SNS Decommissioning Project: Comparative Assessment Report for the Viking VDP2 and VDP3 Pipelines and Associated Mattresses

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ABBREVIATIONS

Abbreviation	Meaning
Al	Aluminium
BEIS	Department for Business, Energy and Industrial Strategy
BMT	British Maritime Technology
BOD	Biological Oxygen Demand
CA	Comparative Assessment
CI	Corrosion Inhibitor
CMS	Caister Murdoch System
CO_2	Carbon Dioxide
CSV	Construction Support Vessel
DAWN	Decommissioning Assurance through Waste Management
DECC	Department of Energy and Climate Change
Defra	Department for Food and Rural Affairs
DP	Decommissioning Programme
DSV	Diving Support Vessel
EIA	Environmental Impact Assessment
ES	Environmental Statement
EUNIS	European Nature Information Service
FAR	Fatal Accident Rate
FLO	Fisheries Liaison Officer
GHG	Greenhouse Gas
GJ	Giga Joules
ICES	International Council for the Exploration of the Sea
IoP	Institute of Petroleum
JNCC	Joint Nature Conservation Committee
km	kilometres
LOGGS	Lincolnshire Offshore Gas Gathering System
Ltd	Limited
m	metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MeOH	Methanol
MMO	Marine Mammal Observer
MOD	Ministry of Defence
MSV	Multi Support Vessel
ND	No Data
NFFO	National Federation of Fishermen's Organisations
NORM	Naturally Occurring Radioactive Material
NTS	Non-Technical Summary
OGP	International Association of Oil and Gas Producers
PLL	Potential Loss of Life
POB	Personnel on Board
ppm	parts per million
ROV	Remotely Operated Vehicle

Abbreviation	Meaning
ROVSV	Remotely Operated Vehicle Support Vessel
SAC	Special Area of Conservation
SNS	Southern North Sea
SPA	Special Protection Area
Te	Tonnes
TGT	Theddlethorpe Gas Terminal
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
WOW	Wait on Weather
Zn	Zinc

NON-TECHNICAL SUMMARY

In line with Department for Business, Energy and Industrial Strategy (BEIS) (formerly Department of Energy and Climate Change (DECC)) 'Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998', ConocoPhillips (U.K.) Limited (ConocoPhillips) undertook a Comparative Assessment of the feasible decommissioning options for the subsea structures, pipelines and associated mattresses included in the VDP2 and VDP3 Decommissioning Programmes (DPs). The infrastructure covered by VDP2, VDP3 and this Comparative Assessment comprises:

- Eleven pipelines and one umbilical (methanol and control fluids) included under VDP2;
- Four pipelines and one umbilical (control fluids) included under VDP3.

The pipelines and umbilicals being decommissioned are located within the North Norfolk Sandbanks and Saturn Reef and cross through the Inner Dowsing Race Bank and North Ridge Special Area of Conservation. Both of these areas have been designated for the protection of two European Annex I habitats. These habitats are 'Sandbanks which are slightly covered by sea water all the time' and 'Reefs', the biogenic reef *Sabellaria spinulosa*. The Joint Nature Conservation Committee has classified the North Norfolk Sandbanks and North Ridge as representing good 'conservation' examples of these habitats.

The Comparative Assessment provided a framework for assessing proposed decommissioning options and assigning scores to five main criteria, further divided into eight sub-criteria (Table 1).

Table 1: Comparative Assessment criteria

Criteria	Sub Criteria
Technical Feasibility	Technical feasibility
	Risk of project failure
Safety	Risk to workforce
	Risk to 3rd parties
Environmental	Environmental risk
	Energy use and CO_2 emissions
Societal	Socioeconomic risk/impact
Cost	Project cost

The scores were then ranked and weighted to allow direct comparisons between the criteria for each option. This enabled a balanced and transparent comparison in order to identify a preferred option for decommissioning of the VDP2 and VDP3 pipelines and associated mattresses.

As part of the comparative assessment process, ConocoPhillips also undertook a workshop to assess the technical feasibility of potential decommissioning options and evaluate the environmental and societal impacts from the activities/ operations of the options taken forward.

During subsea survey, a pressure pulse test detected leak sites on both PL161 and PL134 and an adjacent blockage site on PL161. Subsequent inspection in 2016 confirmed pipeline damage on PL134 but did not confirm the location of the blockage or leak on PL161. A risk assessment was undertaken at the time of inspection, concluding that the damaged area of the pipeline did not pose a significant risk to the environment or other users of the sea. A subsequent survey concluded further damage to PL134 and identification of the requirement to undertake remediation work of PL134. ConocoPhillips is in consultation with BEIS on the cleaning and decommissioning approach for these pipelines. Further discussions with BEIS will be conducted to assure compliance throughout operations.

From an initial list of options for decommissioning of the pipelines, the technical feasibility assessment identified five options which were taken forward through the comparative assessment process, these were:

- Option 1: Full Removal – Reverse S-lay/ Reel;
- Option 2: Full Removal – Cut and Lift;
- Option 3: Partial Removal – Cut and Lift;
- Option 4: Decommission in situ – Minor Intervention; and
- Option 5: Decommission in situ – Minimum Intervention.

Minor intervention relates to the removal of all mattresses, where safe to do so, and the placement of rock on exposed/ spanned sections of the pipeline.

Minimum intervention relates to mattresses being decommissioned in situ, with additional rock-placement (maximum 25 tonnes) on each end only. The results of the Comparative Assessment revealed the main differentiators between criteria to be Environmental Aspects, Safety and Cost.

The Comparative Assessment concluded that Option 5: Decommission in situ – Minimum Intervention is the preferred option for decommissioning the VDP2 and VDP3 pipelines. This option would result in minimal disturbance to the marine protected areas within which the VDP2 and VDP3 infrastructure is situated and scored highly in the environmental aspects (Environmental Risk, Energy Usage and Emissions). Other aspects that differentiated Option 5 from the others included Safety and Cost, due in part to the minimum number of vessel activities required for decommissioning of the pipelines. However, there is the potential for a slightly greater risk to other sea users (e.g. snagging risk to trawlers) due to the pipelines and associated protective materials being decommissioned in situ in the current burial state. This increase is far less than the increased risk to personnel involved in decommissioning the infrastructure under full or partial removal. Decommissioning the mattresses in situ would minimise additional disturbance to the seabed and would potentially remove the need to deploy additional rock-placement over the pipelines to ensure future stability. It also reduces the safety implications for divers due to the likelihood that manual intervention would be required to pick up the mattresses. Decommissioning the mattresses in situ would be considered a re-use of the mattresses as a stabilising medium for maintaining burial of the pipelines, whilst not introducing additional material, such as quarried rock, into the marine environment including the two Special Areas of Conservation.

ConocoPhillips will endeavour to manage this risk by ensuring that an accurate record of the location of the pipelines and mattress protection is documented and that this is passed to the relevant bodies for them to incorporate in navigational charts and aids. Full overtrawlability surveys will be undertaken in the 500 m zone where stabilisation features predominantly exist. In addition, there will be a suitable and appropriate monitoring programme agreed with BEIS.

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1.0 INTRODUCTION

This report describes the Comparative Assessment (CA) of technically feasible decommissioning options for Viking VDP2 and VDP3 pipelines and associated mattresses, which ConocoPhillips (U.K.) Limited (ConocoPhillips) intend to decommission as part of the southern North Sea (SNS) Decommissioning Project.

The CA has been undertaken in line with Department for Business, Energy and Industrial Strategy (BEIS) (formerly the department of Energy and Climate Change (DECC)) 'Guidance Notes: Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998' (DECC, 2011).

1.1 Background

Within the SNS, ConocoPhillips operate three main gas areas: the Caister Murdoch System (CMS), and the Viking and Lincolnshire Offshore Gas Gathering System (LOGGS) comprising 42 platforms, 157 wells and associated pipelines.

The Viking Area comprises eight gas fields (Viking A, Viking B, Viking C, Viking D, Viking E, Victor, Vixen and Victoria). The Viking gas fields are located in the SNS, approximately 130 km east of the Lincolnshire coast, in UKCS Blocks 49/11d, 49/12a, 49/16c and 49/17a. Gas from the Viking fields is tied back to the Viking "B complex" and exported to LOGGS, commingled with the gas from LOGGS and transported to the Theddlethorpe Gas Terminal (TGT) via a 120 km 36" diameter LOGGS gas trunkline.

ConocoPhillips propose to decommission the fields and facilities in a phased approach. This has so far included the submission of the VDP1 CA, Decommissioning Programmes (DPs) and accompanying Environmental Statement (ES). The next DPs continue with pre-planning stages to investigate feasibility for the potential decommissioning and disposal options of the SNS subsea structures, pipelines and associated mattresses due to be decommissioned within VDP2 and VDP3. The infrastructure included in these DPs is detailed in Section 1.2.

The infrastructure to be decommissioned and included as part of VDP2 (Figure 1.1) and VDP3 (Figure 1.2) is located in UKCS Blocks 47/17, 47/18, 47/19, 47/20, 48/16, 48/17, 48/18, 48/19, 48/20, 49/11, 49/12, 49/16, 49/17 & 49/22 and comprises 15 pipelines, 8 surface installations, 2 subsea installations, 2 pipeline structures, 2 umbilicals and a pigging skid.

1.2 Infrastructure Within The Scope Of This CA

The pipelines within the VDP2 and VDP3 areas are shown in Figures 1.1 and 1.2, respectively, and are itemised in Table 1.1. These comprise:

- Eleven pipelines and one umbilical (methanol and control fluids) included under VDP2;
- Four pipelines and one umbilical (control fluids) included under VDP3.

ConocoPhillips commissioned a pipeline burial and mattress inventory report which reviewed all available ROV video footage and depth of burial data for the pipelines included in VDP2 and VDP3 (BMT Cordah, 2015). The report indicated that many of the pipelines have some degree of exposure along the length of the pipeline. However from the information available, this exposure was predominantly below 10% with the exception of two sets of pipelines (gas and methanol piggyback), PL88 and PL1572, which showed 22.5% and 33.3% respectively. Details of any exposed sections and associated spans are presented in Table 1.2.

The work scope for decommissioning the 17 pipelines (including two umbilicals) will be discrete and in isolation of the decommissioning of other SNS infrastructure. This simplification enables a clear boundary to be placed around the assessments to be made under the scope of this CA.

The status of pre-existing exposed/ spanning lengths of pipeline could affect the method of decommissioning (Table 1.2). These sections have been identified through various surveys undertaken for ConocoPhillips (Table 1.3). The lengths of exposed pipelines provided in Table 1.2 have been used to calculate the section lengths that may need to be removed or reburied during decommissioning.

1.3 Infrastructure and Materials Not Within This CA

In accordance with Section 7 of the BEIS Guidance (DECC, 2011), a CA is not necessary for elements of DP involving full removal of associated structures for re-use, recycling or final disposal on land. All of the structural components to be decommissioned in this manner can therefore be excluded from the CA scope. For the VDP2 and VDP3 pipeline infrastructure these are:

- Subsea tee between Viking LD and the Viking KD to Viking BD pipeline;
- Viking BD subsea valve skid between Vixen VM and Victoria SM (in close proximity to Viking BD); and
- Victor JM subsea pigging skid.

These items, including pipeline cleaning to an acceptable standard, are potentially the same across all options and any work associated with them has not been accounted for in this CA. The ES for the VDP2 and VDP3 programmes will address all of the infrastructure to be decommissioned.

Pipeline damage was identified on PL134 between KP 3.667 and KP 4.758 where the pipeline section was found to have been displaced from its original position (Gardline, 2015). A further survey (Fugro, 2016) identified additional damage to the exposed pipeline resulting in 90 m of pipeline being exposed and 230 m of pipeline detached. As a result a dive campaign has been scheduled for June 2018 to remove the 230 m detached pipeline, remove the 90 m exposed pipeline on the remaining Viking BP end and the placement of 12-16 tonnes of rock on the exposed BP end, to make safe for other users of the sea. The remediation results in a partial removal of the single Methanol pipeline PL134. ConocoPhillips has agreed a proposal with BEIS on the basis of permitting the discharge of pipeline contents between Viking AR and the anomaly locations in PL134 and PL161. Operations have been completed under appropriate pipeline chemical permits. The remaining inventory in PL161 between the anomaly and TGT is to be managed under the decommissioning programme.

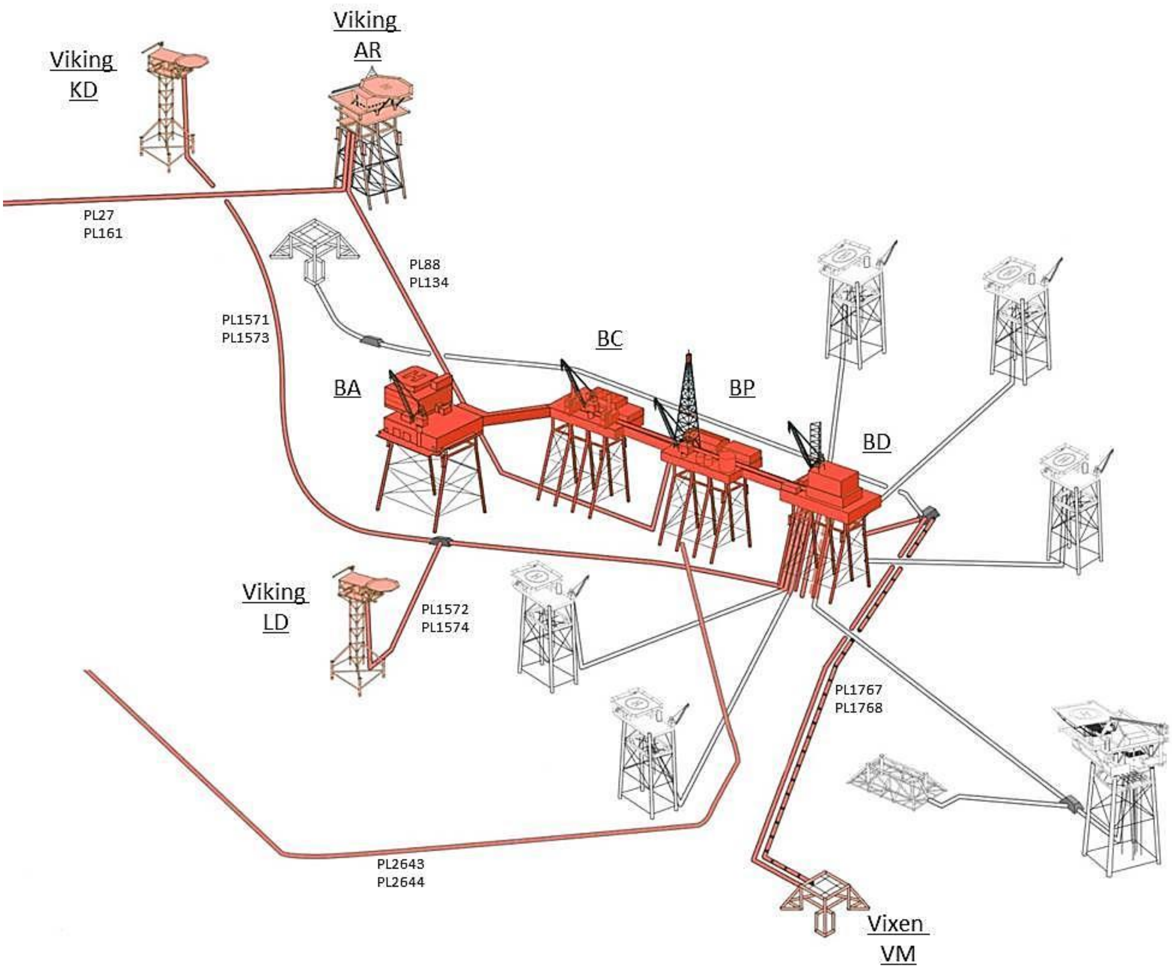

Figure 1.1: The Viking infrastructure to be decommissioned (VDP2)

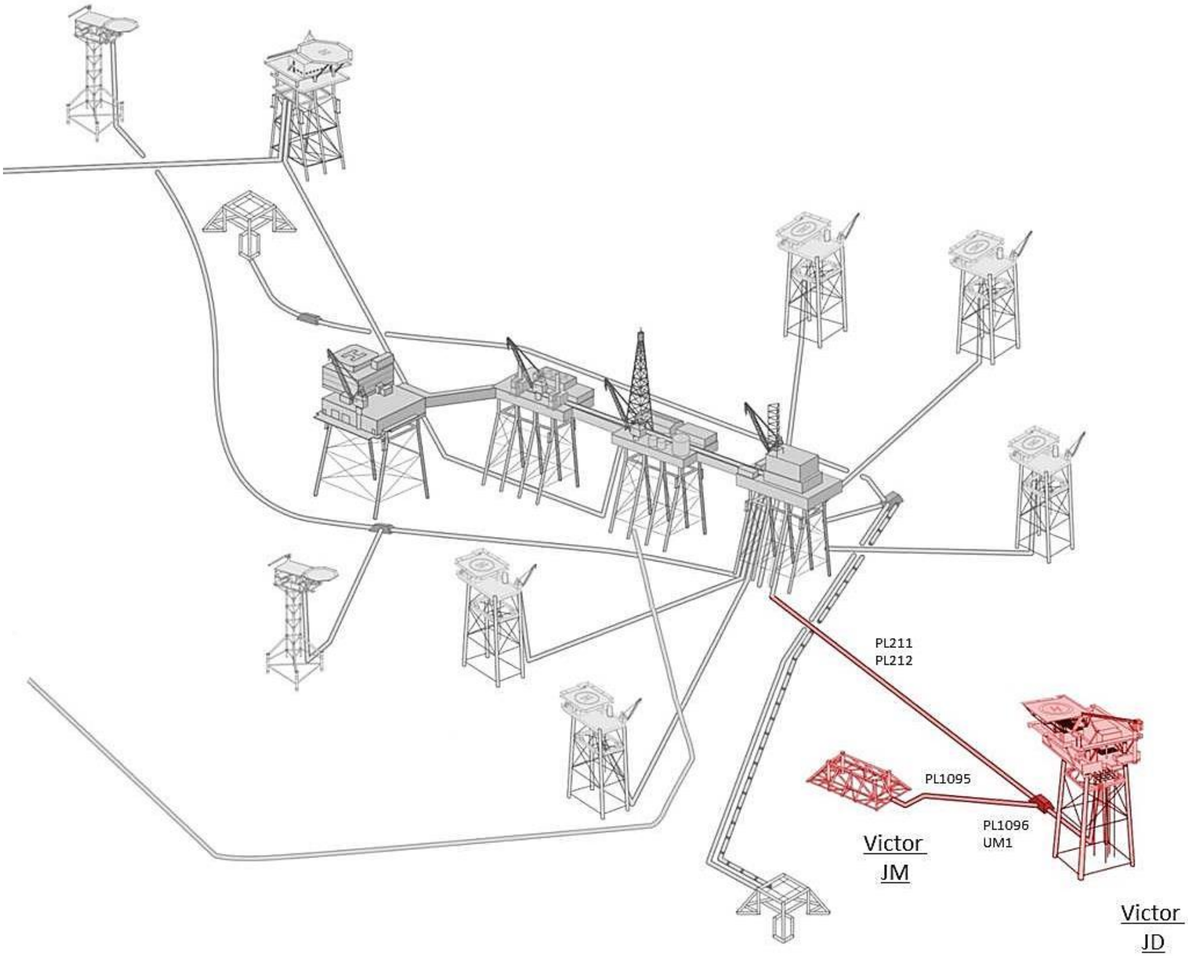

Figure 1.2: The Viking infrastructure to be decommissioned (VDP3)

Table 1.1: VDP2 and VDP3 pipelines within the scope of the SNS Decommissioning Project

Area	Pipeline	Pipeline Description	Installed	Installation Method	Length (km)	Survey Year
VDP2	Viking AR to TGT	28” gas pipeline (PL27)	1971	Buried	139.2	2008
	TGT to Viking AR	3” methanol (MeOH) pipeline (PL161)	1971	Buried	139.2	2008
	Viking BP to Viking AR	24” gas pipeline (PL88)	1971	Buried	10.9	2008
	Viking AR to Viking BP	3” MeOH pipeline (PL134)	1971	Buried	10.9	2008
	Viking KD to Viking BD	16” gas pipeline (PL1571)	1998	Buried	13.6	2011
	Viking BD to Viking KD	3” MeOH pipeline (PL1573)	1998	Buried	13.6	2011
	Viking LD to KD/LD pipeline tie-in tee	16” gas pipeline (PL1572)	1998	Laid on seabed with mattress protection both under and over pipeline spool pieces	0.1	2014
	KD/LD pipeline tie-in tee to Viking LD	3” MeOH pipeline (PL1574)	1998		0.1	2014
	Viking BP to LOGGS PR	16” gas pipeline (PL2643)	2010	Buried	27.5	2012
	LOGGS PR to Viking BP	3” MeOH pipeline (PL2644)	2010	Buried	27.5	2012
	Vixen VM to Viking BD	10” gas pipeline (PL1767)	2000	Buried	8.7	2007
	Viking BD to Vixen VM	Umbilical (PL1768)	–	Buried	8.7	2007
VDP3	Victor JD to Viking BD	16” gas pipeline (PL211)	1984	Buried	13.5	2013/ 2014
	Viking BD to Victor JD	3” MeOH pipeline (PL212)	1984	Buried	13.5	2013/ 2014
	Victor JM to JD pigging skid	12” gas pipeline (PL1095)	1995	Buried	5.1	2013/ 2014
	Victor JD to Victor JM	3” MeOH pipeline (PL1096)	1995	Buried	5.1	2013/ 2014
	Victor JD to Victor JM	4” umbilical (UM1)	–	Buried	5.4	2013/ 2014

[Source: BMT Cordah, 2015]

Table 1.2: VDP2 and VDP3 pipeline exposure status

Pipeline	Description	Pipeline status from most recent full survey							
		Length of pipeline (m)	Length surveyed (m)	Exposed length of surveyed pipeline* (m)	Span length on surveyed pipeline** (m)	% of surveyed pipeline exposed	% of surveyed pipeline spanning	Number of reportable spans***	Survey year (most recent complete survey)
PL27	Viking AR to TGT	139,200	117,590	12,448	151	10.6	0.1	None	2008
PL161	TGT to Viking AR								
PL88	Viking BP to Viking AR	10,300	10,960	2452	75	22.4	0.07	None	2008
PL134[2]	Viking AR to Viking BP								
PL1571	Viking KD to Viking BD	13,600	13,570	175	50	1.3	0.04	None	2011
PL1573	Viking BD to Viking KD								
PL1572	Viking LD to KD/ LD Tie-in Tee	100	81	27	16	33.3	19.8	None	2014
PL1574	KD/ LD Tee-in Tee to Viking LD								
PL2643	Viking BP to LOGGS Platform (PR)	27,500	25,333	50	44.3	0.2	0.2	1	2015
PL2644	LOGGS PR to Viking BP								
PL1767	Vixen VM to Viking BD	8,7000	8,632	7	5.8	0.1	0.1	None	2007
PL1768	Viking BD to Vixen VM								
PL211	Victor JD to Viking BD	13,500	12,740/ 1,145	15/ 126	0/ 22	0.1/ 11.0	0.0/ 1.9	0/ 1[3]	2013/ 2014[1]
PL212	Viking BD to Victor JD	13,500							
PL1095	Victor JM to JD Pigging Skid	5,100	4,197/ 1,091	0/ 63	0/ 44	0.0/ 5.7	0.0/ 4.0	0/ 0	2009/ 2014[1]
PL1096	Victor JD to Victor JM	5,100							
UM1	Victor JD to Victor JM	5,400							

* Exposed length refers to any length of the surveyed pipeline where depth of cover is less than 0 cm.
** Pipeline spans are unsupported pipe sections above the seabed. Pipeline spans may be created due to seabed irregularities during installation or subsequent scouring or pipeline horizontal movements during operations etc
*** Reportable span refers to a span >0.8 m in height and >10 m in length (Fish Safe, 2015; personal communication).
[1] No complete survey data available in any year so information has been presented from two surveys to provide relevant coverage.
[2] 230 m of the pipeline is reported to be have become detached and 90 m is exposed. Sections are planned for removal in June 2018.
[3] Reportable span at pipelines PL211&PL212 is a closing span at the bottom of the Viking BD platform and will be removed as part of the platform removal preparations.

Table 1.3: Studies commissioned by ConocoPhillips to support the VDP2 and VDP3 SNS Decommissioning Project.

Survey Reference	Survey Title
BMT Cordah, 2014a	Noise Assessment Report for the SNS Phase 1 Decommissioning Project: Aspects Associated with the Viking and LOGGS satellite platforms and infield pipelines
BMT Cordah, 2015	SNS Decommissioning Programme VDP2 and VDP3 Pipeline Burial and Mattress Inventory Report
Brown and May, 2014	Commercial Fisheries Socioeconomic Impact Study Viking and LOGGS Fields Decommissioning for ConocoPhillips
ConocoPhillips, 2015	SNS Decommissioning Project: Project Scoping Brief for the SNS Decommissioning Programmes – VDP2 and VDP3
Costain, 2014a	Pipeline Materials Inventory and Degradation Technical Note
Costain, 2014b	Pipeline Cleaning Technical Note – Infield Pipelines
Costain, 2014c	Pipeline Cleaning Technical Note – Export Pipelines
Fugro, 2014a	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viking AR, CD, DD, ED, GD, and HD. Habitat Assessment Report J/1/20/2342-3
Fugro, 2014b	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viscount VO, Vulcan UR and Vampire/Valkyrie OD (LOGGS). Habitat Assessment Report J/1/20/2342-2
Fugro, 2014c	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viking AR, Viking CD and Viking GD. Decommissioning Environmental Report J/1/20/2342
Fugro, 2014d	ConocoPhillips (U.K.) Limited SNS decommissioning survey. UKCS 48 and 49. Viscount VO, Vulcan UR and Vampire/Valkyrie OD (LOGGS). Decommissioning Environmental Report J/1/20/2342
Gardline, 2015	ConocoPhillips (U.K) Limited, SNS pipeline Inspection 2015.Project No. 10489.

