporary.
	PS2: Proposals that require static, sea surface infrastructure which encroaches upon important navigation routes should not be authorised unless there are exceptional circumstances. Proposals should: a) Be compatible with the need to maintain space for safe navigation, avoiding adverse economic impact; b) Anticipate and provide for future safe navigational requirements where evidence and / or stakeholder input allows; c) Account for cumulative impacts upon navigation resulting from the proposal and other existing (and known proposed) activities as well as known proposed developments.	Some of the blocks are located in Deep Water Routes or blocks with 'high' or 'very high' shipping activity. Consultations prior to and communications during decommissioning will be maintained.
(SOC) Social and Cultural	**SOC2:** Proposals that may affect heritage assets should demonstrate, in order of preference: a) That they will not compromise the heritage asset; b) How, if there are impacts on a heritage asset, they will minimise or mitigate these; c) The case for proceeding with the proposal if it is not possible to minimise or mitigate the impact.	The project will not impact on any heritage assets (Refer to Section 3.4.7 of the ES).
	SOC3: Proposals should consider the potential impacts on the terrestrial and marine character of an area, taking into account any proposed mitigation measures.	The project lies partially within two offshore cSACs and one inshore recommended MCZ. Current changes to the integrity of these sites are not expected to be significantly impacted by the proposed operations (Refer to Section 3.3.6)
(TR) Tourism and Recreation	**TR1:** Proposals for development should demonstrate that during construction, in order of preference: a) They will not disrupt or disturb tourism and recreation activities; b) How, if there are impacts on tourism and recreation activities they will minimise or mitigate the impacts;	Given the distance from shore, it is not anticipated that decommissioning activities will disrupt or disturb tourism and recreation activities. Vessels may be seen from the shore, particularly when working on/assessing the pipeline, but the duration of this will be minimal.

Sector	Policy	Relevance to the Thames Area Decommissioning Project
	c) The case for proceeding with the proposal if it is not possible to minimise or mitigate the impacts.	
(WIND) Offshore Wind Renewable Energy	**WIND1:** Proposals for other development or activities that require authorisation, which are in or could affect sites held under a lease or an agreement for lease that has been granted by The Crown Estate for development of an OWF, should not be authorised unless: a) They can clearly demonstrate that they will not compromise the construction, operation, maintenance, or decommissioning of the OWF; b) The lease/agreement for lease has been surrendered back to The Crown Estate and not been re-tendered; c) The lease/agreement for lease has been terminated by the Secretary of State; d) In other exceptional circumstances.	There are no active wind farms in the Thames Area, however the Arthur P1 and 2 wellheads, Arthur manifold, Horne & Wren platforms and the Wissey and Orwell wellheads lie within a Round 3 Wind Farm Zone Search Area (Refer to Section 3.4.6)

Appendix B: Environmental Aspects Tables

B.1: Decommissioning Activities

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.1 Physical Presence												
DC.1.1	P	Presence of a drilling rig and standby / supply vessels	Commercial Fishing	Potential for navigation hazard and emergency situation due to increased risk of collision.	3	3		Y	• There will be a 500m exclusion zone around the drilling rig for the duration of the decommissioning operations. • Sea users will be notified of the presence of intended movements of decommissioning vessels via Notices to Mariners, Navtex and NAVAREA warnings, as well as to the appropriate MRCC. • A guard vessel will be onsite for the duration of the decommissioning activities. • A collision risk management plan will be in place for the decommissioning activities.	2	3	
DC.1.2	P		Shipping and other vessels		3	3		Y		2	3	
DC.1.3	P		Commercial Fisheries	Interference with commercial fishing activities / temporary loss of access to fishing grounds.	5	3		Y	• A Fisheries Liaison Officer (FLO) will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.	5	2	
DC.1.4	P		Marine Mammals	Collision between marine mammals and vessels causing injury or mortality to individuals.	1	2		N	• Vessel movements and speed will be minimised	1	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.1.5	P	Presence of a SLV and standby / supply vessels	Commercial Fishing	Potential for navigation hazard and emergency situation due to increased risk of collision.	3	3		Y	• The SVL will only be positioned within existing 500 m exclusion zones at Thames and Horne & Wren. • Sea users will be notified of the presence of intended movements of decommissioning vessels via Notices to Mariners, Navtex and NAVAREA warnings, as well as to the appropriate MRCC. • A guard vessel will be onsite for the duration of the decommissioning activities. • A collision risk management plan will be in place for the decommissioning activities.	2	3	
DC.1.6	P		Shipping and other vessels		3	3		Y		2	3	
DC.1.7	P		Commercial Fisheries	Interference with commercial fishing activities.	5	3		Y	• A Fisheries Liaison Officer (FLO) will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.	5	2	
DC.1.8	P		Marine Mammals	Collision between marine mammals and vessels causing injury or mortality to individuals.	1	2		N	• Vessel movements and speed will be minimised	1	2	
DC.1.9	P	Presence of other decommissioning vessels	Commercial Fishing	Potential for navigation hazard and emergency situation due to increased risk of collision.	3	3		Y	• Consultations with fisheries and maritime agencies will be undertaken. • Sea users will be notified of the presence of intended movements of decommissioning	2	3	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.1.10	P		Shipping and other vessels		3	3		Y	vessels via Notices to Mariners, Navtex and NAVAREA warnings, as well as to the appropriate MRCC. • A collision risk management plan will be in place for the decommissioning activities.	2	3	
DC.1.11	P		Commercial Fisheries	Interference with commercial fishing activities.	5	3		Y	• A Fisheries Liaison Officer (FLO) will be responsible for the distribution of all key information to fishermen. The FLO will inform fishermen who use the area in advance of offshore activities commencing allowing fishing vessels to plan alternative deployment.	5	2	
DC.1.12	P		Marine Mammals	Collision between marine mammals and vessels causing injury or mortality to individuals.	1	2		N	• Vessel movements and speed will be minimised.	1	2	
DC.1.13	P	Removal of the Thames and Horne & Wren Platforms	Shipping and other vessels	Removal will free up available sea room, as the 500 m exclusion zone will be removed	5	0		Y	• None Required.	5	0	
DC.1.14	P		Commercial Fisheries		5	0		Y		5	0	
DC.2 Seabed Disturbance												

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.2.1	P	Removal of Subsea Infrastructure	Water	Disturbance to sediments, increasing turbidity and decreasing water quality and potential for debris to remain on the seabed.	5	3		Y	• Subsea infrastructure removal methods will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed; • Use of DP vessels, if possible, to avoid the impact of anchors. • Post-decommissioning a debris survey will be undertaken to remove any objects remaining on the seabed.	5	2	
DC.2.2	P		Seabed Sediments		5	3		Y		5	2	
DC.2.3	P		Benthic Flora and Fauna	Mortality and smothering of benthic organisms in decommissioning footprint.	5	3		Y		5	2	
DC.2.4	P	Removal of Concrete Mattresses	Water	Disturbance to sediments, increasing turbidity and decreasing water quality and potential for debris to remain on the seabed.	5	3		Y	• Concrete mattress removal methods will be assessed prior to decommissioning operations beginning, with a view to implement the removal method, with the least impact to the seabed; • Use of DP vessels, if possible, to avoid the impact of anchors. • Post-decommissioning a debris survey will be undertaken to remove any concrete mattresses remaining on the seabed.	5	2	
DC.2.5	P		Seabed Sediments		5	3		Y		5	2	
DC.2.6	P		Benthic Flora and Fauna	Mortality and smothering of benthic organisms in decommissioning footprint.	5	3		Y		5	2	
DC.2.7	P	Disturbance of existing wellbore muds and cuttings	Water	Disturbance to sediments, increasing turbidity and decreasing water quality	2	2		N	• Perenco will undertake seabed sampling to verify the absence of cuttings	2	2	
DC.2.8	P		Seabed Sediments		2	2		N		2	2	
DC.2.9	P		Benthic Flora and Fauna	Mortality and smothering of benthic organisms in decommissioning footprint.	2	2		N		2	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.2.10	P	Drilling rig spud cans	Seabed Sediments	Possible seabed scour as a result of the spud cans being placed on the seabed.	3	3		Y	• Perenco will actively seek to position the drilling rig in as few separate locations as is possible during decommissioning. This will reduce the number of instances that jack-up spud cans will be deployed on the seabed.	3	2	
DC.2.11	P		Benthic Flora and Fauna	Direct impact of rig legs on seabed leading to mortality of benthic species	4	2		N		4	2	
DC.2.12	P	Rig stabilisation material	Seabed Sediments	Physical disturbance to seabed. Raised seabed profile.	3	3		Y	• Perenco will actively seek to minimise the amount of rock required for rig stabilisation.	3	2	
DC.2.13	P		Benthic Flora and Fauna	Smothering of sessile species. Change to seabed composition.	3	3		Y		3	2	
DC.2.14	P		Fish / Shellfish	Loss of spawning grounds.	3	2		N		3	2	
DC.2.15	P	Additional stabilisation and protection material	Seabed Sediments	Physical disturbance to seabed. Raised seabed profile.	3	3		Y	• Perenco will actively seek to minimise the amount of mattresses and grout bags required for pipeline stabilisation.	3	2	
DC.2.16	P		Benthic Flora and Fauna	Smothering of sessile species. Change to seabed composition.	3	3		Y		3	2	
DC.2.17	P		Fish / Shellfish	Loss of spawning grounds.	3	2		N		3	2	
DC.3 Noise												
DC.3.1	P	Surface and subsea noise	Marine Mammals		3	3		Y	• Vessel movements and the use of DP thrusters will be minimised where possible to	3	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.3.2	P	generated by decommissioning activities (vessel movements)	Fish / Shellfish	Possible behavioural impacts in response to elevated noise levels.	3	2		N	reduce the potential impacts on marine mammals. • Vessel movements will be minimised.	3	2	
DC.3.3	P	Surface and subsea noise generated by decommissioning activities (helicopter movements)	Marine Mammals	Possible behavioural impacts in response to elevated noise levels.	3	1		N	• Ensure good pre-planning to minimise the number of helicopter trips necessary to and from the rig / SLV.	3	1	
DC.3.4	P		Fish / Shellfish		3	1		N		3	1	
DC.3.5	P	Surface and subsea noise generated by the use of explosives	Marine Mammals	Possible behavioural and injury impacts in response to elevated noise levels.	3	4		Y	• In order to minimise any potential impact on marine cetaceans from the proposed Thames Area Decommissioning operations (excluding the use of explosives), Perenco will seek to conform to the JNCC protocol for minimising the risk of disturbance and injury to marine mammals from underwater noise throughout operations. • Vessel movements and the use of DP thrusters will be minimised where possible to reduce the potential impacts on marine mammals.	3	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.3.6	P		Fish / Shellfish		3	3		N	• Perenco will also adhere to the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives at all times and where appropriate. • Strive to avoid undertaking explosive activity during periods of known peak cetacean abundance. • Use of trained Marine Mammal Observers (MMOs) to identify if there are any vulnerable cetaceans in the vicinity of the explosive source. It is recommended that a one kilometre radius mitigation zone be set up around the explosion source. If marine mammals are sighted within this area, operations should be ceased / halted until they have left the area at a safe distance. • Use of Passive Acoustic Monitoring (PAM), in conjunction with MMOs, to determine the presence of cetaceans in high sea states, poor visibility, during low light conditions and to identify those which may not surface regularly enough to be sighted. • Use the minimum amount of explosive required to achieve the task based on sound planning and engineering. • Implement a 'soft start' procedure whereby small amounts of explosives are used to scare fish and marine mammals from the vicinity.	3	2	
DC.4 Atmospheric Emissions												

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.4.1	P	Exhaust gas emissions from decommissioning vessels	Air	Emissions to atmosphere may contribute to global warming (CH_4, CO_2), acid effects (SO_x, NO_x). Potential for localised smog formation (VOC, NO_x).	5	3		Y	• Advanced planning to ensure efficient operations. • Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels. • Speed of vessels will be managed to minimise fuel consumption. • Generators will be running on the minimum power for the job task to avoid unnecessary emissions. • Well maintained and operated power generation equipment. • Regular monitoring of fuel consumption.	5	2	
DC.4.2	P	Exhaust gas emissions from processing decommissioning materials	Air	Emissions to atmosphere may contribute to global warming (CH_4, CO_2), acid effects (SO_x, NO_x). Potential for localised smog formation (VOC, NO_x).	5	3		Y	• Licensed waste processing contractors will be chosen for the recycling of decommissioning materials.	5	2	
DC.5 Marine Discharge												
DC.5.1	P	Discharge of chemicals and cement during well abandonment activity	Seabed Sediments	Toxic potential of chemicals could contaminate sediments.	5	3		Y	• Prior to well abandonment activities, Perenco will undertake a chemical risk assessment as part of the chemical permit applications for each well. • The mixing of cement offshore as needed. • Any chemicals identified to be high risk will be substituted for more environmentally friendly alternatives where practicable.	5	2	
DC.5.2	P		Water	Toxic potential of chemicals could degrade water quality.	5	3		Y		5	2	
DC.5.3	P		Benthic Flora and Fauna	Toxic potential of seabed discharges may impact benthic flora and fauna.	5	2		N		5	2	
DC.5.4	P		Plankton		5	2		N		5	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation: Likelihood	Impact Before Mitigation: Consequence	Impact Before Mitigation: Risk	Impact Before Mitigation: Significant Aspect (Y/N)	Mitigation Measures	Residual Impact: Likelihood	Residual Impact: Consequence	Residual Impact: Residual Risk
DC.5.5	P		Fish / Shellfish	Short term degradation in water quality may affect viability of plankton stocks, recruitment for fish stocks and base of food chain.	5	2		N	• Perenco will actively seek to minimise the amount of cementing chemicals required.	5	2	
DC.5.6	P		Seabirds		5	2		N		5	2	
DC.5.7	P		Marine Mammals		5	2		N		5	2	
DC.5.8	P	Discharge of chemicals and residual hydrocarbons from the decommissioning of pipelines	Seabed Sediments	Toxic potential of chemicals / hydrocarbons could contaminate sediments.	5	3		Y	• Prior to flushing activities, Perenco will undertake an environmental risk assessment as part of the chemical permit application. • Perenco will actively seek to aim for an oil in water concentration from pipeline flushing of less than 30 milligrams per litre.	5	2	
DC.5.9	P		Water	Toxic potential of chemicals / hydrocarbons could degrade water quality.	5	3		Y		5	2	
DC.5.10	P		Benthic Flora and Fauna	Toxic potential of seabed discharges may impact benthic flora and fauna.	5	2		N		5	2	
DC.5.11	P		Plankton	Short term degradation in water quality may affect viability of plankton stocks, recruitment for fish stocks and base of food chain.	5	2		N		5	2	
DC.5.12	P		Fish / Shellfish		5	2		N		5	2	
DC.5.13	P		Seabirds		5	2		N		5	2	
DC.5.14	P		Marine Mammals		5	2		N		5	2	
DC.5.15	P	Discharge of food waste and sewage to sea from vessels	Water	Will cause transient organic enrichment of the water column and an increase in biological oxygen demand (BOD). Could lead to a minor increase in plankton and fish populations.	5	3		Y	• Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels. • Each vessel (including the drilling rig) will have a Garbage Management Plan in place.	5	2	
DC.5.16	P		Plankton		5	2		N		5	2	
DC.5.17	P		Benthic Flora and Fauna		5	2		N		5	2	
DC.5.18	P		Fish / Shellfish		5	2		N		5	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.5.19	P		Seabirds		5	2		N	• As part of the HSE Plan, Perenco will ensure that the drilling contractor knows how to react to spills, that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.	5	2	
DC.5.20	P		Marine Mammals		5	2		N		5	2	
DC.5.21	P	Discharge of grey water (domestic chemicals from washing and laundry facilities on vessels)	Water	Short term degradation of water quality. Potential for localised significant toxic effects. Mortality of individuals. May affect viability of plankton stocks, recruitment for fish stocks and base of food chain.	5	3		Y	• Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels. • All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons. • As part of the HSE Plan, Perenco will ensure that the drilling contractor knows how to react to spills, that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.	5	2	
DC.5.22	P		Plankton		5	2		N		5	2	
DC.5.23	P		Benthic Flora and Fauna		5	2		N		5	2	
DC.5.24	P		Fish / Shellfish		5	2		N		5	2	
DC.5.25	P		Seabirds		5	2		N		5	2	
DC.5.26	P		Marine Mammals		5	2		N		5	2	
DC.5.27	P	Drainage water	Water	Release of drainage water or deck water from decommissioning vessels may be discharged. May have minor localised toxicity impacts on the local fauna in the water column.	5	3		Y	• Perenco Representative will also ensure good housekeeping standards are maintained onboard the rig / vessels. • All the drains from the rig floor will be directed to a containment tank and the fluids processed/filtered to remove hydrocarbons. • As part of the HSE Plan, Perenco will ensure that the drilling contractor knows how to react to spills, that the necessary spill kits are onboard the rig in suitable locations and personnel are trained in their use.	5	2	
DC.5.28	P		Plankton		5	2		N		5	2	
DC.5.29	P		Fish / Shellfish		5	2		N		5	2	
DC.6 Accidental Events												

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.6.1	U	Release of gas and associated condensate from Decommissioning pipelines	Air	Emissions of greenhouse and acid gases affecting atmosphere and climate.	2	2		N	• Control measures will be in place to ensure rapid response to loss of containment. • Sea users will be notified of the decommissioning locations via Notices to Mariners and Kingfisher. • Pipelines will be flushed and cleaned before decommissioning.	2	2	
DC.6.2	U		Seabed Sediments	The sediment layer overlying the breach may be mobilised or trap gas. Sediments in immediate vicinity of release may become contaminated with hydrocarbons from gas or condensate which may persist for some time.	2	1		N		2	1	
DC.6.3	U		Water	Degradation of water quality.	2	4		Y		2	4	
DC.6.4	U		Plankton	Degradation in water quality may affect viability of plankton stocks, recruitment for fish stocks, and base of food chain.	2	2		N		2	2	
DC.6.5	U		Benthic Flora & Fauna	Smothering, physical contamination and toxic effects on individuals.	2	1		N		2	1	
DC.6.6	U		Fish / Shellfish	Fish and shellfish will be vulnerable to toxic effects from gas and condensate dissolved in the water column and to local increases in suspended material from sediment disturbance.	2	1		N		2	1	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.6.7	U		Seabirds	Seabirds are unlikely to be affected by a gas release and associated condensate as no slick will form and levels in the atmosphere are unlikely to reach toxic levels. There may be a small risk to seabirds if the volatile hydrocarbons catch fire.	2	4		Y		2	4	
DC.6.8	U		Marine Mammals	Marine mammals could be affected by toxic levels of gas in the overlying atmosphere, but are likely to show avoidance behaviour if present.	2	1		N		2	1	
DC.6.9	U		Commercial Fishing	Decrease in catch and landing value.	2	2		N		2	2	
DC.6.10	U	Spillage of diesel or other oils during bunkering operations and storage	Water	Degradation of water quality.	3			N	• Accidental spills will be kept to a minimum through training, good housekeeping and through storage/handling procedures. • Re-fuelling will only be undertaken during periods of good visibility and in good weather conditions. • Non-return valves will be installed on fuel transfer hoses, and operations will be supervised at all times. • Oil Pollution Emergency Plan will be in place, alongside other Emergency Response documents • Regular inspections will be undertaken to ensure all equipment in good working order.	3	2	
DC.6.11	U		Seabed Sediments	Contamination of sediments.	3	2		N		3	2	
DC.6.12	U		Plankton	Degradation in water quality may affect viability of plankton stocks, recruitment for fish stocks, and base of food chain. Smothering, physical contamination and toxic effects on benthic organisms.	3	2		N		3	2	
DC.6.13	U		Benthic Flora & Fauna		3	2		N		3	2	
DC.6.14	U		Fish / Shellfish		3	2		N		3	2	
DC.6.15	U		Seabirds	Toxic effects on individuals.	3	2		N		3	2	
DC.6.16	U		Marine Mammals		3	2		N		3	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.6.17	U	Spillage of diesel resulting from a collision between vessel, drilling rig and / or SLV	Water	Degradation of water quality.	1	4		Y	• Co-ordination of all support/standby vessel movements • Notices to Mariners, NAVTEX and NAVAREA warnings. • Use of Radar system. • Ship Oil Pollution Emergency Plan will be in place, alongside other Emergency Response documents	1	4	
DC.6.18	U		Seabed Sediments	Contamination of sediments.	2	3		N		2	3	
DC.6.19	U		Plankton	Degradation in water quality may affect viability of plankton stocks, recruitment for fish stocks, and base of food chain. Smothering, physical contamination and toxic effects on benthic organisms.	2	3		N		2	3	
DC.6.20	U		Benthic Flora & Fauna		2	3		N		2	3	
DC.6.21	U		Fish / Shellfish		2	3		N		2	3	
DC.6.22	U		Seabirds	Oiling of a birds plumage destroys its integrity as insulation and may cause the animal to die of hypothermia or by drowning.	1	4		Y		1	4	
DC.6.23	U		Marine Mammals	Toxic effects on individuals.	2	3		N		2	3	
DC.6.24	U		Commercial Fishing	Decrease in catch and landing value.	2	3		N		2	3	
DC.6.25	U	Overboard spill of chemicals during decommissioning activities	Water	Toxic potential of chemical releases could degrade water quality.	3	2		N	• Chemicals with improved environmental performance preferentially chosen. • Accidental spills will be kept to a minimum through training, good housekeeping and through storage/handling procedures.	3	2	
DC.6.26	U		Plankton	Degradation in water quality may affect viability of plankton stocks, recruitment for fish	3	2		N		3	2	
DC.6.27	U		Benthic Flora & Fauna		3	2		N		3	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.6.28	U		Fish / Shellfish	stocks, and base of food chain.	3	2		N	• Regular inspections to ensure all equipment in good working order. • A location specific oil pollution emergency plan and emergency procedures will be in place to minimise any spill.	3	2	
DC.6.29	U		Seabirds		3	2		N		3	2	
DC.6.30	U		Marine Mammals		3	2		N		3	2	
DC.6.31	U	Loss of debris and dropped objects	Commercial Fishing	Debris and dropped objects might fall on the seabed and constitute an uncharted obstacle to fishing gear.	3	1		N	• Prohibition of discarding of debris on the seabed. Audit of all equipment brought onto, and off, the site by all contractors. Retrieval of dropped objects and debris identified during post work surveys.	3	1	
DC.7 Solid Waste												
DC.7.1	P	Onshore disposal of operational waste	Land Use	Effects associated with onshore disposal are dependent on the nature of the site or process. Landfills: land take, nuisance, emissions (methane), possible leachate, and limitations on future land use. Treatment plants: nuisance, atmospheric emissions, potential for contamination of site	5	3		Y	• Waste management in place which will ensure: • Minimisation of the amounts generated; • Segregation of waste by type; • Storage in covered skips to prevent emissions and leaks; • Recycling or re-use prioritised where possible, in particular for scrap metal, waste oil and surplus chemicals; • Waste sent to authorised landfills or incineration facilities, depending on its precise nature, when no other option is possible; • Use of authorised waste contractors; • Auditing of waste management contractors to ensure compliance	5	2	
DC.7.2	P		Air	Atmospheric emissions from the processing and recycling of some materials	5	2		N		5	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.7.3	P	Onshore disposal of decommissioning materials	Land Use	Effects associated with onshore disposal are dependent on the nature of the site or process. Landfills: land take, nuisance, emissions (methane), possible leachate, and limitations on future land use. Treatment plants: nuisance, atmospheric emissions, potential for contamination of site	5	3		Y	• Perenco will ensure that an effective waste management plan is put in place prior to decommissioning activities commencing. • Perenco will ensure all waste contractors are audited and meet relevant legislation. • Perenco will actively seek to reduce the amount of recovered materials that are sent to landfill.	5	2	
DC.7.4	P	Onshore processing / recycling of decommissioning materials	Air	Atmospheric emissions / energy use from the processing and recycling of some decommissioning materials	5	3		Y		5	2	
DC.8 Transboundary Impacts												
DC.8.1	U	Hydrocarbon spill crosses the tranboundary line	Water	Degradation of water quality in international territorial waters	5	3		Y	• Perenco will ensure that the Bonn agreement is fully detailed in the Thames Area Decommissioning OPEP.	5	2	
DC.8.2	P	Atmospheric Emissions	Air	Atmospheric emissions from offshore decommissioning activities crossing the transboundary line	5	3		Y	• Advanced planning to ensure efficient operations. • Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels. • Generators will be running on the minimum power for the job task to avoid unnecessary emissions.	5	2	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
									• Well maintained and operated power generation equipment. • Regular monitoring of fuel consumption.			
DC.8.2	P	Chemical and hydrocarbon discharges	Water	Degradation of water quality in international territorial waters	3	1		N	• None required	3	1	
DC.9 Cumulative Impacts												
DC.9.1	P	Physical Presence	Other sea users	Potential for navigation hazard and emergency situation due to increased risk of collision.	3	3		Y	• Perenco will undertake vessel traffic surveys to assess the potential cumulative impact from the physical presence of the decommissioning vessels / rig.	5	2	
DC.9.2	P	Atmospheric Emissions	Air	Atmospheric emissions contributing to those already generated from other nearby installations.	4	3		Y	• Advanced planning to ensure efficient operations. • Emissions controlled to MARPOL Annex VI standards through the use of cleaner low emission fuels. • Generators will be running on the minimum power for the job task to avoid unnecessary emissions. • Well maintained and operated power generation equipment. • Regular monitoring of fuel consumption.	4	2	
DC.9.3	P	Chemical and hydrocarbon discharges	Water	Increased degradation of water quality with those discharges of other nearby installations.	3	1		N	• None required	3	1	

Ref	Event Type	Environmental Aspect	Environmental Receptor	Description of Potential Impact	Impact Before Mitigation				Mitigation Measures	Residual Impact		
					Likelihood	Consequence	Risk	Significant Aspect (Y/N)		Likelihood	Consequence	Residual Risk
DC.9.4	P	Surface and subsea noise generated by decommissioning activities	Marine Mammals	Cumulative impacts from noise in combination with other ongoing projects	3	3		Y	• In order to minimise any potential impact on marine cetaceans from the proposed Thames Area Decommissioning operations (excluding the use of explosives), Perenco will seek to conform to the JNCC protocol for minimising the risk of disturbance and injury to marine mammals from underwater noise throughout operations; • Perenco will also adhere to the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives at all times and where appropriate. Strive to avoid undertaking explosive activity during periods of known peak cetacean abundance; • Use of trained Marine Mammal Observers (MMOs) to identify if there are any vulnerable cetaceans in the vicinity of the explosive source. It is recommended that a one kilometre radius mitigation zone be set up around the explosion source. If marine mammals are sighted within this area, operations should be ceased / halted until they have left the area at a safe distance; • Use of Passive Acoustic Monitoring (PAM), in conjunction with MMOs, to determine the presence of cetaceans in high sea states, poor visibility, during low light conditions and to identify those which may not surface regularly enough to be sighted; • Prior to planning explosive operations, Perenco will consult with DECC as to whether other operations using explosives are being undertaken at a similar time and location.	3	2	

Appendix C: Environmental Survey

Thames Gas Field

Benthic survey technical report 2013

CMACS Ref: J3235

Prepared for: OSIRIS Projects (on behalf of Perenco UK Ltd and Orbis Energy Ltd)

Document: J3235 TGF benthic technical report 2013 v2

Version	Date	Description	Prepared by	Checked by	Approved by
1	Jan-2014	Issued Draft	KN	IGP	IGP
2	Feb-2014	Final	KN	IGP	IGP

This report has been prepared by Centre for Marine and Coastal Studies Ltd (CMACS) on behalf of Orbis Ltd.

Report to: Orbis Ltd

Cover image: Image taken during benthic survey of Thames Gas Field 2013.

Head Office
CMACS Ltd
80 Eastham Village Road
Eastham
Wirral
CH62 0AW

Tel: +44 (0)151 327 7177
Fax: +44 (0)151 327 6344
e: info@cmacsltd.co.uk
www.cmacsltd.co.uk

Isle of Man
CMACS Ltd
Asahi House
10 Church Road
Port Erin
Isle of Man
IM9 6AQ

Wales
CMACS (Cymru)
Woodland View
Pen-y-Worlod Lane
Penhow
Newport
NP26 3AJ

Centre for Marine and Coastal Studies Ltd

Contents

Table of figures

1. INTRODUCTION

The Thames Gas Field is located in the southern North Sea in an area approximately 40 to 110 kilometres from the coast of Norfolk (Figure 1). Extraction of gas from the field began in 1986 and production of gas is due to end in the near future.

Once production of gas has ceased there will be a period of decommissioning of infrastructure. Should works be undertaken to recover the pipeline infrastructure this would disturb the seabed with potential consequences for benthic habitats and fauna. The pipeline that exports gas back to land crosses the North Norfolk Sandbanks and Saturn Reef candidate Special Area of Conservation (cSAC) and the Haisborough, Hammond and Winterton cSAC, which are designated for ‘sandbanks which are slightly covered by seawater all the time’ and ‘Reefs’ Annex I habitats, namely *Sabellaria spinulosa* biogenic reef in the case of the latter designation.

Prior to decommissioning works, an assessment of the benthic environment is required.

CMACS Ltd were commissioned by OSIRIS Projects Ltd, on behalf of Perenco UK Ltd and Orbis Energy Ltd, to appraise ecological characteristics, including presence/absence of features of interest such as EC Habitats Directive Annex I Habitat based upon benthic data collected by CMACS and Osiris Projects (grab survey) and OSIRIS Projects (camera survey).

