Kingfisher Field
Comparative Assessment
Part 1

Submitted to the U.K. Department for Business, Energy and Industrial Strategy

Shell Report Number KDP-PT-S-AA-7180-00004
June 2020

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## Revision History

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<tr>
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<td>Issued for final review (ER, Lega, BoM and Partners)</td>
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<td>Updated with partner comments and issued for public consultation</td>
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## List of Holds

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External stakeholders consulted during the Kingfisher Decommissioning Comparative
Assessment process:

- Scottish Fishermen’s Federation (SFF);
- Offshore Petroleum Regulator for Environment and Decommissioning (OPRED);
- Joint Nature Conservation Committee (JNCC);
- Marine Scotland.

“Collectively” referred to in this document as “stakeholder consultees”.

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1. Executive Summary

This document provides a record of the Comparative Assessment (CA) of credible decommissioning options, carried out for the Kingfisher Decommissioning Programmes Part 1. It presents the emerging recommendations for statutory and public consultation in support of the Kingfisher Decommissioning Programmes Part 1 [1]. A separate Kingfisher Decommissioning Programmes Part 2 will be submitted at a later date for the remaining infrastructure within the Kingfisher Field.

The Kingfisher field is located 280km north-east of Aberdeen in the Central North Sea (CNS) area of the U.K. Continental Shelf (UKCS). The field consists of six subsea wells tied-back to RockRose UKCS8 LLC’s Brae Bravo platform.

The subsea infrastructure associated with Kingfisher that is located outside of the Brae Bravo 500m safety-zone has been subjected to CA in order to determine the optimal solution for decommissioning. This infrastructure includes two 10”, 9km production pipelines, an umbilical for providing electro-hydraulic control and chemical injection to the well sites and Kingfisher Manifold, as well as associated tie-in spools, jumpers, mattresses and grout bags.

The CA has been conducted in accordance with the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) Guidance Notes on Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 [2].

This CA is submitted by Shell U.K. Limited, registered company number 00140141 (Shell) as operator, on behalf of itself and its co-venturers Esso Exploration and Production UK Limited, registered company number 00207426 (Esso), and RockRose UKCS8 LLC, registered company number BR001797 (Foreign Company no FC009587) (RockRose), all being the recipients of the Section 29 Notices, and throughout this document the terms ‘owners’, ‘we’ and ‘our’ refer to all the co-venturers.

A summary of the recommendations for each scope is presented in Table 1-1 below.
<table>
<thead>
<tr>
<th>Scope</th>
<th>Scope description</th>
<th>Emerging Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Surface-laid lines outside Brae Bravo 500m zone PL1488, PL1489, PLU1490, PLU1491, PLU1492, PLU1493, PLU1494, PLU1495, PLU1496, PL1497, PL1498, PL1499, PL1500, PL1501, PL1502</td>
<td>Pipeline spools and umbilical jumpers to be cut, recovered and returned to shore for recycling / disposal. Exposed mattresses and grout bags to be recovered and returned to shore for recycling / disposal.</td>
</tr>
<tr>
<td>5</td>
<td>Pipeline ends at manifold PL1488, PL1489</td>
<td>Exposed mattresses to be removed, pipelines to be cut where they leave existing rock berm with end recovered and returned to shore for recycling / disposal. Rock cover to be added to cut end to reduce snagging risk. Mattresses and grout bags beneath the existing rock berm will be decommissioned in situ</td>
</tr>
<tr>
<td>6</td>
<td>Trenched and buried sections PL1488, PL1489, PLU1490</td>
<td>Decommission in situ, the crossings will be revisited when the owners of the third party crossed lines submit their decommissioning proposals to OPRED. At that time, we will discuss and agree appropriate decommissioning with OPRED</td>
</tr>
<tr>
<td>7</td>
<td>Umbilical end at manifold PLU1490</td>
<td>Exposed mattresses to be removed, umbilical end at manifold to be cut where it leaves the trench, end either to be lowered by fluidising the soil, or the surrounding soil to be excavated and the cut made at a point where the umbilical has reached 0.6m depth of cover. Cut off to be recovered and returned to shore for recycling / disposal</td>
</tr>
</tbody>
</table>

**Table 1-1 – Emerging Recommendations Summary**

All other infrastructure outside the Brae Bravo 500m zone will be removed during the decommissioning works:

- The production wells will be plugged and made safe;
- The Kingfisher Manifold will be removed and returned to shore for recycling.

(Infrastructure within the Brae Bravo 500m zone is outwith the scope of this comparative assessment)

See Appendix D for a schematic of the main scope groupings 2, 5, 6 and 7 (excludes sub groupings 1, 3 and 4 which will be the subject of a separate Comparative Assessment Report and Decommissioning Programme).
2. Introduction

2.1. Purpose

The purpose of this report is to present the emerging recommendations from the comparative assessment for the Kingfisher subsea infrastructure in support of the Kingfisher Decommissioning Programmes Part 1 [1].

The following is included within this document:

- Description of the infrastructure to be decommissioned;
- Description of decommissioning options considered;
- Comparative assessment methodology;
- Emerging recommendations from the comparative assessment.

The decommissioning options for the pipelines have been subjected to a process of comparative assessment in order to determine the optimum method of decommissioning in compliance with the OPRED Guidance Notes [2].

The portions of the following pipelines that lie outside the Brae Bravo 500m zone are included in the comparative assessment:

<table>
<thead>
<tr>
<th>PL Number</th>
<th>Name</th>
<th>Diameter</th>
<th>Approx. Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL1488 to PL1502 and PLU1490 to PLU1496</td>
<td>Inclusive of the Kingfisher Production Pipelines including spools and jumpers and Kingfisher Manifold Control Umbilical</td>
<td>10” and smaller</td>
<td>Up to 8.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>140mm and smaller</td>
<td>Up to 8.7</td>
</tr>
</tbody>
</table>

Table 2-1 – Pipelines subject to comparative assessment

2.2. Assumptions

Assumptions for the comparative assessment:

- All structures will be recovered as part of the overall decommissioning programme.

2.3. Regulatory Context

The decommissioning of offshore oil and gas installations and pipelines on the UKCS is regulated through the Petroleum Act 1998, as amended by the Energy Acts. It is a requirement of OPRED Guidance Notes [2] that operators conduct a Comparative Assessment when assessing pipeline decommissioning options.

Because of the widely different circumstances of each case, each pipeline must be considered in the light of a CA of the credible options, taking into account the safety, environmental, technical, societal and cost impacts of the options. Cost may only be a determining factor when all other criteria emerge as equal.
2.4. General Definitions

The following table specifies the meaning of wording in this report when it is used in a general context to avoid any confusion or doubt.