1.4 Environmental and Societal Setting

A key concern regarding the decommissioning of the VDP2 and VDP3 infrastructure is that all of the pipelines are sited within or cross through the North Norfolk Sandbanks and Saturn Reef and/ or the Inner Dowsing Race Bank and North Ridge Sites Special Areas of Conservation (SAC). The SACs have been designated for the protection of two Annex I habitats that have been identified within the areas. These habitats are ‘Sandbanks which are slightly covered by sea water all the time’, the biogenic reefs of *Sabellaria spinulosa*, which are encompassed by ‘reefs’. The Joint Nature Conservation Committee (JNCC) has classified the North Norfolk Sandbanks and Saturn Reef SAC as representing good ‘conservation’ examples of these habitats (JNCC, 2017). The entire VDP2 and VDP3 infield infrastructure is within the Southern North Sea candidate SAC (cSAC), designated for the conservation of harbour porpoise (*Phocoena phocoena*) populations of the area. Special consideration should be given when operating in this area to reduce or mitigate adverse impacts.

S. spinulosa were identified in several historic survey reports within and adjacent to the VDP2 and VDP3 areas. Recent surveys (Fugro, 2014a-d) carried out within the Viking field and at the Viking AR platform location observed only occasional, patchy, fragmented areas of *S. spinulosa*; these patches would not be classified as 'reef' under the JNCC *S. spinulosa* reef definition guidance (JNCC, 2007).

Sediments in the decommissioning areas comprise fine to coarse sands, often silty and with variable amounts of shell fragments and occasional pebbles and cobbles. The highly dynamic marine environment restricts the silt and clay content to less than 15%.

Presence of predominantly sandy sediments is confirmed by the presence of sand waves, mega ripples, sand ripples, scour pits and shoal areas at locations within VDP2 and VDP3, including along PL27 and at landfall (ConocoPhillips pipeline surveys). In the nearshore, the dominant wave action from the northeast to east results in net southerly sediment transport.

Appendix A summarises the environmental and socioeconomic characteristics and sensitivities of the sea area surrounding the VDP2 and VDP3 infrastructure.

2.0 DECOMMISSIONING OPTIONS ASSESSED IN THE CA

Table 2.1 introduces the pipeline decommissioning options that ConocoPhillips have taken forward for assessment. The technical feasibility of these options was assessed along with a review of discussions from the previous VDP1/ LDP1 CA. Section 4.1 and Appendix C provide an outline of why these five options (Table 2.1) are considered technically feasible.

Table 2.1: Decommissioning options considered in CA

Decommissioning options	Method	Pipelines Considered	Description
Option 1 – Full removal	Reverse S-lay/ Reverse Reel	Reverse S-lay suitable for all pipelines including large diameter and concrete coated lines. Reverse Reel method only suitable for non-concrete coated lines and diameters less than 15".	Pipelines would be exposed (if required) using jetting methods and would be removed by reverse S-lay (pipelines with concrete coating) or reverse reel (pipelines composed of flexible plastic coating) prior to transport to shore. Reasonable attempts to remove all mattresses would be undertaken where safe to do so.
Option 2 – Full removal	Cut and Lift	All pipelines	Pipelines would be exposed using jetting methods (as required) and would be removed by cutting with an underwater pipe cutter. Cut pipeline sections would then be lifted onto a vessel for transportation to shore. Reasonable attempts to remove all mattresses would be undertaken where safe to do so.
Option 3 – Partial Removal	Cut and Lift	All pipelines	Only exposed/ spanned sections of pipeline would be removed. Cut ends of pipelines would be covered by rock-placement. Reasonable attempts to remove all mattresses would be undertaken where safe to do so. Any remaining pipeline would be left open, ends covered with rock and flooded with seawater.
Option 4 – Decommission in situ	Minor Intervention	All pipelines	Pipelines decommissioned in situ would be left in such a manner that they do not pose a risk to other users of the sea, e.g. fishermen. This would involve rock-placement or trenching of the exposed/ spanned sections. Cut pipeline ends would be covered with rock-placement where required. Reasonable attempts to remove all mattresses would be undertaken where safe to do so. Pipelines would be left open and flooded with seawater.
Option 5 – Decommission in situ	Minimum Intervention	All pipelines	Rock-placement on the cut pipeline ends only, to make them safe to fishermen. The remaining pipeline would be left in its current state, marked on sea charts and notifications issued to fishermen/ other users of the sea.

			All mattresses would be left in situ in their current state* to maintain pipeline stabilisation, minimise disturbance of the established environment and reduce the requirements for the introduction of new material to the SAC. Pipelines would be left open and flooded with seawater.

* In order to gain access to cut the pipeline there may be a need to remove a small number of mattresses. These mattresses would be returned to shore for disposal.

2.1 General Assumptions

For comparative purposes, assumptions and limitations have been made in regard to scope, materials, transportation, vessel usage, etc. These general assumptions and considerations are listed below. Additional assumptions for each of the criteria evaluated in this CA are included in the description of the methodologies in the relevant Appendices.

- All subsea structures have been removed.
- Pipelines have been flushed and cleaned prior to any removal works.
- All options have post-decommissioning surveys associated with them and draw on pre-decommissioning data acquired during the operating phase. In addition, the partial removal and decommission in situ options, which have ongoing liability, have, for comparative assessment purposes, been assumed to require two further monitoring surveys years post-decommissioning.
- All pipelines decommissioned in situ will be flooded with seawater. This will increase the stability of the pipeline and increase the tendency for burial (Costain, 2014c).
- ConocoPhillips provided the breakdown of vessel types, tasks/ activities, durations, crewing (personnel on board), diver numbers, dive durations, and contingency time for wait on weather (WOW). Contingency vessel days due to changes in tidal conditions and WOW are variable depending on the decommissioning option:
    - All subsea operations: 70% WOW (also to account for tidal conditions)
    - CSV and rock-placement activities: 50% WOW (also to account for tidal conditions)
    - Operations at the sea surface: 20% WOW.
- All of the above are percentages of the working vessel days only.
- For all options requiring retrenching or rock-placement, rock-placement has been taken as the worst case environmental impact.
- Where parts of a pipeline are to be removed or covered by rock-placement (where the pipeline is to be decommissioned in situ), values have been calculated using BMT Cordah (2015) estimations of all exposed and free-spanning section lengths and an overtrawlable (3:1 gradient) rock berm profile with a height cover over the pipe of 0.3 m.
- Pipeline component weights are taken from the materials inventory commissioned by ConocoPhillips.
- The materials would be landed onshore at Hartlepool in Teesside (nearest port to existing decommissioning facilities).

- The inventories of pipeline materials landed onshore would be transported by lorry, rather than by rail or subsequently by vessels.
- Inventory weights for pipeline materials landed onshore (BMT Cordah, 2015) have been used to estimate the number of lorry loads required (and hence the number of journeys).
- A worst case transportation scenario has therefore been assumed where all of the gas pipelines would have NORM (Naturally Occurring Radioactive Material) contamination, this NORM contaminated material would be removed and transported for disposal via landfill at Kings Cliffe (266 km from Hartlepool dock).
- A round trip involving a helicopter flight to the centre of the combined VDP2 and VDP3 area is estimated to take 1 hour. Take-offs and landings are each estimated to take 10 minutes (0.17 hour).
- Recovered steel and anode materials are all going to be recycled; recovered concrete, plastic and coal-tar coverings are all going to be taken to landfill.
- Lost items or materials, such as accidentally dropped items, will be reported to the MMO as soon as feasible to avoid damage to surroundings and potential risk to other users of the sea.

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3.0 COMPARATIVE ASSESSMENT METHODOLOGY

The following section details the CA process by which the most appropriate options for decommissioning of the pipelines (including the associated mattresses) were assessed.

Separate assessments and scoring have been applied to the VDP2 and VDP3 pipeline infrastructure. However where pipelines have similar impacts, activities and/or receptors these have been grouped together to reduce the level of duplication and improve efficiency in the CA process.

In preparation for the CA assessments, ConocoPhillips identified and described the decommissioning options, decided upon the assessment criteria (and sub-criteria) to be used in the CA (Section 3.2) and established the weighting to be applied to scores for the individual assessment criteria which reflects the balance of ConocoPhillips' decision-making priorities, corporate values and stakeholder views (Section 3.3).

3.1 Comparative Assessment Workshops

As part of the CA, a workshop was undertaken to assess technical feasibility and the environmental and societal risks. These were independently facilitated and chaired by BMT Cordah on 08 September 2015. Participants at the workshop included a mix of disciplines and specialists from ConocoPhillips and BMT Cordah, including:

- ConocoPhillips (U.K.) Ltd
  - David Reaich – Decommissioning HSE Manager
  - Robert Stevenson – UK Removal and Disposal Manager
  - Ashley Hawkins – Decommissioning Project Engineer
  - Paul Howitt – Subsea Inspection Engineer
  - Paul Hatton – Decommissioning Environmental Scientist
  - Liam Williams – Lead Pipeline Engineer
- BMT Cordah Limited
  - Gareth Jones – Principal Consultant & Chairperson
  - Joseph Ferris – Associate Director & Workshop Facilitator

Due to the level of detail and amount of information already covered within the workshops held for VDP1 and LDP1 (9^{th} & 10^{th} June and 30^{th} July 2015) for each of the decommissioning methods, only one workshop was required to assess that the options and their potential impacts remain appropriate for VDP2 and VDP3 by means of a 'by difference comparison' to the findings from the VDP1 and LDP1 CA. In addition, any project specific impacts were identified during the workshop and these were scored accordingly using the agreed risk assessment matrix and open discussion within the group.

Additional information that was pertinent to safety and cost were noted and taken forward into a workshop session on Safety and a desk-based assessment for Cost.

3.2 Assessment Criteria

The individual decommissioning options were assessed against the five main assessment criteria and associated sub-criteria, details of which are provided in Table 3.1. These were based on the BEIS Guidance Notes (DECC, 2011).

Table 3.1: Assessment criteria/ sub-criteria and a brief description of method used to assess each option.

Main Criteria	Sub-criteria	Description of Assessment Methodology
Technical Feasibility	• Technical Feasibility • Recoverability from Major Project Failure	Qualitative assessment of Technical Feasibility and Recoverability from Major Project Failure. – The assessment was carried out as part of a workshop session involving participants with expert knowledge of the project and a range of relevant specialist disciplines. – Following a discussion on the decommissioning methods available and the issues associated with each option, separate scores for each option were assigned for technical feasibility and recoverability, within five feasibility/ recoverability levels defined within a scoring matrix. Scoring was based on a majority decision from the participants. – Any option that scored as a major or severe risk or being unfeasible or irrecoverable was discontinued from the process and not assessed further. Section 4.1 provides the result of the assessment and Appendix B provides further detail on the methodology and results.
Safety	• Risk to Workforce (onshore/ offshore) • Risk to 3rd Parties (onshore/ offshore)	Qualitative assessment of Safety, both onshore and offshore, based on risk of injury to either the Decommissioning Workforce or the 3rd Parties, such as the general public and commercial fishermen. – The assessment was carried out as part of a workshop session between BMT Cordah and ConocoPhillips Decommissioning Team. – Following a discussion on the decommissioning methods and the issues associated with the individual decommissioning activities, separate scores for each option were assigned based on a risk matrix provided by ConocoPhillips (Section 4.2). This matrix defined the likelihood of risk and the consequence of an accident on the receiving individual, each of these descriptors had five levels of likelihood/ severity. Section 4.2 provides the results of the assessment and Appendix C provides further detail on the methodology and results.

Table 3.1 (Continued): Assessment criteria/ sub-criteria and a brief description of method used to assess each option.

Main Criteria	Sub-criteria	Description of Assessment Methodology
Environmental	• Environmental Risk: ○ Onshore ○ Marine	Qualitative assessment of Environmental Risks onshore and offshore for each of the options using ConocoPhillips' risk assessment methodology and matrix (Section 4.3). – The assessment was carried out in a workshop involving participants with expert knowledge of the project and a range of relevant specialist disciplines. Environmental risks and societal risks (see below) were both assessed within these two workshops. – Each option was broken down into its component activities/ operations and end-points. For each of these components, the CA workshop participants conducted an environmental risk assessment, which identified potential causes of impact to receptors, and assessed the likelihoods of occurrence, consequences and levels of risk using the risk assessment matrix. Causes, consequences, mitigation, implications for the option and any follow-up actions relating to risks within the High and Significant categories were recorded. – For each option, the values of the scores for the different categories of risk were totalled, and the options were then ranked on the basis of these totals (lowest number = 'best' option). Appendix D provides more detail on the methodology and results for the environmental risk assessment.
	• Energy Usage and CO_2 Emissions	Quantitative estimation of Energy Usage and CO_2 Emissions for each of the options (Section 4.5) using the method given in IoP (2000). – Total quantities of energy usage and CO_2 emissions for each option were calculated by estimating parameters such as fuel usage for vessels, helicopters and vehicles used in road haulage, re-manufacture of recyclable material to compensate for that decommissioned in situ, and recycling and disposal of materials returned to shore. – These quantities, fuel and materials were then multiplied by energy and emissions conversion factors detailed in Appendix E. The estimated energy and emissions were then summed to provide a total figure for each decommissioning option, and the options were then ranked on the basis of these totals (lowest number = 'best' option). Appendix E provides more detail on the methodology and results for the energy usage and emissions estimates.
Societal	• Socioeconomic Risk: ○ To other users of the sea ○ To those on land	Qualitative assessment of Societal Risks onshore and offshore using ConocoPhillips' risk assessment methodology and matrix (Section 4.4). – These assessments were made within the same workshop, using the same method, operations/ activities and end-points, as for the environmental risk assessment (except that societal criteria were used for scoring). The scores for each option were summed and the options were ranked on the basis of the total scores (lowest number = best option). Appendix D provides more detail on the methodology and results.
Cost	• Comparative Cost	A quantitative estimation of Cost for each option (Section 4.6) was calculated, this included estimates for vessel usage, recycling and disposal of material, licencing fees, future monitoring, liability and seabed remediation. Appendix F provides the cost breakdown and the associated assumptions used in the assessment.

3.3 Assessment Scoring

Initially, the scores from each of the assessments were expressed in their respective quantitative and qualitative units. Justification for the scores assigned during the assessments, as well as assumptions and limitations were noted and a detailed breakdown of this is provided in Sections 4.1 to 4.6, as well as in the relevant appendices. To enable a comparison to be made of the options, the results were then collated and compared using a normalised/ weighted scoring system. The results of each of the five assessments were expressed in common units and ranked in order of performance from best to worst, based on the weightings assigned by ConocoPhillips (Table 3.2).

The maximum weighting was assigned to the best scoring option for each individual criterion. For example, a maximum weighted score of 30 for Safety was assigned to the best performing option. All subsequent options were assigned a normalised weighted value in proportion to the best performing option. The output was a matrix presenting normalised/ weighted values for the criteria/ sub-criteria for every option.

An overall value was established by totalling the normalised/ weighted values for the assessments and comparing the totals. ConocoPhillips used the output from the CA to select its preferred decommissioning option, with the CA report documenting the justification for their choice.

Table 3.2: Weightings of options

Criteria/ sub-criteria		Weighting (percentage)
Feasibility	Technical Feasibility	5
	Risk of Major Project Failure	5
Safety	Safety Risk (workforce and 3rd parties)	30
Environmental	Environmental Risk	15
	Energy Usage	5
	Emissions	5
Societal	Socioeconomic Risk	10
Cost	Cost	25
Total		**100**

4.0 COMPARATIVE ASSESSMENT RESULTS

The following section presents the results of the CA of the five decommissioning options. Table 4.1 and 4.2 provides the scored results for the options (out of a maximum of 100 points). The overall scores for VDP2 and VDP3 are presented below:

VDP2

- Option 1 (Full Removal – Reverse S-lay/ Reel): 63.0/ 100
- Option 2 (Full Removal – Cut and Lift): 62.1/ 100
- Option 3 (Partial Removal – Cut and Lift): 74.3/ 100
- Option 4 (Decommission in situ – Minor Intervention): 85.4/ 100
- Option 5 (Decommission in situ – Minimum Intervention): 97.3/ 100

VDP3

- Option 1 (Full Removal – Reverse S-lay/ Reel): 70.9/ 100
- Option 2 (Full Removal – Cut and Lift): 61.8/ 100
- Option 3 (Partial Removal – Cut and Lift): 77.1/ 100
- Option 4 (Decommission in situ – Minor Intervention): 86.6/ 100
- Option 5 (Decommission in situ – Minimum Intervention): 97.2/ 100

The option with the highest normalised/ weighted score represents the best option.

Sections 4.1 to 4.6 highlight why the options were considered to be strongly or weakly differentiated from each other and provides a more detailed explanation for the scores awarded to each option.

Table 4.1: Results of the Comparative Assessment of the five decommissioning options for VDP2, ranked in order of preference (highest to lowest score)

Criterion	Feasibility	Safety	Environmental Impact			Societal Impact	Cost	Normalised/ weighted total value
Assessment scope:	Feasibility of successful completion and recoverability from major project failure	Safety risk offshore & onshore	Environmental risk offshore & onshore	Energy	Emissions	Societal risk offshore & onshore	Cost	
Metric:	Qualitative comparison	Summed total of safety risks	Summed total of environmental risks	Quantity of energy used (GJ)	Quantity of and CO_2 emitted (Tonnes)	Summed total of societal risks	Estimated project cost in £ sterling*	
Maximum possible normalised/ weighted value:	**10**	**30**	**15**	**5**	**5**	**10**	**25**	**100**
Option 5: Decommission in situ – Minimum Intervention								
Assessment result	See Section 4.1	195	169	1,783,752	221,005	50	-	
Normalised/weighted value	**8.4**	**29.5**	**15.0**	**4.4**	**5.0**	**10.0**	**25.0**	**97.3**
Option 4: Decommission in situ – Minor Intervention								
Assessment result	See Section 4.1	192	276	1,845,610	225,335	56	-	
Normalised/weighted value	**8.4**	**30.0**	**9.2**	**4.2**	**4.9**	**8.9**	**19.8**	**85.4**
Option 3:Partial Removal – Cut and Lift								
Assessment result	See Section 4.1	194	224	2,155,149	249,725	50	-	
Normalised/weighted value	**6.7**	**29.7**	**11.3**	**3.6**	**4.4**	**10.0**	**8.6**	**74.3**
Option 1: Full Removal – Reverse S-lay/ Reel								
Assessment result	See Section 4.1	247	190	1,566,735	219,124	55	-	
Normalised/weighted value	**3.4**	**23.3**	**13.3**	**5.0**	**5.0**	**9.1**	**3.9**	**63.0**

Option 2: Full Removal – Cut and Lift								
Assessment result	See Section 4.1	226	190	3,422,849	356,955	55	-	
Normalised/weighted value	**6.7**	**25.5**	**13.3**	**2.3**	**3.1**	**9.1**	**2.1**	**62.1**

*Full cost breakdowns have been proided to BEIS

Table 4.2: Results of the Comparative Assessment of the five decommissioning options for VDP3, ranked in order of preference (highest to lowest score)

Criterion	Feasibility	Safety	Environmental Impact			Societal Impact	Cost	Normalised/ weighted total value
Assessment scope:	Feasibility of successful completion and recoverability from major project failure	Safety risk offshore & onshore	Environmental risk offshore & onshore	Energy	Emissions	Societal risk offshore & onshore	Cost	
Metric:	Qualitative comparison	Summed total of safety risks	Summed total of environmental risks	Quantity of energy used (GJ)	Quantity of and CO_2 emitted (Tonnes)	Summed total of societal risks	Estimated project cost in £ sterling*	
Maximum possible normalised/ weighted value:	**10**	**30**	**15**	**5**	**5**	**10**	**25**	**100**
Option 5: Decommission in situ – Minimum Intervention								
Assessment result	See Section 4.1	195	169	174,516	16,329	50	-	
Normalised/weighted value	**8.4**	**29.5**	**15.0**	**4.9**	**5.0**	**9.4**	**25.0**	**97.2**
Option 4: Decommission in situ – Minor Intervention								
Assessment result	See Section 4.1	192	276	182,545	16,922	56	-	
Normalised/weighted value	**8.4**	**30.0**	**9.2**	**4.7**	**4.8**	**8.4**	**21.1**	**86.6**
Option 3:Partial Removal – Cut and Lift								
Assessment result	See Section 4.1	194	224	243,116	21,431	50	-	
Normalised/weighted value	**6.7**	**29.7**	**11.3**	**3.5**	**3.8**	**9.4**	**12.7**	**77.1**
Option 1: Full Removal – Reverse S-lay/ Reel								

Assessment result	See Section 4.1	247	190	169,806	16,916	47	-	
Normalised/weighted value	**3.4**	**23.3**	**13.3**	**5.0**	**4.8**	**10.0**	**11.1**	**70.9**
Option 2: Full Removal – Cut and Lift								
Assessment result	See Section 4.1	226	190	575,488	47,037	47	-	
Normalised/weighted value	**6.7**	**25.5**	**13.3**	**1.5**	**1.7**	**10.0**	**3.1**	**61.8**

*Full cost breakdowns have been proided to BEIS

4.1 Technical Feasibility Differentiation

The results of the technical feasibility assessment, undertaken during the CA workshop, are presented in Table 4.3. All options were carried forward for further consideration in the Comparative Assessment.

Options which scored a *Technical Feasibility* and *Risk of Operational Failure* rating of ‘Slight’, ‘Minor’ or ‘Moderate’ were carried forward for full assessment. Table 4.3 lists the five options considered in this CA. A maximum normalised/ weighted score of 10 (Table 3.2) was applied to the most preferable (lowest risk) option and was subsequently divided between *Technical Feasibility* and *Risk of Operational Failure*, giving a maximum score of 5 for each of these components. As a ‘Slight’ risk is the lowest risk option, this rating was assigned the highest normalised/ weighted score of 5. ‘Minor’ was assigned a score of 3.4 and ‘Moderate’ was assigned the lowest score of 1.7, as described in Appendix B.

Table 4.3: Technical feasibility assessment results and normalised weightings for VDP2 and VDP3 pipelines

	Technical Feasibility		*Risk of Operational Failure*		
Option	Risk Rating	Normalised weighted score	Risk Rating	Normalised weighted value	Combined Feasibility and Failure Risk Scores
5: Decommission in situ – Minimum Intervention	Slight	5	Minor	3.4	8.4
4: Decommission in situ – Minor Intervention	Slight	5	Minor	3.4	8.4
3: Partial Removal – Cut and Lift	Slight	5	Moderate	1.7	6.7
2: Full Removal – Cut and Lift	Slight	5	Moderate	1.7	6.7
1: Full Removal – Reverse S-lay/ Reel	Moderate	1.7	Moderate	1.7	3.4

The worst performing option is the Full Removal by Reverse S-lay/ Reel. This is primarily due to the issues associated with reverse reeling of the pipeline. The majority of the pipelines are concrete coated and this restricts the use of the reverse reel method. There are also technical challenges when dealing with the piggybacked methanol lines which would need to be detached as the pipeline comes up on to the vessel. This is further complicated as the links between these pipelines may already have degraded making recovery difficult and potentially hazardous to personnel on deck. There are also issues to deal with in relation to the concrete coating which may break off during the handling operations. This can make the physical handling of the pipeline challenging and result in the subsequent clean up of concrete debris from both the vessel and the seabed following the retrieval of the pipeline. Due to the lack of knowledge of the integrity of the pipelines and their coatings and the potential issues mentioned above, the reverse s-lay option poses some moderate challenges in terms of potential risk of delay to the project should these complications arise.

Both the Partial and Full Removal by Cut and Lift methods scored 6.7. This option is proven in the UKCS however; risk of potential delays to the project due to the sheer length of pipeline to be removed resulted in a moderate score for *Risk of Operational Failure*.

The decommission in situ options (Minor and Minimum Intervention) both scored a total of 8.4, comprising of a *Technical Feasibility* score of 5 and a *Risk of Operational Failure* score of 3.4. A *Technical Feasibility* score of 'Slight' was applied to these options due to the minimal amount of intervention required and the fact that in situ decommissioning techniques have been undertaken elsewhere on the UKCS. *Risk of Operational Failure* was rated as 'Minor' due to the potential requirement for mitigation if pipelines become exposed over time and the sheer length of pipeline that will be decommissioned.

The lowest score (5) was assigned to Option 1 (Full Removal by Reverse S-lay/ Reel). This option scored 2.5 for *Technical Feasibility* and 2.5 for *Risk of Operational Failure* and has a rating of 'Moderate' for both aspects. Higher ratings were assigned to this option due to the restriction, as discussed above, on the use of the technique on concrete coated pipelines. In addition, there are technical challenges when dealing with the piggybacked methanol lines which would need to be detached as the pipeline comes up on to the vessel. The physical challenges and risks of full removal are reflected in the scores.

4.2 Safety Differentiation

This section presents a comparison of the Safety risk scores for each of the pipeline decommissioning options. The safety risk scores were determined through a qualitative approach using a workshop session assessing likelihood of an accident and the consequence of an incident on the receiving individuals.