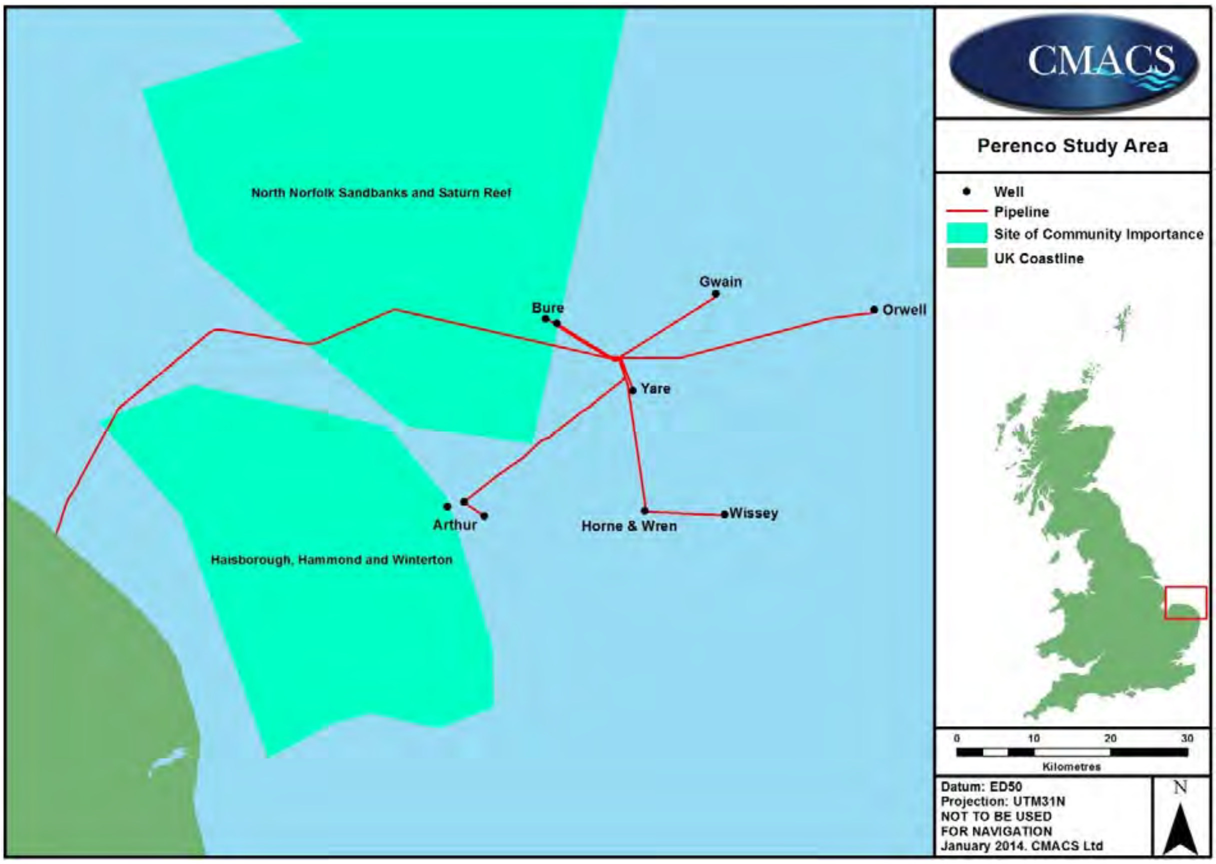


Figure 1. Location of each of the wells on the Thames Gas Field with the export pipeline and areas of conservation interest.

2. METHODS

2.1 Survey Strategy

Sample stations were selected by an experienced marine biologist, who screened side scan sonar with the assistance of an experienced geophysicist. Grab sample locations were selected to cover a range of seabed habitats whereas camera stations were focussed on areas where reflectivity data indicated there to be coarse ground or were suggestive of potential Annex I habitat, particularly biogenic reef. Sample station locations are provided in Appendix 1.

2.2 Grab samples

Grab sampling was used to characterise the benthic fauna across the survey area and samples were placed relatively evenly along the various pipeline routes (Figure 2).

A standard weighted Day grab with a $0.1m^2$ sample area was used for all sediment sampling. The vessel was held on station by the vessel skipper and the samples were collected from within 50m of the target location.

A fix of position, date and time were recorded upon deployment of the grab to the seabed. A single sample for faunal and particle size analysis was obtained from each station, with notes taken on volume, dominant sediment type and any visible taxa upon retrieval to deck. Samples were rejected if there was less than 5 litres of sediment (2.5 litres on hard-packed sands) in the sample or if the grab jaws were not closed properly.

Once the sample had been described and a photograph taken, a subsample of approximately 500g of sediment was removed for particle size analysis (PSA) and total organic carbon (TOC) analysis. All sediment samples were kept as cool as possible and frozen immediately upon arrival at the CMACS Eastham laboratory.

Once the PSA and TOC subsamples had been removed, the remaining material (for faunal analysis) was sieved over a 1mm mesh using a low pressure seawater hose. Faunal samples were labelled both externally on a bucket and internally using a plastic tag. Samples were 'fixed' (preserved) using a buffered formol saline immediately upon return to shore.

At each location a second grab sample was obtained for contaminants testing. Sub-samples for metals analysis were collected with a plastic spoon and stored in a plastic bag. Sub-samples for organics analysis were collected with a metal spoon and stored in hexane washed amber glass jars.

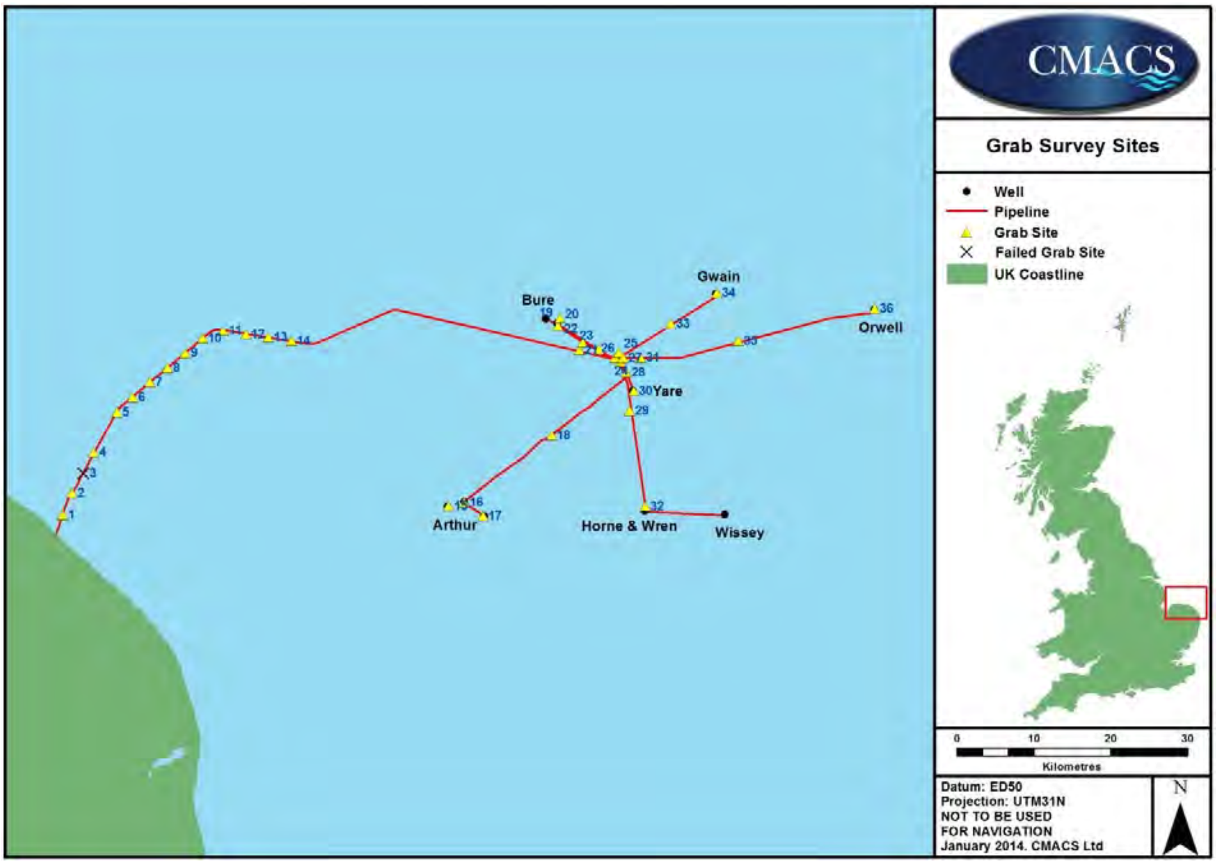


Figure 2. Sample locations for grab survey.

2.3 Camera survey

Drop down camera stations were targeted on areas of high reflectivity and apparent elevation from the seabed in order to investigate for biogenic reef Annex I habitat, particularly that of ross worm *Sabellaria spinulosa*. A geophysicist, in the presence of a marine biologist experienced in the interpretation of sidescan sonar mosaics, derived sample stations on areas of potential reef along each of the pipeline routes (see Figure 3 for sample locations).

A drop down camera with freshwater housing suitable for use in low visibility/high turbidity environments was deployed to capture stills and video of the seabed at each station. The equipment was lowered slowly to the seabed whilst the vessel was held over the target.

The camera was deployed twice on each target position. Particular attention was paid to the potential presence of any Annex I habitat or rare/sensitive species.

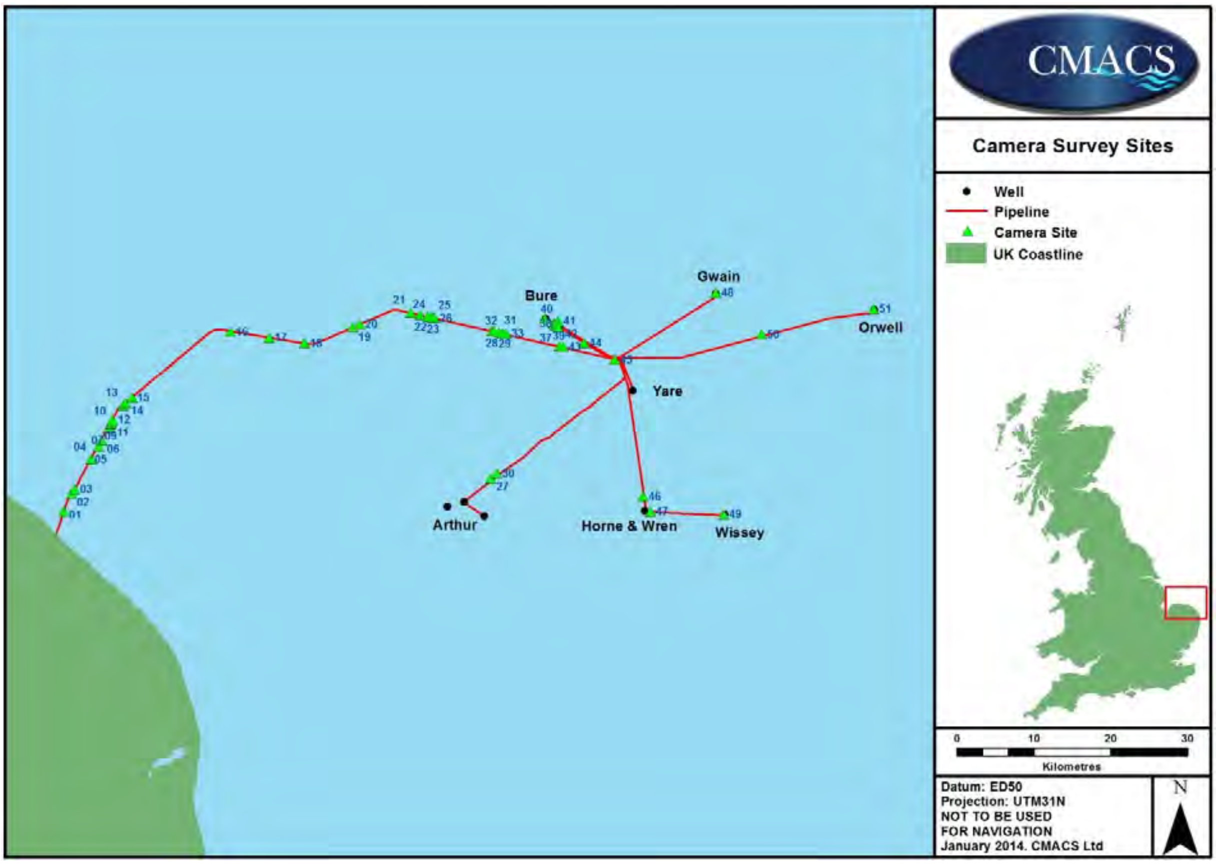


Figure 3. Sample locations for drop down camera survey.

2.4 Laboratory techniques

2.4.1 Particle size analysis (PSA)

Sediment samples obtained from the grab stations were dried and analysed at the CMACS laboratory on the Wirral, which participates in the relevant NMBAQC Scheme. Dry sieving was undertaken using the full phi sieve series displayed in Table 1.

Table 1: Sieve Series used for particle size analysis (mesh size in mm)

Sieve series (mm)											
63	31.5	16	8	4	2.000	1.000	0.500	0.250	0.125	0.063	<0.063

Samples were dried at 80°C for at least 24 hours. Samples were then sieved on Endecott BS 410 test sieves using a Retsch AS200 sieve shaker.

Proportional masses and volumes of sediment were used to calculate mean and median particle sizes, and the determination of sorting index by calculating the standard deviation of Phi. These were then used to determine sediment type according to the definitions as used by Buchanan (1984) (Table 2 and Table 3) and also the Folk and Ward classification system (Folk, 1954) as used by the British Geological Survey (BGS) (Long, 2006) (see Figure 4).

Total organic content (TOC) of dry sediment was determined by loss on ignition at 450ºC, using the sediment fraction less than 1mm.

Table 2: Classification used for defining sediment type (from Buchanan, 1984).

Wentworth Scale (mm)	Phi units	Sediment types
>256mm	<-8	Boulders
64 - 256 mm	-8 to -6	Cobble
4 - 64 mm	-6 to -2	Pebble
2 - 4 mm	-2 to -1	Granule
1 - 2 mm	-1 to -0	Very coarse sand
0.5 - 1 mm	0 - 1	Coarse sand
250 - 500 µm	1 - 2	Medium sand
125 - 250 µm	2 - 3	Fine sand
63 - 125 µm	3 - 4	Very fine sand
<63 µm	>4	Silt

Table 3: Classification used to define the degree of sediment sorting (from Buchanan, 1984).

Standard Deviation of mean Phi	Classification
<0.35	Very well sorted
0.35 - 0.5	Well sorted
0.5 - 0.71	Moderately well sorted
0.71 - 1	Moderately sorted
1 - 2	Poorly sorted
2 - 4	Very poorly sorted
>4	Extremely poorly sorted

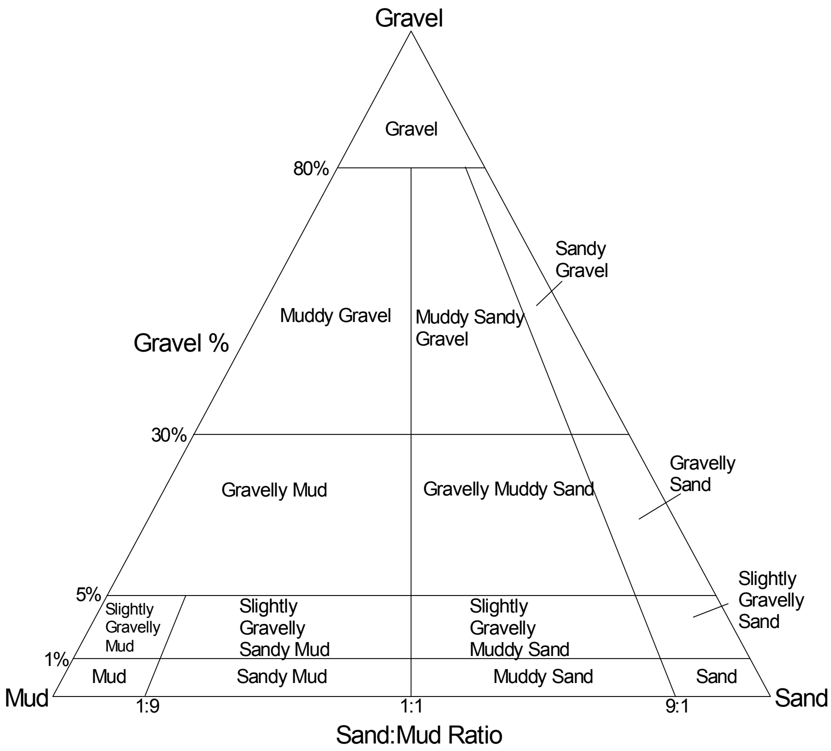


Figure 4: Sediment classification after Folk (1954) as also used by the BGS. "Gravel" is greater than 2mm and "mud" is less than 63μm.

2.4.2 Faunal analysis

Macrofaunal analysis of sub-tidal samples was carried out at the CMACS Ltd laboratory located in Port Erin, Isle of Man, which participates in the NMBQAC scheme. Wherever possible, all macrofauna were identified to species and counted. The following quality control procedures were used for sample collection, specimen sorting and taxonomic identification:

- Experienced operatives carried out all sorting with low power microscopes available to facilitate sorting as necessary. A proportion of samples (minimum 10%; typically one sample randomly selected from each batch of ten recently sorted samples) were re-sorted by an experienced sorter other than the original. Under this protocol, if the total number of animals found increases by more than approximately 5 % following re-sorting, all of the other samples in the appropriate batch sorted by that person must be re-sorted.
- An experienced taxonomist using relevant up to date identification guides and papers, and an appropriate range of stereo and monocular microscopes carried out all identification. Nomenclature follows the World Register of Marine Species (WoRMS) database and MCS species directory codes (Picton & Howson, 2000) are also provided for convenience of sorting data.

2.4.3 Image analysis

Seabed image analysis was focussed on appraising ecological characteristics, including presence/absence of features of interest such as EC Habitats Directive Annex I Habitat, particularly as parts of the survey area are within the North Norfolk Sandbanks and Saturn Reef cSAC and Haisborough, Hammond and WintertoncSAC. Analysis was undertaken by an experienced marine biologist and involved reviewing all images; an image from each of the sites are reported in the results section with a short description of habitat and obvious fauna. Assessment of *Sabellaria spinulosa* reef was carried out with reference to the discussion document of Gubbay (2007) in which it is suggested that aggregations may be classified as 'not a reef' or having low, medium or high 'reefiness' according to the extent and patchiness of *Sabellaria spinulosa*, as well as the height of the aggregations, as defined in Table 4.

Table 4. Range of figures to be used as a measure of 'reefiness'. From Gubbay (2007).

Measure of 'reefiness'	NOT a REEF	LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m^2)	<25	25-10,000	10,000-1,000,000	>1,000,000
Patchiness (% cover)	<10%	10-20	20-30	>30

Elevation could not be directly measured from the images and was estimated using indicators such as the relative size of epifaunal organisms that were also present in the images.

2.4.4 Statistical analysis

Faunal community characteristics were investigated with multivariate analyses carried out in Primer 6.0. Abundance data were square-root transformed to reduce bias towards the most common species before a similarity matrix was created using the Bray-Curtis method. The similarity matrix was then used to create dendrograms and multi-dimensional scaling plots to examine the data for similarities and differences in faunal community between sample stations. In the dendrogram, the Simprof routine was included to determine clusters of samples that were not significantly different from one another. These groups were then analysed with Simper to determine the characterising species of each group and the differences between groups.

2.4.1 Contaminants analysis

Sediment contaminant samples were analysed by a UKAS accredited laboratory. Metals were analysed following Aqua Regia extraction using inductively coupled plasma optical emission spectrometry (ICP-OES). Polycyclic aromatic hydrocarbons (PAHs) were analysed by gas chromatography–mass spectrometry (GC-MS). Hydrocarbons were analysed using gas chromatography-flame ionization detector (GC-FID).

Contaminant levels were compared against published thresholds and guidance levels (see Section 3.1.3).

Determinands and limits of detection are summarised in Table 5.

Table 5. Contaminant analysis determinands and limit of detection (LOD) for each.

Determinand	LOD	units	Determinand	LOD	units
Metals			**TPH CWG**		
Arsenic	<0.5	mg/kg	**Aliphatics**		
Barium	<1	mg/kg	>C5-C6	<0.1	mg/kg
Beryllium	<0.5	mg/kg	>C6-C8	<0.1	mg/kg
Cadmium	<0.1	mg/kg	>C8-C10	<0.1	mg/kg
Chromium	<0.5	mg/kg	>C10-C12	<0.2	mg/kg
Copper	<1	mg/kg	>C12-C16	<4	mg/kg
Lead	<5	mg/kg	>C16-C21	<7	mg/kg
Mercury	<0.1	mg/kg	>C21-C35	<7	mg/kg
Nickel	<0.7	mg/kg	Total aliphatics C5-35	<19	mg/kg
Selenium	<1	mg/kg	**Aromatics**		
Vanadium	<1	mg/kg	>C5-EC7	<0.1	mg/kg
Water Soluble Boron	<0.1	mg/kg	>EC7-EC8	<0.1	mg/kg
Zinc	<5	mg/kg	>EC8-EC10	<0.1	mg/kg
PAHs			>EC10-EC12	<0.2	mg/kg
Naphthalene	<0.04	mg/kg	>EC12-EC16	<4	mg/kg
Acenaphthylene	<0.03	mg/kg	>EC16-EC21	<7	mg/kg
Acenaphthene	<0.05	mg/kg	>EC21-EC35	<7	mg/kg
Fluorene	<0.04	mg/kg	Total aromatics C5-35	<19	mg/kg
Phenanthrene	<0.03	mg/kg	Total aliphatics and aromatics(C5-35)	<38	mg/kg
Anthracene	<0.04	mg/kg			
Fluoranthene	<0.03	mg/kg	MTBE	<5	ug/kg
Pyrene	<0.03	mg/kg	Benzene	<5	ug/kg
Benzo(a)anthracene	<0.06	mg/kg	Toluene	<5	ug/kg
Chrysene	<0.02	mg/kg	Ethylbenzene	<5	ug/kg
Benzo(bk)fluoranthene	<0.07	mg/kg	m/p-Xylene	<5	ug/kg
Benzo(a)pyrene	<0.04	mg/kg	o-Xylene	<5	ug/kg
Indeno(123cd)pyrene	<0.04	mg/kg			
Dibenzo(ah)anthracene	<0.04	mg/kg	Total Phenols HPLC	<0.15	mg/kg
Benzo(ghi)perylene	<0.04	mg/kg			
PAH 16 Total	<0.6	mg/kg	Hexavalent Chromium	<0.3	mg/kg
Benzo(b)fluoranthene	<0.05	mg/kg	Sulphate as SO4	<0.0015	g/
Benzo(k)fluoranthene	<0.02	mg/kg	Chromium III	<0.5	mg/kg
			Total Organic Carbon	<0.02	%

3. RESULTS

3.1 Grab survey

The grab survey was carried out on the 3rd and 4th of July 2013 with samples successfully obtained at 35 of the 36 stations. Field notes are provided in Appendix 2. No sample was obtained from station 3 owing to the very coarse ground there and the grab was repeatedly retrieved with stones holding the jaws open. Images of each grab are presented in Appendix 3.

3.1.1 Sediments

The sediments on the pipeline routes were predominantly sands (69-100%) with varying amounts of gravel (0-30%) and a very low proportion of mud (typically less than 1%). A summary of sediment statistics and classification (according to Long, 2006) are presented in Table 6. Full sediment data can be found in Appendix 3.

At stations 2 and 8 there were quantities of bivalve shell mixed in with the coarser particles, particularly that of blue mussel *Mytilus edulis*.

At station 4, aggregations of *Sabellaria spinulosa* made up a proportion (approximately 25%) of the sediment.

Examination of the sidescan sonar data revealed sand waves across large swathes of the seabed, suggesting that there are strong tidal currents and the sediments are highly mobile. Organic content, as indicated by loss on ignition, of the sediment was low ranging from 0.47 to 1.54% with no trend across the survey area.

Table 6. Summary of particle size analysis data for each sample station.

Sample	Mean µm	Mean Φ	LOI	% Gravel	% Sand	% Mud	Sediment type
1	352.81	1.50	0.66	0.6	99.3	0.1	Sand
2	472.81	1.08	0.70	12.6	87.3	0.2	Gravelly Sand
4	1415.09	-0.50	1.42	30.4	69.0	0.6	Sandy Gravel
5	376.66	1.41	0.94	13.6	85.2	1.1	Gravelly Sand
6	866.99	0.21	0.60	28.1	71.7	0.2	Gravelly Sand
7	371.77	1.43	0.47	2.4	97.5	0.1	Slightly Gravelly Sand
8	440.85	1.18	0.87	9.9	89.9	0.2	Gravelly Sand
9	321.88	1.64	0.56	0.7	99.1	0.2	Sand
10	392.21	1.35	0.90	3.5	96.4	0.1	Slightly Gravelly Sand
11	336.65	1.57	0.75	3.4	96.3	0.3	Slightly Gravelly Sand
12	451.61	1.15	0.63	2.0	97.8	0.1	Slightly Gravelly Sand
13	393.55	1.35	0.53	2.0	97.8	0.1	Slightly Gravelly Sand
14	355.83	1.49	0.53	2.1	97.8	0.1	Slightly Gravelly Sand
15	349.62	1.52	0.65	2.1	97.3	0.6	Slightly Gravelly Sand
16	426.05	1.23	0.94	0.5	99.4	0.1	Sand
17	330.93	1.60	1.37	3.8	95.1	1.1	Slightly Gravelly Sand
18	350.04	1.51	0.51	0.1	99.8	0.1	Sand
19	348.72	1.52	0.91	1.8	97.9	0.3	Slightly Gravelly Sand
20	330.75	1.60	0.57	2.1	97.7	0.2	Slightly Gravelly Sand
21	306.56	1.71	0.89	0.6	98.4	1.0	Sand
22	294.60	1.76	0.79	1.0	98.4	0.6	Slightly Gravelly Sand
23	355.79	1.49	0.75	2.8	97.0	0.2	Slightly Gravelly Sand
24	342.17	1.55	0.51	0.7	99.2	0.1	Sand
25	337.52	1.57	1.03	0.5	98.2	1.3	Sand
26	355.65	1.49	1.44	0.7	99.2	0.1	Sand
27	377.76	1.40	1.54	1.6	98.2	0.2	Slightly Gravelly Sand
28	302.69	1.72	1.19	0.3	97.2	2.4	Sand
29	343.67	1.54	0.70	1.4	98.2	0.4	Slightly Gravelly Sand
30	320.27	1.64	1.26	0.5	97.5	1.9	Sand
31	336.43	1.57	0.74	1.0	98.9	0.1	Slightly Gravelly Sand
32	1044.92	-0.06	0.59	0.2	99.7	0.1	Sand
33	316.81	1.66	0.79	0.6	98.6	0.8	Sand
34	286.72	1.80	0.87	0.8	98.8	0.4	Sand
35	301.45	1.73	1.18	9.1	89.5	1.5	Gravelly Sand
36	276.40	1.86	0.65	0.5	99.0	0.5	Sand

3.1.2 Fauna

Faunal data can be found in Appendix 4.

A total of 263 individual taxa were identified from the grab samples, with a maximum of 133 at station 4 but this was very much the exception, with most samples containing 20 to 30 taxa per grab. Diversity of samples was highly variable over the survey area (see Table 7) and high diversity was not necessarily related to a large number of taxa,) but rather that there was not a numerically dominant taxa in any of the samples, as indicated by the high (i.e. close to 1) evenness scores.

The more abundant taxa in the samples were typical of offshore mobile sands and included polychaetes such as *Lagis koreni*, *Ophelia borealis*, *Spiophanes bombyx, Scoloplos armiger*, *Spio armata* and *Lanice conchilega* which were found throughout the survey area. *Sabellaria spinulosa* was also relatively abundant in terms of total numbers in the survey but most of the individuals were recorded in the sample from Station 4.

There were also some relatively abundant crustaceans in the samples including four species from the amphipod genus *Urothoe* in addition to the cumacean *Monopseudocuma gilsoni* and *Pseudocuma longicornis*. There were also some relatively abundant bivalve taxa including small razor clams of an indeterminate species as well as *Angulus fabula*, a species typical of sands with a coarse sediment component.

There was generally low similarity between the faunal community at each of the sample stations and twelve distinct groups were identified by Simprof (Figure 5), which were analysed with the Simper routine to determine the differences between groups. There were five groups (A, B, C, D and K) which contained only a single sample each and were typically less than 40% similar to other samples. The faunal assemblage of these groups typically contained low numbers of individuals of most component taxa but with only a few species of relatively high abundance. For example, of the 20 taxa recorded in group A (Station 1) only three were present at more than 10 per sample; *Ophelia borealis*, *Travisia forbesi* and *Goodallia triangularis*. Groups A, B and D contained some characterising species of the biotope SS.SCS.ICS.HeloMsim but did not match well overall and the more general classification of SS.SCS.ICS ‘Infralittoral coarse sediment’ is more appropriate. Groups C and K did not match well with any biotope and have been classified as SS.SSA ‘Sublittoral sands and muddy sands’.

Group E was made up of samples from the landward half of the export pipeline and were located in area where there were large sand waves and the fauna was mainly polychaetes such as *Spio armata*, *Ophelia borealis* and *Spiophanes bombyx* although nematode worms were also relatively abundant in the samples. The combination of sediment type and fauna did not match any biotope well but, SS.SSA.CFiSa.EpusOborApri *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand’ was the closest match to the data.

The samples in group F were spread over the survey area and were in areas with less landscaping of the sediment with a fauna that was also characterised by *Ophelia borealis*, *Spio armata* and *Urothoe brevicornis* in addition to nematode and nemertean worms. The combination of low diversity and low abundance made a good match with the biotope SS.SSA.IFiSa.IMoSa ‘Infralittoral mobile clean sand with sparse fauna’.

Group G was made up of samples from the central ‘hub’ where all of the pipelines meet and where there was a fauna of amphipods *Urothoe brevicornis*, polychaetes *Nephtys cirrosa*, cumaceans *Monopseudocuma gilsoni*, nematodes and bivalves *Angulus fabula*. Various species of the amphipod *Bathyporeia* were also present in the samples which made a good overall match with the biotope SS.SSA.IFiSa.NcirBat ‘*Nepthys cirrosa* and *Bathyporeia* spp. in infralittoral sand.

Group H was another cluster containing samples from across the survey area and was another assemblage from a variety of taxa including *Ophelia borealis* (in moderate abundance), *Scoloplos armiger*, *Spiophanes bombyx* and nematode worms. The samples in this group could not be matched to a specific biotope and have been classified at the higher designation of SS.SSA ‘Sublittoral sands and muddy sands’.

Group I was also made up of samples from across the survey area and the fauna was a mixture of polychaetes and other taxa including *Spiophanes bombyx*, *Lanice conchilega*, juvenile razor fish and *Monopseudocuma gilsoni*. The faunal community at the stations in this group shared some species with the biotope SS.SSA.IMuSa.FfabMag ‘*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’ but also elements of SS.SCS.ICS.SLan ‘Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand’.