<table>
<thead>
<tr>
<th>Wording</th>
<th>Definition for the purposes of this assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline</td>
<td>When pipeline is used in the general text, this should be assumed to mean pipeline in general and may also reference the pipeline system (including spools, cathodic protection etc.), e.g. this can refer to a rigid or flexible pipeline. If a specific pipeline is referenced, then this may also include “rigid” or “flexible” pipeline.</td>
</tr>
<tr>
<td>Protection</td>
<td>If protection is referenced this will refer to concrete mattresses and/or grout bags. Any other protection will be specifically referenced.</td>
</tr>
<tr>
<td>Structure</td>
<td>When structure is referenced this will refer to the following:</td>
</tr>
<tr>
<td></td>
<td>• Kingfisher Production Manifold</td>
</tr>
<tr>
<td>Route Length / End / Spool / Jumper</td>
<td>A single pipeline is split into 3 different sections for the purpose of this comparative assessment. The route length, which can generally be described as the section of pipe on the bottom of the trench. The end of a pipeline in general is the section between the trench transition (as the line comes out of a trench) and the tie-in to the structure (including spools). Finally, the spool or jumper which is the section of pipe lain on the seabed and facilitates the tie-in to any structures. The diagram below illustrates the differences between the different sections:</td>
</tr>
</tbody>
</table>

*Plan View*

```
Structure         Spool/Jumper     End       Route Length   End
Structure
```

*Elevation*

```
Structure
```

Diagram illustrating the differences between the different sections of a pipeline.
<table>
<thead>
<tr>
<th>Wording</th>
<th>Definition for the purposes of this assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burial Depth Definitions</td>
<td>Different definitions will be used for different burial depths. The following diagram illustrates the different burial depth definitions:</td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Diagram of burial depth definitions" /></td>
</tr>
<tr>
<td>Exposure</td>
<td>When an exposure is described this is essentially when the crown of the pipe or umbilical can be seen. This does not generally mean a hazard.</td>
</tr>
<tr>
<td>Reportable Span</td>
<td>A reportable span is a significant span which meets set criteria (FishSAFE criteria) of height above the seabed and span length.</td>
</tr>
<tr>
<td>Fluidising</td>
<td>Fluidising is the process of fluidising the seabed to the point where the soil has no inherent strength and hence the pipe or similar will simply fall to the bottom of the trench.</td>
</tr>
</tbody>
</table>

**Table 2-2 – General Definitions**
2.5. Abbreviations

BEIS  Department for Business, Energy and Industrial Strategy (formerly DECC)

CA    Comparative Assessment

CNS   Central North Sea

CoP   Cessation of Production

DECC  Department of Energy and Climate Change (Now BEIS)

OGA   Oil and Gas Authority

OGUK  Oil and Gas UK

OOM   Order of Magnitude

OPRED Offshore Petroleum Regulator for Environment and Decommissioning

OSPAR Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic

PMF   Priority Marine Feature

PMS   Power Management System

POB   Persons on Board

QRA   Quantitative Risk Assessment

ROV   Remotely Operated Vehicle

SFF   Scottish Fishermen’s Federation

SIMOPS Simultaneous Operations

SSIV  Sub-sea Isolation Valve

THC   Total HydroCarbons

UKCS  United Kingdom Continental Shelf

VMS   Vessel Monitoring System

WBM   Water Based Mud

Table 2-3 – Table of Abbreviations
2.6. Field Overview

2.6.1. General

The Kingfisher field lies in Block 16/8 of the UK Sector of the North Sea and comprises three reservoirs: Brae I (Gas/Condensate), Brae II (Volatile Oil) and Heather (Gas/Condensate). The Kingfisher field is located 280km North East of Aberdeen and was developed as a subsea tie-back to the RockRose UKCS8 LLC operated Brae Bravo platform. The field first produced in October 1997 and had a design life of 15 years. Produced oil was exported via the Forties pipeline system while gas was delivered to the Brae Bravo operators as part of the tariff structure.

The Kingfisher development comprises six subsea wells with rigid pipeline jumpers to a subsea manifold. The production fluids from the Brae and Heather wells were commingled in the manifold and routed to the Brae Bravo platform via the two production pipelines. The production pipelines are linked at the Kingfisher manifold to provide a pigging loop to allow round trip pigging.

A single composite control and chemical injection umbilical from the Brae Bravo platform to the Kingfisher manifold provided all the utilities required for operation of the manifold facility.

A SSIV control umbilical from the Brae Bravo platform to the SSIV structure controls the SSIV, although as the SSIV and its control umbilical fully reside within the Brae Bravo 500m zone these are not considered in this comparative assessment.

![Figure 2-1 – Kingfisher Field Location](image-url)
2.6.2. Environmental Summary of Kingfisher Field

The Kingfisher field is located in the Central North Sea (CNS), approximately 280 km north-east of Aberdeen. Environmental surveys completed during summer 2017 around the Kingfisher infrastructure observed sediments to be ‘fine sand’ or ‘very fine sand’ with mean particulate size generally lower within the cuttings pile than the surrounding sediments. Hydrocarbon distribution in the seabed sediments out with 200m of the Kingfisher wellheads were typical of low level, weathered petroleum residues commonly found in the North Sea. Likewise, recorded levels of endocrine disruptors and heavy metals outside 200m were comparable to reference stations and below Effects Range Low (ERL) values. Elevated levels of Total Hydrocarbons (THC) were recorded from cores within the drill cuttings pile itself including evidence of relatively un-weathered Ultidrill drilling fluid, of the type used to drill the wells in 1997. A Stage 1 OSPAR assessment (OSPAR 2006/5) of rate of oil loss to water column and persistent rates calculate both measurements to be well below the OSPAR 2006/5 thresholds.

The Kingfisher field lies at a mean water depth of 114 m with near seabed water currents likely in the region of 1 to 1.5 m/s in a north easterly direction, allowing for some movement and dispersion of any contaminant release into the water column.

Benthic Environment

Benthic communities in the Kingfisher field reflect two different biotopes:

- ‘circalittoral muddy sand’ with silt content typically between 5 and 20% and supporting animal-dominated communities including polychaete worms and echinoderms (star fish, urchins etc). Seapens, bivalve siphons including potentially the Priority Marine Feature (PMF) Ocean Quahog (Arctic Islandia);

- ‘circalittoral mixed sediments’ which are well mixed muddy gravel sands with poorly sorted mosaics of shell cobbles and pebbles embedded in mud, sand or gravel. This habitat type supports a wide range of infaunal polychaete worms, bivalves, echinoderms and burrowing anemones.