Table 4.4 ranks the options in reverse order of the magnitude of the respective overall Safety risk scores, i.e. the best performing option has the lowest overall safety risk score. This table also reveals that the Safety ranking mirrors the overall totals for worker and 3rd party exposure, in turn, reflect the engineering complexity, vessel requirements, onshore transportation requirements and durations of the work programmes for the individual options. Table 4.4 also provides a normalised/ weighted value which assigns a maximum score of 30 to the best performing option, and then scores the remaining options in inverse proportion to their overall risk scores. Appendix C provides a detailed breakdown of the activities and their individual scores associated with each decommissioning method along with the scoring matrix and descriptors for the 'likelihood' and 'consequence' scoring criteria.

Table 4.4: VDP2 and VDP3 safety assessment results and normalised weightings

Option	Safety risk	Normalised weighted score
4: Decommission in situ - Minor Intervention	192	30.0
3: Partial Removal - Cut and Lift	194	29.7
5: Decommission in situ - Minimum Intervention	195	29.5
2: Full Removal - Cut and Lift	226	25.5
1: Full Removal Reverse S-lay or Reel	247	23.3

The Decommission in situ (5 and 4) and Partial Removal options (3) can be differentiated from the other options by having markedly lower requirements for subsea intervention (disconnection of pipelines and rock-placement for protective cover) and associated transport on land of removed material reducing risk to 3rd parties and the decommissioning workforce. There was some increase in risk in particular to commercial fishermen compared to the full removal options due to the infrastructure remaining on the seabed. However, this can be adequately mitigated against with communication and accurate reporting of the final location of infrastructure post-decommissioning.

The Full Removal options (1 and 2) were the worst performing options and the main differentiator was the amount of time to undertake the removal operations increasing the exposure to risk along with the increased risk to 3rd parties both offshore through increased vessel operations and onshore with the transport of the large volume of material by lorry on the road network increasing the risk of exposure to road traffic accidents.

4.3 Environmental Impact Differentiation

Following the feasibility assessments, environmental risk assessments were undertaken for the five decommissioning options. This section provides an outline of the method used in the qualitative assessment of environmental risk in the CA workshop, and summarises the results. The assessment enabled a distinction to be made between four categories of risk: High, Significant, Medium and Low. Differentiation between decommissioning options was based on the level of risk assessed for each receptor and the total number of potentially impacted receptors per activity/ operation or endpoint. Appendix D provides a detailed breakdown of how these results were achieved.

The assessments included the completion of risk assessment worksheets (Appendix D) which address the general activities associated with decommissioning and specific activities associated with the Decommission in situ, Partial and Full Removal options for the pipelines. Totals (Table 4.5) were calculated from the worksheets by adding the risk values assigned to each activity (row-by-row) and summing the activity values relevant to each decommissioning option.

Table 4.5 ranks the options in order of risk from lowest risk option to the highest risk option. The summed totals were normalised by the weights assigned by ConocoPhillips with the maximum weighted value assigned to the lowest risk option. The subsequent normalised/ weighted values were then calculated in relation to this lowest risk option.

Table 4.5: VDP2 and VDP3 environmental risk assessment results and normalised weightings

Option	Summed Total*	Normalised weighted Score
5: Decommission in situ – Minimum Intervention	169	15.0
1: Full Removal – Reverse S-lay/ Reel	190	13.3
2: Full Removal – Cut and Lift	190	13.3
3: Partial Removal – Cut and Lift	224	11.3
4: Decommission in situ – Minor Intervention	276	9.2

*Compiled by totalling the individual criteria scoring for each operation/ activity relevant to environmental risk across each row of Tables D4 to D8 (Appendix D).

The majority of the medium risk activities are derived from activities common to all options (Appendix D; Table D4). These include:

- Anchoring of vessels to the seabed;
- Discharge of waste (oil, sewage, macerated food waste);
- Ballast water uptake and discharge; and
- Atmospheric emissions from vessels and helicopters.

In addition to the activities above, the key environmental risks that differentiate the options include:

- Long term presence of rock-placement and the associated impacts on the seabed sediment structure;
- Long term presence of the rock-placement and associated impacts on habitats; and
- Potentially detrimental impacts on the form and function of the North Norfolk Sandbank and Saturn Reef and the Inner Dowsing Race Bank and North Ridge SAC features.

Option 5 (Decommission in situ – Minimum Intervention) was considered to have the smallest environmental impact and therefore has the highest normalised/ weighted value of 15. This differs from Options 1 and 2 (Full Removal – Reverse S-lay/ Reel and Full Removal – Cut and Lift) by the fact that the pipelines would not be removed and there would be minimal disturbance to the current seabed state. These pipelines have been in situ for between 12 and 40 years and although there has been some exposure, there has been only one reportable span (in excess of 0.8 m in height and more than 10 m in length). Surveys have indicated that a large proportion of the mattresses installed for pipeline stability, are either buried or partially buried. Many of the mattresses were designed with integrated frond mats to improve burial and retention of sediment cover or profiled edges to aid overtrawlability. Option 5 proposes to decommission the mattresses in situ, therefore minimising additional seabed disturbance but also removing the need to deploy additional rock-placement over the pipeline to ensure their future stability. Decommissioning the mattresses in situ would be considered a re-use of the mattresses as a stabilising medium for maintaining pipeline burial, whilst not introducing additional foreign material, such as quarried rock, into the marine environment and SACs.

Options 1 and 2 have scored similarly; the main impact is derived from the seabed disturbance caused by exposing the pipeline for removal and by any additional spread/ loss of degraded concrete coating which may fall to the seabed during the removal process and the addition of rock-placement at cut pipeline ends associated with crossings that are left in situ. Under these options it is proposed to remove all mattresses where safe to do so, however as there would be no pipeline infrastructure left behind there is no need to deploy any additional rock-placement over that required to make safe any cut ends at pipeline crossings. Additional consideration was given to the length of time that full removal options pose on potential impacts to the seabed and suspended sediment issues. A Southern North Sea cSAC has been identified as an area of importance for harbour porpoise in this area of the North Sea; increased sedimentation from exposing the pipeline over a period of years could pose a disturbance risk to this species. Overtrawlability trials would be carried out and a pipeline survey will be undertaken to ensure that any pipeline trench that remains is safe for other users of the sea. This may potentially cause additional seabed disturbance and flattening of some SAC seabed features. However, due to the dynamic nature of the currents at the seabed any physical disturbance would be short-term and temporary, resulting in a normalised/ weighted score of 13.3 for both Options 1 and 2.

Option 3 (Partial Removal – Cut and Lift) is similar to Options 1 and 2; however as this option proposes to remove only the exposed pipeline sections this would result in the addition of rock-placement to the cut ends and any crossings left in situ. There is anticipated to be more cuts under this option when compared to Options 1 and 2. There is also the potential for scour pits to develop over time from the introduction of the rock-placement material. There is evidence from both the Fugro habitat assessments (Fugro, 2014a-d) and pipeline video footage (ConocoPhillips, 2014) of scour development in response to the presence of hard seabed structures e.g. rock-placement, wrecks or exposed pipeline. As a result of these potential impacts, this option was given a normalised weighted value of 11.3.

There was one high risk category (generally considered to be unacceptable) identified during the assessment. This was identified under Option 4 (Decommission in situ – Minor Intervention; Appendix D; Table D5) and relates to the environmental impacts of using rock-placement for the burial of the exposed pipeline. As the VDP2 and VDP3 infrastructure is situated within either the North Norfolk Sandbanks and Saturn Reef SAC or the Inner Dowsing Race Bank and North Ridge SAC, the introduction of a large quantity of rock-placement could represent a localised change to the natural seabed environment and qualifying features of the SAC. This risk could be reduced to medium (Appendix D, Table D5) if pipeline re-trenching was considered, however this would also have an impact as a result of seabed disturbance and suspended sediment concentrations as discussed above for Options 1 and 2. This option also proposes to remove all mattresses, where safe to do so, resulting in the potential need to deploy additional rock-placement for future pipeline stability, further adding to this options impact on the SAC. As a result, this option scored the worst for environmental impacts and was assigned a normalised weighted value of 9.2.

4.4 Energy and Emissions Differentiation

This section presents the quantitative estimates of energy usage and subsequent emissions that provide the basis for differentiating between options. The method outlined here follows the "Guidelines for Calculation of Energy Use and Gaseous Emissions in Decommissioning" (IoP, 2000).

The method considers the fate of decommissioned material from pre-decommissioning preparation to an onshore end-point, such as recycling or disposal to landfill. The total quantities of energy usage and CO_2 emissions were calculated by:

1. Estimating quantities of diesel fuel consumed by vessels involved in the work programmes offshore;
2. Estimating quantities of diesel consumed during the haulage onshore of the materials to landfill, treatment or recycling facilities;
3. Estimating quantities of aviation fuel used for helicopter operations;
4. Estimating quantities of materials required hypothetically for the manufacture of new materials equivalent to the materials lost to society by leaving recyclable material in situ in the seabed or by disposal to landfill;
5. Estimating the energy required for the recycling of pipeline materials; and
6. Multiplying these quantities by energy content and emission factors (IoP, 2000) which are provided in Appendix E; Table E2.

The calculations and initial assessment were undertaken in 2015, there have been no significant changes to the proposed scope since the completion of these calculations.

4.4.1 VDP2 Pipelines and associated mattresses

Table 4.6 provides a summary of the energy use (in giga joules (GJ)) and emissions (in tonnes of CO_2) for each decommissioning option for the VDP2 pipelines. The maximum normalised/ weighted value has been assigned to the most preferable (lowest risk option). Energy and emissions values associated with the pipelines could have been assigned a maximum weighting of 10, which has subsequently been divided between energy use and emissions (a maximum weighted value of 5 for each). The scores for the remaining options have been calculated in inverse proportion to their overall summed totals. The relative contributions from the decommissioning activities are shown graphically in Figures 4.1 (energy use) and 4.2 (emissions).

Table 4.6: Energy and emissions assessment results and normalised weightings for the VDP2 pipelines

Option	Energy		Emissions		Combined normalised weighted score
	Energy usage (GJ)	Normalised weighted score	Emissions (Tonne/ CO_2)	Normalised weighted score	
1. Full Removal – Reverse S-lay/ Reel	1,566,735	5.0	219,124	5.0	10.0
5. Decommission in situ – Minimum Intervention	1,783,752	4.4	221,005	5.0	9.4
4. Decommission in situ – Minor Intervention	1,845,610	4.2	225,335	4.9	9.1
3. Partial Removal – Cut and Lift	2,155,149	3.6	249,725	4.4	8.0
2. Full Removal – Cut and Lift	3,422,849	2.3	356,955	3.1	5.4

Option 1 (Full Removal by Reverse S-lay/ Reel) the lowest energy use and emissions of all the options and therefore has the highest normalised/ weighted value of 10. Most of the energy use and emissions can be assigned to vessel operations.

Option 5 (Decommission in situ - Minimum Intervention) has the second lowest energy use and emissions, and therefore has a high total normalised/ weighted value of 9.4. Most of the energy use and emissions can be assigned to hypothetical replacement of materials to replace those decommissioned in situ or sent to landfill.

Similarly, the majority of the energy use assigned to Option 4 (Decommission in situ - Minor Intervention) can be assigned to the hypothetical replacement of materials decommissioned in situ or sent to landfill. This option has a total normalised/ weighted value of 9.1.

Option 3 (Partial Removal - Cut and Lift) is the option with the second highest energy usage and CO_2 emissions, with a total normalised/ weighted value of 8.0. A large proportion of this can be assigned to the hypothetical replacement of materials decommissioned in situ or sent to landfill, however the increase in vessel spread and number of days to undertake the removal works also differentiates this option from Option 4 and 5.

The option with the highest energy usage and emissions is Option 2 (Full Removal by Cut and Lift). Figures 4.1 and 4.2 indicate that the overriding majority of the energy and emission produced originates from the use of vessels for offshore operations. This option has the lowest total normalised/ weighted value of 5.4 and is therefore the least favourable of the options from an energy and emissions perspective.

A full breakdown of the contributing factors and their relating energy and emission values is presented in Appendix E; Tables E3 to E7.

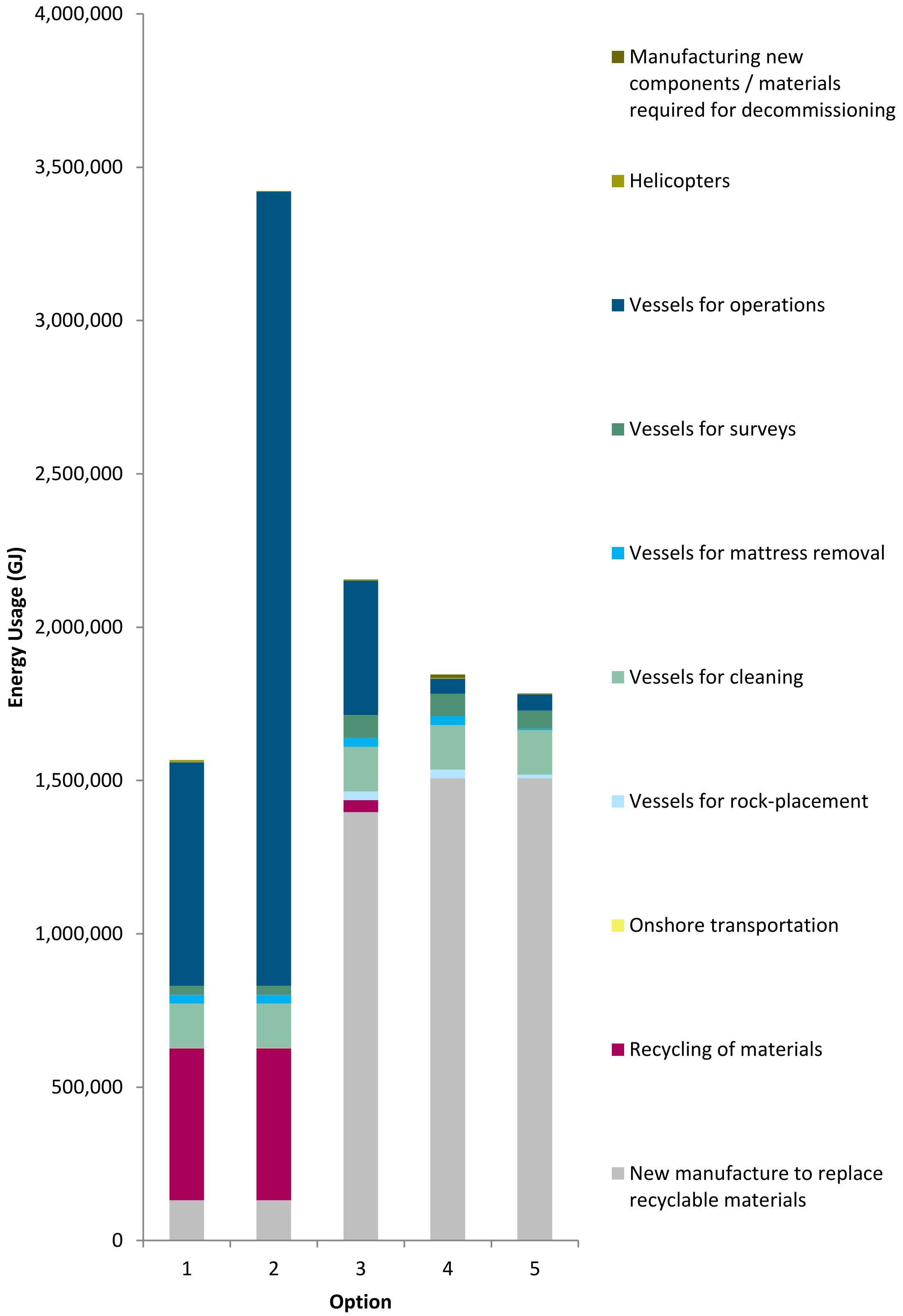


Figure 4.1: Graph showing contributors to the energy use for each decommissioning option for the VDP2 pipelines and associated mattresses

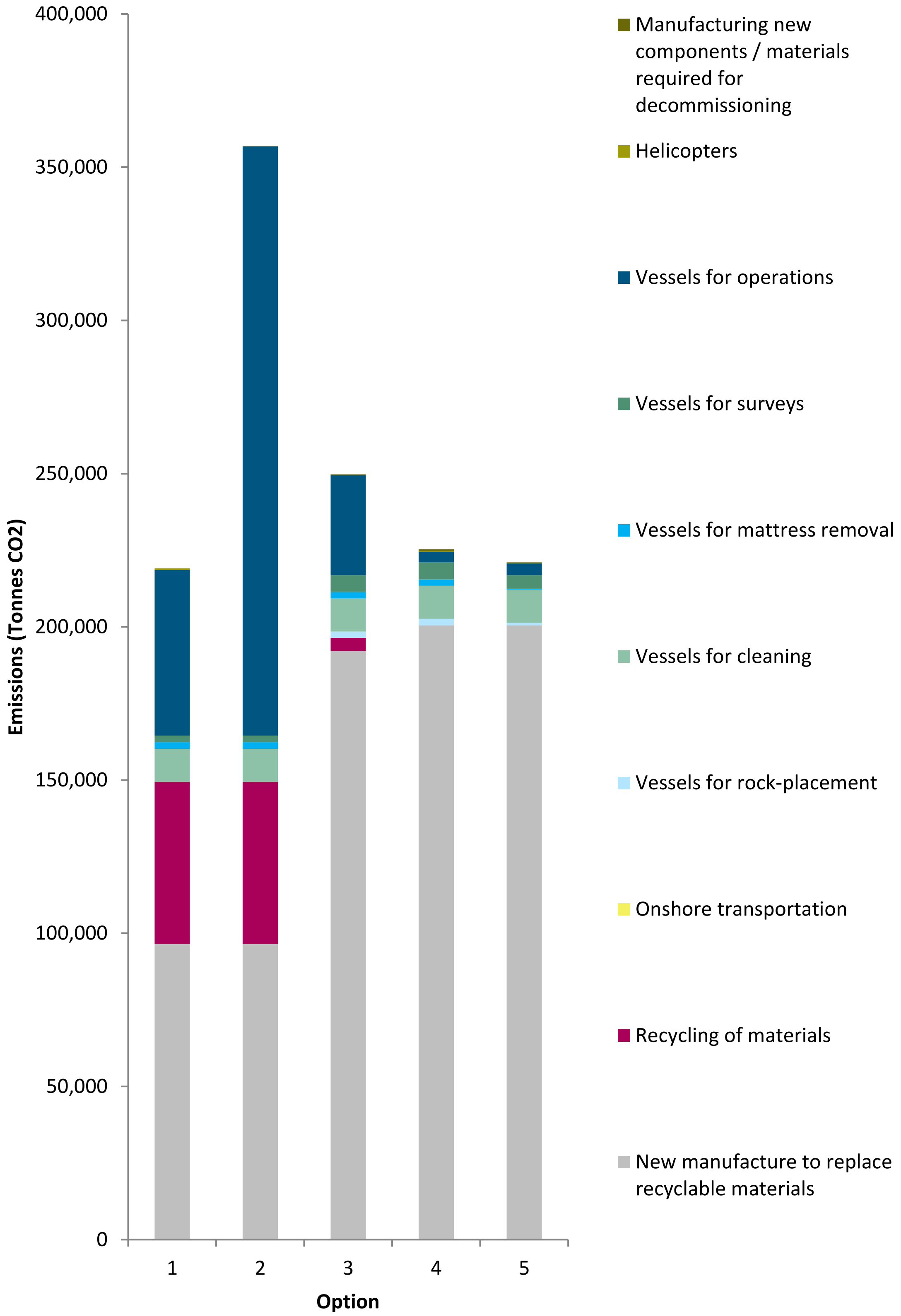


Figure 4.2: Graph showing contributors to the emissions for each decommissioning option for the VDP2 pipelines and associated mattresses

4.4.2 VDP3 Pipelines and associated mattresses

Table 4.7 provides a summary of the energy use (in giga joules (GJ)) and emissions (in tonnes of CO_2) for each decommissioning option for the VDP3 pipelines. The maximum normalised/weighted value has been assigned to the most preferable (lowest risk option). Energy and emissions values associated with the pipelines could have been assigned a maximum weighting of 10, which has subsequently been divided between energy use and emissions (a maximum weighted value of 5 for each). The scores for the remaining options have been calculated in inverse proportion to their overall summed totals. The relative contributions from the decommissioning activities are shown graphically in Figures 4.3 (energy use) and 4.4 (emissions).

Table 4.7: Energy and emissions assessment results and normalised weightings for the VDP3 pipelines

Option	Energy		Emissions		Combined normalised/ weighted score
	Energy usage (GJ)	Normalised weighted score	Emissions (Tonne/ CO_2)	Normalised weighted score	
5. Decommission in situ – Minimum Intervention	174,516	4.9	16,329	5.0	9.9
1. Full Removal – Reverse S-lay/ Reel	169,806	5.0	16,916	4.8	9.8
4. Decommission in situ – Minor Intervention	182,545	4.7	16,922	4.8	9.5
3. Partial Removal – Cut and Lift	243,116	3.5	21,431	3.8	7.3
2. Full Removal – Cut and Lift	575,488	1.5	47,037	1.7	3.2

Option 5 (Decommission in situ - Minor Intervention) has the second lowest energy use and lowest emissions, and has the highest combined normalised/ weighted value of 9.9. The vast majority of the energy use associated with this option (and therefore emissions) is a result of the hypothetical replacement of materials decommissioned in situ.

Option 1 (Full Removal by Reverse S-lay/ Reel) has the lowest energy use and second lowest emissions of all the options and has the second highest combined normalised/ weighted value of 9.8. Most of the energy use and emissions can be assigned to vessel use and a large proportion can also be assigned to the recycling of materials brought onshore.

The majority of the energy use assigned to Option 4 (Decommission in situ - Minor Intervention) can also be attributed to the need to hypothetically manufacture replacement material that has been lost to society. This option has a total normalised/ weighted value of 9.5.

Option 3 (Partial Removal - Cut and Lift) is the option with the second highest energy usage and CO_2 emissions, with a total normalised/ weighted value of 7.3. Most of the energy use and emissions can be assigned to vessel use and a large proportion can also be assigned to the hypothetical replacement of materials left in situ.

The option with the highest energy usage and emissions is Option 2 (Full Removal by Cut and Lift). The overriding majority of the energy and emission produced originates from the use of vessels for offshore operations. This option has the lowest total normalised/ weighted value of 3.2 and is therefore the least favourable of the options from an energy and emissions perspective.

A full breakdown of the contributing factors and their corresponding energy and emission values is presented in Appendix E; Tables E10 to E14.