Group J was a relatively large group of samples with relatively high abundances of the polychaetes *Lagis koreni* and *Spiophanes bombyx* as well as moderate numbers of *Scoloplos armiger* and *Angulus fabula*. The sediments at these sample stations generally contained a higher proportion of silt than elsewhere and were classified as SS.SSA.IMuSa.FfabMag ‘*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand’.

Group L was made up of three inshore samples that had the highest proportion of gravel of all of the stations and were the most diverse of all the faunal assemblages which included *Sabellaria spinulosa*, nemertean worms, *Exogone naidina* and *Spio armata*. These samples also contained some numbers of epifaunal taxa including hydroids and bryozoans which were presumably attached to the coarser particles. *Sabellaria spinulosa* was quite common in the samples from this group but images from the area (see next section) suggest that there was not a biogenic reef present and therefore the area was classified as CR.MCR.CSab.Sspi.ByB ‘*Sabellaria spinulosa* with a bryozoan turf and barnacles on silty turbid circalittoral rock’ which includes pebble, gravel and sand in the substrata listed.

The MDS plot in Figure 6 provides an impression of the low similarity between the fauna at each of the sample stations with points spread out across the plot. Percentage similarity overlaid on the plot reinforces the impression of low similarity between sample stations. Low similarity between samples is not entirely unexpected as the stations are placed in a large geographical area. The stress of the plot is also quite high indicating that the relationships in multidimensional space between samples is not well represented on the 2D plot.

A summary of the biotope at each sample station is provided in Figure 7.

Table 7. Number of taxa, individuals and diversity indices for each faunal sample. Ordered from most diverse to least.

Sample station	Number of taxa	Number of individuals	Pielou's evenness	Shannon-Wiener index	Simpson's Index
5	64	249	0.87	3.60	0.96
6	66	308	0.82	3.42	0.95
4	133	1231	0.63	3.10	0.89
29	27	63	0.92	3.03	0.95
11	50	271	0.77	3.00	0.92
10	29	77	0.88	2.98	0.94
32	22	51	0.91	2.82	0.94
34	22	42	0.91	2.80	0.94
7	36	124	0.78	2.78	0.89
31	23	61	0.88	2.77	0.93
27	19	32	0.94	2.77	0.95
20	23	76	0.84	2.63	0.89
21	23	68	0.82	2.58	0.89
15	23	87	0.82	2.57	0.89
33	22	72	0.82	2.54	0.89
9	23	63	0.81	2.52	0.89
26	18	33	0.86	2.50	0.90
2	22	88	0.78	2.41	0.86
22	22	153	0.75	2.33	0.86
23	24	116	0.73	2.32	0.83
19	25	155	0.71	2.30	0.81
24	21	78	0.69	2.10	0.76
30	24	202	0.66	2.09	0.79
12	16	91	0.75	2.09	0.82
35	20	116	0.65	1.94	0.74
36	13	77	0.71	1.82	0.77
8	34	196	0.51	1.79	0.61
1	20	159	0.59	1.76	0.73
28	23	257	0.52	1.63	0.66
13	36	351	0.45	1.61	0.57
25	27	317	0.46	1.53	0.58
16	14	79	0.53	1.41	0.56
14	14	92	0.53	1.39	0.55
18	10	50	0.60	1.38	0.65
17	18	135	0.35	1.01	0.35

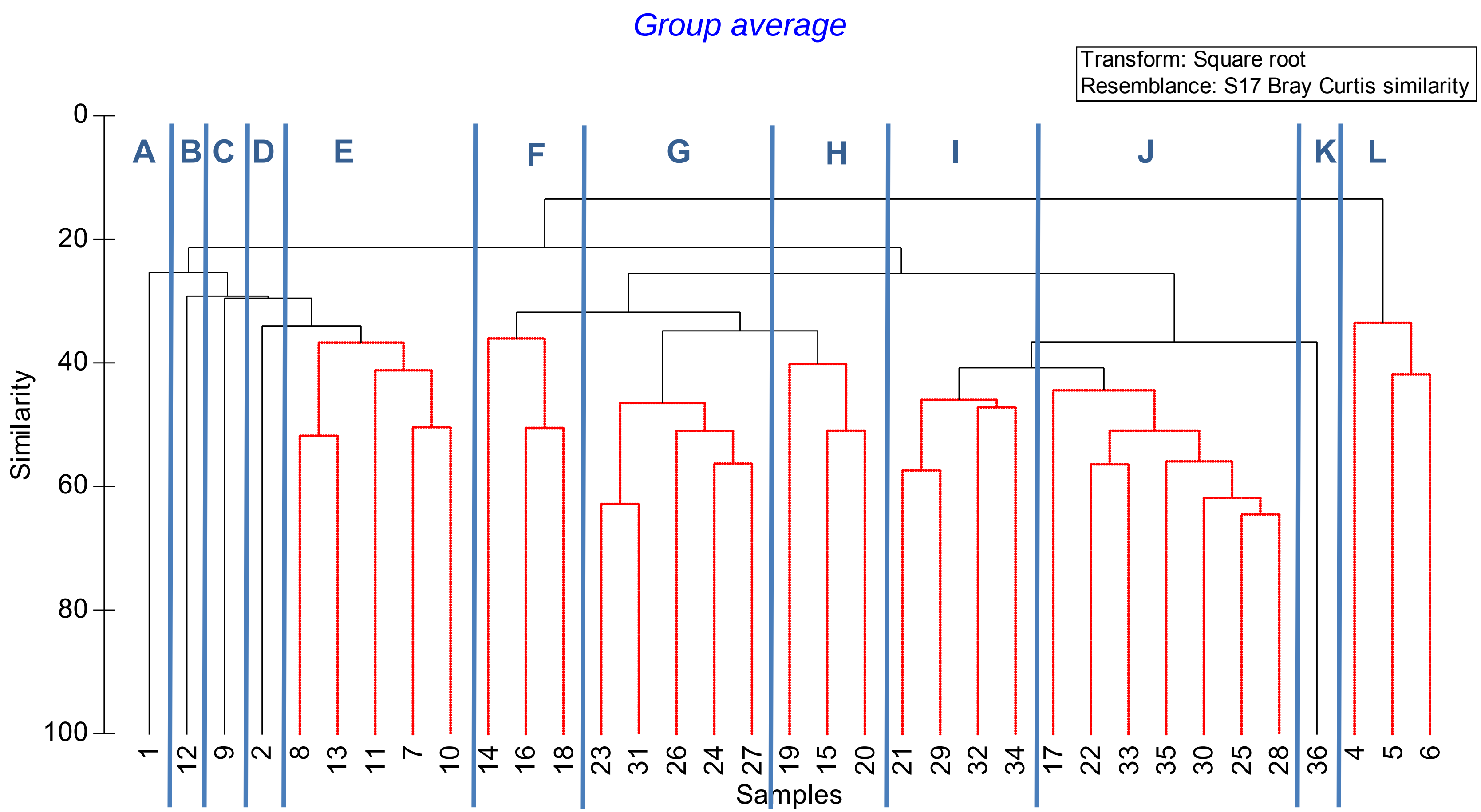


Figure 5. Cluster analysis of faunal data from the grab survey. Samples joined by horizontal red lines are not significantly different from one another (as determined with the Simprof routine).

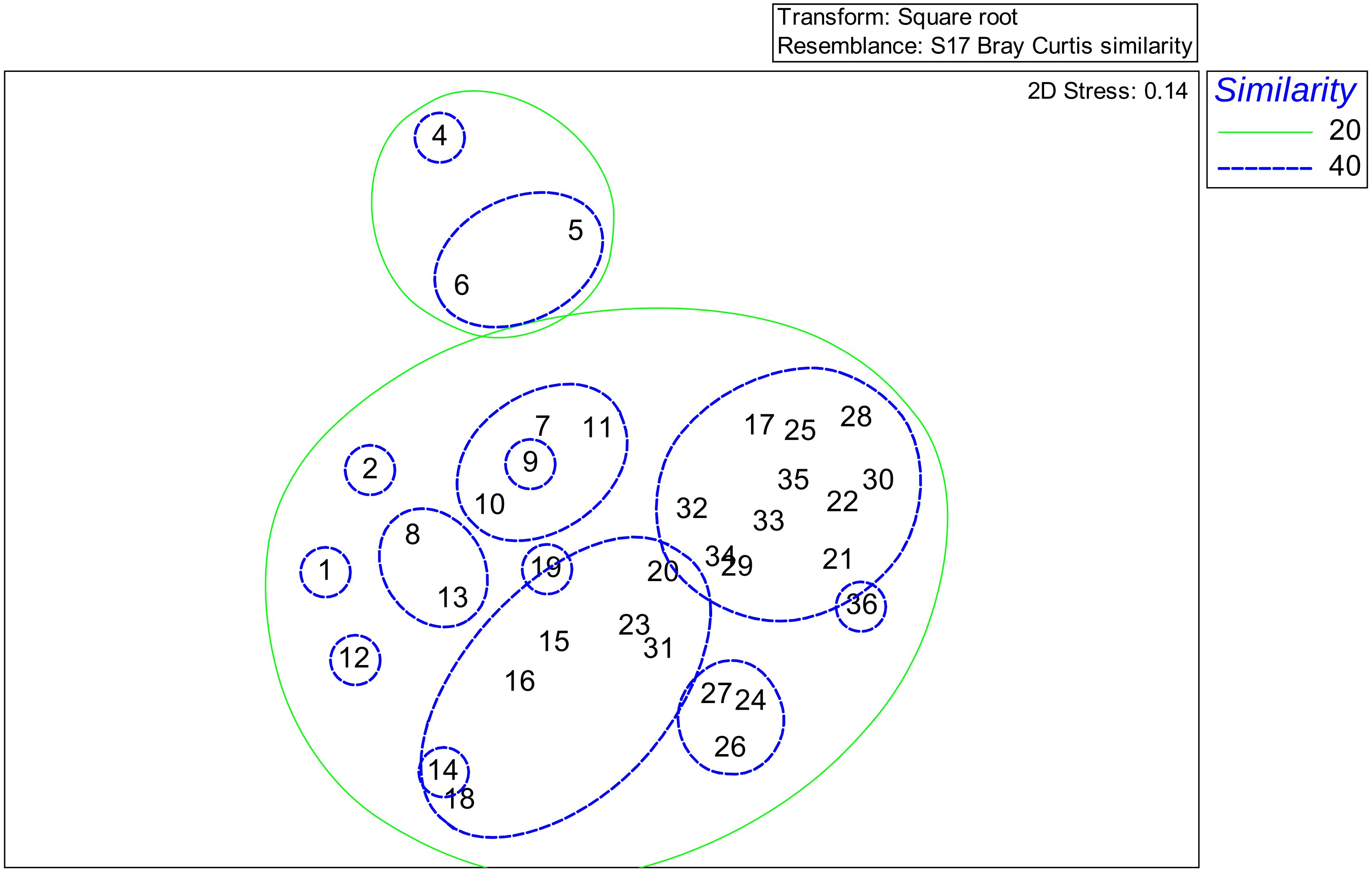


Figure 6. MDS plot overlaid with similarity clusters at 20% and 40% similarity.

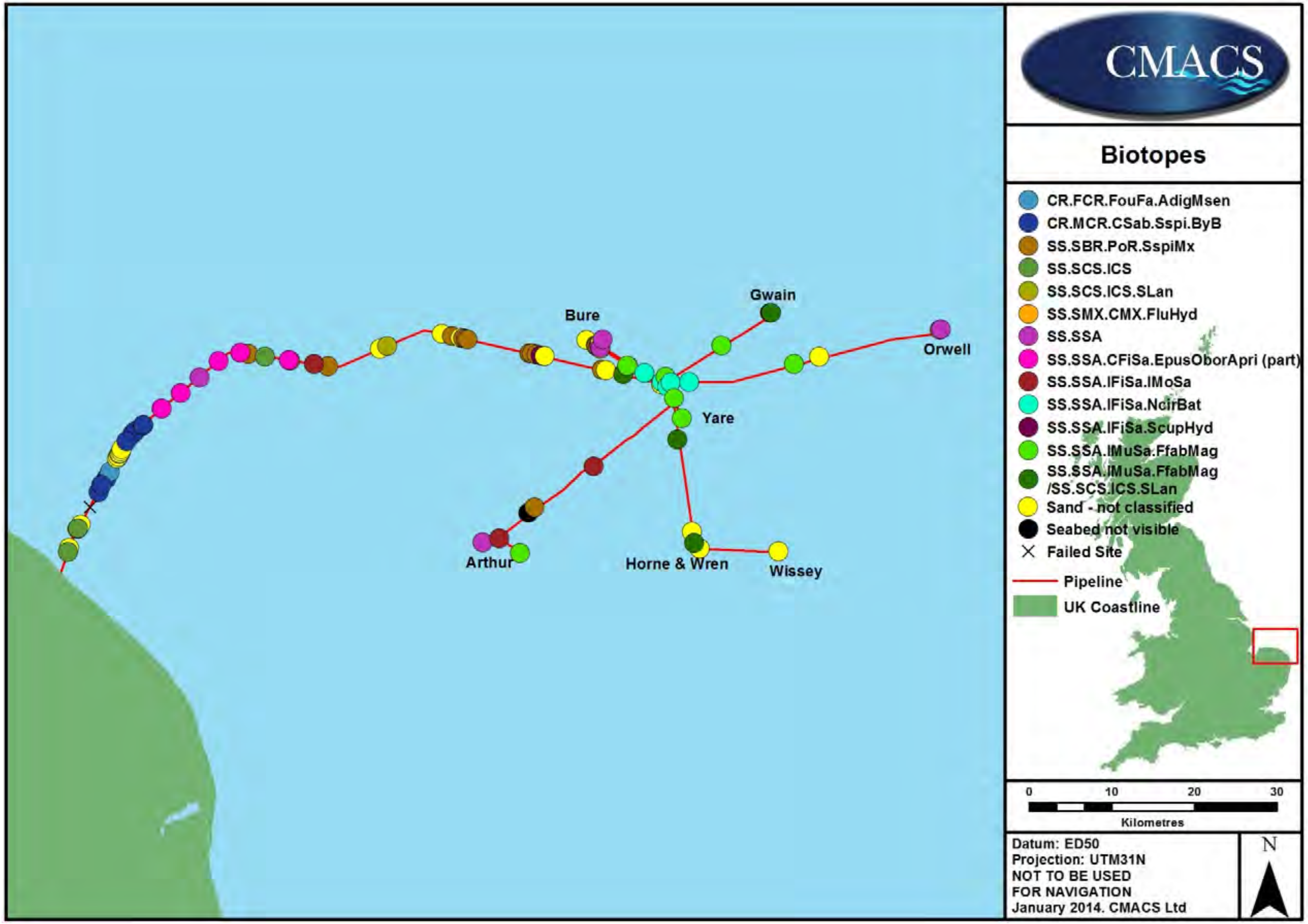


Figure 7. Biotope at each sample station.

3.1.3 Contaminants

Sediment contaminants data were collected at all but two stations. No samples were obtained at Station 3 because the ground was coarse and unsuitable for grab sampling, or at Station 4 where no additional grab sampling was undertaken because of the presence of *Sabellaria spinulosa*. Full results are presented in Appendix 6; key trends are described below.

There are no definitive guides to acceptable contamination levels. A common practice is to assess contamination levels against Cefas or Marine Scotland action levels for the disposal of dredged material (see Appendix 5) and/or the interim sediment quality guideline (ISQG) levels (CCME, 1999 updated in 2001, as referred to in relation to the management of UK SACs by Cole *et al*., 1999). Dredging is clearly a different activity to gas field decommissioning but the industry has relatively well-developed guidelines in relation to remobilisation of sediment contaminants which provide useful reference points for other activities.

CEFAS guidelines have two ‘action levels’, contaminant concentrations below action level one are thought to be of no danger to the environment if disposed of at sea, whilst levels above action level two are considered unsuitable for disposal at sea. Dredged material with contaminant levels between Action Levels 1 and 2 requires further consideration and testing before a decision can be made (CEFAS, undated). Marine Scotland have similar actions levels, though with slightly different values, which have been referred to here when no equivalent Cefas levels are available.

The ISQG levels propose threshold effect levels (TEL) and probable effects levels (PEL). Below the more conservative TEL it is thought that contaminants will have little or no effect on the environment, whilst levels above PEL are expected to show at least some effects on the environment.

Amongst the metals that were analysed (see Section 3.1.3), only arsenic was present above Cefas Action Level 1; arsenic levels exceeded Action Level 1 at the majority of stations but only exceeded Action Level 2 at one location (147ppm at Station 27 in the centre of the offshore survey area). Arsenic is sometimes present at elevated levels due to geological inputs and/or historic industrial discharge (Cole et al., 1999) and the level of contamination present in relation to arsenic and other metals does not suggest any widespread contamination of surface sediments.

Of the other metals, only cadmium was present above Cefas Action Level 1 and then only at one location (0.4ppm at Station 27).

Barium was detectable at all stations. There are no advisory contamination levels for barium, which is a relatively inert metal that is widely used in drilling muds to add weight, and can therefore be used as an indicator for possible contamination by drilling activities. The distribution of barium at between 6 and 36ppm suggests that there are no ‘hot spots’ and likely results from wider drilling activities followed by natural dispersal in the southern North Sea region.

With the exception of PAHs at Station 31 hydrocarbons were not present above limits of detection at any site. The background level of total hydrocarbon content in the southern North Sea is around 4ppm (UKOOA, 2001) which lies below the limits of detection in the analyses applied; however, the results certainly indicate that there is no gross hydrocarbon contamination of superficial sediments in the areas surveyed.

At Station 31 (offshore end of the export pipeline) PAHs were detected above Marine Scotland Action Level 1 (no Action Level 2). Many compounds were present at around 0.3ppm (Total of 16 US Environment Protection Agency priority PAHs 4.4ppm).

3.2 Camera survey

To simplify reporting, stations with similar seabed and/or fauna have been grouped together for description[1]. An appraisal of the presence of Annex I habitat is provided in section 3.3.

Example images are shown below the following summary description.

The majority of the images showed bare sand and most of these had little visible fauna with the exception of occasional epifaunal organisms such as crabs and starfish, though there were some images that showed considerable numbers of the sand mason worm *Lanice conchilega*.

At station 2, one of the inshore sample locations, the seabed was made up blue mussel shell amongst fine sediment with boulder and cobble which supported an epifauna of barnacles and hornwrack *Flustra foliacea*. The images from stations 32 and 48 also showed a sessile epifauna but of various hydroids and sponge and with finer sediments than at station 2.

Further offshore at stations 4, 5, 13 and 14 there were *Sabellaria spinulosa* aggregations growing as a crust over gravel, pebble and sand which also supported sea anemones, bryozoan and several species of hydroid (see image descriptions below for more details).

Of the 51 sample stations, the seabed at 17 of them supported growths of *Sabellaria spinulosa* of varying density over sand, which in turn supported various crab and hydroid species, soft coral and common starfish *Asterias rubens*. The aggregations at some of these stations showed signs of damage, either from storm action or possibly from anthropogenic sources e.g. towed fishing gear.

Station 6 was directly over a wreck which supported a dense turf of anemones, hydroids and soft corals, which is a good match to CR.FCR.FouFa.AdigMsen '*Alcyonium digitatum* with *Metridium senile* on moderately wave-exposed circalitorral steel wrecks'.

The visibility at station DC027 was very poor and it was not possible to discern the seabed or any fauna from the images obtained there.

[1] In some images sediment movement is apparent. This may be natural sediment transport due to tide movement; however, the presence of the camera frame can sometimes lead to localised acceleration of near-bed flows.

Biotopes could not be assigned to most of those stations with a sand seabed (see previous section for likely classifications), but where there was coarser sediment and/or diverse epifauna biotopes were applied as follows:

- Station 2: most likely an impoverished SS.SMX.CMX.FluHyd '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' based on the presence of hornwrack, barnacles and the substratum type.

- Stations 4, 5, 13 and 14: the *Sabellaria spinulosa* at these stations formed a low crust over the coarse particles along with various other sessile epifauna leading to the classification CR.MCR.CSab.Sspi.ByB '*Sabellaria spinulosa* with a bryozoan turf and barnacles on silty turbid circalittoral rock'.

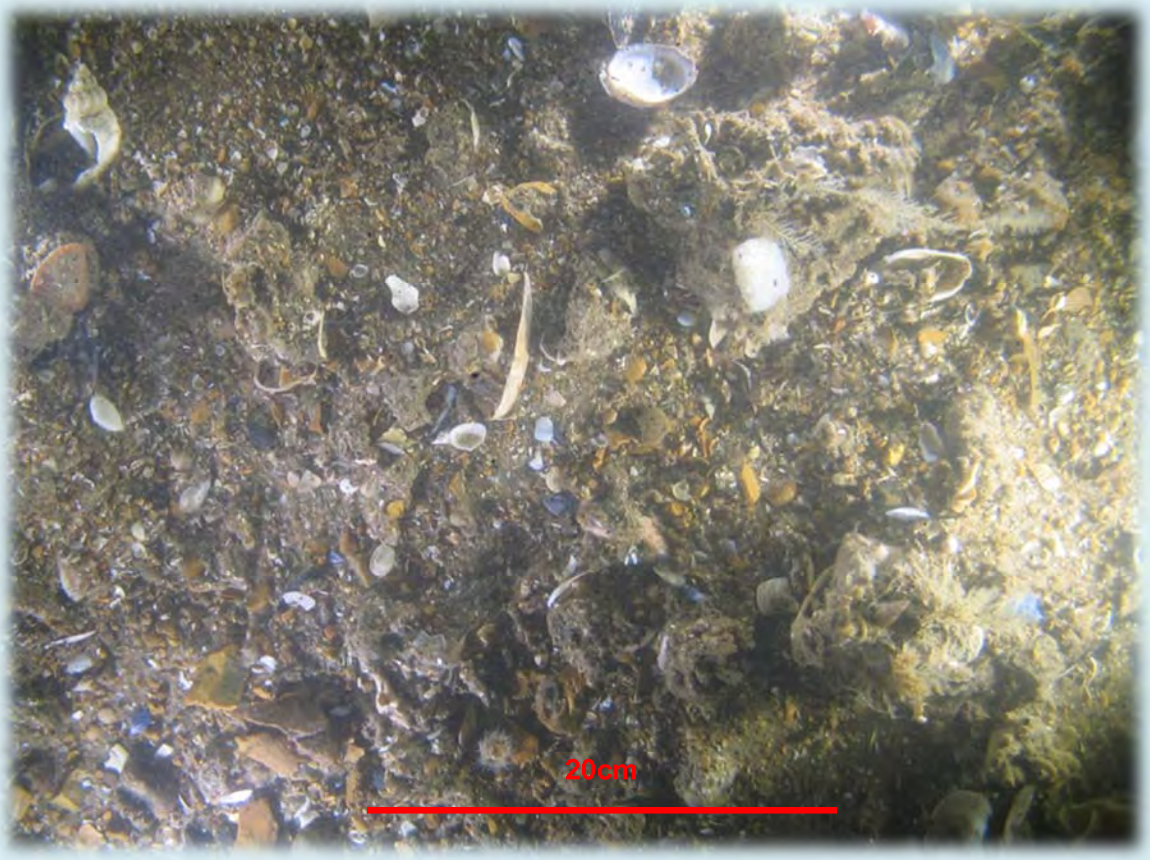
- Stations 15, 16, 17, 18, 22, 24-26, 28-31, 35, 36-39 and 42: based on the sediment at these stations and the surface relief of the *Sabellaria spinulosa* the biotope matches best with SS.SBR.PoR.SspiMx '*Sabellaria spinulosa* on stable circalittoral mixed sediment'.

- Stations 32 and 48: Based on the presence of *Sertularia cupressina* on a predominantly sandy seabed, there was a reasonable match with the biotope SS.SSA.IFiSa.ScupHyd '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles'.

Station	1
Seabed description	Coarse sand and shell fragments with some cobble
Fauna & flora	Barnacles (of indeterminate species), common starfish *Asterias rubens* A faunal turf covering the barnacles can be seen in the top left of the image. Drift seaweed, probably sea oak *Halidrys siliquosa*, on the left of the image.

Station	2
Seabed description	Sand with boulder and blue mussel shell.
Fauna & flora	Hornwrack *Flustra foliacea* attached to hard substratum as are barnacles (of indeterminate species) on the larger particles.

Station	4
Seabed description	Coarse sand, fine gravel and bivalve shell (including empty horse mussel, *Modiolus modiolus*, shell)
Fauna & flora	Clusters and individuals of ross worm *Sabellaria spinulosa* which have begun to bind together the bivalve shells which then supports the hydroids *Abietinaria abietina*, *Sertularia cupressina* and *Nemertesia antennina* (the latter two species recorded from DC004_2) as well as the bryozoan *Flustra foliacea*. Serpulid and spirorbid worms have colonised the dead bivalve shell.

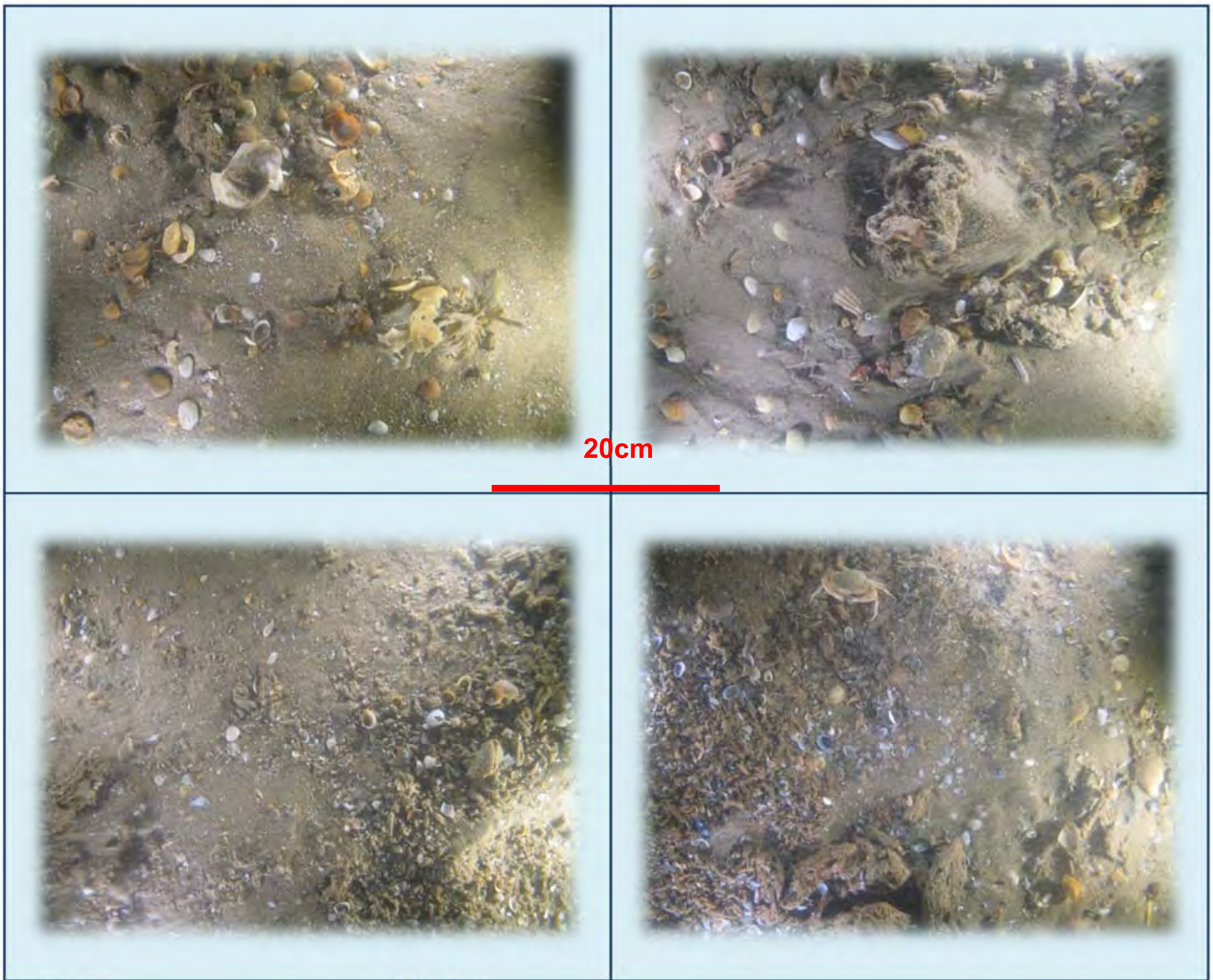


Station	5
Seabed description	Coarse sand, gravel and pebble with dead mollusc shell
Fauna & flora	Aggregations of *Sabellaria spinulosa* which support a turf of hydroid including *Halecium halecium*. Anemone also present, probably *Sagartia troglodytes*.