Fish and Shellfish

Several fish species are known to be present in the CNS including in the area around the Kingfisher infrastructure, although species richness in the CNS is lower than in more coastal areas of the North Sea (ICES, 2008). The Kingfisher infrastructure lies within or in close proximity to known spawning areas for: Blue Whiting Micromesistius poutassou; Cod Gadus morhua, Haddock Melanogrammus aeglefinus; Norway Pout Trisproterus esmarkii; Saithe Pollachius spp.; Sandeels Ammodytidae spp.; Norway lobster Nephrops norvegicus; Herring and mackerel Scomber scombrus. The area is also used as nursery grounds for those listed above as well as Whiting Merlangius merlangus, Ling Molva molva, Hake and Angler fish Lophius piscatorius. (Marine Scotland, 2018). In all cases, the area represents a small proportion of the grounds available for spawning for these species.

Cetaceans and pinnipeds

Whilst a wide range of marine mammal species have been recorded in the waters around the British Isles, only a small number are regularly recorded in the area around the Kingfisher infrastructure. The most commonly sighted species include Harbour Porpoise (Phocoena phocoena); White beaked dolphin (Lagenorhynchus albirostris); Killer whale (Ochinus orca); and the Minke whale (Balenoptera acutorostrata). The most abundant marine mammal species in the North Sea are important predators influencing the food chain and feeding on a wide range of prey including a number of commercially important fish species.

The area around the Kingfisher infrastructure is recorded as an area of low ‘at sea’ usage (0-<1 mean annual) for both Grey seal (Halichoerus grypus) and for Harbour seal (Phoca vitulina).
**Seabirds**

Seabirds are present in the area around the Kingfisher infrastructure throughout the year, although in low numbers as the area is at some distance from their breeding colonies. Aggregated density is expected to be lowest in the area in late spring/summer when many birds are nesting and therefore are in close proximity to coastal colonies. Diversity and density may increase in the offshore area once chicks have fledged as foraging behaviours allow for birds to travel further distances from their coastal colonies.

Seabirds anticipated to be present in the Kingfisher area in small numbers may include: Northern fulmar (*Fulmarus glacialis*), all year round; Northern gannet (*Morus bassanus*), May to February; European storm petrel (*Hydrobates pelagicus*); Pomerine skua (*Stercorarius pomarinus*) March to June; Arctic skua (*Stercorarius parasiticus*) May to August; Great skua (*Stercorarius skua*) May to August; Common gull (*Larus canus*), July to February; Herring gull (*Larus argentatus*), July to April; Great black-backed gull (*Larus marinus*), November to February; Kittiwake (*Rissa tridactyla*), all year; Guillemot (*Uria aalge*), all year; Little auk (*Alle alle*), November to February; and Puffin (*Fratercula arctica*), April to September.

**Protected/Sensitive Habitats**

There are no designated Marine Protected Areas, including Natura 2000 sites, in the area of the Kingfisher infrastructure.

The nearest designated site under the Habitats Directive (92/43/EEC) is the Braemar Pockmarks Special Area for Conservation (SAC) including the Annex I Habitat ‘Submarine Structures made by leaking gases’ which is located approximately 22km to the north of the Kingfisher manifold. The Braemar pockmarks are a series of crater-like depressions in the sea floor. Methane derived authogenic carbonate (MDACS) have been observed deposited within two of the recorded craters as a result of precipitation during the oxidation of methane gas. The Brae Area environmental survey (Fugro 2014) observed pockmarks out with the boundary of the Braemar Pockmarks SAC around the flowlines from RockRose UKCS8 LLC’s Braemar wells to the East Brae platform. No evidence of pockmarks in the seabed around the Kingfisher field has been observed.

Harbour Porpoise (*Phocoena phocoena*); as well as the Grey seal (*Halichoerus grypus*) and the Common seal (*Phoca vitulina*) are specifically identified as protected species under Annex II of the Habitats Directive (92/43/EEC).

All cetaceans are protected under Annex IV of the Habitats Directive, as well as Appendix II of the Bern Convention and under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended).

As discussed above the potential for the presence of OSPAR threatened and or declining habitats and Priority Marine Features (PMFs):

- Seapens and Burrowing Megafauna Communities;
- Ocean Quahog (*A. Islandica*)

**Fishing intensity**

The Kingfisher field is located within ICES rectangle 46F1. 46F1 makes a low (1.8%) contribution to overall fishing effort in UK waters, based on 2017 ICES data for vessels of 15 m in length. ICES rectangle 46F1 also lies within spawning grounds for a number of fish species of commercial and/or conservation importance, including haddock, Norway pout and Norway lobster.

Fishing effort immediately around the Kingfisher and Brae Bravo infrastructure is notably lower than in the surrounding area. It is also noted that a number of significant pieces of oil and gas infrastructure exist within this area, with a number of currently operational safety zones which limit access to this area by fishing boats.
**Commercial Shipping**

Shipping activity in the area around the Kingfisher infrastructure is classified by the OGA (2017) as low. An average weekly density of non-port service vessels is recorded in the adjacent block 16/7 which coincides with the location of RockRose UKCS8 LLC’s Brae Alpha and Bravo platforms. This is consistent with rig supply vessel activity which would be expected. A preferred North Sea cargo vessel transit route is evident passing on an east-west orientation approximately 40 km to the south of the area of the Kingfisher infrastructure.
2.6.3. Kingfisher Field Infrastructure

The field is developed as a subsea tieback to the RockRose UKCS8 LLC operated Brae Bravo Platform with the following pipelines and umbilicals.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Production Pipelines</th>
<th>Manifold Control Umbilical</th>
</tr>
</thead>
<tbody>
<tr>
<td>N# / PL#</td>
<td>N0509/ N0510 N0889 PLU1490</td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td>273.1mm (10”)</td>
<td>132.8mm</td>
</tr>
<tr>
<td>Wall Thickness</td>
<td>17.5 – 13.8mm</td>
<td>N/A</td>
</tr>
<tr>
<td>Material</td>
<td>Super Duplex</td>
<td>N/A</td>
</tr>
<tr>
<td>Length</td>
<td>8.9km; 8.3km within the scope of DP Part 1 and this CA</td>
<td>8.7km; 8.1km within the scope of DP Part 1 and this CA</td>
</tr>
<tr>
<td>Service</td>
<td>Oil Production</td>
<td>Electro-Hydraulic Control and Chemical Injection</td>
</tr>
<tr>
<td>Current Contents</td>
<td>Hydrocarbon</td>
<td>Production chemicals</td>
</tr>
<tr>
<td>Coatings</td>
<td>4-layer Polypropylene</td>
<td>N/A</td>
</tr>
<tr>
<td>Offshore Crossings</td>
<td>3 per pipeline</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2-4 – Main Pipelines and Umbilicals Summary

Production from Kingfisher’s six wells is connected to a common production manifold via surface-laid tie-in spools and from there to the Brae Bravo facility via two 10” diameter, 8.9km super duplex production pipelines (PL1488 & PL1489), see Figure 2-2. The production pipelines were trenched and buried on installation.