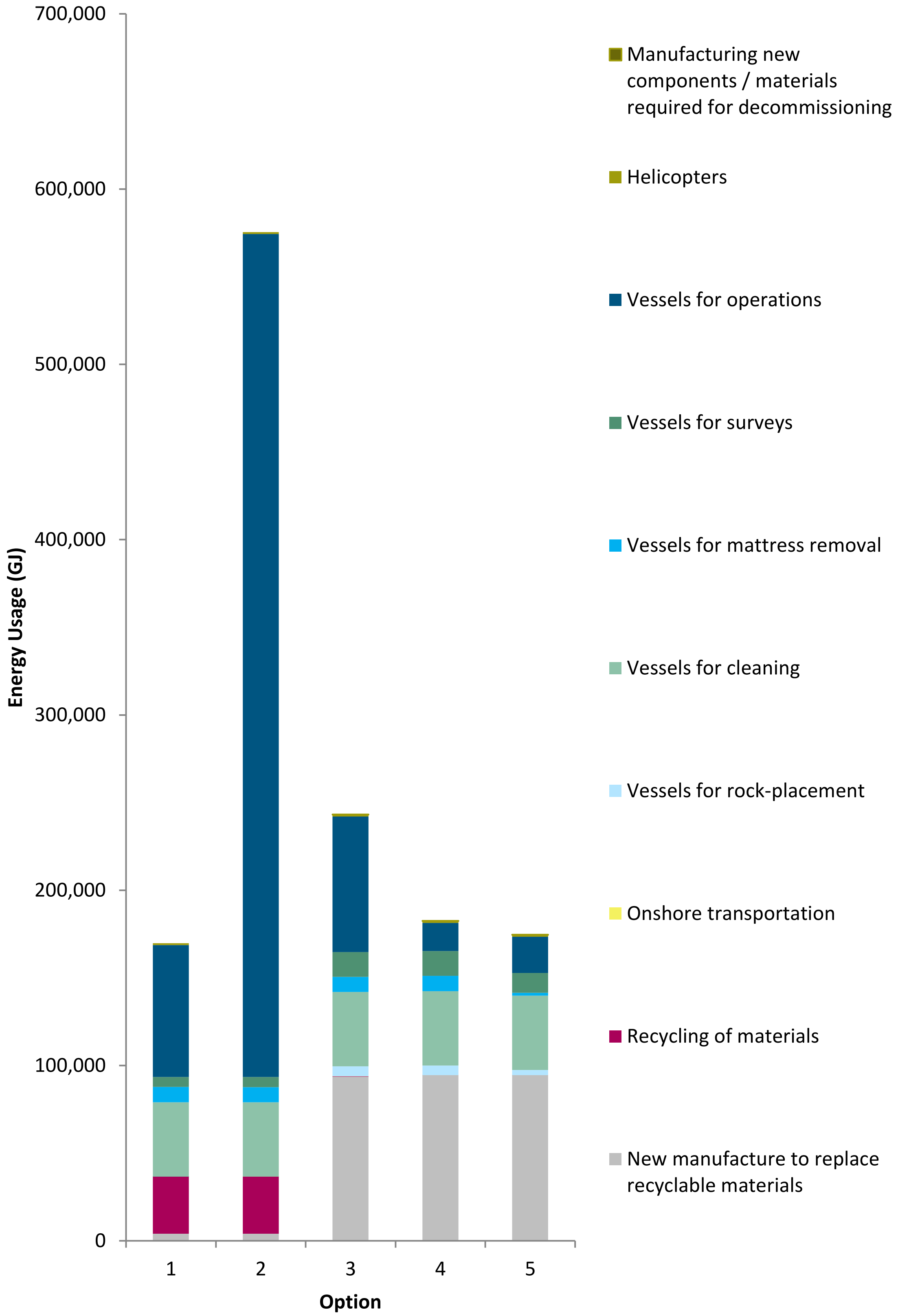


Figure 4.3: Graph showing contributors to the energy use for each option for the VDP3 pipelines and associated mattresses

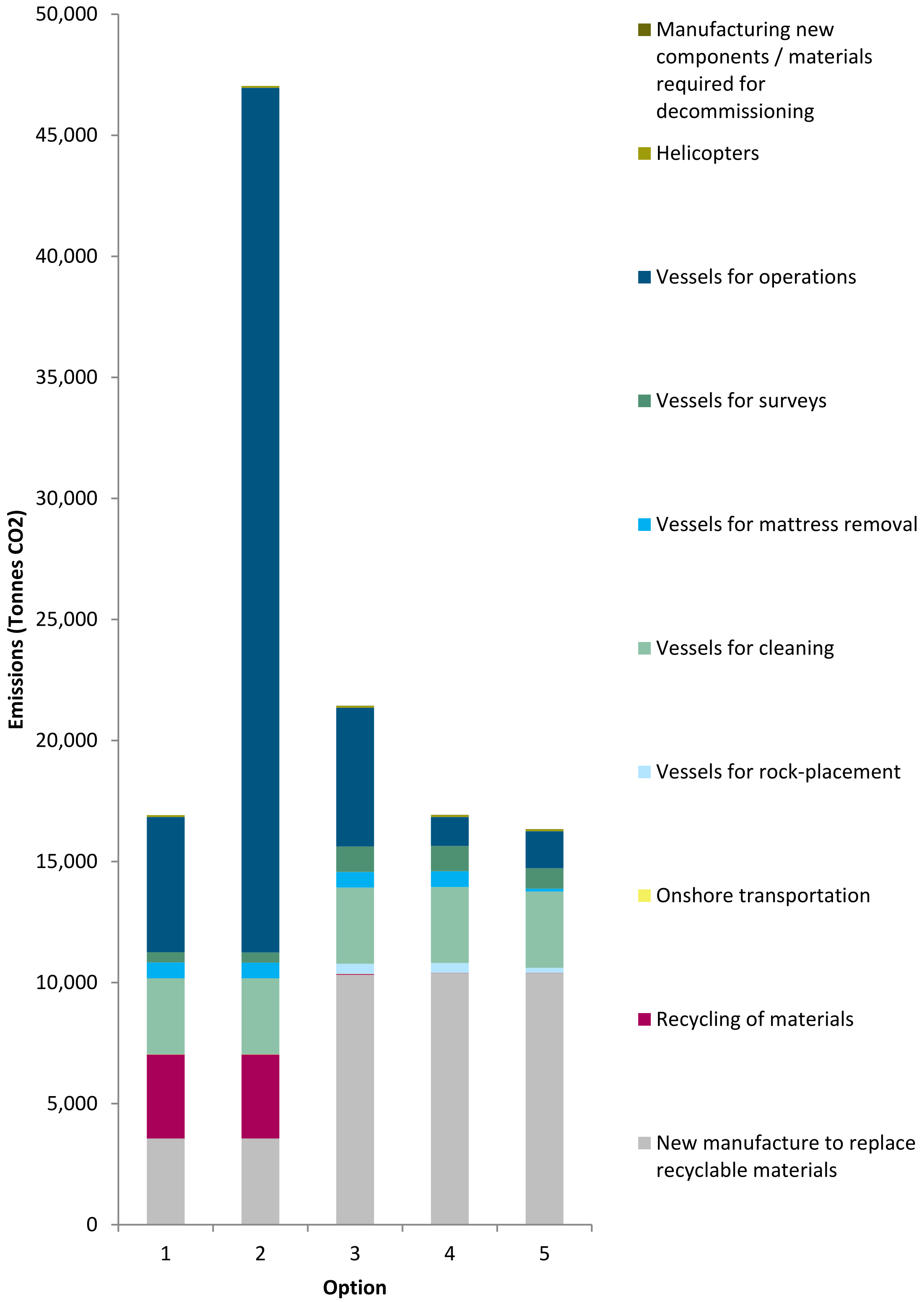


Figure 4.4: Graph showing contributors to the emissions for each option for the VDP3 pipelines and associated mattresses

4.5 Societal Impact Differentiation

Societal risk assessments were undertaken concurrently with the environmental risk assessment and followed the same methodology (Section 4.3). The risk was assigned by participants at the CA workshops. This section summarises the results of the societal impact assessment with Appendix D providing a detailed breakdown of how these results were achieved. Separate assessments were undertaken for VDP2 and VDP3 due to the complexities and length of the pipelines included in VDP2 compared to VDP3.

Tables 4.8 and 4.9 rank the options in order of preference from most preferable (lowest risk option) to least preferable (highest risk option) for VDP2 and VDP3 respectively. The summed totals were normalised by the weighting as before.

VDP2 Pipelines and Associated Mattresses (Table 4.8)

Although Option 3 and 5 scored similarly overall for societal risks (10.0) the differentiating factor between these two options is in relation to the treatment of concrete mattresses. Under Option 5 the concrete mattresses are proposed to be decommissioned in situ, this scored as a medium risk to other users of the sea, primarily as a result from the potential for snagging hazards over time. Option 3 had additional risk posed from the removal of the mattresses (removed where safe to do so). Under this method, there is the potential for some mattresses to be decommissioned in situ due to either the safety risk to divers during removals or from pieces of degraded mattresses being left behind. Due to the dynamic nature of the seabed sediments in the SNS, mattresses can become exposed or buried over time.

The summed risk scores for Options 1, 4 and 2 were very similar (55, 56 and 57 respectively); however, the risks were scored against different activities resulting in different impacts on societal receptors. Options 1 and 2 scored an additional medium risk associated with the physical presence of vessels in relation to PL27. The full removal of this pipeline is estimated to use between 1,371 and 2,489 vessel days, in relation to Option 1 and 2 respectively. This is a combination of extra vessel requirements and the total number of days required to just remove PL27 alone. This would have impacts on commercial fishermen, in particular creel fishermen, who currently fish gear on or across the pipeline. This gear would need to be moved to allow access by the decommissioning vessels. There are limited places creel fishermen can move to because much of the neighbouring areas are used by other creel fishers or mobile gears which could damage static gear such as pots and creels. (Pers Comm; MREKEP workshop, 2013). In addition, there is some indication from cable laying operation for windfarms which suggests that the fishing grounds take a number of years to re-establish themselves once sediment disturbance has occurred. Option 2 would take longer and therefore has scored worse than Option 1.

Option 4 sits between Option 1 and 2 in terms of impact to societal receptors and is differentiated by the risk of impact to fishing gear from the increased volume of rock-placement associated with burial of exposed sections of the pipework. If re-trenching is used instead of rock-placement, the issues are similar to those described above relating to seabed disturbance.

No significant or high categories were associated with the societal risks for any of the decommissioning options (Appendix D; Table D10).

Table 4.8: Societal risk assessment results and normalised weightings for VDP2 decommissioning options

Option	Summed total*	Normalised weighted value
3: Partial Removal – Cut and Lift	50	10.0
5: Decommission in situ – Minimum Intervention	50	10.0
1: Full Removal – Reverse S-lay/ Reel	55	9.1
4: Decommission in situ – Minor Intervention	56	8.9
2: Full Removal – Cut and Lift	57	8.8

*Compiled by totalling the individual criteria scoring for each operation/activity relevant to societal risk across each row of Tables D4 to D8 (Appendix D).

VDP3 Pipelines and Associated Mattresses (Table 4.9)

Societal risks were the same for Options 1 and 2 (Full Removal – Reverse S-lay/ Reel and Full Removal – Cut and Lift) for VDP3 pipelines and mattresses, with a normalised/ weighted value of 10 for each. This is as a result of all the pipelines being fully removed leaving minimal infrastructure to give rise to snagging hazards and the significantly smaller scope of work included in VDP3 compared to that of VDP2. Of note is that ConocoPhillips would also undertake a post-decommissioning overtrawlability survey in 500 m zone where stabilisation features predominantly exist. Overtrawl surveys would be carried out to ensure any residual pipe trenches or rock berms are passible and any large berms of sediment have been dispersed, along with any crossings which have been left in situ. Any rock berms will be designed and installed using graded rock and an overtrawlable design.

With the exception of Option 5, all mattresses would be removed where safe to do so, reducing any minimal snagging risk from partially exposed mattresses. Options 1 and 2 removes the slight risk associated with Options 3 and 4 in relation to leaving behind unidentified mattresses. As the pipeline requires to be exposed along its full length to fully remove the pipeline this should allow the identification of all mattresses placed along the pipeline lengths.

Option 3 and 5 had similar scores of 9.4. Although they had similar scores, there were different risks attributing to these scores. The differentiating factor between these two options is in relation to the treatment of concrete mattresses. Under Option 5 the concrete mattresses are proposed to be decommissioned in situ, this scored as a medium risk to other users of the sea, primarily as a result from the potential for snagging hazards over time. Option 3 had additional risk posed from the removal of the mattresses removed where safe to do so, under this method there is the potential for some mattresses to be decommissioned in situ due to either the safety risk to divers during removals or from pieces of degraded mattresses being left behind. Due to the dynamic nature of the seabed sediments in the SNS, mattresses can become exposed or buried over time.

The societal risks identified for Options 3 and 5 relate to the rock-placement at each cut end or pipeline left in situ, leaving a potential issue for certain types of fishing gear depending on the grading and volume of rock required and the number of cut ends left. The main fishing effort within the study area is undertaken by heavy beam-trawlers (Brown and May, 2014). Due to the horsepower of these vessels, the high towing speeds

(~7 knots) and the heavy beam trawl gear (between 5 and 7 tonnes); the potential for these vessels to snag on any exposed pipeline resulting in a potential loss of vessel is negligible. If an impact does occur, the gear is most likely to break the exposed line with a minor potential of damage to the fishing gear itself in the form of torn nets. In addition, the first 65 km of pipeline nearest to shore is targeted by moderate creel activity. These are generally small vessels (<15 m in length) working light static gear. If this were to get snagged during retrieval, the potential for a vessel loss is low and it would be anticipated that the fishing gear would be lost before any significant risk was posed to the vessel itself.

The suggested mitigation measures proposed to minimise any risk to commercial fishermen following the completion of the decommissioning activities include; accurate mapping of the areas of rock-placement, in situ pipelines and mattresses post decommissioning, transference of this information on to accessible navigation charts/ aids and an agreed programme of post-decommissioning monitoring following the completion of the decommissioning activities.

Option 4 was the worst performing option in terms of societal risk with a normalised/ weighted value of 8.4. The placement of rock material over currently exposed pipeline sections may create additional areas of scour on the seabed thus revealing areas of pipeline that may become a snagging hazard to fishermen. This differs from Option 5 as fishermen would likely continue to avoid the area of the pipeline.

No significant or high categories were associated with the societal risks for any of the decommissioning options (Appendix D; Table D10).

Table 4.9: Societal risk assessment results and normalised weightings for VDP3 decommissioning options

Option	Summed total*	Normalised weighted value
1: Full Removal – Reverse S-lay/ Reel	47	10.0
2: Full Removal – Cut and Lift	47	10.0
3: Partial Removal – Cut and Lift	50	9.4
5: Decommission in situ – Minimum Intervention	50	9.4
4: Decommission in situ – Minor Intervention	56	8.4

*Compiled by totalling the individual criteria scoring for each operation/activity relevant to societal risk across each row of Tables D4 to D8 (Appendix D).

4.6 Cost Differentiation

This section provides cost estimates for the five decommissioning options. Vessel days and rates have been estimated based on costs provided by ConocoPhillips (as per August 2015). Full cost breackdown has ben provided to BEIS.

Tables 4.10 and 4.11 provide a comparison for the five options ranked by Cost from lowest to highest for each Decommissioning Programme. Appendix F includes the details of the cost estimation for the five options. Figures 4.5 and 4.6 illustrate the breakdown of the total costs by activity for each option; these have been split into separate tables for VDP2 and VDP3 infrastructure. The maximum normalised/weighted value was assigned to the most preferable (lowest cost option). The values for the remaining options have been calculated in inverse proportion to their overall summed totals.

Table 4.10: Cost estimates and normalised weightings for VDP2 decommissioning options

Option	Normalised weighted score*
5: Decommission in situ – Minimum Intervention	25.0
4: Decommission in situ – Minor Intervention	19.8
3: Partial Removal – Cut and Lift	8.6
1: Full Removal – Reverse S-lay/ Reel	3.9
2: Full Removal – Cut and Lift	2.1

*Note: Estimated costs and calculations were based on 2015 vessel rates.

Table 4.11: Cost estimates and normalised weightings for VDP3 decommissioning options

Option	Normalised weighted score*
5: Decommission in situ – Minimum Intervention	25.0
4: Decommission in situ – Minor Intervention	21.1
3: Partial Removal – Cut and Lift	12.7
1: Full Removal – Reverse S-lay/ Reel	11.1
2: Full Removal – Cut and Lift	3.1

*Note: Estimated costs and calculations were based on 2015 vessel rates.

Although the estimated costs differ between VDP2 and VDP3, the order of the decommissioning options performance under the Cost criteria is the same and the reasoning behind these is similar in both DPs so the differentiators have been described together for efficiency.

Option 5 (Decommission in situ – Minimum Intervention) is the least expensive option in both DPs. This is a result of the option having the minimum number of vessels and shortest number of days to complete the decommissioning and remediation works. The indicative cost of the additional rock-placement for Option 4 (Decommission in situ – Minor Intervention) is shown in Figures 4.5 and 4.6. The need for this additional remediation work under Option 4 accounts for the higher costs relative to Option 5. Options 4 and 5 have the highest future liability costs compared to the other options based on the amount of infrastructure decommissioned in situ and the potential for the pipelines to become exposed in the future.

Although Option 1 (Full Removal – Reverse S-lay/ Reel) has the largest vessel spread, the number of days required to undertake the full removal is significantly less than that required for Option 2 (Full Removal – Cut and Lift). The presence of strong tidal currents in this area of the SNS requires a significant amount of WOW contingency to be applied to the working days associated with cut and lift operations. Diving operations may be limited in duration due to tidal conditions, which can in turn lead to reduced visibility, thus reducing the amount of time that can be spent in the water in the course of a working day. Option 2 is the most expensive option for both VDP2 and VDP3. Figures 4.5 and 4.6 clearly show that the majority of this cost can be attributed to the number of CSV days associated with this option.

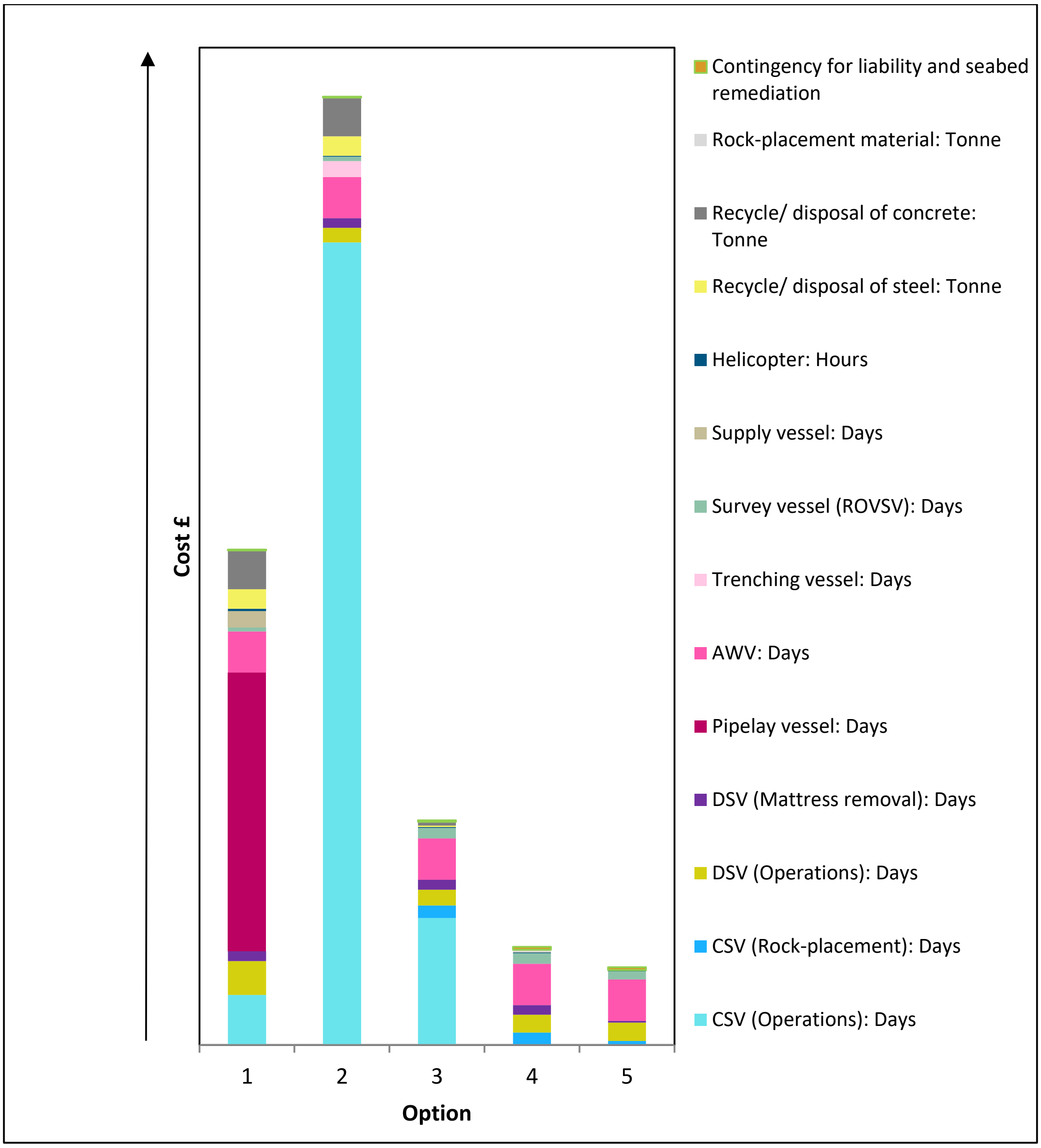


Figure 4.5: Graph showing contributing factors to the estimated costs for each option for the VDP2 pipelines and mattresses

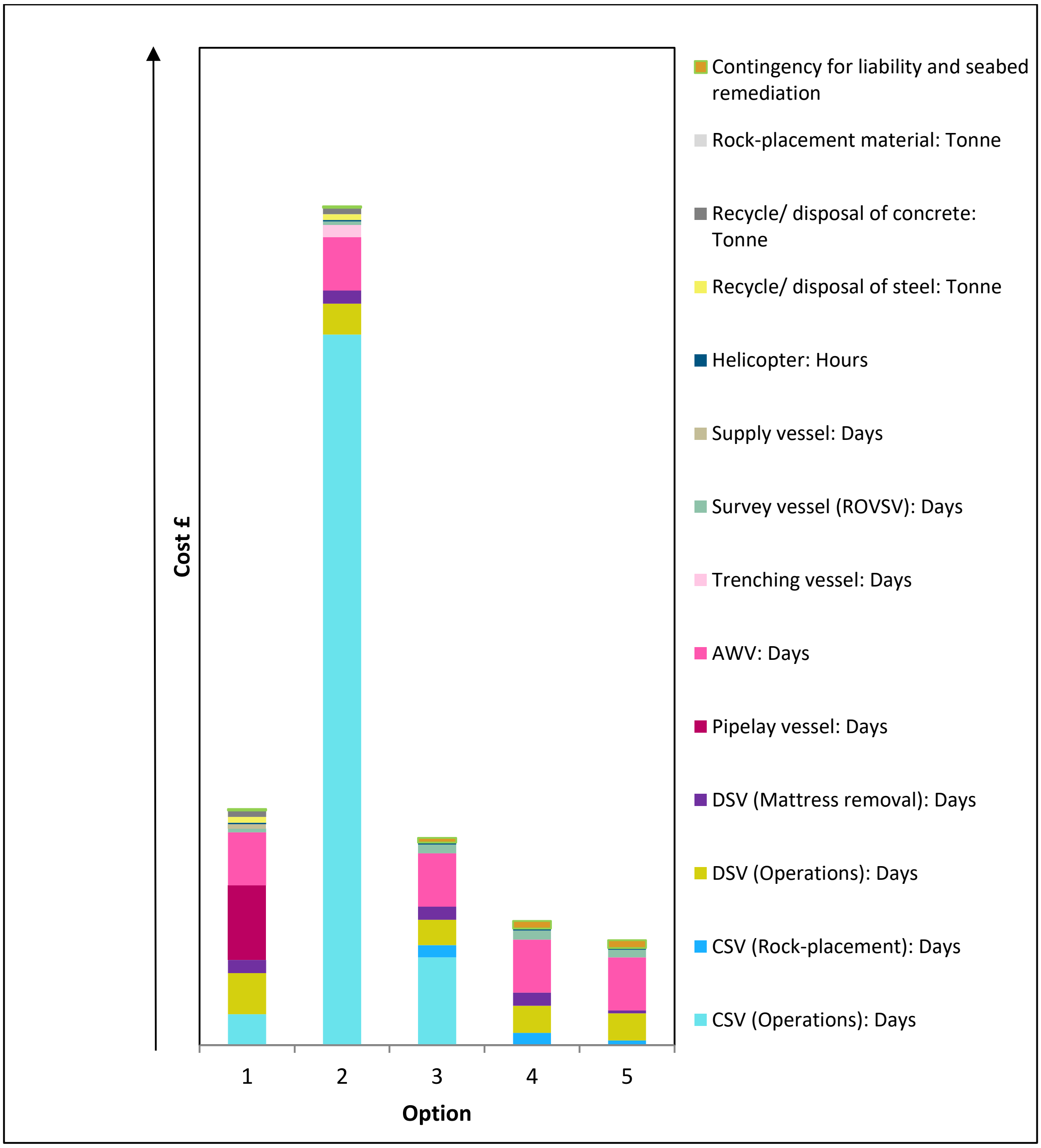


Figure 4.6: Graph showing contributing factors to the estimated costs for each option for the VDP3 pipelines and mattresses

5.0 CONCLUSIONS

The cumulative scoring of the criteria for the five pipeline decommissioning options is listed below from the highest to the lowest scores. The performances of the evaluation criteria for the options are represented graphically such that the higher normalised/ weighted value the better the outcome. These have been separated into the individual Decommissioning Programmes.

VDP2 Pipelines and Associated Mattresses

Option 5: Decommission in situ – Minimum Intervention

Minimum Intervention scored highest **(97.3/ 100)** due to a strong performance against several criteria including; Societal, Environment and Cost which the highest normalised weighted values (10, 24.4 and 25%, respectively) (Figure 5.1).

Option 4: Decommission in situ – Minor Intervention

Minor Intervention, ranked second **(85.4/ 100)** and had slightly lower scores for Cost, Environment and Societal (Figure 5.1).

Option 3: Partial Removal – Cut and Lift

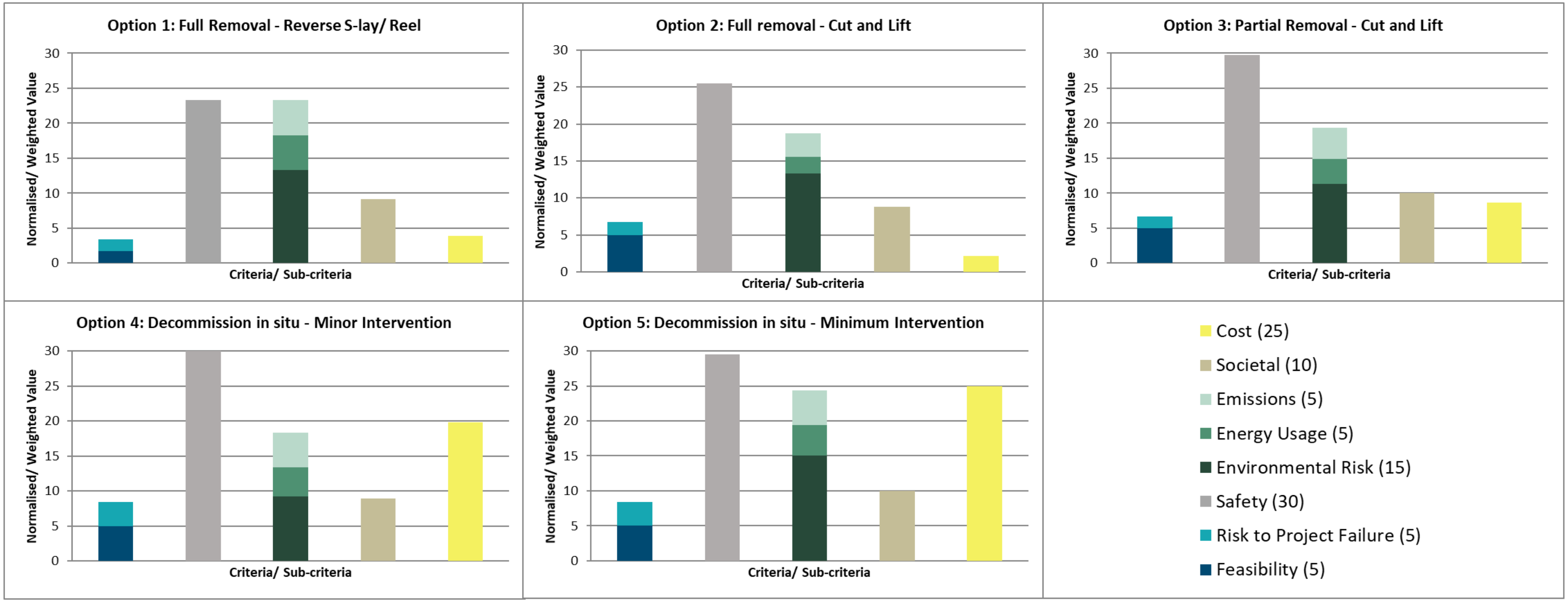
Partial Removal - Cut and Lift, placed third **(74.3/ 100)** although this option had joint maximum score for Societal with Option 5 (Figure 5.1).