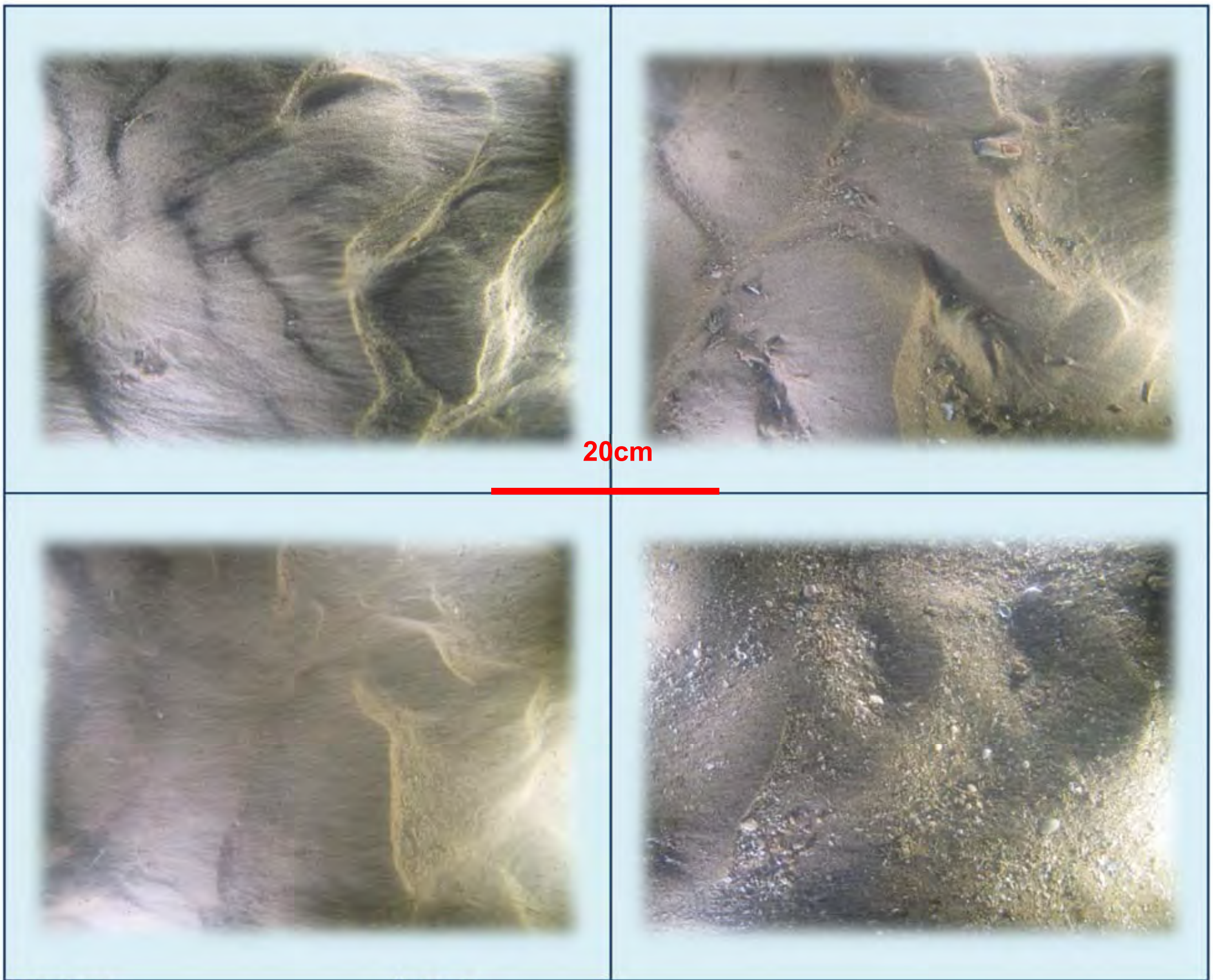
Station	6
Seabed description	Shipwreck
Fauna & flora	Dense faunal turf that includes the hydroids *Nemertesia ramosa* and *Tubularia* sp., dead man's fingers *Alcyonium digitatum*, the bryozoan *Flustra foliacea* and the anemone *Sagartia elegans* (orange and white colour morphs).

Station	13
Seabed description	Gravel and pebble with dead bivalve shell
Fauna & flora	Encrusting growths of *Sabellaria spinulosa*, hydroids including *Sertullaria cupressina* and anemones, probably *Sagartia troglodytes* and possibly one *Sagartia elegans*.

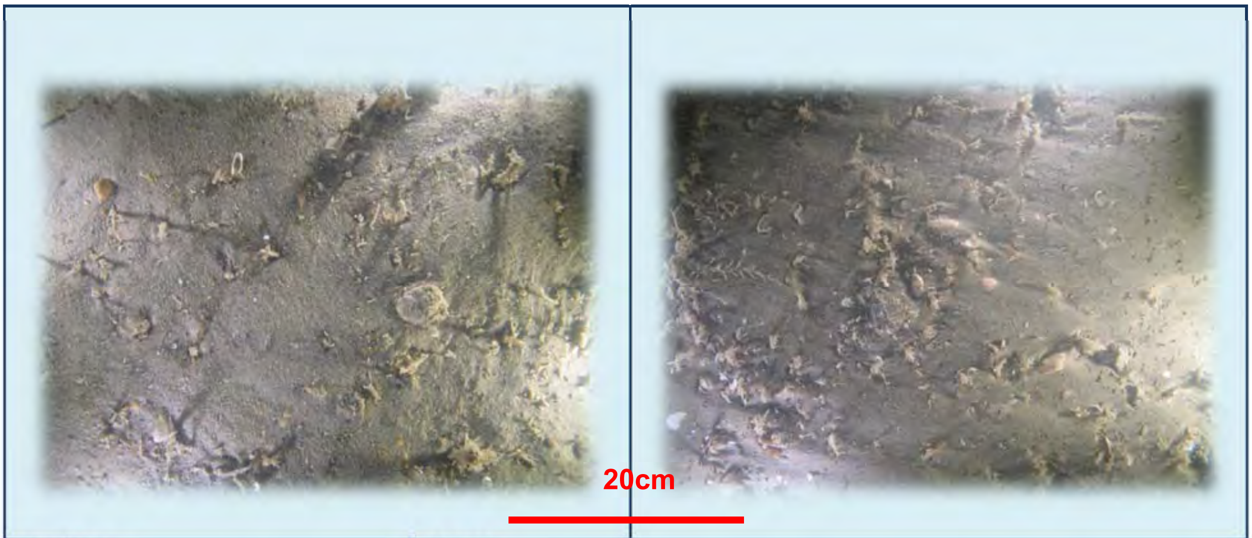
Station	**14**
Seabed description	Gravel and shell
Fauna & flora	Broken aggregations of *Sabellaria spinulosa* with *Flustra foliacea*, anemone, probably *Sagartia troglodytes* and hydroids.



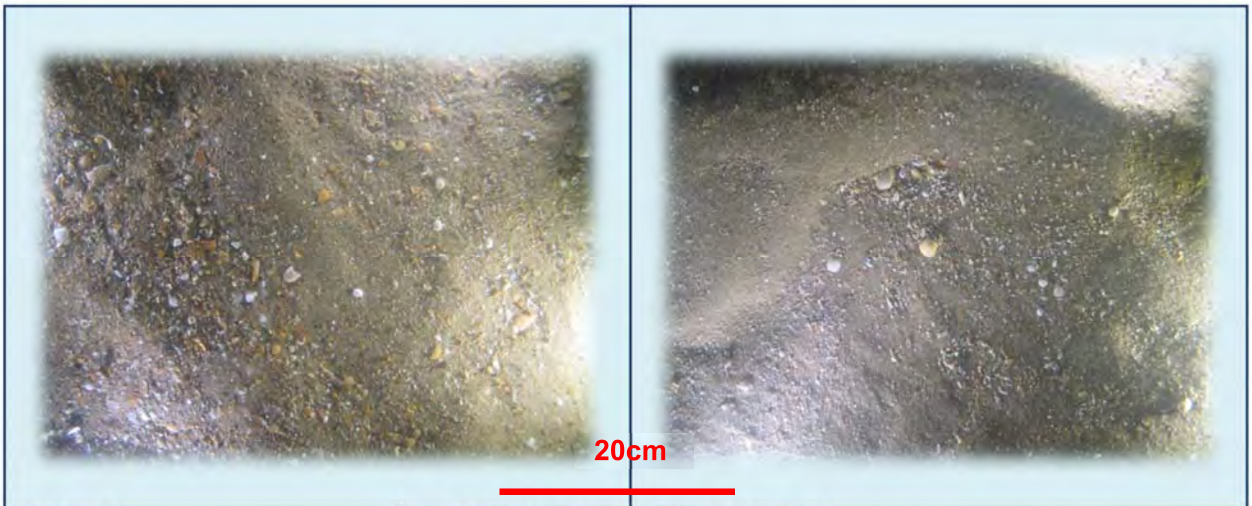
Stations	**15, 16** **17, 18**
Seabed description	Sand and shell.
Fauna & flora	A sessile fauna of isolated aggregations of *Sabellaria spinulosa* as well as hornwrack *Flustra foliacea*. Mobile fauna includes a swimming crab *Liocarcinus* sp., hermit crab *Pagurus* sp. and brittlestar *Ophiura albida*.



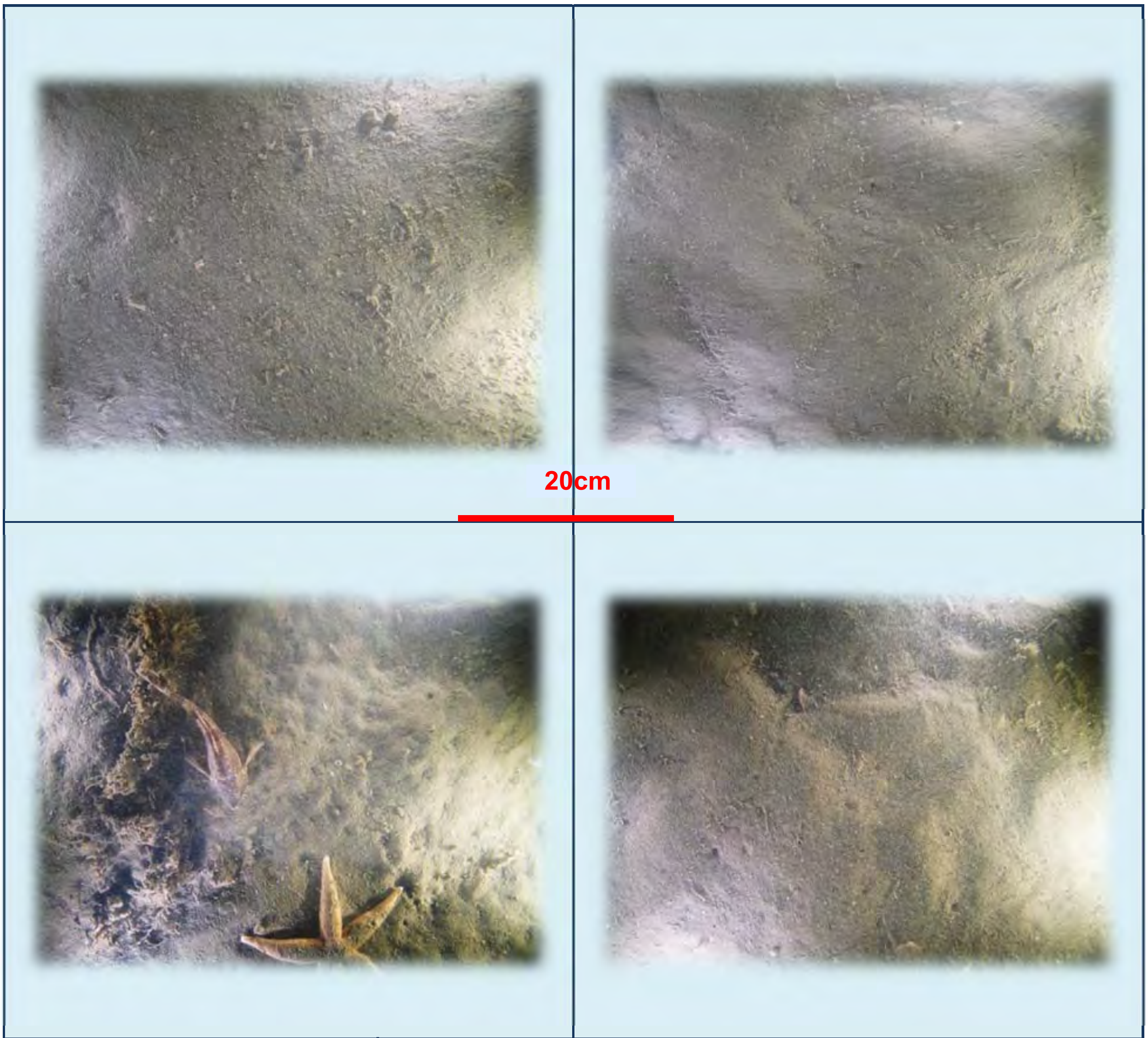
Stations	**19, 33** **34, 41**
Seabed description	Rippled sand
Fauna & flora	None visible



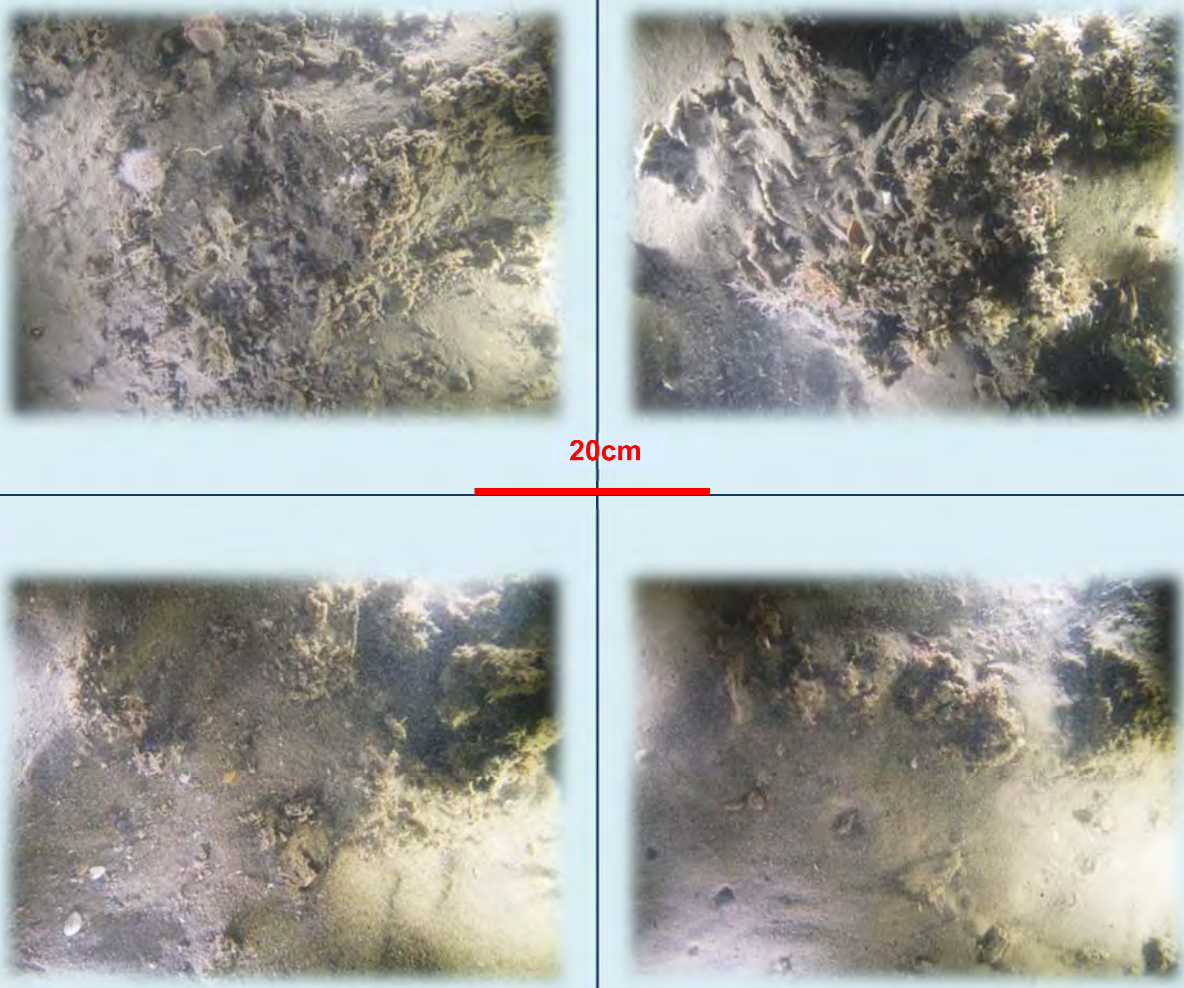
Stations	**20, 51**
Seabed description	Sand and shell fragments
Fauna & flora	Sand mason worm *Lanice conchilega* are numerous at both stations, with the hydroid *Hydrallmania falcata* present on the left hand side of the image from DC051_2.



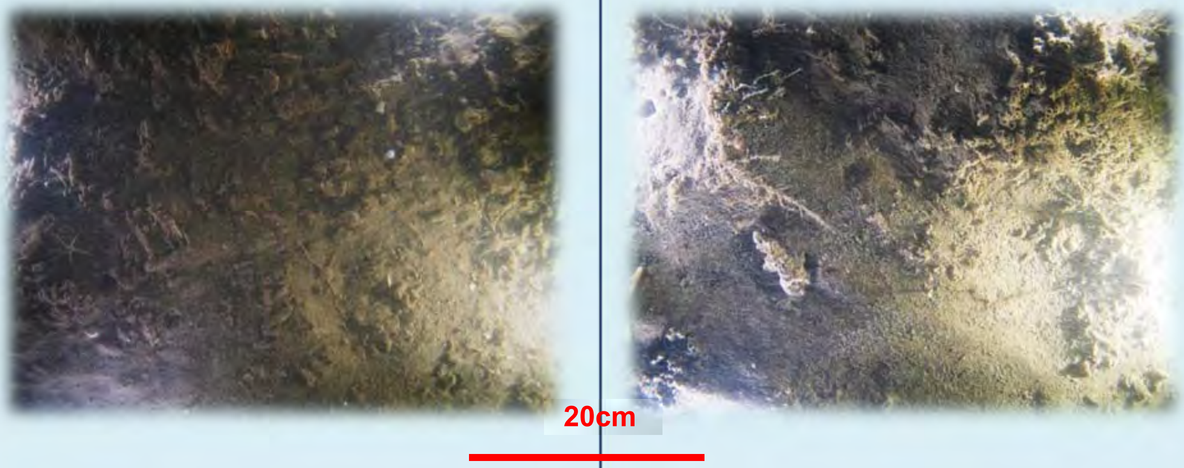
Stations	**7, 11 (Stations 7 to 12 are similar)**
Seabed description	Rippled sand
Fauna & flora	None visible.



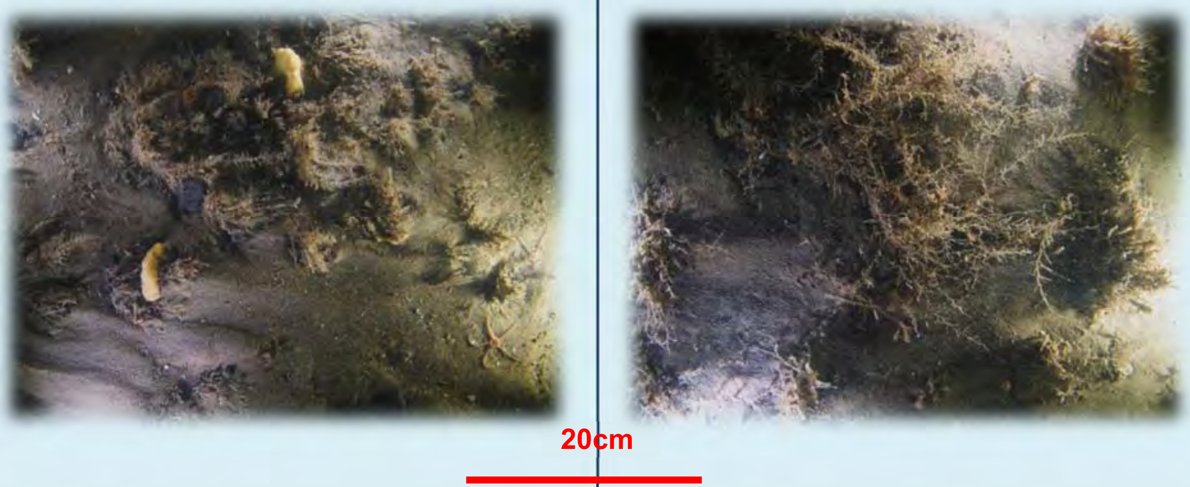
Station	**23, 40** **43, 45**
Seabed description	Fine sand and mud
Fauna & flora	None visible in the upper pair of images. DC043_2: a pogge *Agonus cataphractus* and a common starfish *Asterias rubens* are present along with an encrusting fauna including the hydroid *Tubularia* sp. on an unidentified object. DC045_2: In the upper part of the image, the tubes of the sand mason worm *Lanice conchilega* are visible.



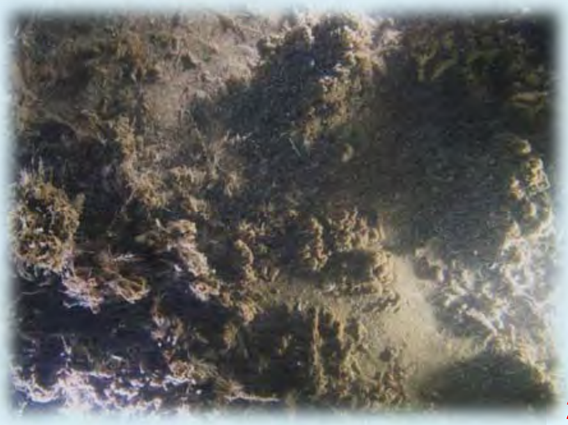
Station	**24, 25** **26, 28**
Seabed description	Sand
Fauna & flora	Aggregations of *Sabellaria spinulosa* which support a sessile fauna of dead man's fingers *Alcyonium digitatum* and hydroids including *Tubularia* sp. A hermit crab *Pagurus* sp. is visible at the top of image DC024_2 which has a shell encrusted by the hydroid *Hydractinia echinata*.



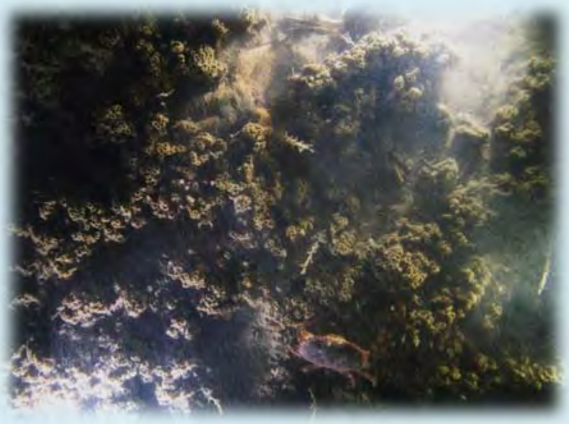
Stations	**29, 30**
Seabed description	Sand
Fauna & flora	Aggregations of *Sabellaria spinulosa*, anemones possibly *Sagartia* sp and the hydroids *Tubularia* sp. and *Sertullaria* sp. Mobile fauna includes the brittlestar *Ophiura albida* and common starfish *Asterias rubens*.



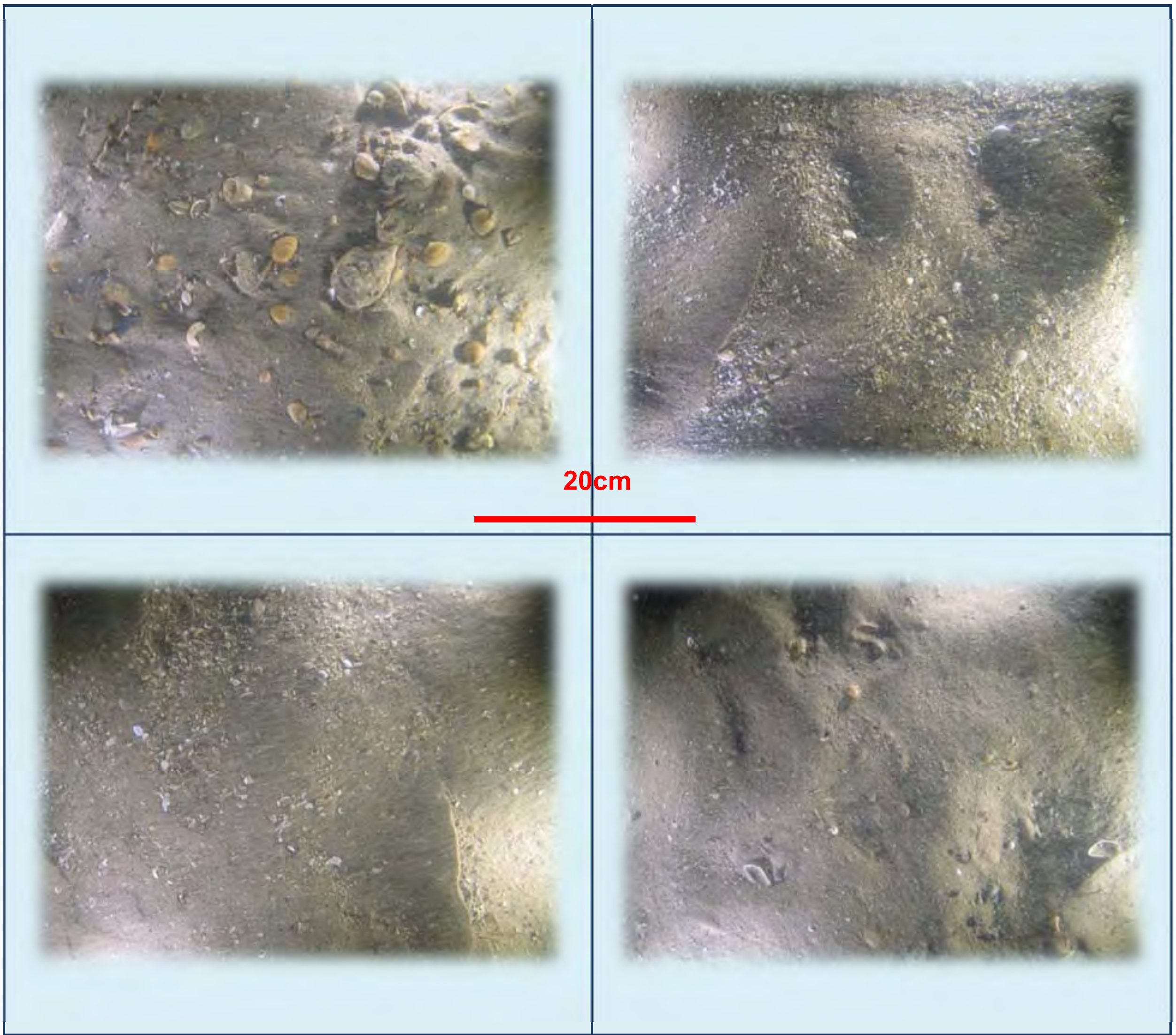
Stations	**32, 48**
Seabed description	Sand and pebble/cobble
Fauna & flora	Abundant hydroid including *Sertullaria cupressina*, *Tubularia* sp. and possibly *Halecium* sp. A yellow sponge of indeterminate species is present at station 32. Mobile fauna is limited to the brittlestar *Ophiura albida*.



20cm

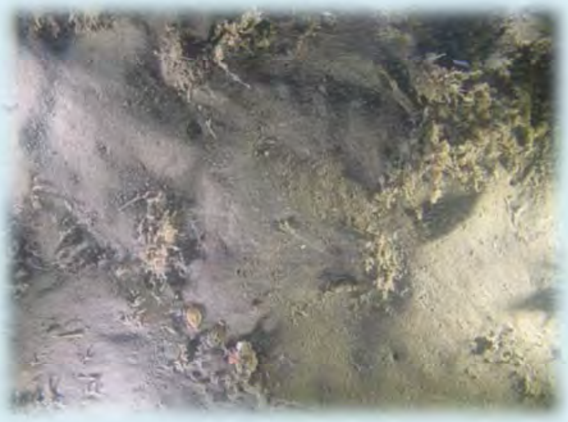


Stations	**31, 35** **42**
Seabed description	Sand
Fauna & flora	*Sabellaria spinulosa* aggregations of at least medium 'reefiness' and very likely to be of high 'reefiness' in the area around DC042_1. The reef supports numerous hydroids including *Tubularia* sp. and probably *Halecium* sp. Mobile fauna includes brown crab *Cancer pagurus* and velvet swimming crab *Necora puber* as well as common starfish *Asterias rubens*.



Station	**21, 41** **46, 49**
Seabed description	Rippled sand and shell
Fauna & flora	A small hermit crab in the centre of image DC049_2

20cm



Station	**22, 36** **37, 38** **39**
Seabed description	Sand and shell with pebble-sized pieces of clay in places
Fauna & flora	Sparse *Sabellaria spinulosa* tubes as well as some small aggregations. A hydroid, possibly *Tubularia* sp. at the bottom left-hand corner of DC022. Mobile fauna of common starfish *Asterias rubens*, hermit crab *Pagurus* sp. and brittlestar *Ophiura albida*.

Stations	44, 50
Seabed description	Sand and shell
Fauna & flora	Various hydroids including *Tubularia* sp.

Stations	3, 33 34
Seabed description	Rippled sand and shell
Fauna & flora	None visible

3.3 Annex I habitat

Aggregations of *Sabellaria spinulosa* were recorded from three parts of the survey area; around the Bure well, on the export pipeline from Arthur to the central hub and on the pipeline from the central hub to the mainland. Assessment of 'reefiness' of the aggregations of *Sabellaria spinulosa* has been separated into these three areas and is summarised in Table 8 to Table 10, below. Areas of high reflectivity and surface relief were identified on the side scan sonar mosaic and ground-truthed with the drop down camera and therefore the assessment of 'reefiness' was carried out under the assumption that the seabed images are representative of the wider seabed in each area.

Aggregations of *Sabellaria spinulosa* in the Arthur and Bure (Figure 8 and Figure 9 respectively) areas generally covered large areas of the seabed (but overall a low proportion of the pipeline routes) but were of low 'reefiness' owing to the sparseness of cover and the low elevation of the aggregations. Many of the images indicated that the aggregations had been damaged (by unknown means) as evidenced by the eroded appearance of some of the aggregations and the presence of worm tubes scattered on their sides on the seabed (see images in section 3.1.3).

On the export pipeline route (Figure 10 to Figure 15) there were similar numbers of areas of low and medium 'reefiness' and a pair of stations that were classified as 'not a reef', partly with reference to the parameters of Gubbay but also as an expert assessment based on the state of the *Sabellaria spinulosa* observed in the images; many loose single tubes and loose aggregations on the sediment surface with no evidence of stabilisation of the sediment. The areas of medium 'reefiness' were at the eastern end of the export pipeline route and showed some healthy aggregations of *Sabellaria spinulosa* at station 42 but those at stations 25 and 31 indicated damage in the past. There was a notable associated epifauna of various hydroids and the crabs *Cancer pagurus* and *Necora puber* at these stations.

Sandbanks are generally very large seabed features (i.e. many kilometres in length and breadth) and as a result confirming their presence with the bathymetric data available is not necessarily simple. However, the bathymetric data for the inter-well pipeline routes indicates that there are points of shallower water and therefore raised seabed at two points on the Arthur pipeline, two points on the Orwell pipeline and another that is less well defined on the Gawain pipeline. These areas contain sand waves and are interspersed with areas of deeper water which suggests that Annex I sandbank habitat is present.

Bathymetric data was not available for the export pipeline to the British coast but as described in the Introduction, the export pipeline passes through two candidate SACs which are partly designated for 'sandbanks at least partially covered with sea water at all times' Annex I habitat. The sidescan data of the export pipeline shows large areas of sandwaves which suggests that there is at least some Annex I sandbank habitat present Much of the fauna recorded in the grab samples is typical of mobile sands and their sensitivity to disturbance has been assessed in a later section.