Figure 2-2 – Subsea Infrastructure at Kingfisher Manifold and Wells
The production pipelines PL1488 and PL1489 as well as the main umbilical PLU1490 are crossed by the BP Miller Pipeline PL1971 as they exit the Brae Bravo 500m zone; and cross over the Equinor Heimdal 8” Condensate Pipeline PL301 and Brae Alpha to East Brae Power Management System (PMS) Cable approximately 4.0km from the Brae Bravo 500m zone. The manifold umbilical, which is trenched from the Brae Bravo 500m zone, exits the trench on approach to the Kingfisher production manifold, with the surface-laid section of approximately 185m protected by mattresses. Surface-laid, mattress protected jumpers provide electro-hydraulic control and chemical injection from the production manifold to the wellheads, as shown in Figure 2-2.
Figure 2-3 – Kingfisher Field Schematic
3. **Comparative Assessment Process**

3.1. **General Process Description**

The comparative assessment process was performed in accordance with the OPRED Decommissioning Guidance Notes [2] and guidance was used from the OGUK pipeline Comparative Assessment Guidelines [3].

The following sections present the comparative assessment methodology used for each of the Kingfisher scopes, however a summary of the process used is as follows:

- Scoping of subsea infrastructure to be decommissioned and inventory mapping;
- Decommissioning assessment criteria and sub-criteria;
- Decommissioning options to be considered;
- Screening workshop to initially agree the decommissioning options to take further and any grouping to be considered.
- Selection of groups with similar circumstances, to be assessed as a scope group;
- Traffic light assessment, as required;

Stakeholder engagement and multi-disciplinary reviews have formed an important part of the comparative assessment process.

3.2. **Scoping and Inventory Mapping**

The initial phase of the comparative assessment process was to identify the scope to be decommissioned and map the inventory which requires decommissioning. This is summarised in section 2.6.3.
### 3.3. Criteria and Sub-Criteria

The next step in the comparative assessment process is to agree the criteria and sub-criteria to be used. The following table presents the selected criteria and sub-criteria, which was used to assess each option for decommissioning during the comparative assessment process. The criteria are in line with the criteria recommended in the OGUK comparative assessment guidelines [3], except for the impact of operations and legacy impact of operations and legacy impact sub-criteria which have been adapted as shown in the table below.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-Criteria</th>
<th>Applicable to</th>
<th>Applicable When</th>
<th>Factors</th>
<th>Potential Sources of data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Project risk to personnel – Offshore</td>
<td>Project team offshore, project vessels crew, diving teams, supply boat crew, heli-ops, survey vessels crew</td>
<td>During execution phase of the project including any subsequent monitoring surveys</td>
<td>Type of activity&lt;br&gt;&lt;br&gt;Number of personnel involved &amp; project duration.&lt;br&gt;&lt;br&gt;Number of crew changes (helicopter transfers)&lt;br&gt;&lt;br&gt;Number of vessels involved &amp; SIMOP activity Numbers, durations and depth that divers are anticipated to work.&lt;br&gt;&lt;br&gt;Any unique or unusual handling or access activities required of personnel.</td>
<td>Decommissioning methodology for each option; vessel study; diving study; etc&lt;br&gt;&lt;br&gt;Coarse QRA data based on POB / exposure, durations and activity Fatal Accident Rate (FAR).&lt;br&lt;br&gt;Industry data will be used to derive the probability of loss of life.</td>
</tr>
<tr>
<td>Safety</td>
<td>Project risk to other users of the sea</td>
<td>Navigational safety of all other users of the sea, fishing vessels, commercial transport vessels, military vessels</td>
<td>During execution phase of the project including any subsequent monitoring surveys</td>
<td>Likelihood of incursion into project exclusion zone by other users of the sea Number and type of transits by project vessels to and from the project work site</td>
<td>Fishing study on anticipated activity in area of activity&lt;br&gt;&lt;br&gt;Other vessels movements review, stakeholder engagement</td>
</tr>
<tr>
<td>Safety</td>
<td>Operational risk to personnel – Onshore</td>
<td>Onshore dismantling and disposal sites personnel; extent of materials transfers / handling on land</td>
<td>During execution phase of the project, through to final disposal of recovered materials</td>
<td>Extent of dismantling required &amp; hazardous material handling anticipated. Numbers of road transfers from dismantling yard to final disposal site.</td>
<td>Decommissioning methodology for each option, considering volume and type of material to be returned to shore&lt;br&gt;&lt;br&gt;Coarse QRA data based on POB / exposure, durations and activity Fatal Accident Rate (FAR)</td>
</tr>
<tr>
<td>Safety</td>
<td>Potential for a high consequence event</td>
<td>Project team offshore and onshore; project vessels, diving teams; supply boat crew; heli-ops; survey vessels; onshore dismantling and disposal sites personnel</td>
<td>During execution phase of the project including any subsequent monitoring surveys</td>
<td>Decommissioning philosophy; potential for dropped object over a live pipeline; degree of difficulty anticipated in onshore dismantling</td>
<td>Decommissioning methodology for each option; vessel study; diving study; etc</td>
</tr>
<tr>
<td>Safety</td>
<td>Residual risk to other users of the sea</td>
<td>Fishing vessels, fishermen, supply boat crews, military vessel crews, commercial vessel crew and passengers, other users of the sea</td>
<td>Following completion of the Decommissioning project and residual / ongoing impact in perpetuity</td>
<td>Extent of facility / equipment / pipeline left in situ on completion of the project and its likelihood to form a future hazard; likelihood for further deterioration; predicted future fishing activity; proximity of retained facilities to main transport routes</td>
<td>Decommissioning methodology for each option, focussing on volume and type of infrastructure to be left in situ; fishing navigational safety study on anticipated activity in area(s) where infrastructure is decommissioned in situ; assessment(s) of degradation for infrastructure left in situ; stakeholder engagement</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>Impact of operations</td>
<td>Environmental impact to the marine environment, nearshore areas and onshore caused by project activities</td>
<td>During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not</td>
<td>Associated planned discharges; marine noise; seabed disturbance, including seabed footprint (area), sediment suspension and contaminated sediment including drill cuttings; protected habitat and species in nearshore, marine and&lt;br&lt;br&gt;Asset knowledge, decommissioning methodologies; Environmental Baseline Survey, Habitat Survey, Waste Inventory, Environmental Appraisal Report, project schedule, collision assessment, predicted discharges to sea, historic events</td>
<td></td>
</tr>
<tr>
<td>Criteria</td>
<td>Sub-Criteria</td>
<td>Applicable to</td>
<td>Applicable When</td>
<td>Factors</td>
<td>Potential Sources of data</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>Energy and emissions and resource consumption</td>
<td>Project activities from vessel mobilisation to the final destination of waste, including the energy and emissions penalty for leaving recyclable material in field. Includes vessel mobilisation, demobilisation, waiting on weather, post-decommissioning monitoring surveys.</td>
<td>During execution phase of the project from mobilisation of vessels to the end of project activities at the waste processing / disposal site (does not include landfill and long-term storage impacts) Not recovering and recycling the installations material will require that raw material and energy will be consumed to replace the materials which would have been recycled if the structure had been brought onshore</td>
<td>Number and type of vessels; duration of vessel activities; tasks vessels are fulfilling; vessel station keeping approach Energy and emissions required to replace recyclable materials not recovered for recycle of re-use Helicopter trips are not to be included as impact is marginal.</td>
<td>Energy and emissions assessment, undertaken per Institute of Petroleum: Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures</td>
<td></td>
</tr>
<tr>
<td>Legacy Impact</td>
<td>Ongoing long term environmental impact and benefit caused by materials left in place or long-term waste storage / landfill</td>
<td>Following completion of the Decommissioning project and residual / ongoing impact For rock placement, trenching and dredging any changes to habitat and species are included here - seabed disturbance is included in Impact of Operations, depending on area of impact.</td>
<td>Waste disposal including onshore landfill and long-term waste storage; habitat alteration and long-term changes in species composition; physical and chemical degradation of products left on the seabed (make and content of material like wax, chemicals, plastic and concrete, steel, debris). CA will be conducted with assumption that reasonable endeavours are used to clean the infrastructure.</td>
<td>Decommissioning methodology for each option, focussing on volume and type of infrastructure to be left in situ; Environmental Baseline Survey; Habitat Survey; Waste Inventory</td>
<td></td>
</tr>
<tr>
<td>Risk of major project failure</td>
<td>Overall Project</td>
<td>From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.</td>
<td>Maturity of scope definition, confidence level that project will proceed as foreseen; ability to recover from unplanned events which could impact completion of the project as planned; extent of potential re-engineering that may be required and its impact if strategy goes wrong</td>
<td>Decommissioning methodology for each option, concept / pre-FEED study, lessons learned from industry</td>
<td></td>
</tr>
<tr>
<td>Technology demands, Availability / Track Record</td>
<td>Overall Project</td>
<td>From project select phase through to completion, including monitoring surveys and ultimate disposal of materials returned to shore.</td>
<td>Extent of new or emerging technology proposed by the option; extent of application of existing technology to different uses; extent that the approach has been completed before</td>
<td>Decommissioning methodology for each option, concept / pre-FEED study, lessons learned from industry</td>
<td></td>
</tr>
<tr>
<td>Criteria</td>
<td>Sub-Criteria</td>
<td>Applicable to</td>
<td>Applicable When</td>
<td>Factors</td>
<td>Potential Sources of data</td>
</tr>
<tr>
<td>----------</td>
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<td>---------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Societal</td>
<td>Commercial impact to fisheries</td>
<td>Impacts from both the decommissioning operations and the end-points on the present commercial fisheries in and around the field</td>
<td>During and following completion of the Decommissioning project and residual / ongoing impact</td>
<td>Residual impact on fishing areas: • If exclusion zones are to be retained where equipment or materials are left in-situ • If fishing habitats are inhibited as a result of the decommissioning methods adopted</td>
<td>Fishing study on anticipated activity in area of activity; decommissioning methodology for each option focussing on volume and type of infrastructure to be left in situ; vessel study; publicly available data; stakeholder engagement</td>
</tr>
<tr>
<td>Societal</td>
<td>Socio-economic impact on communities and amenities</td>
<td>The impact from any near shore and onshore operations and end-points (dismantling, transporting, treating, recycling, land filling) on the health, well-being, standard of living, structure or coherence of communities or amenities. E.g. business or jobs creation, job loss, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads.</td>
<td>During and following completion of the Decommissioning project and residual / on-going impact</td>
<td>May be positive or negative; jobs created; establishment of track record; improvements to roads and quaysides; use of limited landfill resource</td>
<td>Decommissioning methodology for each option; publicly available data; stakeholder engagement</td>
</tr>
<tr>
<td>Economic</td>
<td>Cost</td>
<td>Overall Project</td>
<td>Full decommissioning project cost including future monitoring surveys and proposed remediation, if required</td>
<td>Actual cost estimates are not to be included in the CA report, but a normalised scale can be produced to indicate the comparison between each option</td>
<td>Cost and schedule estimates</td>
</tr>
<tr>
<td>Economic</td>
<td>Cost Risk / Uncertainty</td>
<td>Overall Project</td>
<td>Project execution phase and ongoing cost liability (surveys and potential remedial action)</td>
<td>Uncertainty in estimates prepared, potential for / risk of growth through the project, risk will be greater with a larger number of unknowns and where activities are weather sensitive</td>
<td>Risk and opportunity register</td>
</tr>
</tbody>
</table>