Option 1: Full Removal – Reverse S-lay/ Reel

Reverse S-lay/ Reel, ranked fourth **(63.0/ 100)** although this option scored relatively well for the Energy and Emissions and Societal aspects but poorly for Technical Feasibility and Cost (Figure 5.1).

Option 2: Full Removal – Cut and Lift

Full Removal - Cut and Lift, was the lowest scoring **(62.1/ 100)** option due to poor performance against Risk to Project Failure, Cost and Energy and Emissions, however it did score highly for Technical Feasibility (Figure 5.1).



[Total scores available for each criteria given in brackets]

Figure 5.1: Weightings per criteria for VDP2 Options 1-5

VDP3 Pipelines and Associated Mattresses

Option 5: Decommission in situ – Minimum Intervention

Minimum Intervention scored highest **(97.2/ 100)** due to a strong performance against several criteria including; Environment, Societal and Cost which have the highest weightings (25, 10 and 25%, respectively) (Figure 5.2).

Option 4: Decommission in situ – Minor Intervention

Minor Intervention, ranked second **(86.6/ 100)** and had marginally lower scores for Cost, societal and Environment than Option 5 (Figure 5.2).

Option 3: Partial Removal – Cut and Lift

Partial Removal - Cut and Lift, placed third **(77.1/ 100)** although this option score well for Safety, and Societal it scored poorly against Risk of Project Failure and Cost (Figure 5.2).

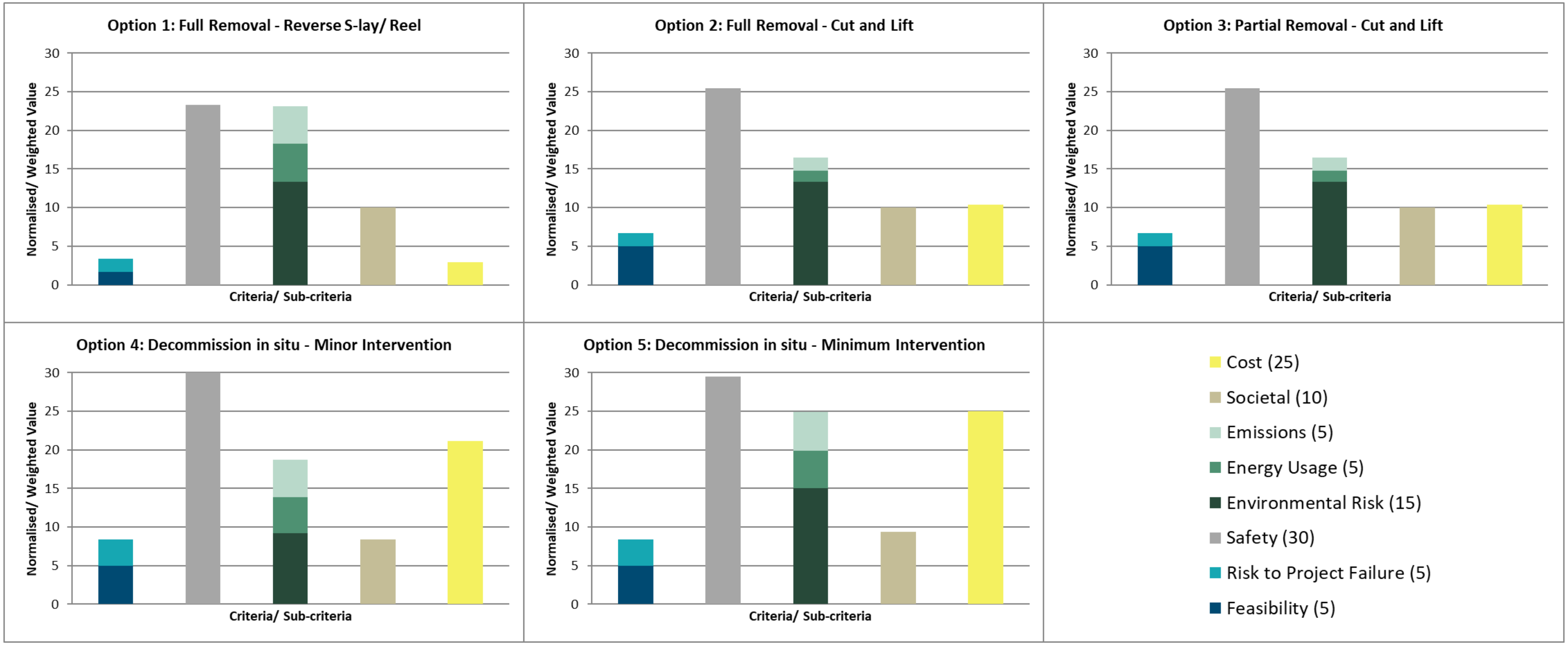
Option 1: Full Removal – Reverse S-lay/ Reel

Reverse S-lay/ Reel, ranked fourth **(70.9/ 100)** although this option scored relatively well for the Environmental aspects and Societal but poorly for Technical Feasibility, Safety and Cost (Figure 5.2).

Option 2: Full Removal – Cut and Lift

Full Removal - Cut and Lift, was the lowest scoring **(61.8/ 100)** option due to poor performance against Cost, Safety and Energy and Emissions, however it did have joint maximum score for Societal impact with Option 5 (Figure 5.2).

In summary, based on the findings from the CA presented in this report, ConocoPhillips has concluded that **Option 5: Decommission in situ – Minimum Intervention** is the preferred decommissioning option for the both the VDP2 and VDP3 pipelines and associated mattresses. For the two detached sections of PL134, remediation measures will be undertaken in consultation with BEIS, which is currently ongoing.



[Total scores available for each criteria given in brackets]

Figure 5.2: Weightings per criteria for VDP3 Options 1-5.

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APPENDICES

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APPENDIX A

ENVIRONMENTAL AND SOCIETAL SENSITIVITIES

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Table A1: Summary of Environmental Characteristics and Sensitivities

Aspect	
Site overview	
The VDP2 and VDP3 infrastructure covered by this CA are located in Blocks 47/17, 47/18, 47/19, 47/20, 48/16, 48/17, 48/18, 48/19, 48/20, 49/11, 49/12, 49/16, 49/17 & 49/22 in the SNS.	
Conservation interests	
Offshore Annex I habitats	
North Norfolk Sandbanks and Saturn Reef SAC	All of the infield infrastructure included in VDP2 and VDP3 are located within this SAC. Approximately 20 km of PL27 pipeline also crosses this SAC. The sandbanks typically have fields of sand waves associated with them. The Annex I biogenic reef habitats formed by the polychaete worm (S. spinulosa) are also present in the SAC (JNCC, 2017a).
Inner Dowsing, Race Bank and North Ridge SAC	PL27 crosses the northern extent of this SAC. The SAC is designated for its sandbanks which are slightly covered by seawater all the time, and for its *S. spinulosa* reef habitats (JNCC, 2017b).
Haisborough, Hammond and Winterton SAC	The SAC is located 41 km south of the VDP2 and VDP3 areas. The SAC is designated for sandbanks which are slightly covered by seawater all the time, and for *S. spinulosa* reef habitats (JNCC, 2017c).
Southern North Sea cSAC	All of the infield infrastructure included in VDP2 and VDP3 are located within this candidate SAC (cSAC). Approximately 42 km of the VTS pipeline crosses this cSAC. The site is designated due to the populations of harbour porpoise, and Annex II species, in the area (JNCC, 2017d).
Coastal conservation sites	
SACs	The closest SAC with marine components (Humber Estuary) is located, approximately, 6 km north of PL27 landfall (JNCC, 2017e).
SPAs	The closest SPA with marine components (Humber Estuary) is located, approximately, 6 km north of PL27 landfall (JNCC, 2017f).
Coastal and Offshore Annex II species	
Harbour porpoise	Abundance varies throughout the year, from low to very high. The greatest abundance typically occurs during August.
Bottlenose dolphins	Only a low abundance is inferred for two months of the year (August and November).
Grey seals	Within the infield infrastructure, there could be between 0 - 5 grey seals per 25 km^2. The greatest abundance along PL27 occurs at landfall and could be up to 10 grey seals per 25 km^2 (Jones et al., 2015).
Common seals	Within the infield infrastructure, there could be between 0 - 1 grey seals per 25 km^2. The greatest abundance along PL27 occurs at landfall and has the potential to be up to 100 grey seals per 25 km^2 (Jones et al., 2015).
Designated areas	
Only PL27 crosses recommended Marine Coastal Zones (Wash Approach; Silver Pit; Lincs Belt)	
Plankton	
Plankton in the sea area surrounding VDP2 and VDP3 are typical for the SNS. Dominant phytoplankton species are dinoflagellates of the genus *Ceratium*, including *C. fusus*, *C. furca* and *C. tripos*. High numbers of the genus *Cheaetoceros* are also present. Dominant species of zooplankton present include the (small) copepods *Para-Pseudoclanus spp*., and echinoderm larvae. The larger species of copepods, *Calanus helgolandicus* and *Metridia lucens,* are also present.	

Table A1 (continued): Summary of Environmental Characteristics and Sensitivities

Aspects and Seasonal Sensitivities

Benthic environment

Seabed sediments	Sediments in both decommissioning areas comprise fine to coarse sands, often silty and with variable amounts of shell fragments and occasional pebbles and cobbles. The highly dynamic marine environment restricts the silt and clay content to less than 15 %. Five seabed habitats can be identified using the EUNIS classification system: • A5.14 - Infralittoral coarse sediment • A5.15 – Deep circalittoral coarse sediment • A5.23 or A5.24: Infralittoral fine sand or infralittoral muddy sand • A5.25 or A5.26: Circalittoral fine sand or circalittoral muddy sand • A5.27: Deep circalittoral sand • A5.44: Circalittoral mixed sediments • A5.45: Deep circalittoral mixed sediments
Benthic fauna	Benthic fauna identified during seabed surveys are typical for this area of the SNS. The shallow-water infaunal assemblage is characterised by polychaetes, bivalve molluscs and amphipods and crustaceans. *S. spinulosa were* identified in several nearby historical survey reports. More recent surveys did not observe sections of *S. spinulosa* habitat which would qualify as reef under the JNCC guidelines.

***Fish* – spawning and nursery areas within ICES rectangles**

Spawning areas	35F0	There are spawning areas for herring, lemon sole, sandeels and common sole. There are no known areas of high intensity spawning in the area.
	35F1	There are spawning areas for herring, lemon sole, mackerel, sandeels and common sole. There are no known areas of high intensity spawning in the area.
	35F2	There are spawning areas identified for cod, lemon sole, mackerel, sandeels, plaice and sprat. The plaice spawning area has been shown to have a high abundance of eggs and larvae indicating a potential high intensity area of spawning.
	36F2	There are spawning areas identified for cod, lemon sole, mackerel, herring, sandeels, plaice and sprat. The plaice spawning area has been shown to have a high abundance of eggs and larvae indicating a potential high intensity area of spawning.
Nursery areas		There are potential nursery areas identified in the ICES rectangles containing VDP2 and VDP3 infrastructure. These include anglerfish, cod, common sole, herring, horse mackerel, mackerel, Norway pout, plaice, sprat, whiting, lemon sole, Nephrops, sandeels, spurdog, thornback ray and tope shark. Areas with a high abundance of juveniles have been found for whiting and herring and may be high intensity nursery areas for these species.

Marine mammals *(denotes generalised index score for Quadrants 47, 48 and 49 (UKDMAP, 1998; SCANS III, 2017; Reid et al., 2003)*

Month	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Harbour porpoise		M	H	L	H			VH	H			L
White-beaked dolphin	M			VH	L				M	M		
White-sided dolphin								L				

Table A1 (continued): Summary of Environmental Characteristics and Sensitivities

Seabirds *(denotes median score for blocks containing infrastructure)*

The most common species of seabird found in these areas of the SNS include: Fulmar, Gannet, Guillemot, Kittiwake, Razorbill, Puffin, Little Auk; as well as numerous species of gull, tern and skua.

Seabird sensitivity to oil pollution within the Blocks of Interest (JNCC, 2017g)

Block	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
47/17	4	4	3	5	5	5	5	5	5	2	2	2
47/18	4	4	2	5	5	5	5	4	4	1	2	2
47/19	3	3	2	5	5	5	5	4	4	3	1	2
47/20	3	4	2	5	5	5	5	4	4	3	1	2
48/16	3	4	3	3	5	5	5	4	5	4	2	3
48/17	3	3	3	3	5	5	5	3	4	2	1	3
48/18	1	2	3	3	5	5	5	3	3	1	1	1
48/19	1	1	3	3	3	5	5	3	3	1	1	1
48/20	1	1	1	ND	3	5	5	5	5	ND	1	1
49/11	1	1	1	ND	ND	1	1	5	5	ND	ND	1
49/12	ND	1	ND	ND	5	5	1	5	5	5	ND	1
49/16	2	2	2	ND	ND	5	5	5	5	ND	2	1
49/17	ND	1	2	ND	ND	2	2	5	5	5	ND	1
49/22	1	3	3	3	ND	5	5	5	3	3	1	1

Overall the seabirs sensitivity in the area is 'high'. A clear seasonality in seabird sensitivity occurs within the decommissioning area, with the highest sensitivities in the winter months (JNCC, 2017g)

Key

Seabird sensitivity		**Marine mammal sightings**	
1	Extremely high	VH	Very high
2	Very High	H	High
3	High	M	Moderate
4	Medium	L	Low
5	Low		No data
ND	No data		
x	Interpolated data (where "x" is the interpolated value)		

Table A2: Summary of Socioeconomic Characteristics and Sensitivities

Aspect	Characteristics
Commercial fishing	
Low to moderate fishing activity occurs within the vicinity of the VDP2 and VDP3 facilities (ICES Rectangles 35F0, 35F1, 35F2 and 36F2). Netherlands and the UK are the two main nationalities that work in the area. Creel vessels, small dredgers and trawlers fish in the first 65km from shore with a shift to larger stern trawlers and beam trawlers in ICES rectangles 35F2 and 36F2. The UK vessel activity is targeted closer inshore along the AR pipeline, and consists primarily of potting vessels fishing for crab and lobsters. Dutch vessels primarily fish further offshore using beam trawlers targeting demersal species, including plaice. Based on VMS data there is little vessel activity in the immediate vicinity of the infield pipelines.	
Other users	
Shipping activity	Shipping activity in the area of the VDP2 and VDP3 facilities ranges from very low to high.
Oil and Gas	The nearest non-ConocoPhillips development is the Wenlock Platform, located approximately 6 km to the north east of the Viking AR Platform.
Telecommunications	The Tampnet Telecommunications cable passes within 2 km of the Vixen VM well and Viking B facilities and crosses the Viking BD, ED, GD, AR and KD infield pipelines.
Military activities	No military exercise areas in the blocks containing VDP2 or VDP3 infrastructure.
Aggregate extractions	The entire VDP2 and VDP3 infrastructure lies within an area of optimal aggregate resource'. However no licensed sites directly coincide with the VDP2 and VDP3 assets. The nearest is located, approximately, 1 km to the north.
Carbon Capture and Storage	All blocks are located within Bunter Sandstone Formation, which is thought to have the best aquifer storage potential for CO2 amongst the reservoir rocks of SNS. The export pipeline crosses through several aquifer areas, and several aquifers are present in the infield area.
Windfarms	There are two windfarms within 35 km of the main VDP2 and VDP3 areas. Hornsea zone (32 km N) and East Anglia zone (33 km SE) and seven within 30 km of PL27. From offshore to onshore, the Dudgeon wind farm (5.6 km S), Triton Knoll (5.7km N), Race Bank (2.4 km S), Sheringham Shoal (20.4 km S), Lincs (12 km S), Inner Dowsing (16 km S) and Lynn (23.4 km S). The Triton Knoll export cable agreement also crosses the TGT pipeline 33 km from the shore.
Wrecks	Of the 124 wrecks located within the 14 blocks, none are designated and 52 are classified as dangerous. However, none coincide with VDP2 and VDP3 infrastructure.

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APPENDIX B

TECHNICAL FEASIBILITY

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Introduction

This section presents the assessment of the *Technical Feasibility* and the *Risk of Operational Failure* criteria for the options considered at the CA workshop. These options were based on the findings from the CA report for the VDP1 and LDP1 infrastructure. It was agreed with ConocoPhillips that infrastructure for this decommissioning program is fundamentally similar in composition and location to VDP1 and LDP1. Therefore the previously assessed methods of removal would be similar with the main difference being the additional length of pipeline included within VDP2 and VDP3 and the location of the export pipeline aspects associated with VDP2.

Method

Both the *Technical Feasibility* and the *Risk of Operational Failure* criteria were considered for each option. The scoring was based on a majority decision by the participants at the CA workshop. Any option that scored ‘Major’ or ‘Severe’ was not carried forward for further assessment in the CA. Descriptions of the scoring criteria are provided in Table B1. A combined assessment was made for both VDP2 and VDP3 pipelines with any specific justifications given in the comments section of the assessment table (Table B2).

Technical Feasibility Summary of Options Carried Forward

Tables B2 and B3 summarise the assessment of the various pipeline removal options carried forward from the CA workshop for the SNS Decommissioning Project VDP2 and VDP3 pipelines. *Technical Feasibility* (indicated by the blue asterisk on Table B2 and B3) and *Risk of Operational Failure* (indicated by the red asterisk on Table B2) criteria were considered for each option. Scoring was based on a majority decision by participants at the CA workshops.

Table B1: Scoring criteria for technical feasibility and risk of major operational failure

Criteria	1 Slight	2 Minor	3 Moderate	4 Major	5 Severe
Technical Feasibility Risk (up-front evaluation of concept)	Technically robust concept that has been applied successfully on many comparable projects AND Limited development work required for use on proposed project AND No apparent/ negligible engineering or supply chain constraints (no risk to availability of option or schedule)	Concept that has been seriously considered, is believed to be technically robust but not proven on comparable projects AND Development work required for proposed project AND/ OR Minor engineering or supply chain constraints would have minor effects on availability of option or schedule	Concept that has been previously considered and is believed to be technically robust but not proven on comparable projects AND Significant development work is required for proposed project AND/ OR Engineering or supply chain constraints would delay the schedule and limit availability of option	Concept that has not previously been considered but could potentially be viable although not proven and with high degree of uncertainty AND A very large amount of development work required for proposed project AND/ OR Engineering or supply chain constraints would seriously impact the schedule and restrict availability of option	Concept has not been proven, is not technically robust, has not been considered on comparable projects and is not considered viable OR Engineering or supply chain constraints would completely prevent use of option
Risk of Major Operations Failure (after field operations have started)	Negligible/ Low risk of major operation failure with good prospects of recovery in the event of failure AND No/ Minor schedule delay (part days) AND No impact on planned operations' deliverables/ outcome.	Low risk of operation failure with good prospects of recovery BUT With low/ moderate schedule delay (days) AND No impact on planned operations' deliverables/outcome	Moderate risk of operation failure with moderate prospects of recovery AND/OR Moderate/ significant schedule delay (weeks) AND/ OR Moderate re-engineering to achieve operations' deliverables/ outcome	High risk of operation failure with limited prospects of recovery AND/ OR Protracted schedule delay (months) AND/ OR Extensive re-engineering to achieve operations' deliverables/ outcome	High risk of catastrophic, unrecoverable operation failure where operations would be aborted completely and re-engineered.

Table B2. Options carried forward from the technical feasibility assessment for the VDP2 and VDP3 pipelines

Method	Scoring					Comments
	Slight	Minor	Moderate	Major	Severe	
Full removal (exposure and removal of all pipelines , excluding sections underneath live pipeline crossings)						
Reverse S-lay			* *			• Moderate engineering solutions may be required. • This technique is suitable for long sections of pipeline coated in concrete which are not flexible.
Reverse Reel			* *			• Moderate engineering solutions may be required. • This technique is only suitable for long sections of flexible plastic pipeline and would not be appropriate for concrete-coated pipelines. • Not suitable for large diameter pipelines (in excess of 15”)
Cut and Lift	*		*			• Cut and Lift techniques are proven and have been employed elsewhere on the UKCS. • This technique would be appropriate for concrete coated and plastic pipelines with piggybacked MeOH pipelines.
Partial removal (removal of exposed and spanned sections of pipeline and the burial of pipeline ends)						
Cut and Lift	*		*			• Cut and Lift techniques are proven and have been employed elsewhere on the UKCS. • This technique would be appropriate for concrete and plastic coated pipelines with piggybacked MeOH pipelines.
Decommission in situ (see comments for individual descriptions)						
Minor Intervention	*	*				• This would involve rock-placement/ trenching of pipeline ends *and* exposed or spanned sections. • This is a proven technique that has been used elsewhere on the UKCS. • Slight risk of operational failure due to the potential requirement for mitigation if pipelines become exposed over time. • Pipelines decommissioned in situ will be monitored and assessed periodically for additional remediation as required.
Minimum Intervention	*	*				• This would involve rock-placement and/ or trenching of pipeline ends. • Pipelines decommissioned in situ will be monitored and assessed periodically for additional remediation as required. • Mattresses would be decommissioned in situ in their current state.

Note: * = Technical Feasibility rating; * = Risk of Operational Failure rating.

Scores were assigned against each of the scoring criteria as defined in Table B3. These were based on the percentage weightings assigned by ConocoPhillips for technical feasibility. For each option, the assessment criteria were scored and a combined feasibility score was calculated by adding these scores together for each option. A summary of these scores is provided in Table B4.

Table B3. Normalised scores for the CA workshop ratings

Scoring	Normalised/ weighted score (per criteria)
'Slight'	5.0
'Minor'	3.4
'Moderate'	1.7

Table B4. Summary of feasibility assessment outcome for the VDP2 and VDP3 pipeline decommissioning options

Option	Technical feasibility	Risk of operational failure	Combined feasibility scores
2: Full Removal - Cut and Lift	5.0	1.7	6.7
3: Partial Removal - Cut and Lift	5.0	1.7	6.7
4: Decommission in situ - Minor Intervention	5.0	3.4	8.4
5: Decommission in situ - Minimum Intervention	5.0	3.4	8.4
1: Full Removal Reverse S-lay or Reel	1.7	1.7	3.4

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APPENDIX C

ASSESSMENT OF SAFETY RISKS

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Introduction

This section presents a comparison of the Safety risks for each of the options for decommissioning the pipelines with in the two Decommissioning Programmes, VDP2 and VDP3. This assessment has been based on a qualitative approach. Safety criteria descriptors were provided by ConocoPhillips.

The CA safety assessment contains a method statement governing the assessment process, qualitative safety assessment score tables for each of the options, and an ordered ranking of the options based on the outcome of the assessment.

The use of a qualitative assessment of risk is necessarily limited to relatively high-level comparisons. More detailed assessments and studies on safety hazards and risks, as well as control and mitigation requirements, will however be conducted as the engineering programme for decommissioning progresses.

Assessment Method

The qualitative assessment of Safety risk for each option was carried as follows:

1. For the purposes of the assessment potential risk is considered post-mitigation. A summary of the general mitigation measures that are commonly employed is given below in Table C1; however more detailed control and mitigation measures would be detailed in further submissions as the engineering programme for decommissioning progresses.
2. Individual assessments for each activity during the work programme were undertaken by multiplying the ‘likelihood’ of exposure to individuals by the ‘consequence’ of the impact on individuals. The ‘likelihood’ and ‘consequence’ tables are presented in Tables C2 and C3. Table C4 shows the resulting categories of risk and how these are calculated via the matrix from the ‘likelihood’ and ‘consequence’ scoring.
3. ConocoPhillips provided: estimates of the numbers of Personnel on Board (POB); the various types of vessels potentially required for work programmes for each decommissioning option; the durations of vessel operations (including Waiting on Weather (WOW)); numbers of air divers and dive durations; numbers of lifts by crane; and descriptions of the activities that would be undertaken during the decommissioning works.
4. The risk assessment was carried out in a workshop format with open discussion between the participants and reviewed by ConocoPhillips engineering and safety teams.
5. Both VDP2 and VDP3 were scored together for safety as the physical aspects of the decommissioning activities are similar.
6. For each option, the receptor scores for each activity were added together to get an overall activity risk score. To achieve the final total risk score for each option all the overall activity scores are added together.