Table 8. Assessment of *Sabellaria spinulosa* reefiness on Arthur area. Areas are estimates and are rounded to the nearest 100m^2.

Station	Area (m^2)	Percent cover	Elevation (cm)	Reefiness	Notes
27	1,200	<10	<2	Not a reef	
	200	≤20	1-5	Low	
30	2,700	10-20	1-5	Low	
	3,100	<10	<2	Not a reef	No images for these areas, assessment based on side scan mosaic of areas adjacent to station 30.
	4,700				

Table 9. Assessment of *Sabellaria spinulosa* reefiness on Bure area. Areas are estimates and are rounded to the nearest 100m^2.

Station	Area (m^2)	Percent cover	Elevation (cm)	Reefiness	Notes
35 & 36	15,400	≈20	1-5	Low	Damaged reef, broken aggregations on sediment surface.
	4,400	<10	<5	Low	
37	64,700	<10	<5	Low	Appears to be remains of a reef that has been damaged some time ago, extant aggregations are worn smooth at the edges.
38	800	<10	<5	Low	
39	3500	<5	<5	Low	

Table 10. Assessment of *Sabellaria spinulosa* reefiness on the export pipeline route. Areas are estimates and are rounded to the nearest 100m².

Station	Area (m²)	Percent cover	Elevation (cm)	Reefiness	Notes
4	9,500	5-20	1-5	Low	
	15,700	5-20	1-5	Low	No images of this area, assessment based on similarity of reflectivity in side scan sonar mosaic to that around station 4
5	2,400	5-20	1-5	Low	
	3,400	5-20	1-5	Low	No images of these areas, assessment based on similarity of reflectivity in side scan sonar mosaic to that around station 5
	3,500	5-20	1-5	Low	
	3,800	5-20	1-5	Low	
	3,500	5-20	1-5	Low	
	8,100	5-20	1-5	Low	
	1,500	5-20	1-5	Low	
13, 14 & 15	184,400	10-30	<2	Low	Mainly a crust of worm tubes binding together gravel and pebble.
16	900	<10	2-5	Low	Worn remnant aggregations.
17	3,300	<10	<2	Not a reef	Scattered tubes and unattached aggregations.
18	5,200	≈10	<2	Not a reef	Scattered tubes and unattached aggregations.
22	2,600	20	<2	Low	Many broken tubes on sediment surface
24	3,300	<20	<5	Low	Scattered aggregations, possibly remnant reef
25	5,100	0-50	0-5	Medium	Damaged/worn aggregations supporting hydroids
26	5,500	≈20	<5	Low	Damaged/worn aggregations supporting hydroids
28 & 29	30,100	≤20	<2	Low	Very broken up, hard to distinguish between unattached debris and attached aggregations.
31	2,300	>50	1-10	Medium	
	400	>50	1-10	Medium	No images of these areas, assessment based on similarity of reflectivity in side scan sonar mosaic to that around station 31
	1000	>50	1-10	Medium	
42	28,300	50-100	1-10	Medium	Actual area may be larger but constrained to north and south by limit of side scan sonar coverage.

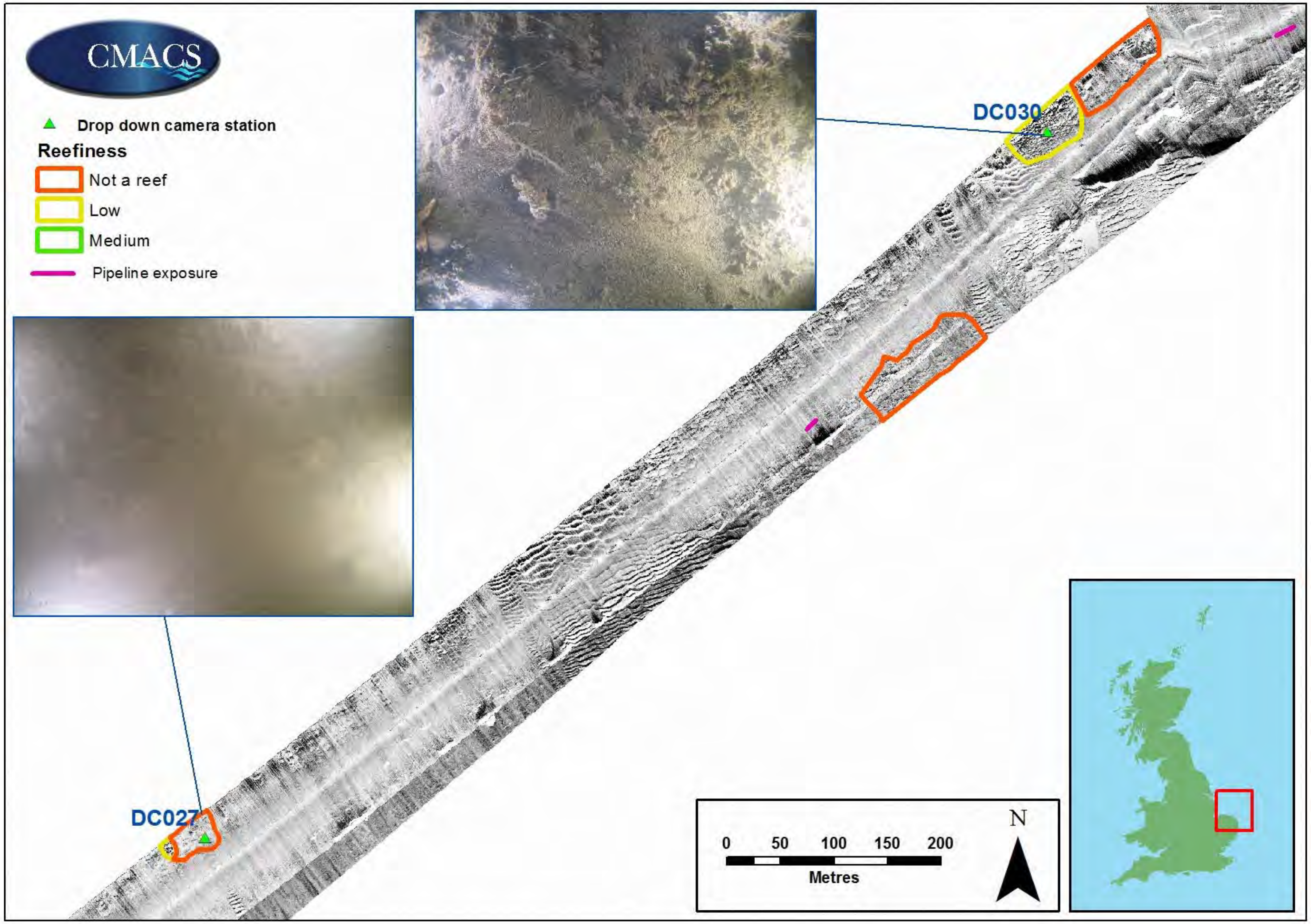


Figure 8. Assessment of reefiness on the pipeline route from the Arthur well.

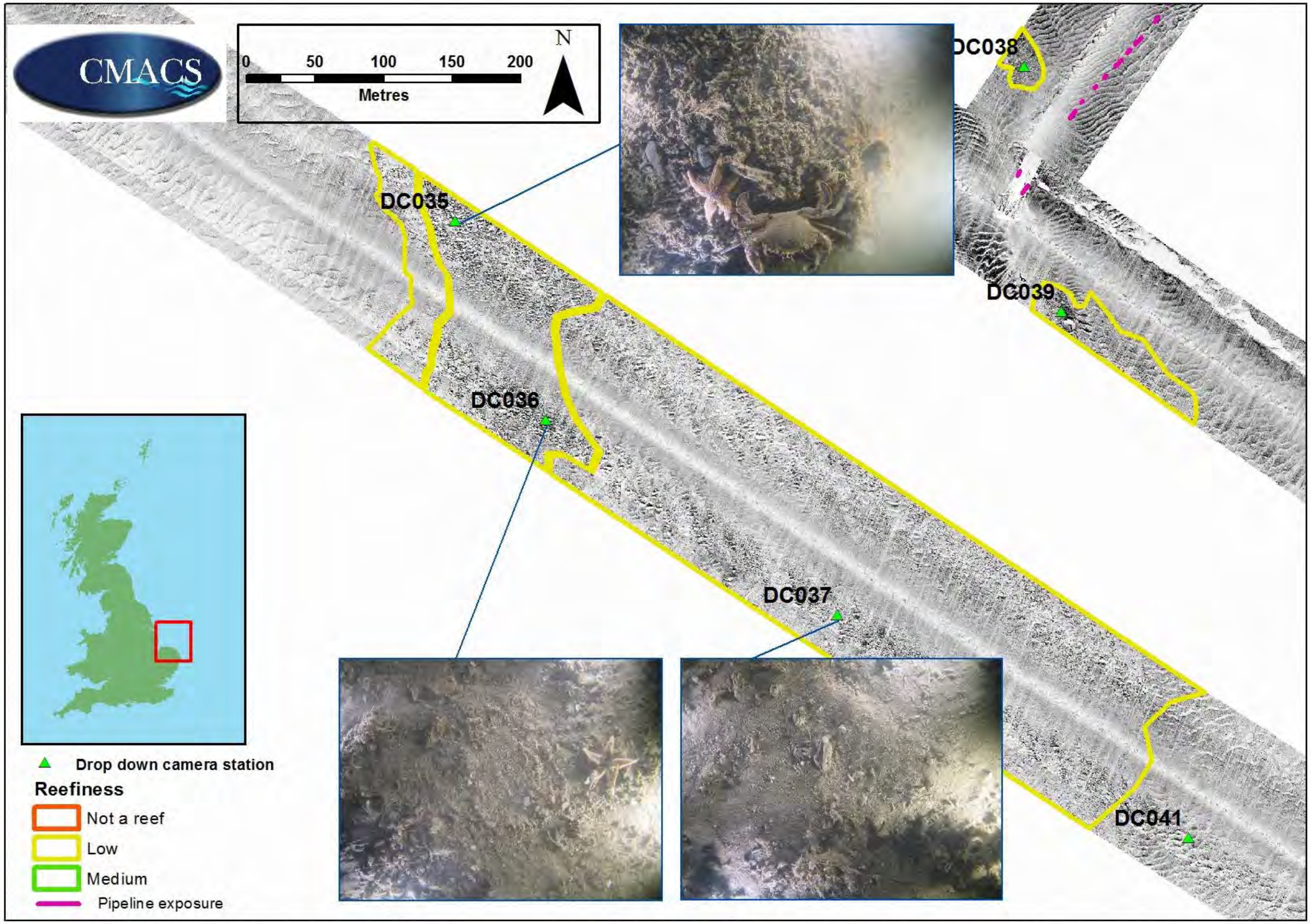


Figure 9. Assessment of reefiness around the Bure well.

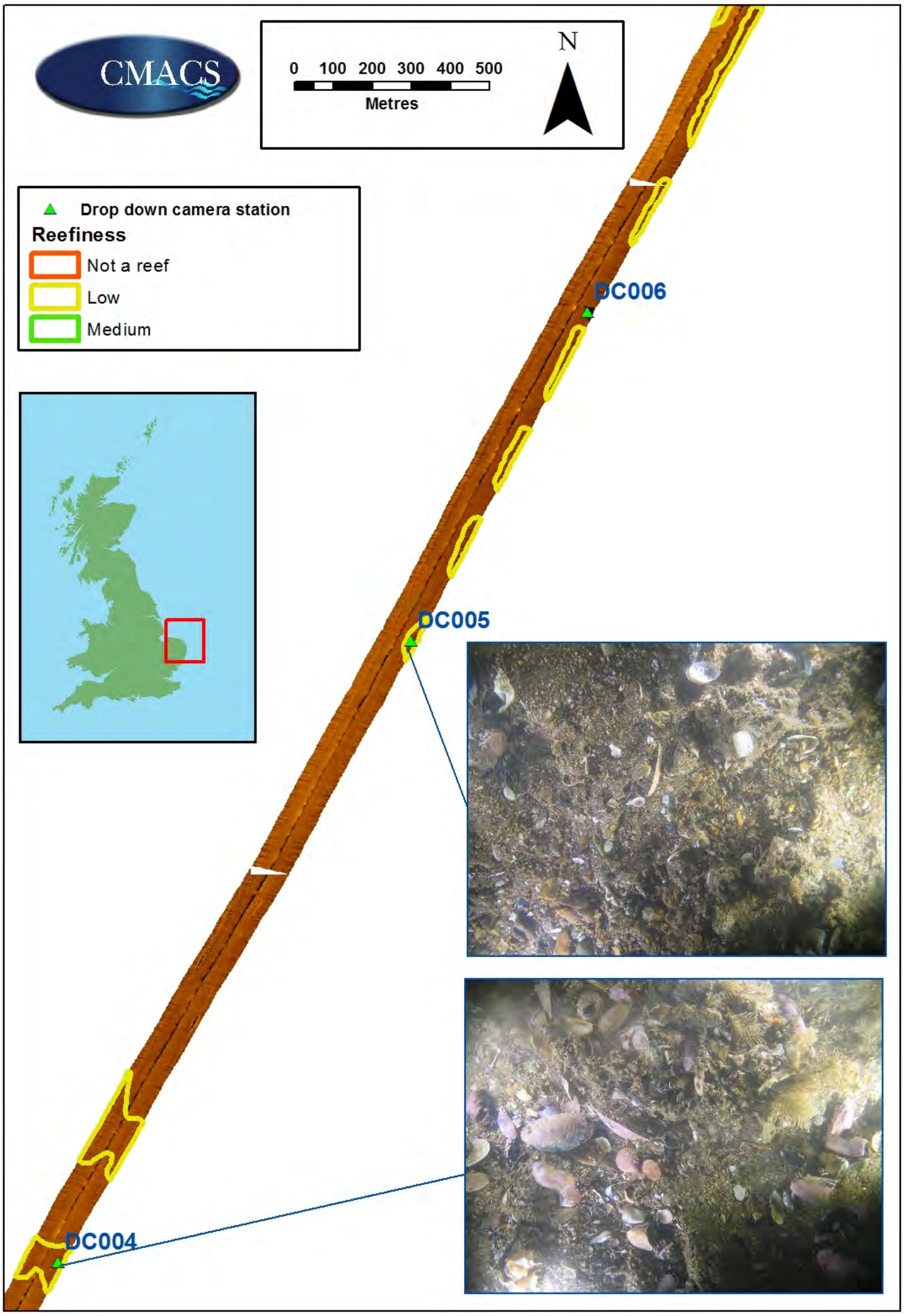


Figure 10. Assessment of reefiness on the export pipeline route.

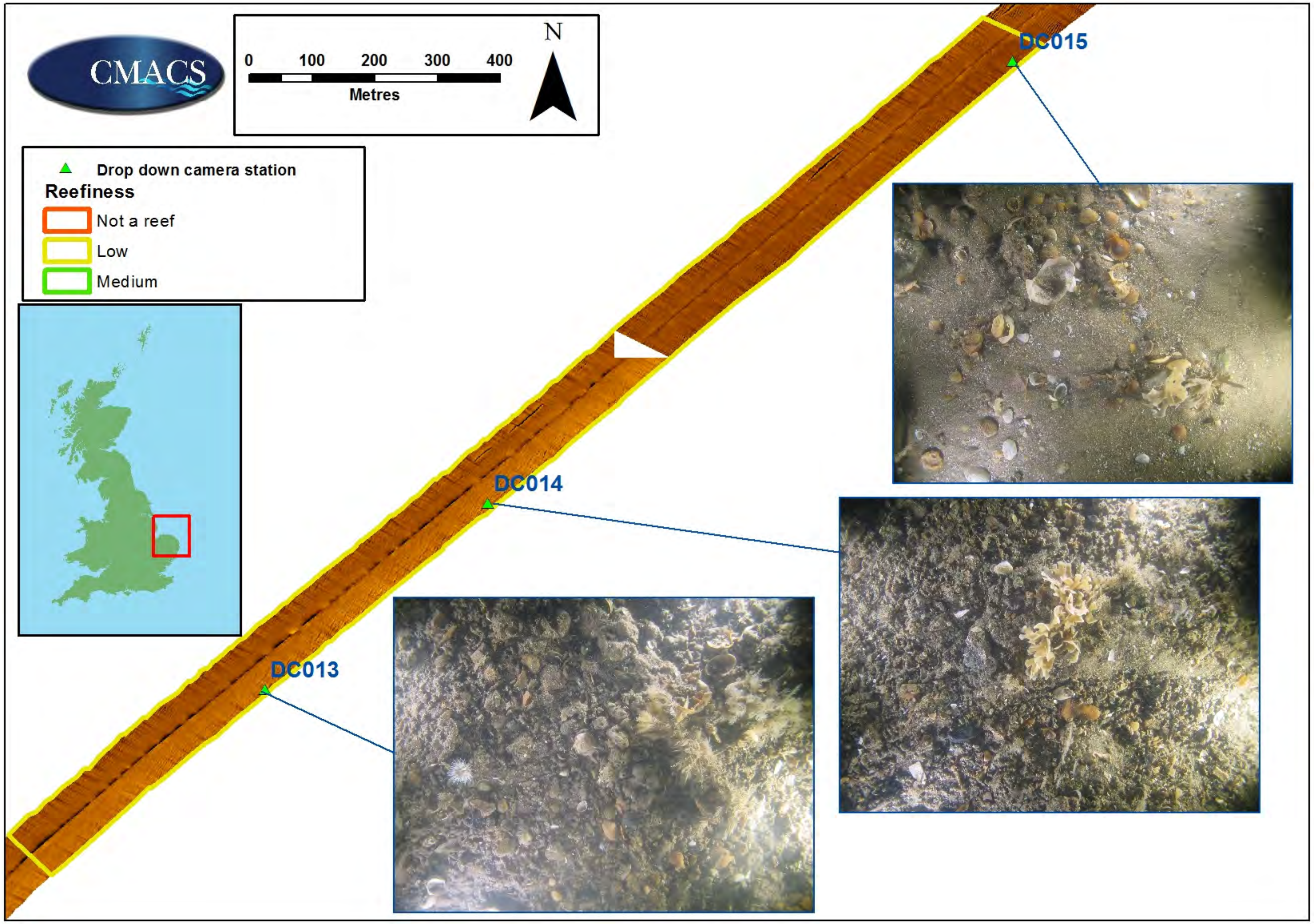


Figure 11. Assessment of reefiness on the export pipeline route.

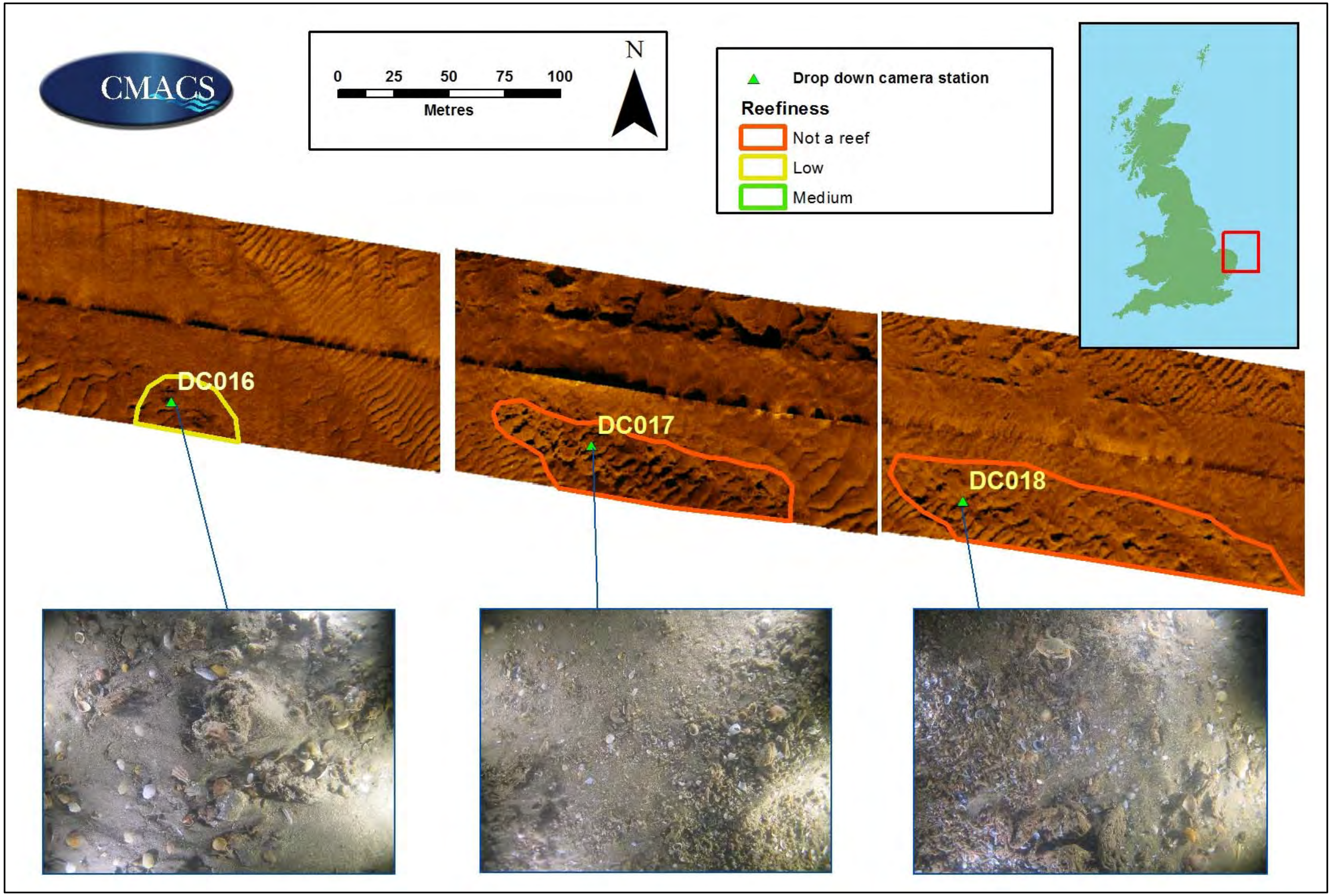


Figure 12. Assessment of reefiness on the export pipeline route. Note: distance between the stations has been shortened to allow all three stations to be shown on a single page.

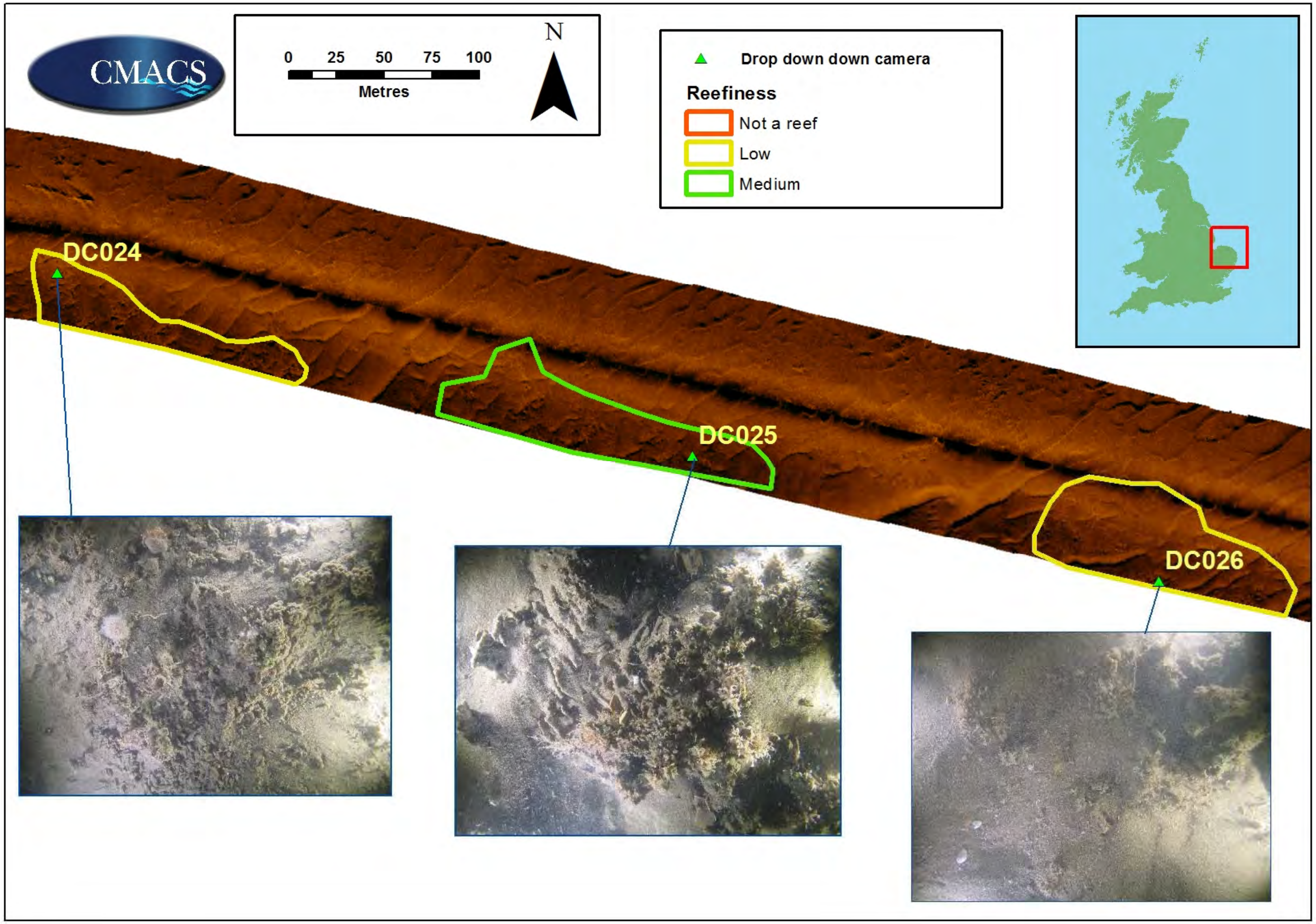


Figure 13. Assessment of reefiness on the export pipeline route.

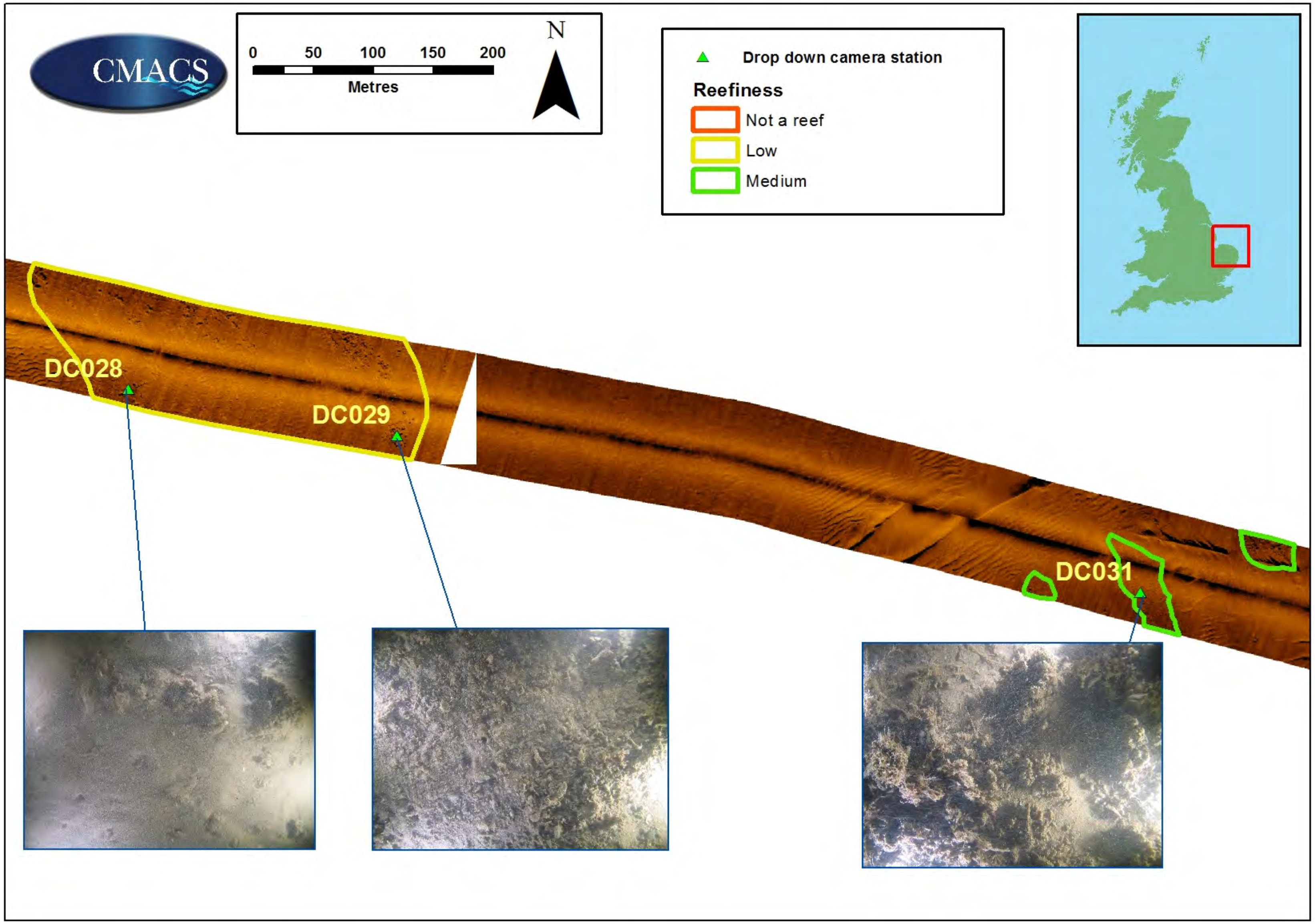


Figure 14. Assessment of reefiness on the export pipeline route.