Table 3-1 – Comparative Assessment Criteria and Sub-Criteria
3.4. Decommissioning Options and Initial Screening Workshop

3.4.1. Decommissioning Options
The options available for decommissioning have been considered and were assessed as part of the initial screening process to assess each option’s feasibility. The options for decommissioning being assessed are shown in section 4.

3.4.2. Initial Screening Workshop
An initial screening workshop was held where experts were consulted to assess the technical feasibility and practicality of each of the decommissioning options relating to each scope. The initial screening workshop also identified which scopes displayed similar characteristics and could therefore be grouped and assessed together. Internal assessment was performed for each scope against the five Comparative Assessment criteria, with decommissioning recommendations identified for each scope.

3.5. Comparative Assessment Workshops
A Comparative Assessment (CA) workshop was held, including licence partners and the stakeholder consultees to inform the emerging recommendations. During the CA workshop, the scopes were presented to and discussed with the attendees detailing the circumstances associated with each item of infrastructure, the credible options identified, and the impacts against the five CA criteria. The decommissioning recommendations were presented for discussion with the stakeholders in attendance.
4. Decommissioning Options

A brief discussion of the decommissioning options is presented below, which will cover the high-level options of pipeline removal, re-use, remediation or leave in-situ.

4.1. Re-use

There are no credible re-use opportunities as the host is being decommissioned and removed.

4.2. Removal

4.2.1. Cut and lift

The cut and lift method to date has been the most commonly used method to remove pipelines. The method requires the pipeline to be un-trenched and water flooded. The pipeline will then be cut into sections by an ROV using hydraulic shears and then recovered by a vessel using a hydraulic lifting beam ready for transport to shore and disposal. A simplified schematic of the cut and lift process is shown in Figure 4-1. The preferred method of cutting will generally be decided by the contractor performing the work, subject to risk assessment and endorsement by Shell, however will most likely be hydraulic shears.

The cut and lift method can be used for the entire pipeline removal or localised sections, such as spools or spans.

