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.

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.

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

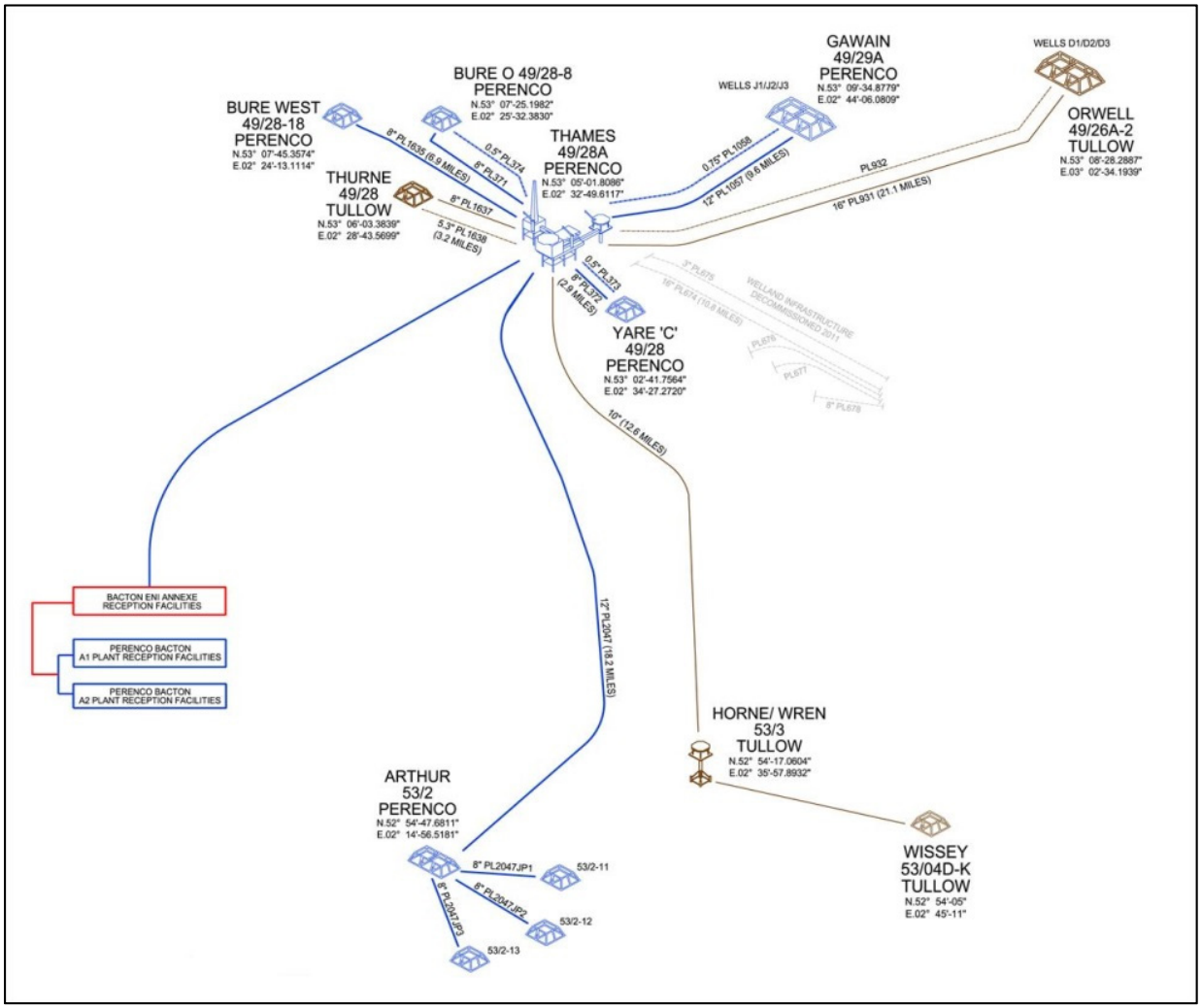


Table 1.2: Thames Area Decommissioning Project – Pipelines, Jumpers, Flowlines, MEG lines and Umbilicals

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.