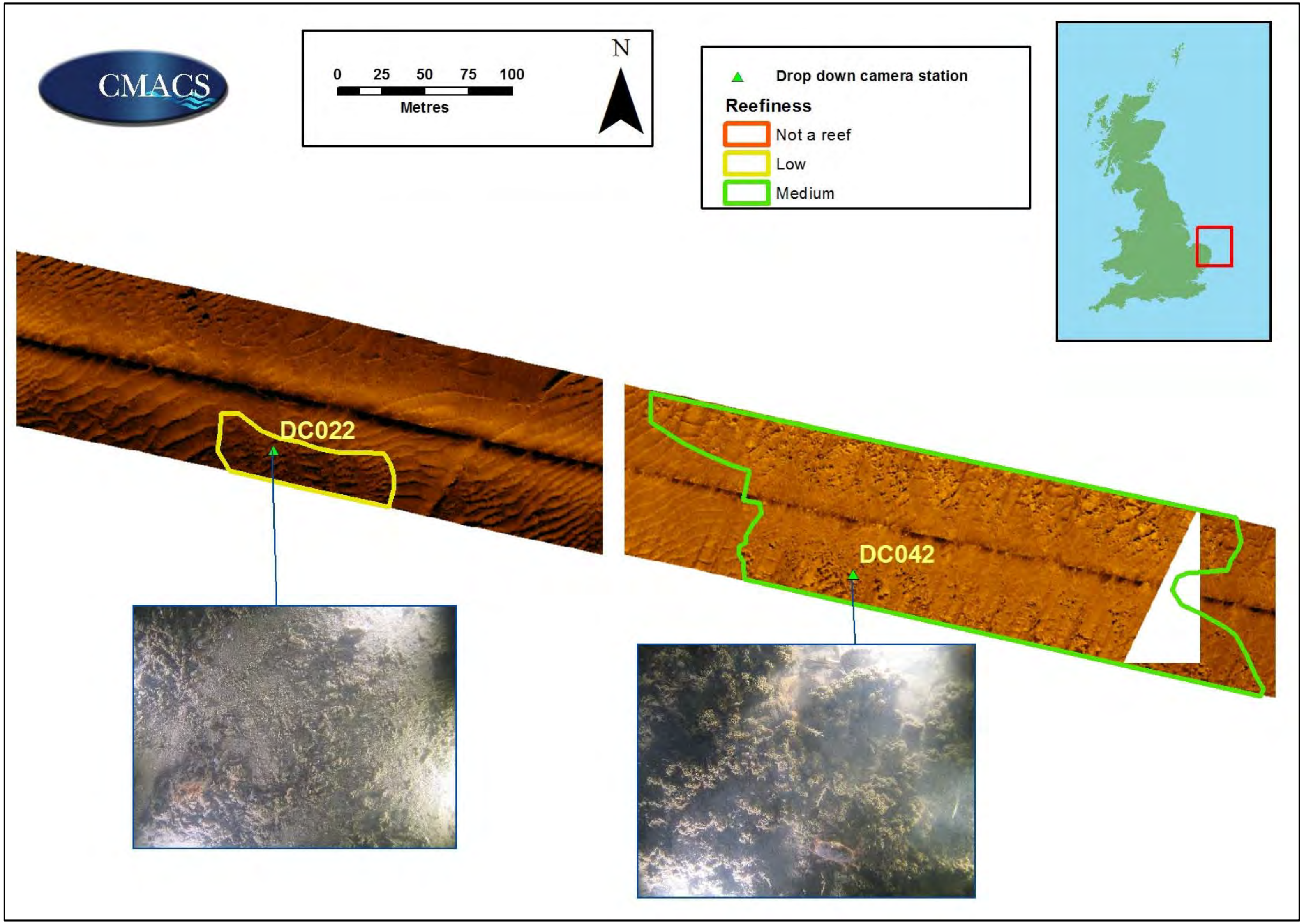


Figure 15. Assessment of reefiness on the export pipeline route. Note: the distance between the stations has been shortened in order to allow both to be displayed on a single page.

4. DISCUSSION

Results of the survey reported here indicate that the seabed around the Thames Gas Field and along the export pipeline to land has been formed by powerful tidal forces with substantial bed-transport of sediment as indicated by sand ripples and waves as well as high densities of *Sabellaria spinulosa* in some areas. Coarse sediments with scour-tolerant epifauna on inshore areas also indicate strong currents. These seabed characteristics and associated infauna share many similarities with other benthic studies carried out in the southern North Sea (e.g. Heip & Craeymeersch, 1995; Robinson *et al*., 2005).

The relatively high abundance of the polychaetes *Lagis koreni*, *Ophelia borealis* and *Spiophanes bombyx*, coupled with the predominantly sand seabed complicated the determination of biotopes for the sampled areas. However, the best matches have been suggested and these provide a very useful tool for assessing sensitivity to industrial activities rather than considering each taxa in the faunal community separately (see below).

4.1 Sensitivities

Based on the assumption wells are to be completely removed from the seabed along with any protective matting and/or rock dump over the pipeline, sensitivity of biotopes to the following factors was determined:

- Increase in suspended sediment;
- Physical disturbance;
- Hydrocarbon contamination.

The first two factors are based on the fact that above-seabed infrastructure would need to be removed, causing disturbance and mobilising sediment into the water column. Hydrocarbon contamination from any residue left in the wellheads is unlikely but is considered here for completeness.

Most of the biotopes recorded are considered to be not sensitive to an increase in suspended sediment owing to the mobile nature of the sediments with high bed transport of sand as a feature. The one exception is SS.SSA.IMuSa.FfabMag which is regarded as having a very low sensitivity, with the increased suspended sediment potentially interfering with the filter-feeding mechanisms of some of the taxa present which would probably stress these organisms rather than cause mortality (Rayment, 2006).

Most of the sediment biotopes, including the *Sabellaria spinulosa* reef, have a low or very low sensitivity to physical disturbance (Budd, 2006a, 2006b; Marshall, 2006; Rayment, 2006). Some mortality of infauna can be expected particularly of polychaetes, bivalves and burrowing echinoids which are somewhat fragile but mobile organisms such as amphipods are unlikely to be affected. Organisms such as *Sabellaria spinulosa* and *Lanice conchilega* are able to repair their tubes after mechanical damage (Budd, 2006a; Jackson & Hiscock, 2008) and colonial taxa such as hydroids and erect bryozoans can regenerate upright parts as long as the base remains attached to the substratum (e.g. Jackson, 2004; Tyler-Walters & Ballerstedt, 2007). Recovery of infauna from the biotopes described is rapid: polychaete (e.g. Spionidae or Nephtydae) populations can take up to six months to recover but can also be as little as forty days in some cases (e.g. *Spiophanes bombyx* (Ager, 2009)) via larval settlement . Others, such as *Lagis koreni* are annual species with high mortality from winter storms with recovery every year in spring from settling planktonic larvae (Nicolaidou, 1983). Similarly, while the sea potato *Echinocardium cordatum* is vulnerable to physical damage, the high fecundity and planktonic larvae of this species mean that populations can recover quickly via larval recruitment (Rayment, 2006).

The sensitivity of the faunal communities to hydrocarbon contamination is considered to be low to moderate with high mortality of amphipods and polychaetes and some mortality of bivalves and echinoderms (Budd 2006b; Rayment, 2006). Recovery depends on the residence time of the contamination within the sediment, which is expected to be low in this area owing to the mobility of the seabed and the low volume of contaminant, should a leak occur. In these circumstances, recovery times are likely to be similar to those for physical disturbance.

4.2 Conclusions

The survey of the Thames Gas Field has identified two types of potential Annex I habitat in the area; biogenic reef formed by *Sabellaria spinulosa* and sandbanks which are at least slightly covered by seawater at all times. There was, however, no biogenic reef of high ‘reefiness’ like that found on the Saturn Reef which lies to the north of the Thames Gas Field (JNCC, 2010). The nature of any sandbanks was more difficult to assess owing to the scale of the survey area relative to the size of offshore sandbanks in general. Nevertheless, side scan sonar mosaics and bathymetric data from the survey did suggest that there were sandbanks present on the export pipeline route and at least on the pipelines from the Arthur and Orwell wells.

Decommissioning of the wells and pipelines is expected to have some effect on the infaunal and epifaunal organisms of the area but recovery of both mobile and sessile invertebrates is expected to be rapid, less than one year in many cases.

In general, there is no evidence of any significant contamination of sediments above levels typical of this part of the southern North Sea; however, at Station 31 (offshore end of the export pipeline) there were elevated levels of polycyclic aromatic hydrocarbons and any operations resulting in exposure and mobilisation of sediments in this area would need to be informed by further investigations to assess the full extent in terms of the area and depth of contamination.

5. REFERENCES

Ager, O. 2009. *Spiophanes bombyx*. A bristleworm. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/speciesfullreview.php?speciesID=4356

Budd, G.C. 2006a. Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/habitatsbasicinfo.php?habitatid=116&code=2004

Budd, G.C. 2006b. *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/habitatsbasicinfo.php?habitatid=154&code=2004

CCME. 2001. Canadian sediment quality guidelines for the protection of aquatic life: Summary tables. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers for the Environment, Winnipeg.

Cefas (undated). http://www.cefas.defra.gov.uk/media/562541/cefas%20action%20levels.pdf accessed 8 January 2014.

Cole, S., Codling, I.D., Parr, W. & Zabel, T. 1999. Guidelines for managing water quality impacts within UK European marine stations. Prepared for the UK Marine SAC Project. Natura 2000.

Heip, C. and Craymeersch, J.A. 1995. Benthic community structures in the North Sea. *Helgoländer Meeresunters*. Vol 49 pp 313-328.

Jackson, A. 2004. *Nemertesia ramosa*. A hydroid. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/speciesfullreview.php?speciesID=3864

Jackson, A. and Hiscock, K. 2008. *Sabellaria spinulosa*. Ross worm. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/speciesfullreview.php?speciesID=4278

JNCC. 2010. Offshore Special Area of Conservation: North Norfolk Sandbanks and Saturn Reef. SAC Selection Assessment.

Marshall, C.E. 2006. *Sabellaria spinulosa* on stable circalittoral mixed sediment. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line].

Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/habitatsbasicinfo.php?habitatid=377&code=2004

Nicolaidou, A. 1983. Life History and Productivity of *Pectinaria koreni* Malmgren (Polychaeta). *Estuarine, Coastal and Shelf Science*. Vol. 17 pp 31-43.

Rayment, W.J. 2006. *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/habitatsbasicinfo.php?habitatid=142&code=2004

Robinson, J.E., Newell, R.C., Seiderer, L.J. and Simpson, N.M. 2005. Impacts of aggregate dredging on sediment composition and associated benthic fauna at an offshore dredge site in the southern North Sea. *Marine Environmental Research.* Vol. 60 pp 51-68.

Tyler-Walters, H. and Ballerstedt, S. 2007. *Flustra foliacea*. Hornwrack. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 07/01/2014]. Available from: http://www.marlin.ac.uk/speciesfullreview.php?speciesID=3342

UKOOA (2001) An analysis of UK Offshore Oil & Gas Environmental Surveys 1975-95. A study carried out by Heriot-Watt University at the request of The United Kingdom Offshore Operators Association.

Appendix D: Comparative Assessment

Perenco UK Limited & Tullow Oil SK Limited

Thames Area Decommissioning Comparative Assessment

August 2014

Rev 02

PERENCO

TULLOW Oil plc

Document Control Page

Client:	Perenco UK Limited & Tullow Oil SK Limited
Report Title:	Thames Comparative Assessment Report
Date:	August 2014
Document Ref:	PER-SNS-DECOM-THA-001
Prepared By:	Perenco UK Limited & Tullow Oil SK Limited in conjunction with Orbis Energy Limited

Revision Record:

DATE	REV NO.	DESCRIPTION	PREPARED	CHECKED	CLIENT APPROVED
16/12/13	00	Drafts for Client Review	JG	OB/YW/MC/DC	MC
14/01/14	01	For Issue	JG	OB/YW/MC/DC	MC
04/08/14	02	Update in Response to DECC comments	JG	OB/YW/MC/DC / DS / IM	MC

Table of Contents

Abbreviations

CA	Comparative Assessment
cSACs	candidate Special Areas of Conservation
DECC	Department of Energy and Climate Change
FAC	First Aid Case
GJ	Gigajoule
MEG	Monoethylene Glycol
MLW	Mean Low Water
MTC	Medically Treated Case
N/S	No Score
OSPAR	Oslo Paris Convention
Perenco	Perenco UK Limited
rMCZ	Recommended Marine Conservation Zone
RWC	Restricted Work Case
Tullow	Tullow Oil SK Limited
UKCS	United Kingdom Continental Shelf

1 Introduction

1.1 Scope and Objective

Note: This is a joint EIA Submission for both Perenco UK Limited (hereafter referred to as 'Perenco') and Tullow Oil SK Limited (hereafter referred to as 'Tullow'). However, for ease of reading the Operators are referred to as 'Perenco' throughout the document.

Perenco is planning to cease production from the Thames Complex (situated in United Kingdom Continental Shelf (UKCS) Block 49/28 of the Southern North Sea) in 2014 and decommission the Thames Area infrastructure.

In addition to Thames, it is proposed that the infrastructure from the following assets, which tie-back to Thames, will also be decommissioned (these assets are owned by either Perenco or Tullow:

- Thames Field (Perenco);
- Arthur Field (Perenco);
- Bure West Field (Perenco);
- Bure O Field (Perenco);
- Gawain Field (Perenco);
- Orwell Field (Tullow);
- Yare C Field (Perenco);
- Horne and Wren Field (Tullow);
- Wissey Field (Tullow); and
- Thurne Field (pipeline & subsea infrastructure covered by Perenco; the well is covered by Tullow).

Note that Thurne was previously called Deben and therefore some lines within this CA are referred to as Deben.

On the UKCS, the decommissioning of offshore oil and gas installations and pipelines is controlled through the Petroleum Act 1998, as amended by the Energy Act 2008. Under the Petroleum Act 1998, the owners of an offshore installation or pipeline must obtain approval of a Decommissioning Programme from the Department of Energy and Climate Change (DECC) before they can proceed with its decommissioning.

Due to the licensing area involved for the Thames Decommissioning Project, the individual licensees (i.e. Perenco and Tullow) have prepared the following separate Decommissioning Programmes for their assets:

The assets will be grouped into the following Decommissioning Programmes:

<u>Perenco Assets</u>

1. Thames Field Decommissioning Programme (DP1)
   a. **Thames**: Platforms, Wells, Umbilicals, Flowlines, Jumpers, Wellhead Protection Structures, Stabilisation Materials and Pipelines (including the Thames to Bacton export pipeline PL370);
   b. **Bure O:** Well, Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline;
   c. **Bure West**: Well, Monoethylene Glycol (MEG) line, Wellhead Protection Structure, Stabilisation Materials and Pipeline;

   d. **Yare C:** Well, Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline.

   e. **Thurne:** Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline.

2. Gawain Field Decommissioning Programme (DP2)
   a. **Gawain:** Wells, Umbilical, Wellhead Protection Structures, Stabilisation Materials and Pipelines.

3. Arthur Field Decommissioning Programme (DP3)

   a. **Arthur:** Wells, Umbilicals, Flowlines, Jumpers, Wellhead Protection Structures, Stabilisation Materials and Pipelines.

<u>Tullow assets</u>

1. Horne & Wren Field Decommissioning Programme (DP4):
   a. **Horne & Wren:** Platform, Wells, MEG line, Stabilisation Materials and Pipeline.

2. Orwell Field Decommissioning Programme (DP5)
   a. **Orwell:** Wells, Umbilical, MEG line, Wellhead Protection Structures, Stabilisation Materials and Pipelines.

3. Wissey Field Decommissioning Programme (DP6):
   a. **Wissey:** Well, Umbilical, Wellhead Protection Structure, Stabilisation Materials and Pipeline.

4. Thurne Field [Note 1]
   a. **Thurne:** Wellhead (all other infrastructure covered by DP1).

Note 1: For the decommissioning of the Thurne Field, all of the infrastructure, except the Thurne wellhead, will be covered by the Thames decommissioning programme (DP1). The Thurne wellhead is not included in DP1, as it is a contractually responsibility of Tullow. However, as only a wellhead is being decommissioned, it is not subject to a full decommissioning programme; instead it will be removed under a Marine License.

Under the terms of OSPAR Decision 98/3, which entered into force in 1999 and has been accepted by the UK government, there is a prohibition on the dumping and leaving wholly or partly in place of offshore installations. The topsides of all installations must be returned to shore. All steel installations with a jacket weight less than 10,000 tonnes, as is the case for the Thames and Horne & Wren Platforms, must be completely removed for reuse, recycling or final disposal on land. Subsea installations (including wellhead protection structures) also fall within the definition of a steel or concrete installation and must be completely removed for reuse, recycling or final disposal on land. Perenco and Tullow are therefore committed to the complete removal of the offshore installations associated with the Thames Decommissioning Project and to maximise recycling of the materials.

The provisions of OSPAR Decision 98/3 do not, however, apply to pipelines and there are no international guidelines on the decommissioning of disused pipelines. As such, in accordance with the DECC Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act (March 2011) (*DECC, 2011*), a Comparative Assessment (CA) has been undertaken to assess all feasible decommissioning options for the pipelines, umbilicals, MEG lines, flowlines and jumpers, which fall within the scope of the Thames Area Decommissioning Project. Note that stabilisation materials have not been assessed during this CA, as all materials (except concrete mattresses) will remain in-situ. For concrete mattresses, an attempt to remove the mattresses safely will be made and where this is not possible a proposal will be made to DECC.

The CA has been written to support the decommissioning plans.

This report presents the findings of the CA workshop jointly undertaken by Perenco and Tullow on the 16th October 2013 and supports the decommissioning plans (as listed above).

1.2 Thames Decommissioning Project Infrastructure

The facilities within the remit of the Thames Area Decommissioning Project are illustrated in Figure 1.1 and Table 1.2.

The infrastructure from these assets is located across 13 UKCS Blocks (48/28-30, 49/26-30, 50/26, 52/3, 53/2-4) in the Southern North Sea. A summary of the facilities that will be commissioned at each of the fields within the Thames development area is shown in Table 1.1.

Table 1.1: Summary of the Thames Area Fields and Infrastructure to be Decommissioned

	Infrastructure							
Decommissioning Field	**Platforms**	**Wells**	**Wellheads**	**WPS**	**Manifold / Template**	**Pipelines**	**Umbilicals**	**MEG Lines**
Thames	3	9	4	4	-	5	3	1
Gawain	-	3	3	1	1	1	1	-
Arthur	-	3	3	4	1	4	4	-
Horne & Wren	1	2	-	-	-	1	-	1
Orwell	-	3	3	1	1	1	1	1
Wissey	-	1	1	1	-	-	1	-
Thurne	-	1	1	-	-	-	-	-

Figure 1.1: Thames Decommissioning Project Area

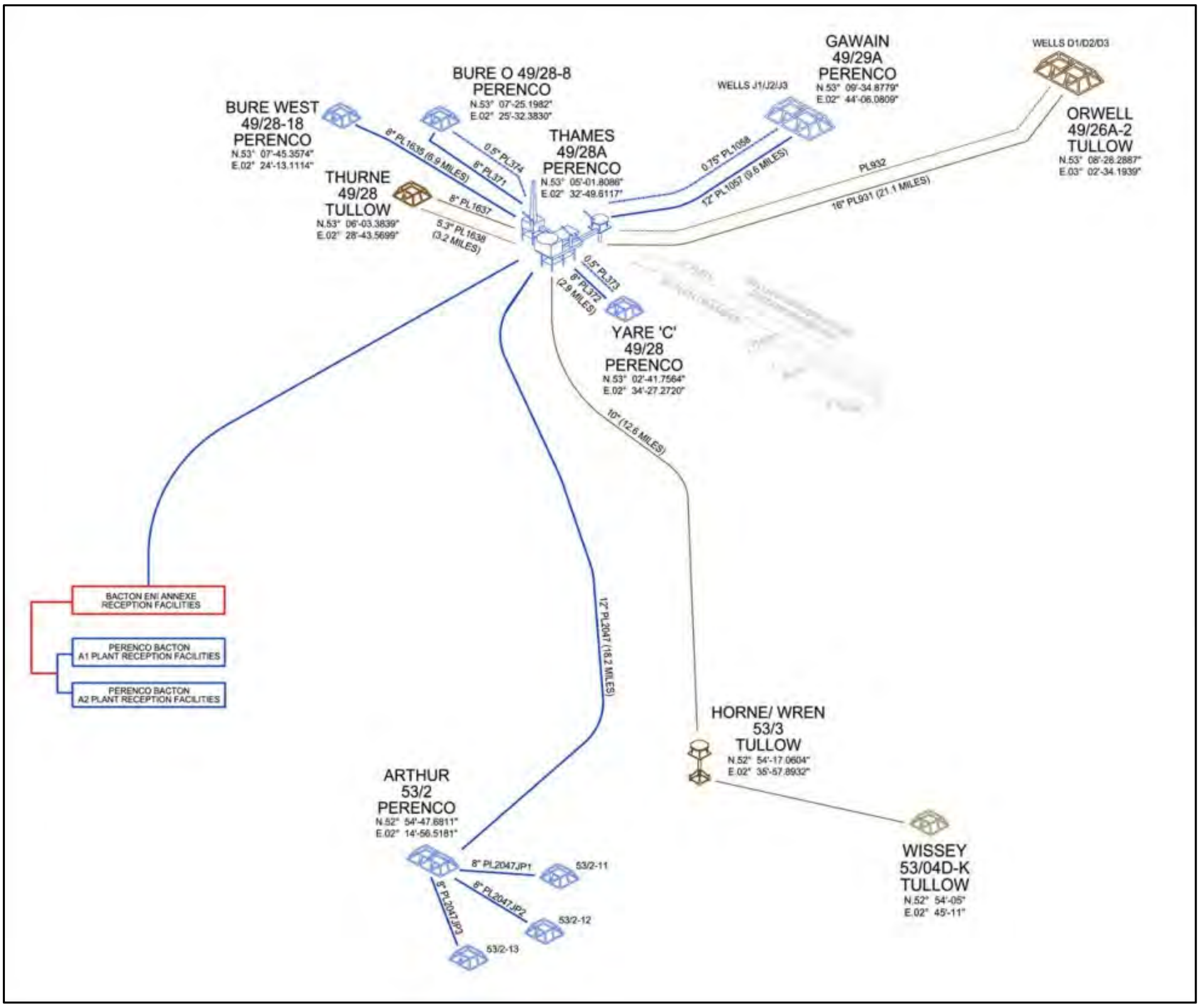


Table 1.2: Thames Area Decommissioning Project – Pipelines, Jumpers, Flowlines, MEG lines and Umbilicals

DECC Ref	From	To	Nominal Diameter (inches)	Length (km)	Date of Installation	Composition	Contents	Condition of line	Percentage of Line Exposed	Status of line
Perenco Operated Gas Pipelines										
PL370	Thames AW	Bacton	24	89.5	1986	Steel with concrete coating	Gas	Trenched & buried to 91%	9%	Operational – cleaned & flushed
PL371	Bure 'O'	Thames AW	8	9.3	1986	Steel with concrete coating	Gas	Trenched & buried to 99%	1%	Operational – flushed
PL372	Yare 'C'	Thames AW	8	4.8	1986	Steel with concrete coating	Gas	Trenched & buried to 99.5%	0.5%	Operational – flushed
PL1057	Gawain	Thames AW	12	15.1	1986	Steel with concrete coating	Gas	Trenched & buried to 99%	1%	Operational – flushed
PL1635	Bure West	Thames AR	8	11.2	1986	Steel with concrete coating	Gas	Trenched & buried to 95.5%	4.5%	Operational – flushed
PL2047	Arthur	Thames AW	12	30	2004	Steel	Gas	Trenched & buried to 99.8%	0.2%	Operational – flushed
PL2047JP1	Arthur 1	Arthur Manifold	8	0.07	2004	Steel	Gas	Trenched & buried to 100%	-	Operational – flushed

DECC Ref	From	To	Nominal Diameter (inches)	Length (km)	Date of Installation	Composition	Contents	Condition of line	Percentage of Line Exposed	Status of line
PL2047JP2	Arthur 2	Arthur Manifold	8	3.24	2004	Flexible pipe	Gas	Trenched & buried to 100%	-	Operational – flushed
PL2047JP3	Arthur 3	Arthur Manifold	8	2	2004	Flexible pipe	Gas	Trenched & buried to 100%	-	Operational – flushed
PL1637	Thurne	Thames AR	8	6.3	2007	Steel	Gas	Trenched & buried to 98%	2%	Out of use - flushed
Perenco Operated MEG Pipelines										
PL1636	Bure West	Thames AR	0.8	11.2	1986	Umbilical	Chemicals	Trenched & buried to 98%	2%	Operational – chemical cores flushed, hydraulic cores hold Transaqua
Perenco Operated Umbilicals and Jumpers										
PL374	Thames AW	Bure 'O'	4	9.3	1986	Umbilical	Chemicals	Trenched & buried to 100%	-	Operational – flushed
PL1058	Thames AW	Gawain	5	15.4	1995	Umbilical	Chemicals	Trenched & buried to 100%	-	Operational – flushed

DECC Ref	From	To	Nominal Diameter (inches)	Length (km)	Date of Installation	Composition	Contents	Condition of line	Percentage of Line Exposed	Status of line
PL373	Thames AW	Yare C	0.5	4.8	1986	Umbilical	Chemicals	Trenched & buried to 97%	3%	Operational – flushed
PLU2048	Thames AW	Arthur	8	30	2004	Umbilical	Chemicals	Trenched & buried to 99%	1%	Operational – flushed
PLU2048JP1	Arthur 1	Arthur Manifold	3	30	2004	Umbilical	Chemicals	Trenched & buried to 100%	-	Operational – flushed
PLU2048JP2	Arthur 2	Arthur Manifold	3	30	2004	Umbilical	Chemicals	Trenched & buried to 98%	2%	Operational – flushed
PLU2048JP3	Arthur 3	Arthur Manifold	3	30	2004	Umbilical	Chemicals	Trenched & buried to 99.8%	0.2%	Out of use - flushed
PL1638	Thames AR	Thurne	4	6,3	2007	Umbilical	Chemicals	Trenched & buried to 100%	-	Out of use - flushed
Tullow Operated Gas Pipelines										
PL2491	Wissey	Horne / Wren	8	10.3	2008	Steel	Gas	Trenched & buried to 99.9%	0.1%	Operational - flushed
PL2080	Horne / Wren	Thames AR	10	20.3	2005	Steel	Gas	Trenched & buried to 100%	-	Operational - flushed

DECC Ref	From	To	Nominal Diameter (inches)	Length (km)	Date of Installation	Composition	Contents	Condition of line	Percentage of Line Exposed	Status of line
PL931	Orwell	Thames AW	16	35	1993	Steel	Gas	Trenched & buried to 99.9%	0.1%	Out of use - flushed
Tullow Operated MEG Pipelines										
PL2081	Thames AR	Horne / Wren	2.5	20.3	2005	Steel	Chemicals	Trenched & buried to 100%	-	Operational – flushed
PL932	Thames AW	Orwell	3	35	1993	Steel	Chemicals	Trenched & buried to 100%	-	Out of use - flushed
Tullow Operated Umbilicals										
PLU2492	Horne / Wren	Wissey	4	10.4	2008	Umbilical	Chemicals	Trenched & buried to 100%	-	Operational – flushed
PL933	Thames AW	Orwell	4	35.0	1993	Umbilical	Chemicals	Trenched & buried to 99.9%	0.1%	Out of use - flushed

1.3 Marine Protected Areas

There are a number of marine protected areas (MPAs) the Thames Area pipelines pass through.

The main types of MPAs in English waters are:

- **Marine Conservation Zones (MCZs)** and **Sites of Special Scientific Interest (SSSIs)** with marine components giving protection to species and habitats of national importance; and
- **European Marine Sites** giving legal protection to species and habitats of European importance.

To date 27 MCZs have been designated in English waters, with two further tranches of MCZs planned over the next three years to complete the contribution to the ecologically coherent network (*JNCC, 2014*).

Table 1.3 lists the protected areas with 40 kilometres of the Thames infrastructure and Figure 1.2 shows the location of the Thames infrastructure in relation to the protected areas around it.