![Figure 4-1 – Cut and Lift Pipeline Removal Illustration](image)

4.2.2. Reverse Reel

Reverse reeling of the buried pipelines or umbilicals would potentially require them to first be un-trenched and de-watered to reduce the submerged unit weight. The pipeline or umbilical ends would then need to be cut or disconnected and then the reeling vessel would connect to and recover the end using the A&R (abandonment and recovery) winch until the tensioner could grip and proceed to pull the pipeline or umbilical on to the vessel. The pipeline or umbilical would then need to be connected to the main reel, so that the vessel could proceed to reel on. The pipeline or umbilical would then be transported to shore for disposal or recycling.
4.2.3. **Reverse S-lay**

Reverse S-lay is a potentially feasible option to recover pipelines. Reverse S-lay is the reversal of the common S-lay installation technique, which generally consists of a pipeline lay vessel or barge equipped with a stinger and tensioner and then the line pipe is welded together on the vessel, prior to being laid onto the seabed, which is controlled by the applied tension to the pipeline.

![Reverse S-lay Illustration](image)

Figure 4-2 – Reverse S-lay Illustration

For the removal process the tensioner would be used to recover the pipeline from the seabed and then it would be cut to manageable lengths on the vessel and transported back to shore.

The pipeline would need to be un-trenched to perform this method of recovery. In addition, it would be prudent to dewater the pipeline (air filled or nitrogen purged) to reduce the equivalent weight of the pipeline and hence reduce the required tension. A summary of the reverse S-lay methodology is set out in Figure 4-2.

4.3. **Leave In-situ**

4.3.1. **Pipelines (No remediation)**

This option consists of leaving the pipeline or umbilical in-situ with no further remediation, however the pipeline ends may be cut and buried or cut and rock covered.

4.3.2. **Pipelines (Re-trench)**

Re-trenching pipelines or umbilicals is an option where lines are subject to increased risk from snagging or becoming unstable (e.g. buoyant pipelines or free spanning pipelines) due to a reduction in the burial depth or cover. The retrenching of a pipeline or umbilical can be performed by a jet trencher, plough or mass flow excavator. Re-trenching on areas with remedial rock may need the rock removed prior to trenching, depending on the rock grade.

4.3.3. **Localised Cut and Lift**

For localised exposures or areas of low cover, localised cut and lift operations can be used, which would be executed in a similar manner to that shown in section 4.2.1.
4.3.4. Pipelines (Remedial Rock Cover)

Remedial rock cover involves either blanket or locally placing rock at specific locations to increase the cover on the pipeline to reduce the risk of snagging or it affecting other users of the sea. Due to the water depth at Kingfisher (approx. 114m) a fall pipe vessel, shown in Figure 4-3, would be the most likely method for additional rock cover.

Figure 4-3 – Remedial Rock Cover Installation Illustration
5. Comparative Assessment Results

5.1. Initial Decommissioning Options Screening and Grouping

A number of stakeholder engagements took place during the initial screening phase to further understand and clarify each stakeholder’s concerns and views regarding the decommissioning of the Kingfisher Field. Internal workshops to screen the options were held by Shell in Q1 2018 utilising information from both internal and external survey data gathered over the life of the field. The workshops enabled the project team to identify and define credible options for each scope, assessing what data gaps existed for each option and defining whether any studies were required to inform the comparative assessment workshop.

During the initial screening workshop, the credible options for each grouping was assessed against the five CA criteria identified in Section 3.3 and, as appropriate, decommissioning recommendations identified. In addition, the pipelines were grouped, where applicable, for the purposes of the comparative assessment workshop. A summary of the grouping and options assessed for each scope is shown in Table 5-1.

Details of the conclusions for each scope and group are contained within the following sections.
<table>
<thead>
<tr>
<th>Scope</th>
<th>Description</th>
<th>Decommissioning Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 3, 4</td>
<td>Scopes 1, 3 and 4 will be covered by a separate Decommissioning Programme and Comparative Assessment</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Surface-laid lines outside Brae Bravo 500m Zone (PL1488, PL1489, PLU1490, N/A, PL1497, PL1498, PL1499, PL1500, PL1501, PL1502, PLU1491, PLU1492, PLU1493, PLU1494, PLU1495, PLU1496)</td>
<td>Decommission in situ Blanket rock cover Total removal</td>
</tr>
<tr>
<td>5</td>
<td>Pipeline ends at manifold (PL1488 &amp; PL1489)</td>
<td>Decommission in situ Blanket rock cover Total removal</td>
</tr>
<tr>
<td>6</td>
<td>Trenched and buried sections (PL1488, PL1489, PLU1490)</td>
<td>Decommission in situ Total removal</td>
</tr>
<tr>
<td>7</td>
<td>Umbilical end at manifold (PLU1490)</td>
<td>Decommission in situ Blanket rock cover Total removal</td>
</tr>
</tbody>
</table>

Table 5.1 – Summary of Decommissioning Options and Grouping

Notes:
Options with a strikethrough (e.g. Decommission in situ) were deselected during initial screening.
5.2. Scope 2 – Surface Laid Lines Outside Brae Bravo 500m Zone

This scope includes the surface-laid sections of the manifold umbilical (PLU1490) and both 10” production lines (PL1488 and PL1489) at the Kingfisher Manifold; and the tie-in spools and jumpers between the Kingfisher Manifold and six Kingfisher wellheads (PL1497, PL1498, PL1499, PL1500, PL1501, PL1502, PLU1491, PLU1492, PLU1493, PLU1494, PLU1495, PLU1496). Most of the surface laid sections are covered by mattresses. The stabilisation features associated with this scope were included within the CA.

Scope 2 infrastructure adjacent to the Kingfisher Manifold and wellheads is shown in Figure 5-1.

Three credible options were identified for this infrastructure:

- Total removal
- Decommission in situ
- Blanket rock cover and decommission in situ

The three credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.

In terms of safety impact, decommissioning the spools and jumpers in situ was deemed to leave an unacceptable safety risk to future users of the sea as the infrastructure would present a snagging risk in open water. This option was therefore discounted.

Total removal is in line with both the regulatory expectation and stakeholder preference for clear seabed on conclusion of decommissioning activities. All pipelines, umbilicals and spools associated with this scope are surface-laid, with the mattresses broadly accessible and expected to be in good condition given the age of the field. Therefore, whilst representing a comparatively higher safety risk to project personnel offshore than blanket rock cover, total removal would not impose any unusual safety risks. Further, blanket rock cover would reduce the legacy safety risk of snagging by other users of the sea compared with decommissioning in situ, however it would represent a comparatively higher risk than total removal.
For environmental impact, total removal would be less significant than blanket rock-cover. The latter would create seabed disturbance across a greater footprint in the short-term and have a comparatively higher long-term impact by introducing new and habitat-altering substrate.