General Mitigation Measures

The following table provides examples of controls that would typically be applied to mitigate safety risks to personnel involved both onshore and offshore during the decommissioning operations for the VDP2 and VDP3 pipelines. Because detailed controls would be developed once the preferred decommissioning option had been selected, the examples given below are generic and are not intended to be exhaustive.

Table C1: Examples of controls applied during pipeline decommissioning operations

Operation	Control Measures
Vessels during transit and working onsite	• Definition of parameters for safe voyage and window of operation. • Emergency planning, command, control, communication roles and response procedures, equipment and training/exercises (in line with SOLAS). • Route plans for transit. • Simultaneous operations (SIMOPS) procedures/vessel management plan. • Use of DP ships where appropriate. • Mooring analysis and anchor management plans, where appropriate. • Hi-tech navigation, sonar, radar, communication and AIS systems. • Operations within existing platform exclusion zones or temporary exclusion zones, where appropriate. • Consultation with National Federation of Fishermen's Organisations prior to operational planning. • ERRV or standby vessel on station during on-site working. • Guard vessel support where required • Vigilance, good seamanship and communication.
Lifting operations	• Mattress recovery from the seabed with minimal diver intervention • Design, testing and certification (as appropriate) of cranes, lifting frames, warps, slings, sea fastenings and other equipment. • On-board condition checks and seabed worksite checks by divers/ROVs. • Operations governed by permit-to-work, risk assessments, controls, operating procedures, communication and vigilance. • Vessel loading plan, dedicated laydown and storage areas, accessed only by designated personnel during loading operations. • Deployment and lifting to/from designated locations on seabed. • Designated loading/unloading areas for third party vessels alongside the cranes. • Dropped object risk assessment. • Identification of dropped object zone, from which divers on seabed excluded during lifting/deployment. • Divers within protective shelter during lifting/deployment. • Dropped objects will be recovered where practicable, and reported in line with BEIS requirements. • Monitoring of subsea operations by ROV, and ongoing communication between the onboard and subsea teams.
Diving operations	• Project implementation according to diving and subsea industry standards, e.g. OGP Diving Recommended Practice (OGP, 2008). These cover organisation, responsibilities, compliance, planning, implementation, safety, performance measurement and improvement. • Governed by dive plans, permit to work, risk assessments, controls, operating procedures, communication lines and diver vigilance. • ROVs and remote, robotic, hydraulically controlled equipment will be deployed subsea, rather than diver intervention, where practicable, e.g. for subsea excavation.

	• Use of qualified divers experienced in subsea excavation, cutting, removal and rigging/slinging operations. Techniques used will be those conventionally applied during routine subsea operations for the offshore oil and gas industry. • Condition of individual mattresses. • Placement of recovered mattresses and pipeline sections in containers on seabed ready for lifting. • Access to the decompression chamber and medical resources for commercial air or saturation diving, as appropriate. • Other relevant detailed under Lifting Operations.
Waste management operations	• Materials handled onshore by licenced waste management contractor. • Materials inventory tracking system (waste and HAZMAT inventories). • Governed by operator training, competence assurance and supervision, permit to work, risk assessments, safe procedures for waste handling, storage, transportation, recycling and disposal, and PPE appropriate to the risk. • Stringent controls for flushing, filtration, solids removal/recovery/disposal and discharge to sea of treated liquid effluent. Specialists will deal with the recovering, containment, storage and processing/disposal of any solids contaminated with NORM, mercury or other toxic substances. • Other waste materials are non-hazardous s (steel, other metals, plastics and concrete). • Quayside loading/unloading facilities and operations governed by controls similar to those detailed under Lifting Operations.
Road haulage (by lorry)	• Established road haulage contractor with good safety record, employing licenced, experienced HGV drivers. • Well maintained vehicle fleet with the sufficient capacity to safely accommodate the loads. • Traffic management plan, with designated routes appropriate to the lorry type, traffic density, expected time of travel. • Note that transportation will be by conventional road haulage vehicles.
Seabed surveys	• Pre- and post-decommissioning surveys will be undertaken to validate that seabed condition meets decommissioning programme and intended design. • Good navigation, sonar, radar, communication and AIS systems, good seamanship and vigilance during survey operations.
As-left condition	• Rock-placement is graded and profiled to minimise the risk of interaction with fishing gear. • Crossings will be left in situ in all of the decommissioning options. • A preliminary assessment of the safety risks of gear entanglement for each of the options is provided within this report. More detailed assessment will be conducted as the decommissioning project progress.
Unplanned accidental and emergency situations	• Emergency procedures govern situations such oil, fuel and chemical spills both on-board and overboard, fires, ship collision, groundings, fatalities, medical emergencies and evacuations. • Dropped objects are subject to a dropped object risk assessment which identifies the radius encompassing deck/seabed impact zone, including personnel and infrastructure at risk, and specifies mitigation measures.

Table C2: Likelihood descriptors

Likelihood (most likely down to least likely)			
Category	**One Word Descriptor**	**Description**	**Quantitative Range per Year**
5	Frequent	• Likely to occur several times a year. • Very high likelihood	$>10^{-1}$
4	Probable	• Expected to occur at least once in 10 years. • High likelihood	10^{-3} to 10^{-1}
3	Rare	• Occurrence considered rare. • Moderate likelihood	10^{-4} to 10^{-3}
2	Remote	• Not expected nor anticipated to occur. • Low likelihood	10^{-6} to 10^{-4}
1	Improbable	• Virtually improbable and unrealistic. • Very low likelihood	$<10^{-6}$

Table C3: Consequence descriptors

Consequence – Severity Description (most severe down to least severe)		
Category	**One Word Descriptor**	**Severity of Consequence**
5	Severe	Fatalities of 5 or more people
4	Major	Fatalities of 1 to 4 people
3	Moderate	One or more severe injuries, including permanently disabling injuries
2	Minor	One or more injuries, not severe
1	Slight	No or minor injury, e.g. treated by first aid

Table C4: ConocoPhillips Risk Matrix and Risk Categories

Risk Matrix						
Likelihood	5	II 5	II 10	III 15	IV 20	IV 25
	4	I 4	II 8	III 12	III 16	IV 20
	3	I 3	II 6	II 9	III 12	III 15
	2	I 2	I 4	II 6	II 8	II 10
	1	I 1	I 2	I 3	I 4	II 5
		1	2	3	4	5
		Consequence Category				

Score (Likelihood x Consequence)	Risk Categories	
IV: 17-25	High	High Risk. Manage risk utilising prevention and/ or mitigation with highest priority. Promote issue to appropriate management level with commensurate risk assessment detail.
III: 12-16	Significant	Significant Risk. Manage risk utilising prevention and/ or mitigation with priority. Promote issue to appropriate management level with commensurate risk assessment detail.
II: 5-10	Medium	Medium Risk with Controls Verified. No mitigation required where controls can be verified as functional.
I: 1-4	Low	Low Risk. No mitigation required.

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Results

The risk assessment resulted in the completion of risk assessment worksheets addressing the activities associated with each decommissioning option. Activities were assessed across all pipelines within VDP2 and VDP3 for tables C5 to C9.

Table C5: Activities associated with decommission in situ minimum intervention method (Option 5)

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Mobilisation & demobilisation operations	• Marine mob & demob operations • Quayside lifting to and from vessel • Manual handling • Loading & Offloading operations • Machinery and Equipment operations	L	2	2						The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4	4						
		R	8	8						
Transit to and from offshore sites	• General vessel operations • Normal crew operations, working practices and maintenance	L	2							Risk may increase during unfavourable weather conditions
		C	3							
		R	6							
Pre & post-decommissioning surveys (e.g. side scan sonar & ROV)	• General vessel operations • Lifting operations • Towing operations • Machine and equipment operations	L	2		2	2	2	2		Operations present a very low snagging risk. Greatest risk is associated with fisherman hauling ropes, nets and creels on board
		C	4		3	1	1	1		
		R	8		6	2	2	2		
Overtrawl survey	• General vessel operations • Lifting and deployment operations • Chain mat towing operations • Machine and equipment operations	L	3		2	2	2	2		Equipment deployment undertaken from contracted small fishing vessel. Crews are experienced in this type of survey. There are no known fatalities as a result of these operations
		C	3		3	1	1	1		
		R	9		6	2	2	2		
Infrastructure remaining on the seabed	• Potential snagging hazard	L			2		2	1		Infrastructure left in place will be marked on navigation charts. Any currently exposed sections are decommissioned in their current state of burial.
		C			5		1	1		
		R			10		2	1		
Excavation & cutting - subsurface	• General vessel operations • Diver operations • Lifting for ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4		1	1	1	1		
		R	8		1	1	1	1		

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Lifting & removal – lifting mattresses and pipeline to vessel	• General vessel operations • Diver operations • Lifting operations • Machine and equipment operations	L	2		1	1	1	1		Controlled lifts have an inherent risk due to unknown integrity of the pipework and mattresses. The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4		1	1	1	1		
		R	8		1	1	1	1		
Rock-placement & burial operations	• General vessel operations • Fall pipe deployment operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		Only addresses rock placement operations
		C	3		1	1	1	1		
		R	6		1	1	1	1		
Presence of rock-placement material	• Creation of a snagging hazard	L			1		1	1		Not considered further in the application as rock placement will follow industry standards and therefore have no perceived risk. Localised impact. Would only impact on small creel vessels with minimal crew complements.
		C			4		1	1		
		R			4		1	1		
Waste transportation, disposal & recycling	• General vehicle operations – Road haulage • Lifting operations • Machine and equipment operations	L		1					1	Low lorry numbers will be required to transport the volume cut end sections
		C		4					4	
		R		4					4	
Exposure to hazardous substances	• Cleaning operations • Lifting operations • Diving operations • Cutting operations	L	2	2					1	Appropriate PPE will be worn at all times, there will be minimal contact opportunity due to appropriate health and safety practice adherence
		C	4	4					3	
		R	8	8					3	
Unplanned events	• Oil spill • Collision risk • Dropped objects • Fire or explosion • Unfavourable weather conditions • Risk of grounding	L	2	2	1	1	1	1		Unplanned events are post mitigation. They have low probabilities due to good working practices and adherence to appropriate Health and Safety guidance and practices.
		C	5	4	5	5	5	5		
		R	10	8	5	5	5	5		

Table C6: Activities associated with decommission in situ minor intervention method (Option 4)

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Mobilisation & demobilisation operations	• Marine mob & demob ops • Quayside lifting to and from vessel • Manual handling • Loading & Offloading operations • Machinery and Equipment operations	L	2	2						The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4	4						
		R	8	8						
Transit to and from site	• Marine vessel operations • Normal crew operations, working practices and maintenance	L	2							Risk may increase during unfavourable weather conditions
		C	3							
		R	6							
Pre & post-decommissioning surveys (e.g. side scan sonar & ROV)	• General vessel operations • Lifting operations • Towing operations • Machine and equipment operations	L	2		2	2	2	2		Operations present a very low snagging risk. Greatest risk is associated with fisherman hauling ropes, nets and creels on board
		C	4		3	1	1	1		
		R	8		6	2	2	2		
Overtrawl survey	• General vessel operations • Lifting and deployment operations • Chain mat towing operations • Machine and equipment operations	L	3		2	2	2	2		Equipment deployment from contracted fishing vessel, undertaken by experience crews. No known fatalities as a result of operations
		C	3		3	1	1	1		
		R	9		6	2	2	2		
Infrastructure remaining on the seabed	• Potential snagging hazard	L			2		2	1		Not considered applicable as no exposed sections of pipeline remaining on seabed.
		C			5		1	1		
		R			10		2	1		
Excavation & cutting - subsurface	• General vessel operations • Diver operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4		1	1	1	1		
		R	8		1	1	1	1		
Lifting & removal – lifting mattresses and pipeline to vessel	• General vessel operations • Diver operations • Lifting operations • Machine and equipment operations	L	2		1	1	1	1		Controlled lifts have an inherent risk due to unknown integrity of the pipework and mattresses. The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Assessment of integrity of materials. If degraded, mattresses will be left in situ.
		C	4		1	1	1	1		
		R	8		1	1	1	1		

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Rock-placement & burial operations	• General vessel operations • Fall pipe deployment operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		Only addresses rock-placement operations. Not considered further in the application as rock placement will follow industry standards and therefore have no perceived risk.
		C	3		1	1	1	1		
		R	6		1	1	1	1		
Presence of rock-placement material	• Creation of a snagging hazard	L			1		2	2		Localised impact. Would only impact on small creel vessels with minimal crew complements. Overtrawl trials will be undertaken following deployment of rock. It is noted that there will be more rock than Option 5, but the risk is still considered to be minimal.
		C			4		1	1		
		R			4		2	2		
Waste Transportation, disposal & recycling	• General vehicle operations – Road haulage • Lifting operations • Machine and equipment operations	L		1					1	A small volume of pipework resulting from removed cut end sections will only require a small number of lorries for onshore transport.
		C		4					4	
		R		4					4	
Exposure to hazardous substances	• Cleaning operations • Lifting operations • Diving operations • Cutting operations	L	2	2					1	Appropriate PPE will be worn at all times, there will be minimal contact opportunity due to appropriate health and safety practice adherence
		C	4	4					3	
		R	8	8					3	
Unplanned events	• Oil spill • Collision risk • Dropped objects • Fire or explosion • Unfavourable weather conditions • Risk of grounding	L	2	2	1	1	1	1		Unplanned events are post mitigation. They have low probabilities due to good working practices and adherence to appropriate Health and Safety guidance and practices.
		C	5	4	5	5	5	5		
		R	10	8	5	5	5	5		

Table C7: Activities associated with partial removal cut and lift method (Option 3)

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Mobilisation & demobilisation operations	• Marine mob & demob ops • Quayside lifting to and from vessel • Manual handling • Loading & Offloading operations • Machinery and Equipment operations	L	2	2						The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4	4						
		R	8	8						
Transit to and from site	• Marine vessel operations • Normal crew operations, working practices and maintenance	L	2							Risk may increase during unfavourable weather conditions
		C	3							
		R	6							
Pre & post-decommissioning surveys (e.g. side scan sonar & ROV)	• General vessel operations • Lifting operations • Towing operations • Machine and equipment operations	L	2		2	2	2	2		Operations present a very low snagging risk. Greatest risk is associated with fisherman hauling ropes, nets and creels on board
		C	4		3	1	1	1		
		R	8		6	2	2	2		
Overtrawl survey	• General vessel operations • Lifting and deployment operations • Chain mat towing operations • Machine and equipment operations	L	3		2	2	2	2		Equipment deployment undertaken from contracted small fishing vessel. Crews are experienced in this type of survey. There are no known fatalities as a result of these operations
		C	3		3	1	1	1		
		R	9		6	2	2	2		
Infrastructure remaining on the seabed	• Potential snagging hazard	L			2		2	1		Infrastructure left in place will be marked on navigation charts. Not considered applicable as no exposed sections of pipeline remaining on seabed.
		C			5		1	1		
		R			10		2	1		
Excavation & cutting - subsurface	• General vessel operations • Diver operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4		1	1	1	1		
		R	8		1	1	1	1		
Lifting & removal – lifting mattresses and pipeline to vessel	• General vessel operations • Diver operations • Lifting operations • Machine and equipment operations	L	2		1	1	1	1		Controlled lifts have an inherent risk due to unknown integrity of the pipework and mattresses. The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Assessment of integrity of materials. If degraded, mattresses will be left in situ.
		C	4		1	1	1	1		
		R	8		1	1	1	1		

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
lacement & burial operations	• General vessel operations • Fall pipe deployment operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		Only addresses rock placement operations
		C	3		1	1	1	1		
		R	6		1	1	1	1		
Presence of rock-placement material	• Creation of a snagging hazard	L			1		1	1		Localised impact. Not considered further in the application as rock placement will follow industry standards and therefore have no perceived risk.
		C			4		1	1		
		R			4		1	1		
Waste transportation, disposal & recycling	• General vehicle operations – Road haulage • Lifting operations • Machine and equipment operations	L		2					2	Moderate lorry numbers will carry the cut end sections.
		C		4					4	
		R		8					8	
Exposure to hazardous substances	• Cleaning operations • Lifting operations • Diving operations • Cutting operations	L	2	2					1	Appropriate PPE will be worn at all times, there will be minimal contact opportunity due to appropriate health and safety practice adherence
		C	4	4					3	
		R	8	8					3	
Unplanned events	• Oil spill • Collision risk • Dropped objects • Fire or explosion • Unfavourable weather conditions • Risk of grounding	L	2	2	1	1	1	1		Unplanned events are post mitigation. They have low probabilities due to good working practices and adherence to appropriate Health and Safety guidance and practices. Dropped Objects - Pipeline integrity: concrete in pipeline sections may be dislodged during retrieval
		C	5	4	5	5	5	5		
		R	10	8	5	5	5	5		

Table C8: Activities associated with full removal cut and lift (Option 2)

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Mobilisation & demobilisation operations	• Marine mob & demob ops • Quayside lifting to and from vessel • Manual handling • Loading & Offloading operations • Machinery and Equipment operations	L	3	3						The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials The demobilisation operations will involve offloading of the whole pipeline with multi-vessel operations (CSVs) and multiple lifts. Scored as 3 to reflect confidence in controls and mitigation.
		C	4	4						
		R	12	12						
Transit to and from site	• Marine vessel operations • Normal crew operations, working practices and maintenance	L	3							Increased expose to unfavourable weather conditions is likely due to the increase in vessel transits
		C	3							
		R	9							
Pre & post-decommissioning surveys (e.g. side scan sonar & ROV)	• General vessel operations • Lifting operations • Towing operations • Machine and equipment operations	L	2		2	2	2	2		Operations present a very low snagging risk. Greatest risk is associated with fisherman hauling ropes, nets and creels on board
		C	4		3	1	1	1		
		R	8		6	2	2	2		
Overtrawl survey	• General vessel operations • Lifting and deployment operations • Chain mat towing operations • Machine and equipment operations	L	3		2	2	2	2		Equipment deployment undertaken from contracted small fishing vessel. Crews are experienced in this type of survey. There are no known fatalities as a result of these operations
		C	3		3	1	1	1		
		R	9		6	2	2	2		
Infrastructure remaining on the seabed	• Potential snagging hazard	L			1		1	1		Not considered further in the application as there will be full removal/ all 19 crossings will be under rock placement. All remaining infrastructure will be recorded on navigation charts.
		C			5		1	1		
		R			5		1	1		
Excavation & cutting - subsurface	• General vessel operations • Diver operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	3		1	1	1	1		The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials
		C	4		1	1	1	1		
		R	12		1	1	1	1		

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Lifting & removal – lifting mattresses and pipeline to vessel	• General vessel operations • Diver operations • Lifting operations • Machine and equipment operations	L	3		1	1	1	1		Controlled lifts have an inherent risk due to unknown integrity of the pipework and mattresses. The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Assessment of integrity of materials. If degraded mattresses will be left in situ.
		C	4		1	1	1	1		
		R	12		1	1	1	1		
Rock-placement & burial operations	• General vessel operations • Fall pipe deployment operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		Only addresses rock-placement operations on cut ends and crossings.
		C	3		1	1	1	1		
		R	6		1	1	1	1		
Presence of rock-placement material	• Creation of a snagging hazard	L			1		1	1		Localised impact. Not considered further in the application as rock placement will follow industry standards and therefore have no perceived risk.
		C			4		1	1		
		R			4		1	1		
Waste transportation, disposal & recycling	• General vehicle operations – Road haulage • Lifting operations • Machine and equipment operations	L		3					2	High lorry numbers will be required carry the pipeline sections.
		C		4					4	
		R		12					8	
Exposure to hazardous substances	• Cleaning operations • Lifting operations • Diving operations • Cutting operations	L	2	2					1	Appropriate PPE will be worn at all times, there will be minimal contact opportunity due to appropriate health and safety practice adherence
		C	4	4					3	
		R	8	8					3	
Unplanned events	• Oil spill • Collision risk • Dropped objects • Fire or explosion • Unfavourable weather conditions • Risk of grounding	L	2	2	2	2	2	2		Unplanned events are post mitigation. They have low probabilities due to good working practices and adherence to appropriate Health and Safety guidance and practices. Increased number and duration of decommissioning activities leading to increased risk.
		C	5	4	5	5	5	5		
		R	10	8	10	10	10	10		

Table C9: Activities associated with full removal reverse s-lay/ reel (Option1)

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Mobilisation & demobilisation operations	• Marine mob & demob ops • Quayside lifting to and from vessel • Manual handling • Loading & Offloading operations • Machinery and Equipment operations	L	3	3						The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials There will be an increase in the number of lifts.
		C	4	4						
		R	12	12						
Transit to and from site	• Marine vessel operations • Normal crew operations, working practices and maintenance	L	3							Increased expose to unfavourable weather conditions is likely due to the increase in vessel transits.
		C	3							
		R	9							
Pre & post-decommissioning surveys (e.g. side scan sonar & ROV)	• General vessel operations • Lifting operations • Towing operations • Machine and equipment operations	L	2		2	2	2	2		Operations present a very low snagging risk. Greatest risk is associated with fisherman hauling ropes, nets and creels on board.
		C	4		3	1	1	1		
		R	8		6	2	2	2		
Overtrawl survey	• General vessel operations • Lifting and deployment operations • Chain mat towing operations • Machine and equipment operations	L	3		2	2	2	2		Equipment deployment undertaken from contracted small fishing vessel. Crews are experienced in this type of survey. There are no known fatalities as a result of these operations.
		C	3		3	1	1	1		
		R	9		6	2	2	2		
Infrastructure remaining on the seabed	• Creates a potential snagging hazard	L			1		1	1		Not considered further in the application as there will be full removal/ all 19 crossings will be under rock placement. All remaining infrastructure will be recorded on navigation charts.
		C			5		1	1		
		R			5		1	1		
Excavation & cutting - subsurface	• General vessel operations • Diver operations • Lifting for ROV deployment • Machine and equipment operations	L	3		2	2	2	2		The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Integrity of materials Increased volume of operations will lead to an increase in potential risk.
		C	4		1	1	1	1		
		R	12		2	2	2	2		
Pipeline control during S-lay operations	• General vessel operations • Machine and equipment operations	L	2		1					Risk when disconnect, loss of concrete coat may occur during retrieval. However debris contained during operations. Unknown integrity of pipework and coating material.
		C	4		1					
		R	8		1					

Operation/End-Point	Potential Impact		Risk to Personnel Offshore	Risk to Personnel Onshore	Commercial fishing	Shipping	Other commercial users	Recreation users	Onshore Communities	Additional Justification
Cutting and Lift – on deck	• General vessel operations • Lifting and reeling operations • Machine and equipment operations	L	2							Risk when disconnecting umbilical, loss of concrete coat may occur during retrieval. However debris contained during operations. Unknown integrity of pipework and coating material.
		C	4							
		R	8							
Lifting & removal – lifting mattresses and pipeline to vessel	• General vessel operations • Diver operations • Lifting operations • Machine and equipment operations	L	3		1	1	1	1		Controlled lifts have an inherent risk due to unknown integrity of the pipework and mattresses. The majority of risks from routine operations are mitigated against through: • Adherence to health and safety requirements • Controlled working environment • Assessment of integrity of materials. If degraded mattresses will be left in situ. Includes full removal of all mattresses where safe to do so.
		C	4		1	1	1	1		
		R	12		1	1	1	1		
Rock-placement & burial operations	• General vessel operations • Fall pipe deployment operations • Lifting operations • ROV deployment operations • Machine and equipment operations	L	2		1	1	1	1		This is in relation to placement on cut ends and crossings. Not considered further in the application as rock placement will follow industry standards and therefore have no perceived risk.
		C	3		1	1	1	1		
		R	6		1	1	1	1		
Presence of rock-placement material	• Creation of a snagging hazard	L			1		1	1		Localised impact. Would only impact on small fishing vessels typically with small crew compliments.
		C			4		1	1		
		R			4		1	1		
Waste transportation, disposal & recycling	• General vehicle operations – Road haulage • Lifting operations • Machine and equipment operations	L		3					2	High lorry numbers will be required carry the pipeline sections.
		C		4					4	
		R		12					8	
Exposure to hazardous substances	• Cleaning operations • Lifting operations • Diving operations • Cutting operations	L	2	2					1	Appropriate PPE will be worn at all times, there will be minimal contact opportunity due to appropriate health and safety practice adherence. Includes onshore cutting operations for Reel.
		C	4	4					3	
		R	8	8					3	
Unplanned events	• Oil spill • Collision risk • Dropped objects • Fire or explosion • Unfavourable weather conditions • Risk of grounding	L	2	2	2	2	2	2		Unplanned events are post mitigation. They have low probabilities due to good working practices and adherence to appropriate Health and Safety guidance and practices. Increased number and duration of decommissioning activities leading to increased risk.
		C	5	4	5	5	5	5		
		R	10	8	10	10	10	10		

Table C10: Safety risk scores

Activity	Option 1 Total Score	Option 1 Number of Receptors per Risk Class	Option 2 Total Score	Option 2 Number of Receptors per Risk Class	Option 3 Total Score	Option 3 Number of Receptors per Risk Class	Option 4 Total Score	Option 4 Number of Receptors per Risk Class	Option 5 Total Score	Option 5 Number of Receptors per Risk Class
Mob/ demob operations.	24	0	24	0	16	0	24	0	24	0
		0		0		2		2		2
		2		2		0		0		0
		0		0		0		0		0
Transit to and from offshore sites	9	0	9	0	6	0	6	0	6	0
		1		1		1		1		1
		0		0		0		0		0
		0		0		0		0		0
Pre & post-decommissioning surveys (e.g. side scan sonar & ROV)	20	3	20	3	20	3	20	3	20	3
		2		2		2		2		2
		0		0		0		0		0
		0		0		0		0		0
Overtrawl survey	21	3	21	3	21	3	21	3	21	3
		2		2		2		2		2
		0		0		0		0		0
		0		0		0		0		0
Infrastructure remaining on the seabed	7	0	7	0	13	0	0	0	13	2
		0		0		0		0		1
		0		0		0		0		0
		0		0		0		0		0
Excavation & cutting - subsurface	20	4	16	4	17	4	13	4	13	4
		0		0		1		1		1
		1		1		0		0		0
		0		0		0		0		0

Activity	Option 1 Total Score	Option 1 Number of Receptors per Risk Class	Option 2 Total Score	Option 2 Number of Receptors per Risk Class	Option 3 Total Score	Option 3 Number of Receptors per Risk Class	Option 4 Total Score	Option 4 Number of Receptors per Risk Class	Option 5 Total Score	Option 5 Number of Receptors per Risk Class
Lifting & removal – lifting mattresses and pipeline to vessel	16	4	16	4	12	4	12	4	12	4
		0		0		1		1		1
		1		1		0		0		1
		0		0		0		0		0
Rock-placement & burial operations	10	0	10	0	10	0	10	0	10	0
		0		0		0		0		0
		0		0		0		0		0
		0		0		0		0		0
Presence of rock-placement material	6	3	6	3	6	3	8	3	6	3
		0		0		0		0		0
		0		0		0		0		0
		0		0		0		0		0
Pipeline control during S-lay operations	9	1								
		1								
		0								
		0								
Cutting and Lift – on deck	8	0								
		1								
		0								
		0								

Activity	Option 1 Total Score	Number of Receptors per Risk Class	Option 2 Total Score	Number of Receptors per Risk Class	Option 3 Total Score	Number of Receptors per Risk Class	Option 4 Total Score	Number of Receptors per Risk Class	Option 5 Total Score	Number of Receptors per Risk Class
Exposure to hazardous substances	19	1	19	1	19	1	19	1	19	1
		2		2		2		2		2
		0		0		0		0		0
		0		0		0		0		0
Waste transportation, disposal & recycling	20	0	20	0	16	0	8	2	8	2
		1		1		2		0		0
		1		1		0		0		0
		0		0		0		0		0
Unplanned events	58	0	58	0	38	0	38	0	38	0
		6		6		6		6		6
		0		0		0		0		0
		0		0		0		0		0
Total Score	247		226		194		179		190	

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Comparison of Options

The comparison shown below ranks the options in reverse order of the magnitude of the respective overall qualitative safety risk, i.e. the best performing option has the lowest overall risk score.