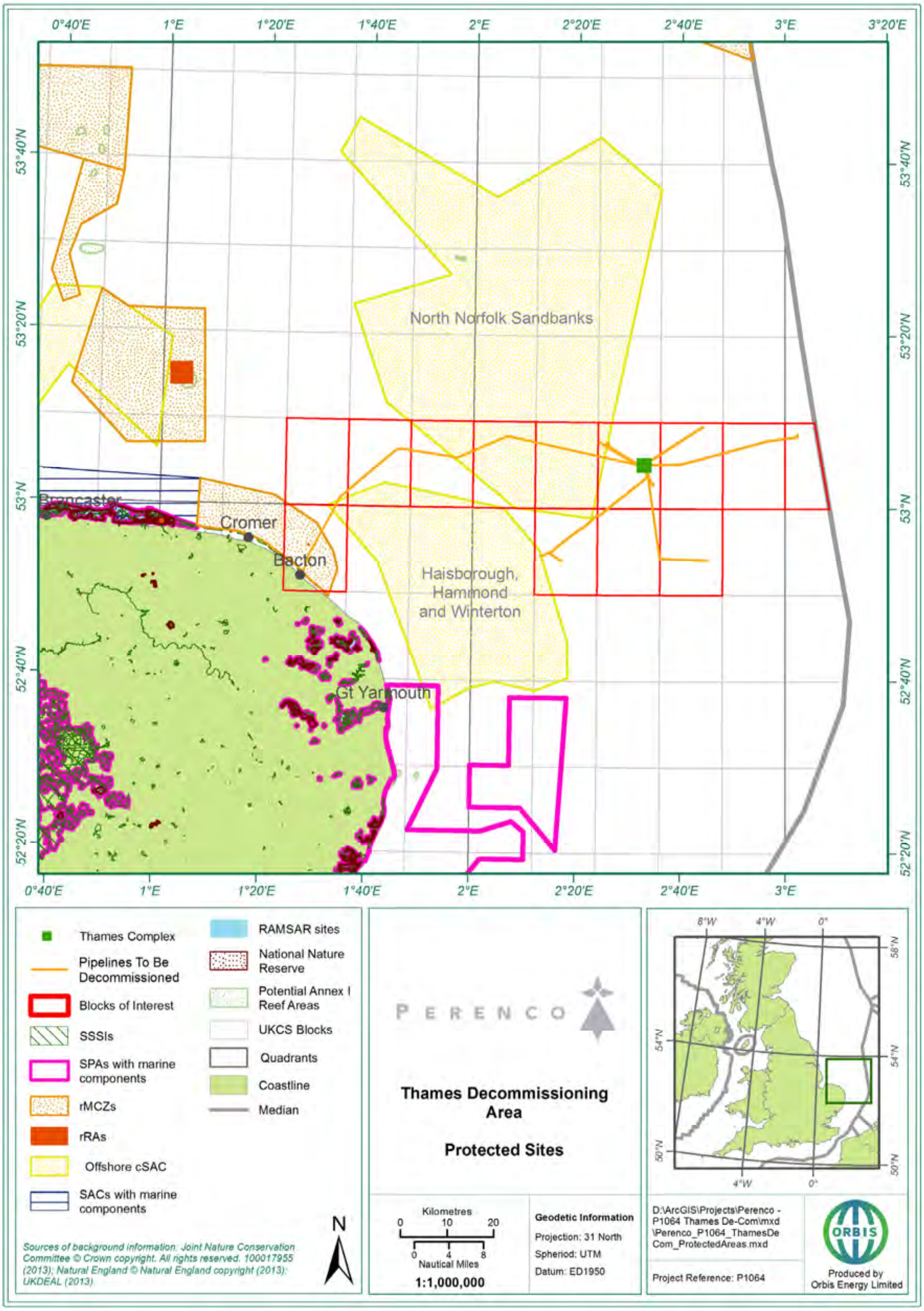
Table 1.3: Marine Protected Areas within 40 kilometres of the Proposed Thames Decommissioning Programme Area (*Net Gain, 2011; Natural England, 2013; JNCC, 2013a; JNCC, 2013b*)

Site Name	Designation	Distance From Thames Infrastructure	Site Description
Cromer Shoal Chalk Beds (NG2)	rMCZ	Overlaps	The site is recommended for designation due to the presence of the three broadscale habitats 'high energy infralittoral rock', 'moderate energy infralittoral rock' and 'moderate energy circalittoral rock' as well as the habitat of conservation importance, subtidal chalk.
Haisborough, Hammond and Winterton	cSAC	Overlaps	This site is designated for the presence of Annex I habitats 'Sandbanks which are slightly covered by sea water all the time' (1110) and 'Reefs' (1170).
North Norfolk Sandbanks and Saturn Reef	cSAC	Overlaps	This site is designated for the presence of Annex I habitats 'Sandbanks which are slightly covered by sea water all the time' (1110) and 'Reefs' (1170).
North Norfolk Blue Mussel Beds (RA1)	rRA	1km W	This site is primarily being recommended for designation for the presence of blue mussel (*Mytilus edulis*) beds. In addition three other features are recommended for designation, moderate energy infralittoral rock, subtidal chalk (modelled) and subtidal sands and gravels (modelled).
Mundesley Cliffs	SSSI	1.5km NW	A nationally important site for its extensive geological Pleistocene sequence.
Sidestrand & Trimingham Cliffs	SSSI	4km NW	Site is of geological importance. This is probably the best soft rock cliff site for invertebrates in East Anglia.
Happisburgh Cliffs	SSSI	6km SE	An important site for dating the Pleistocene succession of East Anglia.

Site Name	Designation	Distance From Thames Infrastructure	Site Description
Overstrand Cliffs	SSSI	10km NW	Some of the best example of soft cliff habitat in East Anglia. A diverse range of submaritime habitats of considerable botanical, entomological and ecological importance.
East Runton Cliffs	SSSI	15km NW	Geological importance.
West Runton Cliffs	SSSI	16km NW	Geological importance.
Winterton-Horsey Dunes	SSSI	16.5km SE	An extensive dune system. A wide range of both breeding and overwintering birds occur, including Little Terns on the foreshore, while the areas of scrub attract passage migrants. A rare amphibian breeds in shallow pools behind the main dune ridge, and the site is the only Norfolk locality for a rare butterfly.
Beeston Cliffs	SSSI	18km NW	A nationally important Pleistocene reference site.
Weybourne Cliffs	SSSI	19.5km NW	Geologically significant. Additional biological interest is provided by colonies of sand martins in the cliff-face and of fulmars (73 pairs in 1982) on the cliff ledges.
North Norfolk Coast	SSSI, Ramsar, SPA	25.5km NW	The area consists primarily of intertidal sands and muds, saltmarshes, shingle banks and sand dunes. There are extensive areas of brackish lagoons, reedbeds and grazing marshes. A wide range of coastal plant communities is represented and many rare or local species occur. The whole coast is of great ornithological interest with nationally and internationally important breeding colonies of several species. It is especially valuable for migratory birds and wintering waterfowl, particularly brent and pink-footed geese. Very large numbers of waterbirds occur throughout the year.
Seahorse Lagoon and Arnold's Marsh (RA2a and 2b)	rRA	29km W	These sites are being recommended for designation for the presence of starlet sea anemones (*Nematostella vectensis*) in the saline lagoons.
Outer Thames Estuary	SPA	29km S (Arthur)	This site it protected because of its use by over wintering Red Throated Divers (*Gavia stellata*), an Annex I species, which represented 38% of the population in Great Britain.

Site Name	Designation	Distance From Thames Infrastructure	Site Description
Glaven Reedbed (RA3)	rRA	30km W	The site is recommended for the protection of the broad-scale habitat saline reedbeds which provides habitat for birdlife and a variety of algae and invertebrates.
Great Yarmouth North Denes	SSSI	30.5km SE	This site supports a full successional sequence of vegetation from pioneer to mature types. The largest UK breeding colony of the rare Little Tern is located on the foreshore.
Wash Approach (NG4)	rMCZ	31km WNW	This site is recommended for designation for the following broadscale habitat types and Habitats of Conservation Interest; subtidal sand, subtidal mixed sediments and subtidal sands and gravels.
Blakeney Marsh (RA4)	rRA	32km W	This site is being proposed to protect the broad-scale habitat 'coastal saltmarshes and saline reedbeds'.
Blakeney Seagrass (RA5)	rRA	35km W	This site is being recommended for designation for the presence of seagrass beds (*Zostera* species).
Morston Cliff	SSSI	35km WNW	Geological importance.
Wash Approach (RA8)	rRA	39.5km NW	This site is recommended for designation for the following broadscale habitat types and Habitats of Conservation Interest; subtidal sand, subtidal mixed sediments and subtidal sands and gravels.
Inner Dowsing, Race Bank and North Ridge	cSAC	40km NW	This site is designated for the presence of Annex I habitats 'Sandbanks which are slightly covered by sea water all the time' (1110) and 'Reefs' (1170). In addition, this site is also designated for the presence of Annex II species harbour porpoise (*Phocoena phocoena*) and grey seals (*Halichoerus grypus*)

Figure 1.2: Marine and Coastal Protected Areas in the Vicinity of the Thames Decommissioning Programme Area



It can be seen from Table 1.3 and Figure 1.2 that the Thames Infrastructure overlaps with the boundaries of three MPAs described below.

Cromer Shoal Chalk Beds rMCZ (NG2)

The Cromer Shoal Chalk Beds rMCZ is an inshore site measuring 316 square kilometres. It has been recommended for designation as a MCZ for the presence of five features. These features comprise of three broad scale habitats (high energy infralittoral rock, moderate energy infralittoral rock and moderate circalittoral rock), one Habitat Features of Conservation Importance (FOCI), subtidal chalk, and one geological feature; North Norfolk coast (subtidal).

Of particular interest within this site is the subtidal chalk feature which represents one of the best examples of subtidal chalk in the Net Gain region and is the only example of this feature within the southern North Sea.

Circalittoral rock habitat communities are important secondary producers through growth of epibiotic organisms (which live on the body of another organism) including sponges and tunicates. This habitat is characterised by high species diversity supporting a range of fauna including polychaetes, sponges, soft and hard corals, bryozoans as well as mobile species in more sheltered areas.

The site, is also an important fish spawning ground, and provides a good foraging area for seabirds. Small cetaceans and seals are also recorded in the site.

This is an important site for benthic biodiversity. The site also provides good foraging areas for seabirds (*RSPB, 2010*), frequent sightings of small cetaceans and pinnipeds (whales, dolphins, porpoises and seals) (*Clark et al., 2010*) and unusual sightings of species such as sunfish and basking shark (*Spray, 2011 pers. comm*.).

Haisborough, Hammond and Winterton cSAC

The Haisborough, Hammond and Winterton site lies off the north east coast of Norfolk, and is designated as a cSAC due to the presence of a series of sandbanks which meet the Annex I habitat description 'Sandbanks slightly covered by sea water all the time'. The site also contains areas of the Annex I habitat biogenic reef.

The sandy sediments within the site are very mobile due to the strong tidal currents which characterise the area (*HR Wallingford et al., 2002*). Infaunal communities of the sandy bank tops are consequently of low biodiversity, characterised by mobile polychaetes (catworms) and amphipods (shrimp-like crustaceans) which are able to rapidly re-bury themselves into the dynamic sediment environments. Along the flanks of the banks, and towards the troughs between the banks, the sediments tend to be slightly more stable with exposed gravels in areas. In these regions of the site, infaunal and epifaunal communities are much more diverse. There are a number of areas where sediment movements are reduced and these areas support an abundance of attached bryozoans, hydroids and sea anemones. Other tube-building worms such as keel worms *Pomatoceros* sp. and sand mason worms *Lanice conchilega* are also found in these areas, along with bivalves and crustaceans.

Sabellaria spinulosa reefs are located at Haisborough Tail, Haisborough Gat and between Winterton Ridge and Hewett Ridge. They arise from the surrounding coarse sandy seabed to heights of between five centimetres to 10 centimetres. The reefs are consolidated structures of sand tubes showing seafloor coverage of between 30 per cent to areas where reef occupies 100 per cent of the sediment. Some parts of the reefs appear to be acting as sediment traps, with exposed tube height accordingly reduced within the core parts of reefs (*JNCC, 2010*).

North Norfolk Sandbanks and Saturn Reef cSAC

The North Norfolk Sandbanks and Saturn Reef site is a cSAC due to the presence of two Annex I habitats:

i) a series of ten main sandbanks and associated fragmented smaller banks formed as a result of tidal processes ('Sandbanks which are slightly covered by sea water all the time); and
ii) areas of *Sabellaria spinulosa* biogenic reef.

The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters (*Graham et al., 2001*). They are subject to a range of current strengths which are strongest on the banks closest to shore and which reduce offshore (*Collins et al., 1995*). 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 (*Collins et al., 1995*). 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 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 (*BMT Cordah, 2003*). Reefs formed by *Sabellaria* allow the settlement of other species not found in adjacent habitats leading to a diverse community of epifaunal and infaunal species (*JNCC, 2008*).

The Thames infrastructure that lies within these three MPAs includes approximately 51 kilometres of pipeline (see Table 1.4) and the three wellheads: West Bure, Bure 'O' and Arthur 3.

Table 1.4: Distances Over Which Thames Pipelines Cross MPAs

MPA	Pipeline Number	Pipeline Diameter (Inches)	Distance (Metres)
North Norfolk Sandbanks cSAC	PL370	24	34,000
	PL371	8	270
	PL374	0.5	590
	PL1635	8	1,940
	PL1636	0.75	1,940
		Subtotal	*38,740*
Haisborough, Hammond & Winterton Sandbanks cSAC	PL370	24	2,350
	PLU2048JP3	3	250
	PL2047JP3	8	250
		Subtotal	*2,850*
Cromer Shoal Chalk Beds rMCZ	PL370	24	9,500
		Subtotal	*9,500*
		Total	**51,090**

2 Decommissioning Options

2.1 Pipelines, Jumpers, Flowlines, MEG Lines and Umbilicals

As outlined in the DECC guidance notes it is recommended that the following decommissioning options should be considered for pipelines:

1. Re-Use

The potential for reuse of the Thames Area Decommissioning project pipelines, jumpers, flowlines, MEG lines and umbilicals in connection with further hydrocarbon developments or with other existing projects (such as hydrocarbon storage and carbon capture and storage) was initially explored by Perenco and Tullow, however, no suitable opportunities could be identified. However, due to the age of the pipelines and the technical issues with re-use, Perenco and Tullow deemed this option not feasible. Therefore, the option to re-use is no longer considered with this CA.

2. Leave in-situ

The DECC guidance notes states that as a general guide the following pipelines (inclusive of any "piggyback" lines and umbilicals that cannot easily be separated) may be considered for in-situ decommissioning:

- Those which are adequately buried or trenched and which are not subject to development of spans and are expected to remain so;
- Those which were not buried or trenched at installation but which are expected to self-bury over a sufficient length within a reasonable time and remain so buried;
- Those where burial or trenching of the exposed sections is undertaken to a sufficient depth and it is expected to be permanent;
- Those which are not trenched or buried but which nevertheless are candidates for leaving in place if the comparative assessment shows that to be the preferred option (e.g. trunk lines);
- Those where exceptional and unforeseen circumstances due to structural damage or deterioration or other cause means they cannot be recovered safely and efficiently.

Note: it is expected that burial or trenching to a minimum depth of 0.6 metres above the top of the pipeline will be necessary in most cases. Any spans or areas that are buried <0.6 metres will be further assessed and remedial action considered.

The current status of the Thames Decommissioning project pipelines, jumpers, flowlines, MEG lines and umbilicals is identified in Table 1.2.

Operators should also make reasonable endeavours to remove contaminants for those lines to be decommissioned in-situ, after all hydrocarbons have been removed.

As a base case, regardless of the fate of the lines, Perenco and Tullow are committed to flushing all gas pipelines to reduce hydrocarbon content to as low as reasonably practicable (ALARP). MEG lines jumpers and umbilicals will be flushed where possible, otherwise chemical cores will be left in-situ.

3. Remove

Small diameter pipelines, including flexible flowlines, jumpers and umbilicals which are neither trenched nor buried should normally be entirely removed. The removal of a pipeline should be performed in such a way as to cause no significant adverse effects upon the marine environment.

Based on the above, the following five options for decommissioning of the pipelines, jumpers, flowlines, MEG lines and umbilicals were assessed in the CA workshop:

1. Completely remove the line;
2. Trench and bury the entire line (or the specific areas which are exposed);
3. Rock dump the line in specific areas where the line is uncovered;

4. Partial removal of uncovered sections of the line;
5. Leave in situ with monitoring - The frequency and scope of the monitoring arrangements will be discussed and agreed with the DECC.

3 The Comparative Assessment Process

A Comparative Assessment workshop of the available decommissioning options was conducted on the 16th October 2013. The workshop involved a multi-disciplinary team, including:

- Matthew Colby (Decommissioning Process Engineer - Perenco);
- Ying Wang (Decommissioning Engineer - Perenco);
- Richard Innes (Decommissioning Engineer - Perenco);
- Oliver Brandon (HSE Advisor (Environment) – Perenco);
- Chris Davies (Project Engineer – Perenco);
- Frederic De Meo (Decommissioning Manager – Perenco);
- Darin Scales (Project Manager – Tullow);
- John Girling and Susanna Black (HSE Consultants – Orbis Energy Limited).

The workshop involved working through the appropriate decommissioning options and assigning considered impact values (see Appendix A, Table A.1) and likelihood values (see Appendix A, Table A.2) to generate the overall semi-quantitative assessment of the option (see Appendix A, Table A.3).

Each decommissioning option was scored against a set of assessment criteria using categories derived from DECC guidance (*DECC, 2011*):

1. Safety
2. Environmental
3. Technical
4. Societal
5. Commercial

Legal compliance was not assessed, as any of the chosen methodologies will require regulatory approval before proceeding.

Please note for the assessment of safety risk the potential risk is not higher than when it was carried out during normal operations.

The criteria for evaluating the potential impact of the options are presented in Appendix A. This has been developed by Perenco and is based on original work by Project Development International Limited, 139 Gallowgate, Aberdeen AB25 1BU.

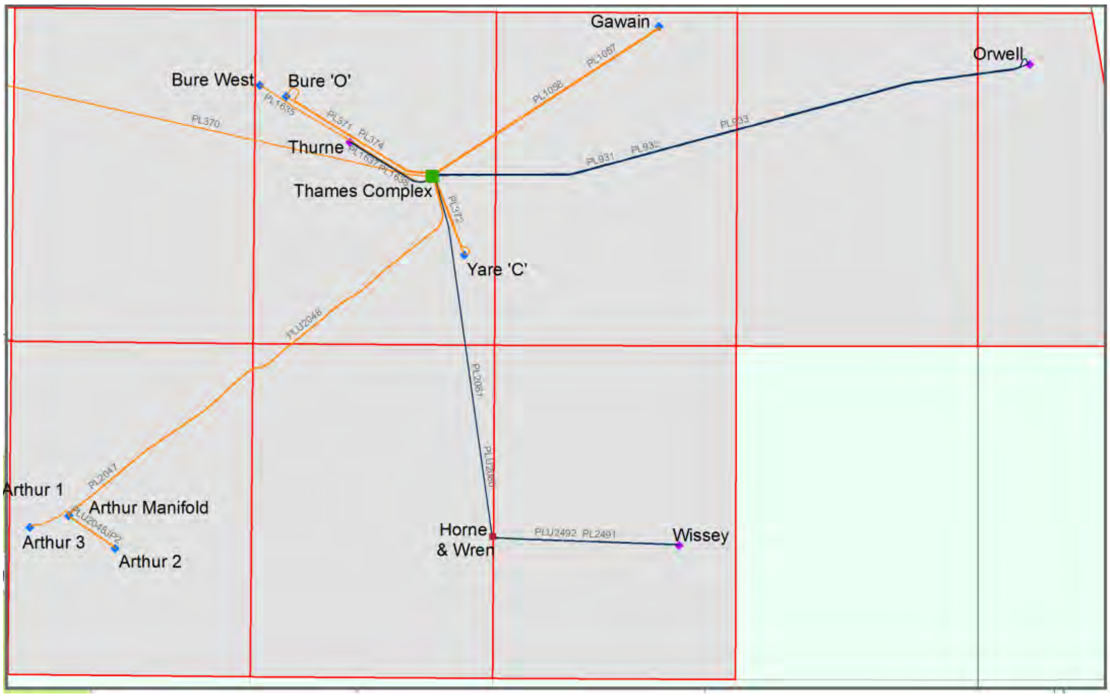
4 Comparative Assessment Results

4.1 Pipelines, Jumpers, Flowlines, MEG Lines and Umbilicals

This section of the report summarises the main outcomes from the CA workshop held on the 16th October 2013. It describes the currently recommended decommissioning options for the Thames Area Decommissioning Project infrastructure and provides the main justification behind each of the recommendations.

Figure 1 shows the pipelines (with pipeline numbers) that will be decommissioned in the Thames Area.

Figure 1: The Pipelines that are to be decommissioned in the Thames Area



The pipelines, umbilicals and MEG lines were grouped by location in relation to the nearby candidate Special Areas of Conservation (cSACs). The grouping is as follows:

1. **Thames AW to Bacton (PL370)**

   - This pipeline was individually assessed as it goes back to mean low water (MLW), is the longest and has largest diameter and crosses through North Norfolk Sandbanks and Saturn Reef cSAC, Haisborough, Hammond & Winterton Sandbanks cSAC and Cromer Shoal Chalk Beds recommended Marine Conservation Zone (rMCZ).

2. **Bure 'O' to Thames AW (PL371 and PL374) and Bure West to Thames AR (PL1635 and PL1636)**

   - The pipeline and umbilical were assessed as a group as they cross through North Norfolk Sandbanks and Saturn Reef cSAC.

3. **Arthur 3 Pipeline and Umbilical (PL2047JP3 and PLU2048JP3)**

   - The pipeline (jumper) and umbilical were assessed together as they cross the Haisborough, Hammond & Winterton Sandbanks cSAC.

4. **Gawain to Thames AW (PL1057 and PL1058), Orwell to Thames AW (PL931, PL932 and PL933), Wissey to Horne & Wren (PL2491 and piggybacked PLU2492)**

   - These pipelines and umbilicals were assessed as a group as they lie within a Deep Water Route, which is a shipping route that larger vessels use.

5. **The Remaining Pipelines: Yare C to Thames AW (PL372), Arthur (PL2047 and PL2047JP1), Horne & Wren to Thames AR (PL2080), Thurne to Thames AR (PL1637) and Arthur 2 jumper (PL2047JP2)**

/ Remaining MEG Lines & Umbilicals: Bure West to Thames AR (PL636), Yare C to Thames AW (PL373), Thames AW to Arthur (PLU2048, PLU2048JP1, PLU2048JP2), Thames to Horne & Wren (PL2081), Thames AR to Thurne (PL638)

- These remaining pipelines, jumpers, flowlines, umbilicals and MEG lines are grouped together as they are all situated outside of any designated areas of interest.

During the pipeline survey (*Osiris, 2013*) a number of the pipelines were identified as having exposed sections (including free spans) along their route. Therefore, for each of the above groupings where more than one pipeline is being assessed, a worst case scenario has been assumed, based on the pipeline with the greatest exposed sections.

Note: a pipeline exposure is defined as pipelines which are visible on the seabed.

It is important to note that the methodology used allows for only a relatively high-level comparison of the decommissioning options whereby, generally, the lower the comparative score, the more favourable the option.

4.1.1 Thames AW to Bacton (Thames Main Export Pipeline - PL370)

The decommissioning options considered in the CA workshop for the Thames main export pipeline (PL370) were:

1. Completely remove the line;
2. Trench and bury the approximate 10% of exposed line;
3. Rock dump the line in specific areas where the line is uncovered (ca. 10%);
4. Partial removal of uncovered sections of the line;
5. Leave in situ with monitoring.

Data from the pipeline survey (*Osiris, 2013*), identified that around 10% of the PL370 pipeline was exposed.

The comparative assessment scores for each option are detailed in Table 4.1, with the lowest overall comparative score being option 5 (leave in situ with monitoring), with a score of 4.4. This is Perenco's chosen option for this assessment group.

Option 5 has the lowest overall comparative score, which is attributed to the low individual scoring for the safety, environmental and technical categories. These individual low scores are due to the fact that leaving the pipeline in situ has the 2nd from lowest safety risk, as there is no physical removal of the pipeline. Option 5 has the lowest environmental score as there will be minimal seabed disturbance, chemical and hydrocarbon discharge, energy use and waste to landfill. Option 5 also scores the lowest for the technical category as the technical challenge of leaving the pipeline in situ is negligible.

The overall recommended option for the Thames main export pipeline (PL370) is Option 5: To leave it in-situ, with monitoring.

Table 4.1: Comparative Assessment of Thames AW to Bacton (Thames Main Export Pipeline - PL370) Decommissioning Options

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R
1. Safety															
1.1 Risk to other users of the sea (post ops)	1	1	**1**	2	2	**4**	2	2	**4**	1	2	**2**	3	2	**6**
1.2 Risk to those offshore (during ops)	3	3	**9**	2	3	**6**	1	1	**1**	3	3	**9**	1	1	**1**
1.3 Risk to 3rd party assets/vessels (during ops) Note 2	2	2	**4**	2	2	**4**	1	2	**2**	2	2	**4**	1	1	**1**
1.4 Level of Diving Intervention	2	4	**8**	1	1	**1**	1	1	**1**	4	5	**20**	1	1	**1**
1.5 Risk to those onshore (during ops)	3	3	**9**	1	2	**2**	1	1	**1**	2	2	**4**	1	1	**1**
Average Safety Value:		**6.2**			**3.4**			**1.8**			**7.8**			**2**	
2. Environmental															
2.1 Chemical Discharge	2	2	**4**	1	1	**1**	1	1	**1**	2	2	**4**	1	1	**1**
2.2 Hydrocarbon discharge	2	2	**4**	1	1	**1**	1	1	**1**	2	2	**4**	1	1	**1**
2.3 Seabed Disturbance	5	5	**25**	2	3	**6**	2	3	**6**	2	3	**6**	1	1	**1**
2.4 Energy Usage	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**	1	1	**1**
2.5 Estimated Discard to Sea (% of total material)	1	1	**1**	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**
2.6 Estimated Discard to Landfill (% of total material)	5	5	**25**	1	1	**1**	1	1	**1**	2	5	**10**	1	1	**1**
2.7 Estimated % of total area of SAC which is impacted	5	5	**25**	5	3	**15**	5	3	**15**	5	3	**15**	1	1	**1**
Average Environmental Value:		**15.6**			**10.6**			**10.6**			**12.7**			**4.4**	
3. Technical															
3.1 Technical Challenge	3	3	**9**	2	1	**2**	1	1	**1**	3	3	**9**	1	1	**1**
3.2 Weather Sensitivity	3	3	**9**	3	3	**9**	2	3	**6**	4	3	**12**	1	1	**1**
3.3 Risk of Major Project failure	2	4	**8**	2	2	**4**	2	3	**6**	2	3	**6**	1	1	**1**
Average Technical Value:		**8.7**			**5.0**			**4.3**			**9.0**			**1.0**	
4. Societal															
4.1 Fisheries and Shipping Access (post ops)	1	1	**1**	3	4	**12**	3	4	**12**	3	4	**12**	3	4	**12**
4.2 Communities (onshore)	2	3	**6**	1	1	**1**	1	1	**1**	2	3	**6**	1	1	**1**
Average Societal Value:		**3.5**			**6.5**			**6.5**			**9.0**			**6.5**	
5. Commercial															
5.1 Economic	5	5	**25**	2	3	**6**	2	3	**6**	5	4	**20**	1	1	**1**
5.2 Ongoing Responsibility	1	1	**1**	3	3	**9**	3	3	**9**	3	3	**9**	5	3	**15**
Average Commercial Value:		**13**			**7.5**			**7.5**			**14.5**			**8**	
Overall Comparative Score		**9.4**			**6.6**			**6.1**			**10.6**			**4.4**	

Note 1: Decommissioning Options

1. Completely remove the line;

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R

2. Trench and bury the approximate 10% of exposed line;
3. Rock dump the line in specific areas where the line is uncovered (ca. 10%);
4. Partial removal of uncovered sections of the line;
5. Leave in situ with monitoring.

Note 2: Rock dumping excludes remediation over spans where live pipelines cross pipelines to be decommissioned (e.g. where PL22 crosses PL370). Therefore, this is not included as part of the assessment.

Key:
L = Likelihood
I = Impact
R = Risk

4.1.2 Bure 'O' to Thames AW (PL371 and PL374) and Bure West to Thames AR (PL1635 and PL1636)

The decommissioning options considered in the CA workshop for the Bure 'O' to Thames AW (PL371 and PL374) and Bure West to Thames AR (PL1635 and PL1636) were:

1. Completely remove the lines;
2. Trench and bury the maximum 9.5% of exposed line(s) (PL374);
3. Rock dump the lines in specific areas where the line is uncovered;
4. Partial removal of uncovered sections of the lines;
5. Leave in situ with monitoring.

Data from the pipeline surveys (*Osiris, 2013*), identified the following percentages of exposed areas alone each pipeline:

- PL371 = ca. 1% of the line exposed;
- PL374 = ca. 9.5% of the line exposed;
- PL1635 = ca. 4.5% of the line exposed;
- PL1636 = 2% of the line exposed.

The comparative assessment scores for each option are detailed in Table 4.2, with the lowest overall comparative score being option 5 (leave in situ with monitoring), with a score of 3.8. This is Perenco's chosen option for this assessment grouping.

Option 5 has the lowest overall comparative score, which is attributed to the low individual scoring for the safety, environmental and technical categories. These individual low scores are due to the fact that leaving the pipelines in situ has the 2nd from lowest safety risk, as there is no physical removal of the pipelines. Option 5 has the lowest environmental score as there will be minimal seabed disturbance, chemical and hydrocarbon discharge, energy use and waste to landfill. Option 5 also scores the lowest for the technical category as the technical challenge of leaving the pipelines in situ is negligible.

The overall recommended option for the pipelines Bure 'O' to Thames AW (PL371 and PL374) and Bure West to Thames AR (PL1635 and PL1636) is Option 5: To leave it in-situ, with monitoring.

Table 4.2: Comparative Assessment of Bure 'O' to Thames AW (PL371 and PL374) and Bure West to Thames AR (PL1635 and PL1636) Decommissioning Options

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R
1. Safety															
1.1 Risk to other users of the sea (post ops)	1	1	**1**	2	1	**2**	2	2	**4**	2	1	**2**	3	2	**6**
1.2 Risk to those offshore (during ops)	3	3	**9**	2	3	**6**	1	1	**1**	3	3	**9**	1	1	**1**
1.3 Risk to 3rd party assets/vessels (during ops)	2	2	**2**	2	2	**4**	1	2	**2**	2	2	**2**	1	1	**1**
1.4 Level of Diving Intervention	2	4	**8**	1	1	**1**	1	1	**1**	4	5	**20**	1	1	**1**
1.5 Risk to those onshore (during ops)	3	3	**9**	1	2	**2**	1	1	**1**	2	2	**4**	1	1	**1**
Average Safety Value:	**5.8**			**3.0**			**1.8**			**7.4**			**2.0**		
2. Environmental															
2.1 Chemical Discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.2 Hydrocarbon discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.3 Seabed Disturbance	5	5	**25**	2	3	**6**	2	3	**6**	2	3	**6**	1	1	**1**
2.4 Energy Usage	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**	1	1	**1**
2.5 Estimated Discard to Sea (% of total material)	1	1	**1**	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**
2.6 Estimated Discard to Landfill (% of total material)	5	5	**25**	1	1	**1**	1	1	**1**	2	5	**10**	1	1	**1**
2.7 Estimated % of total area of SAC which is impacted	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**
Average Environmental Value:	**12.1**			**8.6**			**8.9**			**10.7**			**4.4**		
3. Technical															
3.1 Technical Challenge	3	3	**9**	1	1	**1**	1	1	**1**	3	3	**9**	1	1	**1**
3.2 Weather Sensitivity	3	3	**9**	3	3	**9**	2	3	**6**	4	3	**12**	1	1	**1**
3.3 Risk of Major Project failure	2	4	**8**	2	2	**4**	2	3	**6**	2	3	**6**	1	1	**1**
Average Technical Value:	**8.7**			**4.7**			**4.3**			**9.0**			**1.0**		
4. Societal															
4.1 Fisheries and Shipping Access (post ops)	1	1	**1**	3	4	**12**	3	4	**12**	3	4	**12**	3	4	**12**
4.2 Communities (onshore)	2	3	**6**	1	1	**1**	1	1	**1**	2	3	**6**	1	1	**1**
Average Societal Value:	**3.5**			**6.5**			**6.5**			**9.0**			**6.5**		
5. Commercial															
5.1 Economic	5	5	**25**	2	1	**2**	2	2	**4**	5	2	**10**	1	1	**1**
5.2 Ongoing Responsibility	1	1	**1**	3	3	**9**	3	3	**9**	3	3	**9**	3	3	**9**
Average Commercial Value:	**13.0**			**5.5**			**6.5**			**9.5**			**5.0**		
Overall Comparative Score	**8.6**			**5.6**			**5.6**			**9.1**			**3.8**		

Note 1: Decommissioning Options

1. Completely remove the line;
2. Trench and bury the approximate 9.5% of exposed line(s) (PL374);
3. Rock dump the line in specific areas where the line is uncovered (ca. 9.5%);
4. Partial removal of uncovered sections of the line;
5. Leave in situ with monitoring.