With each option representing a relatively short execution scope and employing well-known, commonly used technology, there is no comparable difference between the two remaining options in terms of technical impact.

Similarly, neither total removal nor blanket rock cover would have a significant societal impact. Resulting in a short offshore campaign and returning small volumes of waste to shore for recycling will have little or no effect on existing employment and supply chains.

In terms of cost, total removal will result in a higher execution cost than blanket rock cover; however the legacy cost of total removal is expected to be lower as fewer post-decommissioning surveys and/or remedial work is required to prove the seabed remains safe for other users of the sea.

Taking into account the above factors, decommission in situ was excluded due to the unacceptable safety risk; whilst total removal is preferable to blanket rock cover for this scope.

Therefore, the recommended decommissioning solution to remove all lines and exposed mattresses was presented at the CA workshop. Removed infrastructure will be recovered to shore for recycling and disposal. There were no objections to this proposal from the stakeholder consultees.

**5.3. Scope 5 – Pipeline Ends at Manifold**

Sections of both 10” production pipelines where they transition from their respective trenches until they exit the existing rock berm. This covers only the ends at the Kingfisher manifold. Sections are approximately 50m in length for each pipeline. Stabilisation features associated with these pipeline ends, i.e. mattresses and grout bags, were included within the CA.

![Figure 5-2 – Scope 5 at Kingfisher manifold (highlighted)](image)

Both ends are completely covered by existing rock berms with no exposures, with a depth-of-rock cover between 0.3m and 1.2m. The depth-of-lowering within the trench should also be considered when assessing the likely snagging risk. Survey data shows total depth-of-lowering or cover varies between 0.4m and 1.4m. The OPRED Decommissioning Guidance Notes ([2] Section 10.19) state that “where rock-dump has previously been used to
protect a pipeline it is recognised that removal of the pipeline is unlikely to be practicable and it is generally assumed that the rock-dump and the pipeline will remain in place. Where this occurs, it is expected that the rock-dump will remain undisturbed”.

Three credible options were identified for these sections of pipeline:

- Total removal
- Decommission in situ
- Decommission in situ with additional rock cover

The three credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.

In terms of safety impact, total removal of the ends would represent the highest risk during execution due to requiring the longest offshore campaign although this risk would not be considered prohibitive. Decommissioning in situ would present the lowest risk during execution as there would be no offshore campaign at all.

Total removal would result in the dispersal of the existing rock-berm by any activity undertaken to de-bury the pipeline ends. This dispersal would result in an increased snagging risk to the fishing industry and therefore represents a comparatively larger risk than either of the decommissioning in situ options.

Further, dispersal of the existing rock-berm would result in a larger level of seabed disturbance and therefore short-term environmental impact than the other options. Of the remaining two options, decommissioning in situ with additional rock cover would have a comparatively greater short-term impact than simply decommissioning in situ due to the seabed disturbance of installing new rock.

Conversely, total removal would have the lowest long-term impact of the three options due to removing all installed material from the seabed. However, the impact of either decommission in situ option was considered to be negligible given the short sections of pipe being considered.

In terms of technical capability and taking into account the short sections considered, there is no significant difference between the three options.

Similarly, none of the three credible options would have a significant societal impact. Resulting in a short offshore campaign or returning small volumes of waste to shore for recycling will have little or no effect on existing employment and supply chains.

In terms of cost, total removal will result in a higher execution cost than either decommissioning in situ or adding more rock. Further, as total removal would result in the dispersal of the existing rock-berm rather than retaining the existing stable rock berm, it would also result in an increased legacy monitoring cost to ensure the area remains safe for other users of the sea compared to the other two options.

Taking into account the above factors, total removal was considered to be the least favourable option. ‘Decommissioning in situ’ and ‘additional rock cover’ were considered to be two variations of the same option, with both resulting in the pipeline sections and existing rock berm remaining in place. The only comparative impacts would result from the volume of additional rock required, if any, with a proportionate rise in environmental impact (both ‘impact of operations’ and ‘legacy impact’) and cost.

Therefore, the recommended decommissioning solution to decommission in situ was presented at the CA workshop. The safety of the rock berm for future users of the sea is to be positively confirmed, where possible without the use of chain-mat over-trawling. This will include verifying the depth-of-cover and profile of the berm, likely to be performed by multi-beam sonar scanning. Any requirement to make this berm more suitable for future users of the sea will be completed using additional rock.

There were no objections to this proposal from the stakeholder consultees.
5.4. Scope 6 – Trenched and Buried Sections

Sections of both the 10” production pipelines (PL1488 and PL1489) and the manifold umbilical (PLU1490) which are trenched and buried for approximately 9km between the boundary of the Brae Bravo 500m safety zone and the Kingfisher Manifold. This area includes the Miller pipeline crossing (Kingfisher lines are crossed) and where all three Kingfisher lines exit their respective trenches to cross the East Brae PMS Cable and Heimdal pipeline approximately 4.5km from the SSIV manifold. The stabilisation features associated with this scope, including the buried mattresses at the crossings, were included within the CA.

Figure 5-3 – Heimdal Crossing

These sections are trenched and buried to a depth-of-cover greater than 0.6m for more than 90% of their length (pre-rock cover data). Where the depth-of-cover is lower than 0.6m, for example at the crossing of the Heimdal line and PMS Cable shown in Figure 5-3, the lines were subsequently covered with rock, see Figure 7-2. There are also small sections of rock cover, used to prevent upheaval buckling during operation. 70% of the section has depth-of-cover greater than 0.7m.

Section 10.12 of the OPRED Guidance Notes [2] states that “as a general guide… pipelines (inclusive of any “piggyback” lines and umbilicals that cannot be easily separated) may be candidates for in-situ decommissioning [if they] … are adequately buried and trenched and… are not subject to development of spans and expected to remain so.” Depth-of-cover charts are shown in Appendix A of this document.

Two credible options were identified for these sections of pipeline:

- Decommission in situ
- Total removal

The two credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.
Total removal would require the pipelines to be de-buried and removed from their existing trench. This would require a significant offshore campaign and result in a disproportionate safety risk to project personnel compared to decommissioning in situ, irrespective of whether total removal was executed by cut-and-lift, reverse s-lay or reverse reel-lay.

Further, the act of de-burying the pipelines and umbilical would create significant seabed spoil on either side of the existing trenches. These spoils would represent a snagging risk to the fishing industry and a higher risk than decommissioning in situ which, considering the stable depth-of-cover shown for these lines, would result in a clear seabed.

The de-burying activities and resulting seabed disturbance across 9km of each line would also cause much greater short-term environmental impact than decommissioning in situ. Conversely, total removal would have the lowest long-term impact of the two options due to removing all installed material from the seabed.