Table C11. Summary of safety assessment outcome

Option	Safety risk
4: Decommission in situ - Minor Intervention	179
3: Partial Removal - Cut and Lift	194
5: Decommission in situ - Minimum Intervention	190
2: Full Removal - Cut and Lift	226
1: Full Removal Reverse S-lay or Reel	247

References

OGP, 2008. Diving Recommended Practice. Report No. 411. June 2008. International Association of Oil & Gas Producers, London, United Kingdom. www.ogp.org.uk/pubs/411.pdf

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APPENDIX D

ASSESSMENT OF ENVIRONMENTAL AND SOCIETAL RISKS

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Introduction

This appendix provides the methodology and results of the qualitative assessment of environmental and societal risk. The assessment enabled a distinction to be made between four categories of risk: High, Significant, Medium and Low. Differentiation between options was based on the total number and characteristics of potential impacts associated with each decommissioning option assessed against these risk categories. The results of environmental and societal components of the risk assessment were compared separately.

Method

Following the Feasibility Assessments, Environmental and Social Risk Assessments were undertaken for the five decommissioning options carried forward. These assessments were undertaken using the following method:

1. Each decommissioning option was broken into its component activities/ operations and end points (e.g. rock-placement, cutting of pipeline sections excavation of buried pipeline and waste in landfill).
2. Receptors at risk (elements of society or the environment) were identified from the potential operational impacts and end-point impacts:
   - Environment (Physical, Chemical and Biological):
     i. Marine environmental impacts/ risks, including operational and end-point impacts/ risks.
     ii. Onshore environmental impacts/ risks, including operational and end-point impacts/ risks.
   - Societal:
     i. Risk to other users of the sea (i.e. fishermen and non-project shipping, including end-point risks from the long-term presence of the pipeline as appropriate).
     ii. Risk to those on land (i.e. onshore transport, quayside lifting operations, waste management, recycling and disposal).
3. The significance of the potential environmental impacts and risks were assessed according to pre-defined criteria. These criteria recognise the likely effectiveness of planned mitigation measures to minimise or eliminate potential impacts/ risks.
4. Assessments were undertaken to determine what level of impacts/ risks the component activity/ operation could pose to the different groups of environmental or societal receptors. The following Scoring Criteria and Risk Matrix were applied to complete the worksheets:
   - ConocoPhillips' Consequence Severity Description (Table D1).
   - ConocoPhillips' Likelihood Matrix (Table D2).
5. The biodiversity impact column was used to assess the consequence and/or severity of the potential impact to the environmental receptors and the socio-cultural

economic impact column was used for socioeconomic receptors. Consideration was also given to the potential remediation costs and exposure when appropriate.

6. The overall risk for a particular activity was determined by ConocoPhillips’ Risk Matrix and Risk Categories (Table D3).

The results were noted on the environmental and societal risk assessment worksheets alongside any relevant comments.

The assessments resulted in the completion of risk assessment worksheets to address any general activities associated with the decommissioning activities and specific activities associated with the decommission in situ, Partial and Full Removal options for the pipelines. Activities were assessed across all pipelines within VDP2 and VDP3 for tables D4-D7. Table D8 provides and assessment of activities which relate specifically to activities associated with the decommissioning of the concrete coated export pipeline PL27 in VDP2.

Table D1: Consequence and Severity Description

	Consequence – Severity Description (most severe down to least severe)			
Category	Socio-Cultural Economic Impact	Biodiversity Impact	Environmental Impact (Remediation Costs)	Negative Public Image Exposure
5	• Permanent loss of access or use of area with permanent reduction in associated community; • Major economic impact to surrounding community; • Irrevocable loss of culture resources; • Scale typically widespread (national or greater level).	• *Very High*: • Catastrophic loss of natural resources or biodiversity typically over a widespread area, with permanent or long-term consequences; and/ or • Irrevocable loss of regionally unique habitat, legally designated conservation site or intact ecosystems. • No mitigation possible.	> $10,000,000	International Coverage
4	• Permanent partial restriction on access or use, or use, or total restriction >10 years in duration; • Temporary reduction in quality of life > 10 years duration; • Harm to cultural resources requiring major mitigation; • Scale typically regional to national level.	• *High*: • Persistent environmental degradation within and beyond the project area, typically with prospects of short-to medium term recovery if the cause of the impact is removed or by natural abatement processes and/ or • Serious loss of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Mitigation only possible through prolonged and resource intensive effort (>50 years).	$1,000,000 to $10,000,000	National Coverage
3	• Temporary restriction <10 years in duration with a moderate reduction in usage levels or quality of life; • Harm to cultural resources recoverable through moderate mitigation efforts; • Scale typically local to regional level.	• *Medium*: • Persistent environmental degradation within and close to the project area, localised within defined areas, typically with prospects of rapid recovery if cause of the impact is removed or by natural abatement processes and/ or	$100,000 to $1,000,000	Regional coverage

	Consequence – Severity Description (most severe down to least severe)			
Category	Socio-Cultural Economic Impact	Biodiversity Impact	Environmental Impact (Remediation Costs)	Negative Public Image Exposure
		• Temporary, but reversible loss of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Moderate mitigation efforts required (>1 to 50 years).		
2	• Brief restriction <5 years in duration with a minor reduction in usage levels or quality of life; • Minor harm to cultural resources that is recoverable through minor mitigation efforts; • Scale typically localised.	• *Low*: • Temporary environmental degradation, typically within and close to project area, with good prospects of short-term recovery; and/ or • Brief, but reversible loss of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Minor mitigation efforts required (<1 year).	$10,000 to $ 100,000	Local Coverage
1	• Restrictions on access without loss of resources; • Temporary but fully reversible impacts on quality of life; • Minor impact on cultural resources; • Typically transient and highly localised.	• *Negligible*: • Highly transitory or highly localised environmental degradation typically contained within the project area and noticeable/ measurable against background only within or in very close proximity to the project area; and/ or • Some minor loss of unique habitat or legally designated conservation site or intact ecosystems within area of study. • Naturally and completely reversible.	$0 to $10,000	No Outside Coverage

Table D2: Likelihood Matrix

Likelihood (most likely down to least likely)			
Category	One word descriptor	Description	Quantitative Range per Year[1]
5	Frequent	• Likely to occur several times a year. • Very high likelihood	$>10^{-1}$
4	Probable	• Expected to occur at least once in 10 years. • High likelihood	10^{-3} to 10^{-1}
3	Rare	• Occurrence considered rare. • Moderate likelihood	10^{-4} to 10^{-3}
2	Remote	• Not expected nor anticipated to occur. • Low likelihood	10^{-6} to 10^{-4}
1	Improbable	• Virtually improbable and unrealistic. • Very low likelihood	$<10^{-6}$

[1] The values in the Quantitative Range are be used as guidance in selecting the appropriate likelihood of occurrence of an impact resulting from unplanned / accidental activities.

Table D3: ConocoPhillips Risk Matrix and Risk Categories

Risk Matrix						
Likelihood	5	II 5	II 10	III 15	IV 20	IV 25
	4	I 4	II 8	III 12	III 16	IV 20
	3	I 3	II 6	II 9	III 12	III 15
	2	I 2	I 4	II 6	II 8	II 10
	1	I 1	I 2	I 3	I 4	II 5
		1	**2**	**3**	**4**	**5**
		Consequence Category*				

* Biodiversity and/or socioeconomic considerations take precedence, for all other factors the worst case score should be assumed from the severity descriptions

Score	Risk Categories	
IV: 17-25	High	High Risk. Manage risk utilising prevention and/ or mitigation with highest priority. Promote issue to appropriate management level with commensurate risk assessment detail.
III: 12-16	Significant	Significant Risk. Manage risk utilising prevention and/ or mitigation with priority. Promote issue to appropriate management level a with commensurate risk assessment detail.
II: 5-10	Medium	Medium Risk with Controls Verified. No mitigation required where controls can be verified as functional.
I: 1-4	Low	Low Risk. No mitigation required.

Table D4: Activities associated with general decommissioning activities (applicable to all options)

Operation or End-Point	Potential Impact	Mitigation	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
				Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																								
Physical presence vessels during transit between port and the offshore sites.	• Localised and transient obstruction to fishing vessels and shipping	• Route-planning • 24hr manned bridge policy • Use of vessel AIS positioning • Navigation aids • Communications • Good seamanship • Consent to locate for vessels • Notice to mariners and consultation with National Federation of Fishermen's Organisation (NFFO)	L															3	3	2	2	2		Shipping/ fishing traffic can readily navigate round the individual vessels as they travel to and from the offshore site.
			C															1	1	1	1	1		
			R															3	3	2	2	2		
Physical presence of vessels, divers, ROVs and other equipment during operations at the offshore sites. Note: Impacts assessed are in relation to areas out with the 500 m exclusion zones.	• Localised and transient obstruction to fishing vessels and shipping • Increased risk of vessel collision	• Project planning • Use of corridors for vessel movements • Small discrete operations • 24 hr manned bridge policy • Notice to mariners and consultation with NFFO • AIS in operation on decommissioning vessels • Navigation aids • Regular stakeholder engagement • Consent to locate for vessels.	L															4	3	2	2	2		Shipping/ fishing traffic can readily navigate round the vessel spread at any given stage during the work programme.
			C															1	1	1	1	1		
			R															4	3	2	2	2		

Key: L= Likelihood; C= Consequence, R= Risk.

Table D4: (continued): Activities associated with general decommissioning activities (applicable to all options)

Operation or End-Point	Potential Impact	Mitigation	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
				Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																								
Footprint of jack-up accommodation work vessel for preparation and cleaning.	• Disturbance to the seabed from jack-up legs. • Potential impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*.	• Pre-planning of vessel location • Safe operation • Pre-surveys of area. • As-left survey • Post-decommissioning monitoring programme	L		4					4		4			2	4								ConocoPhillips will endeavour to site the vessel away from potential receptors.
			C		2					1		1			1	2								
			R		8					4		4			2	8								
Underwater noise associated with vessel engines, Dynamic Positioning thrusters and on-board equipment.	• Avoidance behaviour in sea mammals, fish and birds.	• Regular maintenance to vessel engines and equipment • Power management systems will be in place	L									2	3	1		3								Divers won't be operating subsea in an area where lots of acoustic activity is expected. Low presence of marine mammals in area, No Marine Mammal Observers (MMOs) will be on-board the vessels during routine decommissioning operations.
			C									1	1	1		1								
			R									2	3	1		3								
Underwater noise associated with the use of sonar and other acoustic survey equipment.	• Avoidance behaviour in sea mammals, fish and birds.	• Regular maintenance to vessel engines and equipment • Power management systems will be in place	L									2	3	1		3								Sound is not within frequency range of the Marine Strategy Framework Directive indicator for loud, low and mid-frequency sounds. The southern North Sea cSAC for harbour porpoise has been considered here.
			C									1	1	1		1								
			R									2	3	1		3								

Key: L= Likelihood; C= Consequence, R= Risk.

Table D4 (continued): Activities associated with general decommissioning activities (applicable to all options)

Operation or End-Point	Potential Impact	Mitigation	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
				Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																								
Operational discharges of treated oily bilge.	• Deterioration in water quality.	• Separation systems for oil recovery from bilge • Discharges of oil bilge to marine environment will be within permitted levels of 15 ppm	L			5					5	5												Any discharge will be within permitted limits.
			C			1					1	1												
			R			5					5	5												
Wastes produced from onsite vessels	• Use of waste disposal resources and landfill capacity onshore.	• Materials will be reused or recycled where possible thereby minimising landfill requirements • Compliance with relevant waste legislation and duty of care • Use of designated licensed sites only • Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal	L				5										5							Storage and removal arrangements on the vessels will ensure minimal impact to environment. Small-scale use of landfill capacity for non-reusable and non-recyclable wastes.
			C				1										1							
			R				5										5							
Sewage and grey water discharges.	• Localised increase in biological oxygen demand (BOD) around the point of discharge. • Slight deterioration in seawater quality around the point of discharge.	• Sewage and grey water will be screened as minimum requirement prior to disposal at sea, or contained and shipped to shore • Vessels will be audited to ensure compliance	L			5					5	5												Sewage (organic material only) will be broken down and readily dispersed in the offshore environment. This will result in a localised transient impact with the discharge dissipating to background concentrations within relatively short distance.
			C			1					1	1												
			R			5					5	5												
Macerated food waste discharge.	• Deterioration in water quality. • Localised increase in BOD around the point of discharge.	• Food waste will be macerated prior to discharge; this will aid its dispersal and decomposition in the water column	L			5					5	5												Macerated food waste (organic material only) will be broken down and readily dispersed in the offshore environment. The particles of food waste will be <25 mm in diameter, and will be rapidly and widely dispersed in the water column.
			C			1					1	1												
			R			5					5	5												

Key: L= Likelihood; C= Consequence, R= Risk.

Table D4 (continued): Activities associated with general decommissioning activities (applicable to all options)

Operation or End-Point	Potential Impact	Mitigation	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
				Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																								
Ballast water uptake and discharge from the vessels on site.	• Introduction of non-native species into the water column.	• Adherence to the International Convention for the Control and Management of Ships' Ballast Water and Sediments	L							5	5	5			5	5								ConocoPhillips' adherence to the International Convention for the Control and Management of Ships' Ballast Water is expected to mitigate any potential transboundary, cumulative or global impact that may result from the transfer of organisms
			C							1	1	1			1	1								
			R							5	5	5			5	5								
Atmospheric emissions from vessels.	• Deterioration in air quality and contribution to global atmospheric impacts.	• Vessels will use ultra-low sulphur fuel in line with MARPOL requirements • Regular maintenance to vessel engines and equipment • Power management systems will be in place	L				5																	The emissions will be a small-scale contributor of GHGs and other global gases. Localised transient impact in the vicinity of the exhausts. The atmospheric emissions will disperse in the exposed offshore environment.
			C				1																	
			R				5																	
Atmospheric emissions from helicopters.	• Deterioration in air quality and contribution to global atmospheric impacts.	• Regular maintenance to helicopter engines and equipment • Power management systems will be in place • Industry standard controls based on routine and planned maintenance	L				5																	Small scale contributor of GHGs and other global gases. Localised transient impact in the vicinity of the exhausts. Emissions disperse during flight and the exposed offshore environment.
			C				1																	
			R				5																	

Key: L= Likelihood; C= Consequence, R= Risk.

Table D4 (continued): Activities associated with general decommissioning activities (applicable to all options)

Operation or End-Point	Potential Impact	Mitigation	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
				Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																								
Overboard disposal of the flushed pipeline contents	• Some associated deterioration of water quality. • Potential effect on plankton, fish, shellfish and marine mammals.	• Pipeline contents will be filtered and the hydrocarbons removed Remaining 'clean' flushing will be disposed of down disposal well • Permits required to undertake these operations • Any solids recovered will be taken to shore	L																					The risks associated with the overboard disposal of the flushed pipeline contents will be covered in the Decommissioning Environmental Statement. This will be consistent across the pipelines and will meet BEIS requirements.
			C																					
			R																					
Unplanned Operations																								
Dropped objects	• Disturbance to the seabed, water quality and benthos. • Potential obstruction to commercial fishing and other commercial users of the sea.	• Adhere to lifting and handling procedures and use of certified equipment for lifting • Retrieve major items of debris from the seabed after operations, in compliance with relevant legislation • Undertake a debris/ sweep survey after completion of operations	L																					Predominantly a safety risk and not covered in the workshop. The risks associated with dropped objects will be covered in the Decommissioning Environmental Statement.
			C																					
			R																					
			L																					
			C																					
			R																					

Key: L= Likelihood; C= Consequence, R= Risk.

Table D5: Activities associated with decommission in situ methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Dredging operations to water jet out pipeline at each end (diver operated).	• Displacement and redistribution of seabed sediments. • Alteration of sediment structure and smothering of seabed organisms. • Deterioration of water quality with a potential effect on plankton, fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*. • The dredging operations will result in a hole approximately 9 m by 5m and ~ 2m deep at each pipeline end.	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations • ConocoPhillips will fill the hole with rock or another material after completion of the jetting or trenching operations, to prevent the hole from being left open	in situ: minimal intervention	L	3	3	2				3		2			2	2								All impacts will be small, localised and temporary. Any possible deterioration of water quality will be rapidly dispersed and diluted.
				C	1	1	1				1		1			1	1								
				R	3	3	2				3		2			2	2								
			in situ: minor intervention	L	3	3	2				3		2			2	2								
				C	1	1	1				1		1			1	1								
				R	3	3	2				3		2			2	2								
Rock placed on the seabed to fill the hole created by the dredging operation and cover the pipeline ends (as above)	• Change of habitat type and therefore benthic community • Snagging hazard for the commercial fisheries. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SACs which are protected areas for both sandbanks and the biogenic reef forming worm Sabellaria spinulosa.	• The use of a fall pipe to ensure accurate placement of rock • On-going consultation with fisheries representatives such as the NFFO • The placement of rock will be designed to be overtrawlable • Subsea rock-placement will be included on navigational charts • Post-decommissioning seabed clearance and an overtrawlability survey within the 500 m safety zone. • Post-decommissioning monitoring of the pipelines • Remedial intervention in the event that burial and protection is found to be inadequate	in situ: minimal intervention	L	4	4					4		2			2	2		3						The cumulative impact to the SAC was taken into consideration when assessing the conservation site column.
				C	1	1					1		1			1	1		1						
				R	4	4					4		2			2	2		3						
			in situ: minor intervention	L	4	4					4		2			2	2		3						
				C	1	1					1		1			1	1		1						
				R	4	4					4		2			2	2		3						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D5 (continued): Activities associated with decommission in situ methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Cutting the pipelines with diamond wires.	• Alteration of sediment structure. • Some associated deterioration of water quality with a potential effect on fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*.	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations	in situ: *minimal intervention*	L	3		2						2			1	1								Discharges to the marine environment from the cutting operations will be single discrete releases. (See sections 9 and 11 of the ES) Concrete will be benign and last in environment for many years. The pipelines will be flooded before they are cut, result in the natural dissipation of the pipeline contents. If any NORM is released with the pipeline contents, the release will be localised.
				C	1		1						1			1	1								
				R	3		2						2			1	1								
			in situ: *minor intervention*	L	3		2						2			1	1								
				C	1		1						1			1	1								
				R	3		2						2			1	1								
Leaving behind unidentified mattresses	• Potentially a snagging hazard for trawlers if mattresses become exposed.	• All visible mattresses will be removed where it is feasible and safe to do so. A small number of damaged/ buried mattresses may be left behind (decommissioned in situ) • Any mattresses decommissioned in situ will be mapped on navigational charts.	in situ: *minor intervention*	L															2						No impact to marine environment is expected as mattresses have been in place for an extended length of time. Potential of unknown buried mattresses is low as the pipeline will be removed so any mattresses would be identified. Therefore it is only if these mattresses are too damaged to recover.
				C															1						
				R															2						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D5 (continued): Activities associated with decommission in situ methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Cover exposed or span sections with rock-placement *Note- this is only applicable for the "in situ" minor intervention" option*	• Change of habitat type and therefore benthic community • Potential snagging hazard for the commercial fisheries. • Increased scour	• The use of a fall pipe to ensure accurate placement of rock • On-going consultation with fisheries representatives such as the NFFO • The placement of rock will be designed to be overtrawlable • Subsea rock-placement will be included on navigational charts • Post-decommissioning seabed clearance. • Post-decommissioning monitoring of the pipelines. • Remedial intervention in the event that burial and protection is found to be inadequate	in situ: *minimal intervention*	L																					*This activity is only applicable for the* in situ *minor intervention option, and has therefore not been assessed for the* in situ *minimal intervention option.*
				C																					
				R																					
			in situ: *minor intervention*	L	5	5					5		5			2	4		3						Previous video footage of rock-placement on some of the pipelines indicates that the rock-placement has a short term impact, colonisation appears to have occurred relatively rapidly with marine growth but over time the profile either dissipates or is submerged by mobile sediments. As a result the group decided to score the consequence of seabed impacts in relation to sediment changes and SAC impacts as a maximum of 4. In addition the footprint of the rock-placement is small in comparison to the available habitat which is characteristic of the SACs associated with the pipelines being decommissioned.
				C	4	4					4		3			1	4		2						
				R	20	20					20		15			2	16		6						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D5 (continued): Activities associated with decommission in situ methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Re-burial (trench and bury) *Note- this is only applicable for the "in situ" minor intervention" option*	• Displacement and redistribution of seabed sediments. • Alteration of sediment structure and smothering of seabed organisms. • Deterioration of water quality with a potential effect on plankton, fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *S. spinulosa*.	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations	in situ: minimal intervention	L																					*This activity is only applicable for the* in situ *minor intervention" option, and has therefore not been assessed for the* in situ *minimal intervention" option.*
				C																					
				R																					
			in situ: minor intervention	L	4	4	4				4		4	4		3	3								All impacts will be small, localised and temporary in nature. Any possible deterioration of water quality will be rapidly dispersed and diluted. Additional consideration has been highlight through the assessment of potential impacts on Harbour porpoise given resent stakeholder concerns. Harbour porpoise may leave the area for a short period during decommissioning operations.
				C	1	2	1				2		1	2		2	3								
				R	4	8	4				8		4	8		6	9								
Waste management	• Use of waste disposal resources and landfill capacity onshore. • Small amount of marine growth and associated odours	• Materials will be reused or recycled where possible thereby minimising landfill requirements • Compliance with UK waste legislation and duty of care • Use of designated licensed sites only • Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal • Sections of pipeline will be taken on-board and assessed for NORM	in situ: minimal intervention	L					1														4	4	Includes the removal and disposal of concrete mattresses. Any cleaning required will be undertaken by a specialist contractor. The majority of pipelines will be steel and have a concrete coating. Cost of marine growth removal if brought onshore. Potential for NORM/ additional chemicals to be removed affecting other commercial users There will be fewer mattresses taken to landfill under minimum intervention, as only the mattresses requiring removal will be the ones moved for access during the pipeline cutting.
				C					2														2	2	
				R					2														8	8	
			in situ: minor intervention	L					1														4	4	
				C					2														2	2	
				R					2														8	8	
Bracelet anodes (Al/ Zn or Iridium) located around the pipelines to prevent corrosion.	• Deterioration of water quality. • Potential effect on benthos communities.	N/A	in situ: minimal intervention	L																					The dissipation of the low levels of components (Zinc and Aluminium) released over time could result in bioaccumulation in sediments. This has not been assessed as the anodes have already completely depleted in situ
				C																					
				R																					
			in situ: minor intervention	L																					
				C																					
				R																					

Table D5 (continued): Activities associated with decommission in situ methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Mattresses decommissioned in situ	• Snagging hazards	• Position mapped on navigational charts • Post-decommissioning surveys • Overtrawlability survey within current 500 m safety zone	in situ: *minimal intervention*	L													4		3						*This activity is only applicable for the in situ minimal intervention option, and has therefore not been assessed for the in si*tu minor intervention option. The associated impacts are expected to be small: • Mattresses are already in place for 12 to 40 years. • Surveys indicate that majority of mattresses are buried or partially buried. • No serious snagging incidents were recorded throughout their lifetime. Removal of mattresses would result in a requirement for rock placement to stabilise the pipeline.
				C													1		2						
				R													4		6						
Mattresses removed where safe to do so	• Snagging hazards • Seabed disturbance	• Small number of mattresses maybe decommissioned in situ – damaged or buried mattresses • Any mattresses decommissioned in situ will be mapped on navigational charts	in situ: *minor intervention*	L	4		4				4	4	2	2					4						*This activity is only applicable for the in situ minor intervention option, and has therefore not been assessed for the in situ minimal intervention option.* The associated impacts are expected to be small: • Mattresses are already in place for 12 to 40 years. • Surveys indicate that majority of mattresses are buried or partially buried. • No serious snagging incidents were recorded throughout their lifetime. Removal of mattresses would likely result in a requirement for rock placement to stabilise the pipeline.
				C	1		1				1	1	1	1					1						
				R	4		4				4	4	2	2					4						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D6: Activities associated with partial removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Dredging operations to water jet out pipeline at each end.	• Water jetting operations will result in the displacement and redistribution of seabed sediments. • Dredging operations will result in the: • Alteration of sediment structure and smothering of seabed organisms. • Some associated deterioration of water quality. • Potential effect on plankton, fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*. • The dredging operations will result in a hole approximately 9 m by 5m and ~ 2m deep at each pipeline end.	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations • ConocoPhillips will fill the hole with rock or another material after completion of the jetting or trenching operations	Cut and Lift	L	3	3	2				3		2	2		2	2								All impacts will be small, localised and temporary in nature. Any possible deterioration of water quality will be rapidly dispersed and diluted. Vessel positioning (anchoring) may also affect risk rating
				C	1	1	1				1		1	1		1	1								
				R	3	3	2				3		2	2		2	2								

Key: L= Likelihood; C= Consequence, R= Risk.