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R

Key:
L = Likelihood
I = Impact
R = Risk

4.1.3 Arthur 3 Pipeline and Umbilical (PL2047JP3 and PLU2048JP3)

The decommissioning options considered in the CA workshop for the Arthur 3 Pipeline and Umbilical (PL2047JP3 and PLU2048JP3) were:

1. Completely remove the lines;
2. Trench and bury the maximum ca. 0.2% of exposed line(s) (PLU2048JP3);
3. Rock dump the lines in specific areas where the line is uncovered (only PLU2048JP3);
4. Partial removal of uncovered sections of the lines;
5. Leave in situ with monitoring.

Data from the pipeline surveys (*Osiris, 2013*), identified the following percentages of exposed areas alone each pipeline:

- PL2047JP3 = Line not exposed (100% buried);
- PLU2048JP3 = ca. 0.2% of the line exposed.

The comparative assessment scores for each option are detailed in Table 4.3, with the lowest overall comparative score being option 5 (leave in situ with monitoring), with a score of 3.8. This is Perenco's chosen option for this assessment grouping.

Option 5 has the lowest overall comparative score, which is attributed to the low individual scoring for the safety, environmental and technical categories. These individual low scores are due to the fact that leaving the pipeline and umbilical in situ has the 2nd from lowest safety risk, as there is no physical removal of the pipeline or umbilical. Option 5 has the lowest environmental score as there will be minimal seabed disturbance, chemical and hydrocarbon discharge, energy use and waste to landfill. Option 5 also scores the lowest for the technical category as the technical challenge of leaving the pipeline and umbilical in situ is negligible.

The overall recommended option for the Arthur 3 Pipeline and Umbilical (PL2047JP3 and PLU2048JP3) is Option 5: To leave it in-situ, with monitoring.

Table 4.3: Comparative Assessment of Arthur 3 Pipeline and Umbilical (PL2047JP3 and PLU2048JP3) Decommissioning Options

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R
1. Safety															
1.1 Risk to other users of the sea (post ops)	1	1	**1**	2	1	**2**	2	2	**4**	2	1	**2**	3	2	**6**
1.2 Risk to those offshore (during ops)	3	3	**9**	2	3	**6**	1	1	**1**	3	3	**9**	1	1	**1**
1.3 Risk to 3rd party assets/vessels (during ops)	2	2	**4**	2	2	**4**	1	2	**2**	2	2	**4**	1	1	**1**
1.4 Level of Diving Intervention	2	4	**8**	1	1	**1**	1	1	**1**	4	5	**20**	1	1	**1**
1.5 Risk to those onshore (during ops)	3	3	**9**	1	2	**2**	1	1	**1**	2	2	**4**	1	1	**1**
Average Safety Value:	**6.2**			**3.0**			**1.8**			**7.4**			**2.0**		
2. Environmental															
2.1 Chemical Discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.2 Hydrocarbon discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.3 Seabed Disturbance	5	5	**25**	2	3	**6**	2	3	**6**	2	3	**6**	1	1	**1**
2.4 Energy Usage	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**	1	1	**1**
2.5 Estimated Discard to Sea (% of total material)	1	1	**1**	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**
2.6 Estimated Discard to Landfill (% of total material)	5	5	**25**	1	1	**1**	1	1	**1**	2	5	**10**	1	1	**1**
2.7 Estimated % of total area of SAC which is impacted	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**
Average Environmental Value:	**12.1**			**8.6**			**8.9**			**10.7**			**4.4**		
3. Technical															
3.1 Technical Challenge	3	3	**9**	1	1	**1**	1	1	**1**	3	3	**9**	1	1	**1**
3.2 Weather Sensitivity	3	3	**9**	3	3	**9**	2	3	**6**	4	3	**12**	1	1	**1**
3.3 Risk of Major Project failure	2	4	**8**	2	2	**4**	2	3	**6**	2	3	**6**	1	1	**1**
Average Technical Value:	**8.7**			**4.7**			**4.3**			**9.0**			**1.0**		
4. Societal															
4.1 Fisheries and Shipping Access (post ops)	1	1	**1**	3	4	**12**	3	4	**12**	3	4	**12**	3	4	**12**
4.2 Communities (onshore)	2	3	**6**	1	1	**1**	1	1	**1**	2	3	**6**	1	1	**1**
Average Societal Value:	**3.5**			**6.5**			**6.5**			**9.0**			**6.5**		
5. Commercial															
5.1 Economic	5	5	**25**	2	1	**2**	2	2	**4**	5	2	**10**	1	1	**1**
5.2 Ongoing Responsibility	1	1	**1**	3	3	**9**	3	3	**9**	3	3	**9**	3	3	**9**
Average Commercial Value:	**13.0**			**5.5**			**6.5**			**9.5**			**5.0**		
Overall Comparative Score	**8.7**			**5.6**			**5.6**			**9.1**			**3.8**		

Note 1: Decommissioning Options

1. Completely remove the lines;
2. Trench and bury the maximum 0.2% of exposed line(s) (PLU2048JP3);
3. Rock dump the lines in specific areas where the line is uncovered;
4. Partial removal of uncovered sections of the lines;
5. Leave in situ with monitoring.

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R

Key:
L = Likelihood
I = Impact
R = Risk

4.1.4 Gawain to Thames AW (PL1057 and PL1058), Orwell to Thames AW (PL931, PL932 and PL933), Wissey to Horne & Wren (PL2491 and piggybacked PLU2492)

The decommissioning options considered in the CA workshop for the Gawain to Thames AW (PL1057 and PL1058), Orwell to Thames AW (PL931, PL932 and PL933), Wissey to Horne & Wren (PL2491 and piggybacked PLU2492) were:

1. Completely remove the lines;
2. Trench and bury the maximum ca. 1% of exposed line(s) (PL1057);
3. Rock dump the lines in specific areas where the line is uncovered;
4. Partial removal of uncovered sections of the lines;
5. Leave in situ with monitoring.

Data from the pipeline surveys (*Osiris, 2013*), identified the following percentages of exposed areas alone each pipeline:

- PL1057 = ca. 1% of the line exposed;
- PL1058, PLU2492 & PL932 = Lines not exposed (100% buried);
- PL931 = ca. 0.1% of the line exposed;
- PL933 = ca. 0.1% of the line exposed;
- PL2491 = ca. 0.1% of the line exposed.

The comparative assessment scores for each option are detailed in Table 4.4, with the lowest overall comparative score being option 5 (leave in situ with monitoring), with a score of 3.8. This is Perenco's chosen option for this assessment grouping.

Option 5 has the lowest overall comparative score, which is attributed to the low individual scoring for the safety, environmental and technical categories. These individual low scores are due to the fact that leaving the pipelines and umbilicals in situ have the 2nd from lowest safety risk, as there is no physical removal of the pipelines or umbilicals. Option 5 has the lowest environmental score as there will be minimal seabed disturbance, chemical and hydrocarbon discharge, energy use and waste to landfill. Option 5 also scores the lowest for the technical category as the technical challenge of leaving the pipelines and umbilicals in situ is negligible.

The overall recommended option for the Gawain to Thames AW (PL1057 and PL1058), Orwell to Thames AW (PL931, PL932 and PL933), Wissey to Horne & Wren (PL2491 and piggybacked PLU2492) is Option 5: To leave it in-situ, with monitoring.

Table 4.4: Comparative Assessment of Gawain to Thames AW (PL1057 and PL1058), Orwell to Thames AW (PL931, PL932 and PL933), Wissey to Horne & Wren (PL2491 and piggybacked PLU2492) Decommissioning Options

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R
1. Safety															
1.1 Risk to other users of the sea (post ops)	1	1	**1**	2	1	**2**	2	2	**4**	2	1	**2**	3	2	**6**
1.2 Risk to those offshore (during ops)	3	3	**9**	2	3	**6**	1	1	**1**	3	3	**9**	1	1	**1**
1.3 Risk to 3rd party assets/vessels (during ops)	2	2	**4**	2	2	**4**	1	2	**2**	2	2	**4**	1	1	**1**
1.4 Level of Diving Intervention	2	4	**8**	1	1	**1**	1	1	**1**	4	5	**20**	1	1	**1**
1.5 Risk to those onshore (during ops)	3	3	**9**	1	2	**2**	1	1	**1**	2	2	**4**	1	1	**1**
Average Safety Value:	**6.2**			**3.0**			**1.8**			**7.8**			**2.0**		
2. Environmental															
2.1 Chemical Discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.2 Hydrocarbon discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.3 Seabed Disturbance	5	5	**25**	2	3	**6**	2	3	**6**	2	3	**6**	1	1	**1**
2.4 Energy Usage	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**	1	1	**1**
2.5 Estimated Discard to Sea (% of total material)	1	1	**1**	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**
2.6 Estimated Discard to Landfill (% of total material)	5	5	**25**	1	1	**1**	1	1	**1**	2	5	**10**	1	1	**1**
2.7 Estimated % of total area of SAC which is impacted	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**
Average Environmental Value:	**12.1**			**8.6**			**8.9**			**10.7**			**4.4**		
3. Technical															
3.1 Technical Challenge	3	3	**9**	1	1	**1**	1	1	**1**	3	3	**9**	1	1	**1**
3.2 Weather Sensitivity	3	3	**9**	3	3	**9**	2	3	**6**	4	3	**12**	1	1	**1**
3.3 Risk of Major Project failure	2	4	**8**	2	2	**4**	2	3	**6**	2	3	**6**	1	1	**1**
Average Technical Value:	**8.7**			**4.7**			**4.3**			**9.0**			**1.0**		
4. Societal															
4.1 Fisheries and Shipping Access (post ops)	1	1	**1**	3	4	**12**	3	4	**12**	3	4	**12**	3	4	**12**
4.2 Communities (onshore)	2	3	**6**	1	1	**1**	1	1	**1**	2	3	**6**	1	1	**1**
Average Societal Value:	**3.5**			**6.5**			**6.5**			**9**			**6.5**		
5. Commercial															
5.1 Economic	5	5	**25**	2	1	**2**	2	2	**4**	5	2	**10**	1	1	**1**
5.2 Ongoing Responsibility	1	1	**1**	3	3	**9**	3	3	**9**	3	3	**9**	3	3	**9**
Average Commercial Value:	**13.0**			**5.5**			**6.5**			**9.5**			**5.0**		
Overall Comparative Score	**8.7**			**5.6**			**5.6**			**9.2**			**3.8**		

Note 1: Decommissioning Options
1. Completely remove the lines;
2. Trench and bury the maximum 0.2% of exposed line(s) (PLU2048JP3);
3. Rock dump the lines in specific areas where the line is uncovered;
4. Partial removal of uncovered sections of the lines;
5. Leave in situ with monitoring.

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R

Key:
L = Likelihood
I = Impact
R = Risk

4.1.5 The Remaining Pipelines: Yare C to Thames AW (PL372), Arthur (PL2047 and PL2047JP1), Horne & Wren to Thames AR (PL2080), Thurne to Thames AR (PL1637) and Arthur 2 jumper (PL2047JP2) / Remaining MEG Lines & Umbilicals: Bure West to Thames AR (PL636), Yare C to Thames AW (PL373), Thames AW to Arthur (PLU2048, PLU2048JP1, PLU2048JP2), Thames to Horne & Wren (PL2081), Thames AR to Thurne (PL638)

The decommissioning options considered in the CA workshop for the Yare C to Thames AW (PL372), Arthur (PL2047 and PL2047JP1), Horne & Wren to Thames AR (PL2080), Thurne to Thames AR (PL1637) and Arthur 2 jumper (PL2047JP2), Bure West to Thames AR (PL636), Yare C to Thames AW (PL373), Thames AW to Arthur (PLU2048, PLU2048JP1, PLU2048JP2), Thames to Horne & Wren (PL2081) and Thames AR to Thurne (PL638) were:

1. Completely remove the lines;
2. Trench and bury the maximum ca. 1% of exposed line(s) (PL1057);
3. Rock dump the lines in specific areas where the line is uncovered;
4. Partial removal of uncovered sections of the lines;
5. Leave in situ with monitoring.

Data from the pipeline surveys (*Osiris, 2013*), identified the following percentages of exposed areas alone each pipeline:

- PL372 = ca. 0.5% of the line exposed;
- PL2047 = ca. 0.3% of the line exposed;
- PL1637 = ca. 1.85% of the line exposed;
- PL373 = ca. 3% of the line exposed;
- PLU2048 = ca. 1% of the line exposed;
- PLU2048JP2 = ca. 2% of the line exposed;
- PLU2048JP3 = ca. 0.2% of the line exposed;
- PL2047JP1, PL2080, PL2047JP2, PL636, PLU2048JP1, PL2081 & PL638 = Lines not exposed (100% buried).

The comparative assessment scores for each option are detailed in Table 4.5 with the lowest overall comparative score being option 5 (leave in situ with monitoring), with a score of 3.8. This is Perenco's chosen option for this assessment grouping.

Option 5 has the lowest overall comparative score, which is attributed to the low individual scoring for the safety, environmental and technical categories. These individual low scores are due to the fact that leaving the pipelines, umbilicals and jumpers in situ have the 2nd from lowest safety risk, as there is no physical removal of the pipelines, umbilicals and jumpers. Option 5 has the lowest environmental score as there will be minimal seabed disturbance, chemical and hydrocarbon discharge, energy use and waste to landfill. Option 5 also scores the lowest for the technical category as the technical challenge of leaving the pipelines, umbilicals and jumpers in situ is negligible.

The overall recommended option for Yare C to Thames AW (PL372), Arthur (PL2047 and PL2047JP1), Horne & Wren to Thames AR (PL2080), Thurne to Thames AR (PL1637) and Arthur 2 jumper (PL2047JP2), Bure West to Thames AR (PL636), Yare C to Thames AW (PL373), Thames AW to Arthur (PLU2048, PLU2048JP1, PLU2048JP2), Thames to Horne & Wren (PL2081) and Thames AR to Thurne (PL638) is Option 5: To leave it in-situ, with monitoring.

Table 4.5: Comparative Assessment of Yare C to Thames AW (PL372), Arthur (PL2047 and PL2047JP1), Horne & Wren to Thames AR (PL2080), Thurne to Thames AR (PL1637) and Arthur 2 jumper (PL2047JP2), Bure West to Thames AR (PL636), Yare C to Thames AW (PL373), Thames AW to Arthur (PLU2048, PLU2048JP1, PLU2048JP2), Thames to Horne & Wren (PL2081) and Thames AR to Thurne (PL638) Decommissioning Options

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R
1. Safety															
1.1 Risk to other users of the sea (post ops)	1	1	**1**	2	1	**2**	2	2	**4**	2	1	**2**	3	2	**6**
1.2 Risk to those offshore (during ops)	3	3	**9**	2	3	**6**	1	1	**1**	3	3	**9**	1	1	**1**
1.3 Risk to 3rd party assets/vessels (during ops)	2	2	**4**	2	2	**4**	1	2	**2**	2	2	**4**	1	1	**1**
1.4 Level of Diving Intervention	2	4	**8**	1	1	**1**	1	1	**1**	4	5	**20**	1	1	**1**
1.5 Risk to those onshore (during ops)	3	3	**9**	1	2	**2**	1	1	**1**	2	2	**4**	1	1	**1**
Average Safety Value:	**6.2**			**3.0**			**1.8**			**7.8**			**2.0**		
2. Environmental															
2.1 Chemical Discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.2 Hydrocarbon discharge	2	2	**4**	1	1	**1**	1	2	**2**	2	2	**4**	1	1	**1**
2.3 Seabed Disturbance	5	5	**25**	2	3	**6**	2	3	**6**	2	3	**6**	1	1	**1**
2.4 Energy Usage	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**	1	1	**1**
2.5 Estimated Discard to Sea (% of total material)	1	1	**1**	5	5	**25**	5	5	**25**	5	5	**25**	5	5	**25**
2.6 Estimated Discard to Landfill (% of total material)	5	5	**25**	1	1	**1**	1	1	**1**	2	5	**10**	1	1	**1**
2.7 Estimated % of total area of SAC which is impacted	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**	1	1	**1**
Average Environmental Value:	**12.1**			**8.6**			**8.9**			**10.7**			**4.4**		
3. Technical															
3.1 Technical Challenge	3	3	**9**	1	1	**1**	1	1	**1**	3	3	**9**	1	1	**1**
3.2 Weather Sensitivity	3	3	**9**	3	3	**9**	2	3	**6**	4	3	**12**	1	1	**1**
3.3 Risk of Major Project failure	2	4	**8**	2	2	**4**	2	3	**6**	2	3	**6**	1	1	**1**
Average Technical Value:	**8.7**			**4.7**			**4.3**			**9.0**			**1.0**		
4. Societal															
4.1 Fisheries and Shipping Access (post ops)	1	1	**1**	3	4	**12**	3	4	**12**	3	4	**12**	3	4	**12**
4.2 Communities (onshore)	2	3	**6**	1	1	**1**	1	1	**1**	2	3	**6**	1	1	**1**
Average Societal Value:	**3.5**			**6.5**			**6.5**			**9.0**			**6.5**		
5. Commercial															
5.1 Economic	5	5	**25**	2	1	**2**	2	2	**4**	5	2	**10**	1	1	**1**
5.2 Ongoing Responsibility	1	1	**1**	3	3	**9**	3	3	**9**	3	3	**9**	3	3	**9**
Average Commercial Value:	**13.0**			**5.5**			**6.5**			**9.5**			**5.0**		
Overall Comparative Score	**8.7**			**5.7**			**5.6**			**9.2**			**3.8**		

Note 1: Decommissioning Options
1. Completely remove the lines;
2. Trench and bury the maximum 3% of exposed line(s) (PL373);
3. Rock dump the lines in specific areas where the line is uncovered;

Assessment Criteria	Decommissioning Options (Note 1)														
	1			2			3			4			5		
	L	I	R	L	I	R	L	I	R	L	I	R	L	I	R
4. Partial removal of uncovered sections of the lines; 5. Leave in situ with monitoring. **Key:** L = Likelihood I = Impact R = Risk															

5 Conclusions and Summary of Results

The results from the CA workshop concluded that the following decommissioning option is considered to be the most appropriate for the pipelines, jumpers, flowlines, MEG lines and umbilicals, which fall within the scope of the Thames Area Decommissioning Project:

- All pipelines, umbilicals, jumpers, MEG lines, flowlines and jumpers will be left in-situ and subject to monitoring – The frequency and scope of the monitoring arrangements will be discussed and agreed with the DECC.

Table 5.1 shows the summary of the CA pipeline assessment and the chosen decommissioning options.

Table 5.1: A Summary of the CA Pipeline Assessment and the Chosen Decommissioning Option

Pipeline Name(s)	Pipeline Number(s)	Decommissioning Options	Chosen Decommissioning Option
Thames AW to Bacton	PL370	1. Completely remove the lines; 2. Trench and bury the maximum exposed line(s); 3. Rock dump the lines in specific areas where the line is uncovered; 4. Partial removal of uncovered sections of the lines; 5. Leave in situ with monitoring.	Leave in situ with monitoring
Bure 'O' to Thames AW and Bure West to Thames AR	PL371, PL374, PL1635 and PL1636		Leave in situ with monitoring
Arthur 3 Pipeline and Umbilical (PL2047JP3 and PLU2048JP3)	PL2047JP3 and PLU2048JP3		Leave in situ with monitoring
Gawain to Thames AW, Orwell to Thames AW & Wissey to Horne & Wren	PL1057, PL1058, PL931, PL932, PL933 PL2491 and piggybacked PLU2492		Leave in situ with monitoring
Yare C to Thames AW, Arthur, Horne & Wren to Thames AR, Thurne to Thames AR, Arthur 2 Bure West to Thames AR, Yare C to Thames AW, Thames AW to Arthur, Thames to Horne & Wren, Thames AR to Thurne	PL372, PL2047, PL2047JP1, PL2080, PL1637, PL2047JP2, PL636, PL373, PLU2048, PLU2048JP1, PLU2048JP2 PL2081 & PL638		Leave in situ with monitoring

6 References

1. *DECC (2011) Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998, Version 6, March 2011*

2. *Osiris (2013) Thames & Welland Pipeline Surveys - Volume 2e – Results Report – Environmental Survey (C13021e) - October 2013*

Appendix A: Comparative Assessment Criteria

Each decommissioning option was scored against a set of assessment criteria using categories derived from DECC guidance (DECC, 2011):

1. Safety
2. Environmental
3. Technical
4. Societal
5. Commercial

Each criterion is then further broken down into sub-assessments, which are detailed below.

Pipelines, Umbilicals, MEG Lines, Flowlines and Jumpers:

1. Safety

1.1: Assesses the risk that each decommissioning option poses to other sea users, post operations. This includes fishermen, shipping and other general sea users;

1.2: Assesses the risk that each decommissioning option poses to those personnel working offshore during the operations, including vessel personnel, but excludes subsea divers;

1.3: Assesses the risk that each decommissioning option poses to 3rd party assets and vessels post operations. This can include pipelines, cables, support vessels etc;

1.4: Assesses the risk that each decommissioning option poses to divers by considering diving intervention days;

1.5: Assesses the risk that each decommissioning option poses to personnel onshore (transportation and waste) during operations.

2. Environmental

2.1: Assesses the expected environmental impact that each decommissioning option poses for chemical discharge during operations (i.e. the discharge of pipeline chemicals);

2.2: Assesses the expected environmental impact that each decommissioning option poses for hydrocarbon discharge during operations (i.e. the discharge of residual hydrocarbons from the pipeline);

2.3: Assesses the estimated environmental impact that each decommissioning option poses to the seabed, during operations;

2.4: Assesses expected energy use that each decommissioning option poses for the operations (excludes waste processing energy);

2.5: Assesses the estimated percentage of the material (i.e. pipeline) that each decommissioning option will discard to sea (left in situ);

2.6: Assesses the estimated percentage of the material (i.e. pipeline) that each decommissioning option will place in landfill or be recycled (left in situ);

2.7: Estimated percentage length of pipeline that will be disturbed within an SAC.

Note: The five pipeline decommissioning options will have a varying impact on any protected areas (i.e. cSACs or rMCZs) that they pass through. The potential impacts for each decommissioning option are summarised below:

1. **Complete Removal** – This will be the biggest potential impact to the protected areas which the pipelines pass through, as it will significantly disturb the seabed and increase turbidity;
2. **Trench and bury the exposed line** – This will cause significant disturbance and smothering to the area where the lines are exposed, but will be localised in nature. Could be a significant impact if exposed line areas are within protected areas;
3. **Rock dump the lines in specific areas where the line is uncovered** – This will cause significant disturbance and smothering to the area where the lines are exposed, but will be localised in nature. Could be a significant impact if exposed line areas are within protected areas;
4. **Partial removal of uncovered sections of the lines** – This will cause significant impact, if the exposed lines are within protected areas. The impact will be caused by seabed disturbance and increased turbidity;
5. **Leave in situ with monitoring** – No impact to protected areas, as no remedial work planned.

3. Technical

3.1: Assesses how much of a technical challenge it would be for each decommissioning option;

3.2: Assesses how sensitive each decommissioning activity is to bad weather;

3.3: Assesses the risk of major project failure for each decommissioning option.

4. Societal

4.1: Assesses the risk that each decommissioning option poses to access for fisheries and shipping (exclusion zone or non-trawling areas);

4.2: Assesses the risk that each decommissioning option poses to onshore communities, when materials are brought ashore for disposal or processing (i.e. communities situated near the sites).

5. Commercial

5.1: Assesses the risk that each decommissioning option poses to cost (in £millions);

5.2: Assesses the risk that each decommissioning option poses to on-going responsibility for inspection and correction.

This assessment criteria is developed by Perenco and based on original work by Project Development International Limited, 139 Gallowgate, Aberdeen AB25 1BU. The criteria for determining likelihood are presented in Table A.1.

Table A.1: Impact Assessment Criteria

Assessment Criteria	Impact Level				
	1 (Very Low)	2 (Low)	3 (Medium)	4 (High)	5 (Very High)
1. Safety					
1.1 Risk to other users of the sea (post ops)	No Risk	Potential snagging hazard if protection deteriorates or is moved	Loss of fishing gear / vessel infringes tow exclusion zone	Vessel collision/ damage to vessel	Loss of vessel
1.2 Risk to those offshore (during	FAC or no specific treatment	MTC/RWC	RWC/Day Away from Work Case	Fatality or long term injury	Multiple fatalities or

Assessment Criteria	Impact Level				
	1 (Very Low)	2 (Low)	3 (Medium)	4 (High)	5 (Very High)
ops) – excludes diving activities					long term injuries
1.3 Risk to 3rd party assets/vessels (during ops)	No Risk	Standard operations required in 500m zones	Crossing 3rd party assets	Impact with 3rd party asset: no loss of containment	Impact with 3rd party asset: loss of containment
1.4 Level of Diving Intervention	<10 days	10-20 days	20-30 days	30-40 days	>40 days
1.5 Risk to those onshore (during ops)	FAC or no specific treatment	MTC/RWC	RWC/Day Away from Work Case	Fatality or long term injury	Multiple fatalities or long term injuries
2. Environmental					
2.1 Chemical Discharge	No or negligible discharge	Discharge causes changes which are unlikely to be measureable against background activities	Discharge causes change in ecosystem leading to medium term damage but with good recovery potential	Discharge causes change in ecosystem leading to long term damage but with good recovery potential	Discharge causes change in ecosystem leading to long term damage but with poor recovery potential
2.2. Hydrocarbon discharge	No or negligible discharge	Oil 1-100 litres Low hydrocarbon concentrations and/or very gradual release	Oil 100-1,000 litres Medium hydrocarbon concentration and/or moderate rate of release	Oil 1 - 10m^3 High hydrocarbon concentration and/or rapid rate of release	Oil >10m^3 Very high hydrocarbon concentration and/or very rapid rate of release
2.3 Seabed Disturbance	None	Localised disturbance (0-100% of equipment footprint)	Localised disturbance (100% of equipment footprint)	Wider area of disturbance (100-200% of equipment footprint)	Wide area of disturbance (>200% of equipment footprint)
2.4 Energy Usage	0-10,000Gj	10,001-100,000Gj	100,001-200,000Gj	200,001-400,001Gj	>400,000Gj
2.5 Estimated Discard to Sea (% of total material)	0%	0-20%	20-50%	50-80%	>80%
2.6 Estimated Discard to Landfill or recycled (% of total material)	0%	0-20%	20-50%	50-80%	>80%

Assessment Criteria	Impact Level				
	1 (Very Low)	2 (Low)	3 (Medium)	4 (High)	5 (Very High)
2.7 Estimated % of total of the area within the SAC impacted Note 1	0%	0.010%	0.015%	0.1%	0.15%
3. Technical					
3.1 Technical Challenge	Regular construction task using generic procedures	Regular construction task using detailed procedures	Non-routine task. High level of historical experience	Non-routine task. Low level of historical experience	Novel technique or equipment. No industry experience
3.2 Weather Sensitivity	General operations relying only on ability to launch ROV	Standard operations experiencing expected operational downtime for time of year	Requires specific weather window for small number of tasks. Non schedule critical	Requires specific weather window for certain tasks. Schedule can be optimised to accommodate	Requires specific weather window for prolonged period. Operation on critical path
3.3 Risk of Major Project failure	Existing, proven equipment used for specific task for which it was designed for.	Existing, proven equipment used for new application.	Technology research and development required.	Unable to complete operation in scheduled timeframe. Re-work required prior to revisit.	Potential catastrophic failure of major component.
4. Societal					
4.1 Fisheries and Shipping Access (post ops)	Free, unrestricted access to site	Unrestricted access to site - noted seabed disturbance	Access to site with non-over trawlable charted obstructions	Access to site with non-charted obstructions	Site remains restricted
4.2 Onshore Communities	No impact	Low impact (dust, noise, etc.)	Short-term impact to onshore communities (waste handling, traffic, etc.)	Long-term impact to onshore communities (landfill, infrastructure etc.)	High impact to onshore communities (pollution, loss of amenity, etc.)
5. Commercial					
5.1 Economic	<£1M	£1-5M	£5-10M	£10-15M	>£15M
5.2 Ongoing Responsibility for Inspection and Correction	No ongoing Responsibility	Reactive survey regime	Survey inspection at increasing intervals	Bi-annual survey inspection & ongoing remedial work	Annual surveys & ongoing remedial work

Note 1: The percentage area of the pipeline within protected areas

The criteria for determining the likelihood or the level of uncertainty (whichever is more applicable to the assessment criteria) are presented in Table A.2. The assumption for operations with a low likelihood / high uncertainty is that they have a lower probability of resulting in the associated impact.

Table A.2: Likelihood Assessment Criteria

Likelihood or Level of Uncertainty Rating		
1	**Very Low**	**Very low likelihood; or** **Very low level of uncertainty** (Detailed definition and understanding of methodology, hazards and equipment).
2	**Low**	**Low likelihood; or** **Low level of uncertainty** (High level definition and understanding of methodology, hazards or equipment).
3	**Medium**	**Moderate likelihood; or** **Moderate level of uncertainty** (General definition and understanding of methodology, hazards or equipment).
4	**High**	**High likelihood; or** **High level of uncertainty** (Basic definition and understanding of methodology, hazards or equipment).
5	**Very High**	**Very high likelihood; or** **Very high level of uncertainty** (Limited definition and understanding of methodology, hazards or equipment).

The assessment matrix presented in Table A.3 is used to determine the risk level associated with each of the assessment criteria. The assessment matrix provides numerical scores - these are then averaged for each option to provide an overall comparative score.

Table A.3: Impact and Likelihood Assessment Matrix

Likelihood / Uncertainty	Impact				
	1 (Very Low)	2 (Low)	3 (Medium)	4 (High)	5 (Very High)
1 (Very Low)	1	2	3	4	5
2 (Low)	2	4	6	8	10
3 (Medium)	3	6	9	12	15
4 (High)	4	8	12	16	20
5 (Very High)	5	10	15	20	25
Key:					
	High Risk		Medium Risk		Low Risk