In terms of technical impact, total removal carries significantly more technical risk than decommissioning in situ. Decommissioning in situ requires minimal operational effort and all anticipated activities (over-trawl, survey and mitigating rock-cover) would utilise standard technologies that have an existing track record and high confidence in their success. In contrast, the technical success of removing the pipelines and umbilicals is not certain with little track-record on the UKCS and could result in the need to mobilise additional tooling or vessels.

Total removal would have a greater societal impact than decommissioning in situ, both positively and negatively. With each pipeline and umbilical being returned to shore for dismantling, there would be an increase in volume of work for the decommissioning supply chain. This would be offset by potential for increased odour pollution from returned material and increased use of landfill for non-recyclable items such as concrete mattresses or plastics. However, for both positive and negative effects, the impact was considered to be minimal – with the existing supply chain capable of meeting the demand adequately.

Finally, total removal would have a significantly higher operational cost than decommissioning in situ with significantly more offshore vessel days. Further, as the pipelines and umbilical are trenched and buried with stable depth-of-cover, there is no expectation that future monitoring costs for decommissioning in situ would be higher than total removal. Indeed, with the de-burying of the pipelines and umbilical likely to create extensive seabed disturbance, it is possible that total removal would require more future monitoring than decommissioning in situ.

Taking into account the above factors, total removal was considered to be the least favourable option.

Therefore, to the recommended decommissioning solution to decommission in situ was presented at the CA workshop. The pipelines and umbilicals in this area are either adequately trenched and buried or are adequately rock-covered. Decommissioning in situ achieves clear seabed with the exception of the rock-covered crossings, which due to the depth of rock cover will also be decommissioned in situ at this time. The decommissioning of the crossings will be revisited when the owners of the third party crossed lines submit their decommissioning proposals to OPRED. At that time, we will discuss and agree appropriate decommissioning with OPRED. There were no objections to this proposal from the stakeholder consultees.

5.5. Scope 7 – Umbilical End transition at Manifold

Section of the manifold umbilical (PLU1490) from the Kingfisher manifold to where the umbilical achieves depth-of-cover of 0.6m within its trench. This section is currently protected by concrete mattresses. The stabilisation features associated with this scope were included within the CA.
Three credible options were identified for this infrastructure:
- Total removal
- Decommission in situ
- Blanket rock cover and decommission in situ

The three credible options were reviewed against the five CA criteria of safety, environment, technical, societal and economic impacts.

In terms of safety impact, decommissioning this section of umbilical in situ was deemed to leave an unacceptable safety risk to future users of the sea as the infrastructure would present a snagging risk in open water. This option was therefore discounted.

Total removal is in line with both the regulatory expectation and stakeholder preference for clear seabed on conclusion of decommissioning activities. The umbilical and mattresses in this scope are broadly accessible and expected to be in good condition given the age of the field. Therefore, whilst representing a comparatively higher safety risk to project personnel offshore than blanket rock cover, total removal would not impose any unusual safety risks. Further, whilst blanket rock cover would reduce the legacy safety risk of snagging by other users of the sea compared with decommissioning in situ, the resulting rock-berm would also present a comparatively higher future risk than total removal, albeit a minor one.

For environmental impact, total removal would be less significant than blanket rock-cover. The latter would create seabed disturbance across a greater footprint in the short-term and have a comparatively higher long-term impact by introducing new and habitat-altering substrate.

With each option representing a relatively short execution scope and employing well-known, commonly used technology, there is no comparable difference between the two remaining options in terms of technical impact. Similarly, neither total removal or blanket rock cover would have a significant societal impact. Resulting in a short offshore campaign and returning small volumes of waste to shore for recycling will have little or no effect on existing employment and supply chains.
In terms of cost, total removal will result in a higher execution cost than blanket rock cover; however the legacy cost of total removal is expected to be lower as fewer post-decommissioning surveys and/or remedial work is required to prove the seabed remains safe for other users of the sea.

Taking into account the above factors, decommission in situ was excluded due to the unacceptable safety risk; whilst total removal is preferable to blanket rock cover for this scope.

Therefore, the recommended decommissioning solution is to recover the concrete mattresses, cut the umbilical and either lower the umbilical end by fluidising the soil or excavate the surrounding soil and making the cut at a point where the umbilical has reached 0.6m depth of lowering. Any section of umbilical not buried to a depth-of-cover of at least 0.6m would be recovered to shore for recycling and disposal. Some additional rock cover will likely be required to cover the cut end to mean seabed level as an additional mitigation against future snagging risk. Removed infrastructure will be returned to shore for recycling and disposal.

There were no objections to this proposal from the stakeholder consultees.

6. References

[2] BEIS OPRED Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines, November 2018
7. Appendix A: Pipeline Burial Depth Summary

7.1. General

The burial depth of the pipelines and umbilicals is important information when considering leaving pipelines or umbilicals in-situ or removal. The as-built data and alignment sheets for the Kingfisher pipelines have been assessed and the operational survey data has been assessed to determine the pipelines’ burial depth. The following sections present graphical summaries of the Kingfisher pipeline data.

7.2. Pipeline Burial Depth Definition

The definitions of burial depth that are being reported, generally there are two definitions for burial depth; depth of lowering and depth of cover, which are both illustrated in the figure below. The depth of cover is the conventional definition of burial depth, which is the depth of backfill or rock on top of the pipeline or umbilical. The depth of lowering is the depth of the top of the pipeline or umbilical below the natural mean seabed level. The natural mean seabed level is ignoring any berms to the sides of the trench.

Figure 7-1 – Burial depth definition
7.3. Pipelines

**N0510 As Rockdumped Survey (1997)**  
*Pipeline Crossing KP 4.5 to 5.0 Post Rockdumping Operations*

- Illustrates rock dump coverage of the Heimdal 8" condensate crossing
- N0510, N0509, and the N0889 are laid on top of the Heimdal line
- Heimdal 8" condensate line is operational
- See detailed drawings of depth of rock dump cover below

![Diagram of Heimdal Crossing Depth of Rock Cover](image)

*Figure 7-2 – Heimdal Crossing Depth of Rock Cover*
Figure 7.3 – Kingfisher Production Pipeline Survey Results Summary (N0509 / PL1488)
Figure 7-4 – Kingfisher Production Pipeline Survey Results Summary (N0510 / PLJ489)
7.4. Manifold Umbilical
Figure 7.5 – Kingfisher Manifold Umbilical Survey Results Summary (N0889 / PLU1490)
8. Appendix D: Comparative Assessment Groupings (Schematic)

Figure 8-1 – Comparative Assessment Groupings Schematic

Note that only the coloured elements of Groups 2, 5, 6 and 7 are included in this DP scope.

'Greyed out' infrastructure will be included in a separate Decommissioning Programme to be issued at a later date.