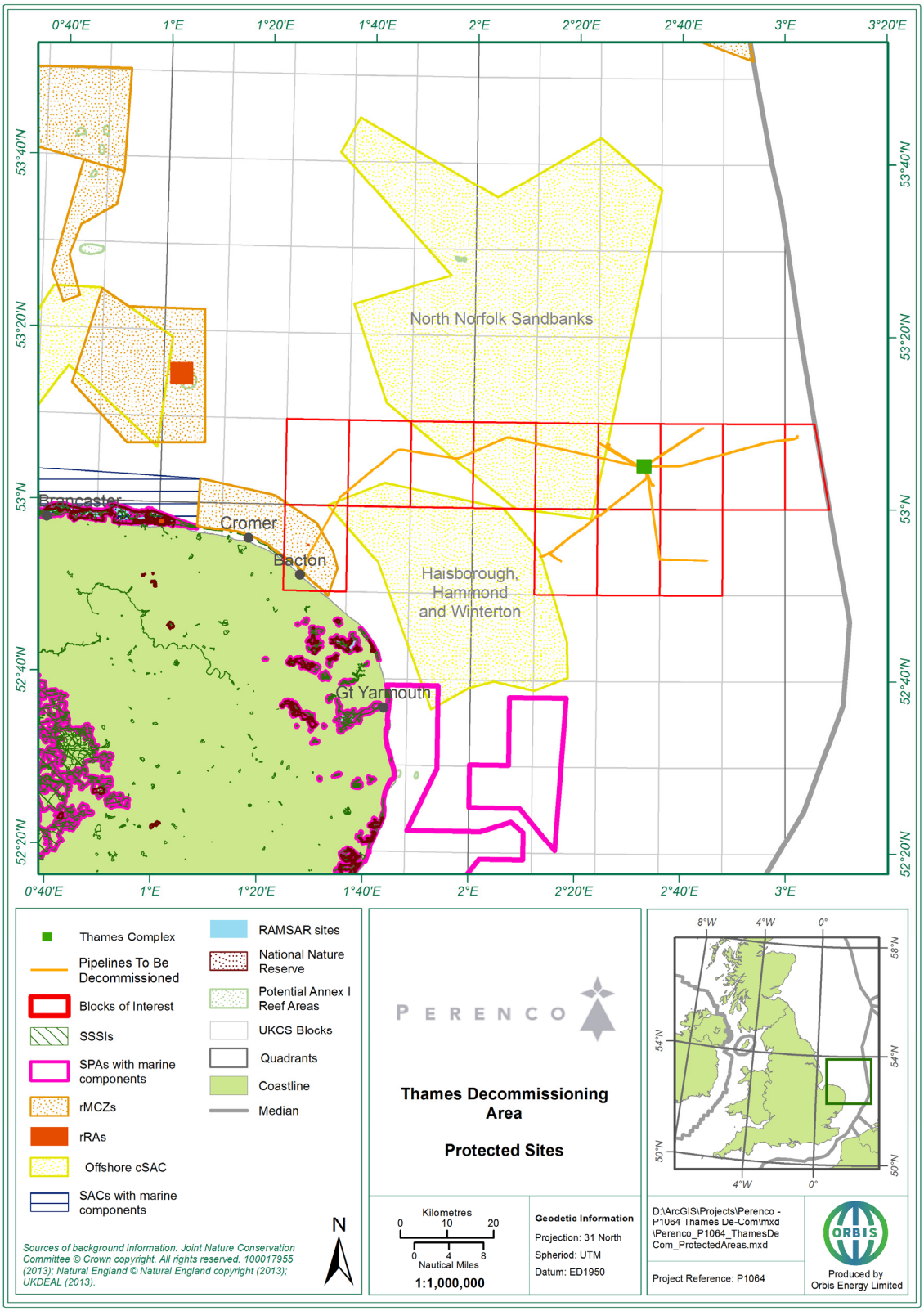
Table 1.3: Marine Protected Areas within 40 kilometres of the Proposed Thames Decommissioning Programme Area (*Net Gain, 2011; Natural England, 2013; JNCC, 2013a; JNCC, 2013b)*

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.

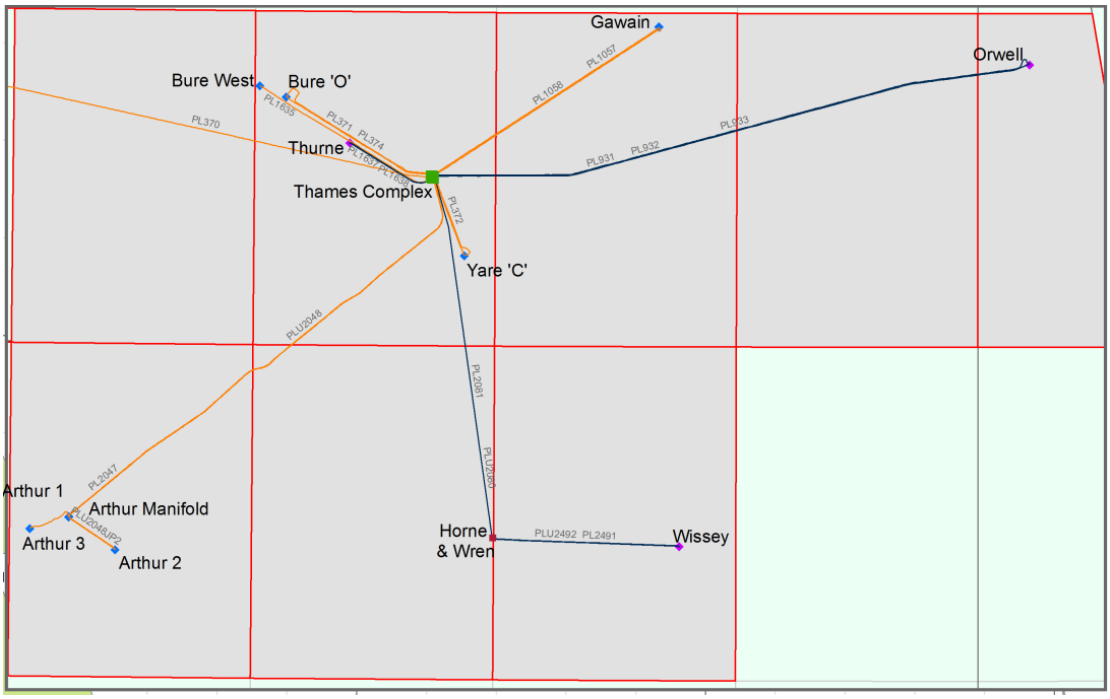
4 Comparative Assessment Results

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**