Table D6 (continued): Activities associated with partial removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Rock placed on the seabed to fill the hole created by the dredging operation (as above) and on cut ends where exposed sections have been removed	• Change of habitat type and therefore benthic community • Snagging hazard for the commercial fisheries. • Increased scour	• The use of a fall pipe to ensure accurate placement of rock • On-going consultation with fisheries representatives such as the NFFO • The placement of rock will be designed to be overtrawlable • Overtrawlability survey of the 500 m safety zone • Post-decommissioning seabed survey of full pipeline to provide positional information of pipeline at point of decommissioning • Post-decommissioning monitoring of the pipelines • Remedial intervention in the event that burial and protection is found to be inadequate	Cut and Lift	L	4	4					4		2			2	2		3						The dredging operations will result in a hole approximately 5m by 3m and ~ 2m deep at each pipeline end (as a worst case). The cumulative impact to the SAC was taken into consideration when assessing the conservation site column.
				C	2	2					2		2			2	2		1						
				R	8	8					8		4			4	4		3						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D6 (continued): Activities associated with partial removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Cutting the pipelines with diamond wires next to the platform.	• Alteration of sediment structure. • Some associated deterioration of water quality. • Potential effect on fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*.	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations	Cut and Lift	L	3		2						2			1	1								Discharges to the marine environment from the cutting operations will be single discrete releases. Any concrete released into the marine environment from the pipeline will be benign and last in environment for many years. The pipelines will be flooded before cutting, which will result in the natural dissipation of the pipeline contents. If any NORM is released with the pipeline contents it will be localised.
				C	1		1						1			1	1								
				R	3		2						2			1	1								
Cutting the pipelines with mechanical methods (Hydraulic shears)	• As above	• As above	Cut and Lift	L	3		2						2			1	1								As above
				C	1		1						1			1	1								
				R	3		2						2			1	1								
Waste management	• Use of waste disposal resources and landfill capacity onshore. • Sections of pipeline will be taken on-board and assessed for NORM. • Small amount of marine growth and associated odours	ConocoPhillips will have in place the following industry standard controls: • Materials will be reused or recycled where possible thereby minimising landfill requirements • Compliance with UK waste legislation and duty of care. • Use of designated licensed sites only • Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal	Cut and Lift	L					1													4		4	This includes the removal and disposal of concrete mattresses Any cleaning required will be undertaken by a specialist contractor. The majority of pipelines will be steel and have a concrete coating. Cost of marine growth removal if brought onshore Potential for NORM/ additional chemicals to be removed affecting other commercial users.
				C					2													2		2	
				R					2													8		8	

Key: L= Likelihood; C= Consequence, R= Risk.

Table D6 (continued): Activities associated with partial removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Bracelet anodes (Al/ Zn or Iridium) located around the pipelines to prevent corrosion.	• Deterioration of water quality. • Potential effect on benthos communities.	N/A	Cut and Lift	L																					The dissipation of the low levels of components (Zinc and Aluminium) released over time could result bioaccumulation in sediments. This has not been assessed as the majority of anodes have already deteriorated in situ and therefore there will be a negligible future impact.
				C																					
				R																					
Release of contaminants from within the pipelines as they are lifted from the seabed to the vessels onsite (applies to partial clean option and level of success of cleanliness to 30 ppm).	• Small loss of pipeline contents (contaminated sand) to the marine environment as the pipelines sections are lifted from the seabed to the vessels onsite. • These releases will result in: • Some associated deterioration of water quality. • Potential effect on plankton, fish, shellfish and marine mammals.	• As the sections of the pipeline are brought to the onsite vessels, they will be placed in a bunded area • Any spillage will be dealt with accordingly • Capped and sealed and any waste will be dealt with for treatment and disposal onshore • Permits required to undertake these operations	Cut and Lift	L	2		2				2	2	2												The infield hydrocarbon pipelines will contain: • Silica based (sand mix) content. • Sand with some NORM. • Condensate coated sand. • Traces of methanol, corrosion inhibitor (CI) and rust • Potentially mercury. The methanol pipelines will contain: • Methanol and CI. • Rust. Discharges will be rapidly dispersed and diluted in the offshore environment and will not be expected to significantly impact the benthos, water column, fish or marine mammals. (See sections 9 and 11 of the ES) **permit requirements to be confirmed
				C	1		2				1	1	1												
				R	2		4				2	2	2												

Key: L= Likelihood; C= Consequence, R= Risk.

Table D6 (continued): Activities associated with partial removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Mattresses removed where safe to do so	• Snagging hazards (where mattresses are left) • Seabed disturbance	• Small number of mattresses maybe decommissioned in situ – damaged or buried mattresses. • Any mattresses decommissioned in situ will be mapped on navigational charts.	Cut and Lift	L	4		4				4	4							4						The associated impacts are expected to be small: • Mattresses are already in place for 12 to 40 years. • Surveys indicate that majority of mattresses are buried or partially buried. • No serious snagging incidents were recorded throughout their lifetime. Removal of mattresses would likely result in a requirement for rock placement to stabilise the pipeline.
				C	1		1				1	1							1						
				R	4		4				4	4							4						
Leaving behind unidentified mattresses	Potentially a snagging hazard for trawlers if mattresses become exposed.	• All visible mattresses will be removed where it is feasible and safe to do so. A small number of damaged/ buried mattresses may be left behind (decommissioned in situ). • Any mattresses decommissioned in situ will be mapped on navigational charts.	Cut and Lift	L															2						No impact to marine environment is expected as mattresses have been in place for an extended length of time.
				C															1						
				R															2						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D7: Activities associated with full removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Dredging operations to water jet out pipeline.	• Water jetting operations will result in the displacement and redistribution of seabed sediments. • Dredging operations will result in the: • Alteration of sediment structure and smothering of seabed organisms. • Some associated deterioration of water quality. • Potential effect on plankton, fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*. • Along the length of the pipeline there may be sediment disturbance up to 500 m on each side of the pipeline	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations	Cut and Lift	L	3	3	2				3		2	2		2	2								All impacts will be small, localised and temporary in nature. Any sediment in the water column will be rapidly dispersed. Any associated deterioration in water quality will be short-lived.
				C	1	1	1				1		1	1		1	1								
				R	3	3	2				3		2	2		2	2								
			Reverse reel/ reverse S-lay	L	3	3	2				3		2	2		2	2								
				C	1	1	1				1		1	1		1	1								
				R	3	3	2				3		2	2		2	2								

Key: L= Likelihood; C= Consequence, R= Risk.

Table D7 (continued): Activities associated with full removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Cutting the pipelines with diamond wires.	• Alteration of sediment structure. • Some associated deterioration of water quality. • Potential effect on fish and shellfish. • Small area of impact in the North Norfolk Sandbanks and Saturn Reef SAC which is a protected area for both sandbanks and the biogenic reef forming worm *Sabellaria spinulosa*.	• Pre-decommissioning site data obtained from the operational phase and post-decommissioning surveys will be undertaken to determine the status of the pipeline and seabed before and after the proposed operations	Cut and Lift	L	3		2						2			1	1								Discharges to the marine environment from the cutting operations will be negligible discrete releases. Any concrete released into the marine environment from the pipeline will be benign and last in environment for many years. The pipelines will be flooded before they are cut, result in the natural dissipation of the pipeline contents. If any NORM is released in the pipeline contents will be localised
				C	1		1						1			1	1								
				R	3		2						2			1	1								
			Reverse reel/ reverse S-lay	L	3		2						2			1	1								
				C	1		1						1			1	1								
				R	3		2						2			1	1								
Cutting the pipelines with mechanical methods (Hydraulic shears)	• As above	• As above	Cut and Lift	L	3		2						2			1	1								As Above
				C	1		1						1			1	1								
				R	3		2						2			1	1								
			Reverse reel/ reverse S-lay	L	3		2						2			1	1								
				C	1		1						1			1	1								
				R	3		2						2			1	1								

Key: L= Likelihood; C= Consequence, R= Risk.

Table D7 (continued): Activities associated with full removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Waste management	• Use of waste disposal resources and landfill capacity onshore. • Sections of pipeline will be taken on-board and assessed for NORM. • Small amount of marine growth and associated odours.	• Materials will be reused or recycled where possible thereby minimising landfill requirements • Compliance with UK waste legislation and duty of care • Use of designated licensed sites only • Permits and traceable chain of custody for waste management, shipment, treatment and onshore disposal	Cut and Lift	L					2													4		4	This includes the removal and disposal of concrete mattresses Any cleaning required will be undertaken by a specialist contractor. The majority of pipelines will be steel and have a concrete coating. Cost of marine growth removal if brought onshore Potential for NORM/ additional chemicals to be removed affecting other commercial users
				C					1													2		2	
				R					2													8		8	
			Reverse reel/ reverse S-lay	L					2													4		4	
				C					1													2		2	
				R					2													8		8	

Key: L= Likelihood; C= Consequence, R= Risk.

Table D7 (continued): Activities associated with full removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Live crossings – Decommission in situ	• Snagging hazard • Damage to live pipelines/ cables	• Rock-placement/ trenching/ mattress cover of exposed ends • Marking and Notification to Mariners • Post-removal survey • Cutting up to 250 m from crossing point (worst case) • Review of crossing agreement and third party responsibilities	Cut and Lift	L															2						Remaining pipelines and associated protection are the responsibility of the operator/owner. Any potential release of hydrocarbons will be assessed in the Environmental Statement. There are 19 crossings over the VDP2 and VDP3 pipelines; these are detailed in the Pipeline burial report (BMT Cordah, 2015). Potentially a greater risk on PL27 due to the large number of crossings.
				C															1						
				R															2						
			Reverse reel/ reverse S-lay	L															2						
				C															1						
				R															2						
Release of contaminants from within the pipelines as they are lifted from the seabed to the vessels onsite (applies to partial clean option and level of success of cleanliness to 30 ppm).	• Some deterioration of water quality. • Potential effect on plankton, fish, shellfish and marine mammals.	• As the sections of the pipeline are brought to the onsite vessels, they will be placed in a bunded area • Any spillage will be dealt with accordingly • Capped and sealed and any waste will be dealt with for treatment and disposal onshore • This mitigation applies to reverse S-lay but not reverse reel. Pipeline will only be cut on the deck during reverse S-ay	Cut and Lift	L	2		2				2	2	2				2								The infield hydrocarbon pipelines will contain: • Silica based (sand mix) content. • Sand with some NORM. • Condensate coated sand. • Traces of methanol, corrosion inhibitor (CI) and rust • Potential mercury. The methanol pipelines will contain: • Methanol and CI. • Rust. Discharges will be rapidly dispersed and diluted in the offshore environment and will not be expected to significantly impact the benthos, water column, fish or marine mammals.
				C	1		2				1	1	1				2								
				R	2		4				2	2	2				4								
			Reverse reel/ reverse S-lay	L	2		2				2	2	2				2								
				C	1		2				1	1	1				2								
				R	2		4				2	2	2				4								

Key: L= Likelihood; C= Consequence, R= Risk.

Table D7 (continued): Activities associated with full removal methods

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
Planned Operations																									
Mattresses removed where safe to do so	• Snagging hazards (where mattresses are left) • Seabed disturbance	• Small number of mattresses maybe decommissioned in situ – damaged or buried mattresses • Any mattresses decommissioned in situ will be mapped on navigational charts	Cut and Lift	L	4		4				4	4							4						The associated impacts are expected to be small: • Mattresses are already in place for 12 to 40 years. • Surveys indicate that majority of mattresses are buried or partially buried. • No serious snagging incidents were recorded throughout their lifetime. • Removal of mattresses would result in a requirement for rock placement to stabilise the pipeline.
				C	1		1				1	1							1						
				R	4		4				4	4							4						
			Reverse Reel/ Reverse S-lay	L	4		4				4	4							4						The associated impacts are expected to be small: • Mattresses are already in place for 12 to 40 years. • Surveys indicate that majority of mattresses are buried or partially buried. • No serious snagging incidents were recorded throughout their lifetime. • Removal of mattresses would likely result in a requirement for rock placement to stabilise the pipeline.
				C	1		1				1	1							1						
				R	4		4				4	4							4						

Key: L= Likelihood; C= Consequence, R= Risk.

Table D8: Additional activities associated with decommissioning of specific pipelines

Operation or End-Point	Potential Impact	Mitigation	Method	Scoring Criteria	Physical and Chemical						Biological								Societal						Justification for Risk Ratings Assigned
					Sediment structure	Seabed Integrity/ Physical change	Water quality	Air quality	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Ecosystem Integrity	Conservation sites	Terrestrial flora & fauna	Commercial fishing	Shipping	Government, institution users (e.g. MOD)	Other commercial users	Recreation and amenity users	Onshore Communities (Resources)	
VDP2: PL27 – (Viking AR to TGT)																									
Planned Operations																									
Physical presence of vessels during Full Removal options	• Impacts to creel fishermen – disturbance to fishing activities, restriction on access to fishing grounds.	• Advanced notification • Regular stakeholder engagement	Cut and Lift	L															5						Increased length of time to undertake the decommissioning works. Creels located on pipeline. Not easy for creel fishermen to move to new grounds as fishing practice is quite territorial. Once seabed is disturbed, fishing can take a period of time to return to levels pre-disturbance.
				C															2						
				R															8						
			Reverse Reel/ Reverse S-lay	L															4						Increased length of time to undertake the decommissioning works. Creels located on pipeline. Not easy for creel fishermen to move to new grounds as fishing practice is quite territorial. Once seabed is disturbed, fishing can take a period of time to return to levels pre-disturbance.
				C															2						
				R															8						

Key: L= Likelihood; C= Consequence, R= Risk.

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Table D9: Summary of environmental risk assessment and contribution numbers of receptors per risk class

Activity	Option 1		Option 2		Option 3		Option 4		Option 5	
	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class
Dredging operations to water jet out pipeline at each end (diver operated)					19	8	17	7	17	7
						0		0		0
						0		0		0
						0		0		0
Dredging operation to water jet out the buried pipeline	19	8	19	8						
		0		0						
		0		0						
		0		0						
Rock placed on the seabed to fill the hole created by the dredging operation and cover the pipeline end cuts (partial removal and in situ), and crossings (partial removal)					36	3	18	6	18	6
						3		0		0
						0		0		0
						0		0		0
Cutting the pipelines with diamond wires.	9	5	9	5	9	5	9	5	9	5
		0		0		0		0		0
		0		0		0		0		0
		0		0		0		0		0

Cutting the pipelines with mechanical methods (Hydraulic shears)	9	5 0 0 0	9	5 0 0 0	9	5 0 0 0				
Rock-placement on exposed or span sections (worst case over re-burial)							93	1 0 2 3		
Waste management	2	1 0 0 0	2	1 0 0 0	2	1 0 0 0	2	1 0 0 0	2	1 0 0 0
Release of contaminants from within the pipelines as they are lifted from the seabed to the vessels onsite (applies to partial clean)	16	6 0 0 0	16	6 0 0 0	12	5 0 0 0				
Mattresses decommissioned in situ									4	1 0 0 0
Mattress removal where safe to do so	16	4 0	16	4 0	16	4 0	16	4 0		

		0		0		0		0		
		0		0		0		0		
Decommissioning activities common to all options (as described in Table D4)	**119**	**11**	**119**	**11**	**119**	**11**	**119**	**11**	**119**	**11**
		17		**17**		**17**		**17**		**17**
		0		**0**		**0**		**0**		**0**
		0		**0**		**0**		**0**		**0**
Total Score	**190**		**190**		**224**		**276**		**169**	

Summary

The scores against each receptor were added up for every activity/ operation. These were subsequently added together to give a total score for each option. The scores for general activities were added to all options. Tables D9 and D10 summarise the scores per activity/ operation and the number of receptors assessed as having the potential to be impacted by this activity/ operation. These are colour-coded based on the risk category that each receptors score received.

Table D10: Summary of societal risk assessment and contribution numbers of receptors per risk class

Activity	Option 1		Option 2		Option 3		Option 4		Option 5	
	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class
Rock placed on the seabed to fill the hole created by the dredging operation and cover the pipeline ends(as above) and crossings ends (partial/ full removal)					3	1	3	1	3	1
						0		0		0
						0		0		0
						0		0		0
Rock-placement on exposed or span sections to 0.6 m cover and replace stability following mattress removal							6	0		
								1		
								0		
								0		
Waste management	16	0	16	0	16	0	16	0	16	0
		2		2		2		2		2
		0		0		0		0		0
		0		0		0		0		0
Mattresses decommissioned in situ									6	0
										1
										0

Activity	Option 1		Option 2		Option 3		Option 4		Option 5	
	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class
										0
Mattress removal where safe to do so.	4	1	4	1	4	1	4	1		
		0		0		0		0		
		0		0		0		0		
		0		0		0		0		
Live crossings – Decommissioning in situ	2	1	2	1						
		0		0						
		0		0						
		0		0						
Physical presence vessels during transit between port and the offshore sites.	12	5	12	5	12	5	12	5	12	5
		0		0		0		0		0
		0		0		0		0		0
		0		0		0		0		0
Physical presence of vessels, divers, ROVs and other equipment during operations at the offshore sites.	13	5	13	5	13	5	13	5	13	5
		0		0		0		0		0
		0		0		0		0		0
		0		0		0		0		0
Physical presence of vessels over PL27 during Full	8	0	8	0						
		1		1						

Activity	Option 1		Option 2		Option 3		Option 4		Option 5	
	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class	Total Score	Number of Receptors per Risk Class
Removal options (only in relation to VDP2).		0		0						
		0		0						
Leaving behind unidentified mattresses					2	1	2	1		
						0		0		
						0		0		
						0		0		
Total	55		55		50		56		50	

Tables D11 and D13 presents the ranked summed total scores for each option in order of best to worst performance. Societal risk has been separated in to VDP2 and VDP3 infrastructure due to the added societal risk presented by the removal options for the Viking AR to TGT pipeline, PL27.

Table D11: VDP2 and VDP3 decommissioning options ranked according to the total risk scores for environmental risk.

Option	Total risk score*
	Environmental
5: Decommission in situ – Minimum Intervention	169
1: Full Removal – Reverse S-lay/ Reel	190
2: Full Removal – Cut and Lift	190
3: Partial Removal – Cut and Lift	224
4: Decommission in situ – Minor Intervention	276

*Compiled by totalling the individual criteria scoring for each operation/activity relevant to societal risk across each row of Tables D4 to D8

Table D12: VDP2 decommissioning options ranked according to the total risk scores for societal risk.

Option	Total risk score*
	Societal
5: Decommission in situ – Minimum Intervention	50
3: Partial Removal – Cut and Lift	50
1: Full Removal – Reverse S-lay/ Reel	55
2: Full Removal – Cut and Lift	55
4: Decommission in situ – Minor Intervention	56

*Compiled by totalling the individual criteria scoring for each operation/activity relevant to societal risk across each row of Tables D4 to D8

Table D13: VDP3 decommissioning options ranked according to the total risk scores for societal risk.

Option	Total Risk Score*
	Societal
1: Full Removal – Reverse S-lay/ Reel	47
2: Full Removal – Cut and Lift	47
5: Decommission in situ – Minimum Intervention	50
3: Partial Removal – Cut and Lift	50
4: Decommission in situ – Minor Intervention	56

*Compiled by totalling the individual criteria scoring for each operation/activity relevant to societal risk across each row of Tables D4 to D8

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APPENDIX E

ENERGY USAGE AND EMISSIONS ESTIMATES

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Introduction

This section presents the quantitative estimates of energy usage and emissions that provide the basis for differentiating between options for decommissioning the ConocoPhillips VDP2 and VDP3 Decommissioning Project pipelines and mattresses. The method follows the "*Guidelines for Calculation of Energy Use and Gaseous Emissions in Decommissioning*" (IoP, 2000).

Assessment Method

The method encompasses the fate of decommissioned material from pre-decommissioning preparation to an onshore end-point, such as recycling or disposal in landfill. The total quantities of energy usage and CO_2 emissions were calculated by:

1. Estimating quantities of diesel fuel consumed by vessels involved in the work programmes offshore;
2. Estimating quantities of diesel consumed during the haulage onshore of the redundant materials to landfill, treatment or recycling facilities;
3. Estimating quantities of aviation fuel used for helicopter operations;
4. Estimating quantities of materials required, hypothetically, for the manufacture of new materials equivalent to the materials lost to society by leaving recyclable material in situ in the seabed or by disposal to landfill;
5. Estimating the energy required for the recycling of pipeline materials;
6. Multiplying these quantities by energy content and emissions factors which are provided in Tables E1 and E2; and
7. Summing the estimated energy and emissions to provide a total figure for each decommissioning option. Within the bounds of uncertainty inherent in all energy and emission assessments, these figures may be used as an indicator of environmental performance and assist in selecting the most energy-efficient decommissioning methods.

Table E1: Conversion factors for fuels

Fuel type	Energy consumption (GJ/Tonne)	CO_2 emissions (Tonne CO_2/ Tonne)	Source*
Marine diesel fuel	43.1	3.2	IoP (2000)
Aviation fuel	46.1	3.2	IoP (2000)
DERV (diesel fuel)	44.0	3.2	Defra/DECC 2011

Table E2: Conversion factors for recycling and manufacture of replacement materials

Material	Recycling		New manufacture		Source
	Energy consumption (GJ/Tonne)	CO_2 emissions (Tonne CO_2/Tonne)	Energy consumption (GJ/ Tonne)	CO_2 emissions (Tonne CO_2 /Tonne)	
Standard steel	9	0.96	25	1.889	IoP (2000)
Aluminium	15	1.080	215	3.589	IoP (2000)
Plastics*	20	0.693	105	3.179	Harvey (2010); Defra/ DECC(2011)
Concrete	ND	ND	1	0.88	IoP (2000)
Aggregate	ND	ND	0.1	0.005	University of Bath (2008)

Note: ND = No Data available

* Mid-range energy consumption for 'Plastics' from Harvey (2010); CO_2 expressed as CO_2 equivalent emissions from open loop manufacture of plastics from recycled and raw materials from Defra/ DECC (2011)

Assumptions

For the calculation of the energy use and gaseous emissions during the decommissioning of the VDP2 and VDP3 pipelines, the following assumptions were made:

- It was assumed that energy usage and emissions would originate principally from six sources:
  1. Combustion of marine diesel fuel by the vessels involved removal operations
  2. Combustion of aviation fuel by the helicopters used to transport personnel offshore
  3. Combustion of diesel fuel by trucks transporting material to treatment, landfill and recycling facilities
  4. Onshore deconstruction of the pipeline components
  5. Recycling of materials following deconstruction and treatment
- Hypothetical manufacture of new materials to replace those lost to society because otherwise recyclable material has been decommissioned in situ. All options have post-decommissioning surveys associated with them. Any option with ongoing liability (i.e. the partial removal and decommission in situ options), have, for comparative assessment purposes, two further monitoring surveys associated with them at five and ten years post-decommissioning.
- Pipeline component weights are taken from the D3 Consulting (2015) materials inventory (DAWN).
- Where parts of a pipeline are to be removed or covered by rock-placement (where decommissioned in situ), values have been calculated using BMT Cordah’s (2015) estimations of all exposed and free-spanning section lengths and an overtrawlable (3:1) rock berm profile.

- A round trip by helicopter to the centre of the Viking area is estimated to take 1 hour and the helicopter (a Superpuma EC225 is used in this example) uses approximately 1030 litres of aviation fuel per hour (Airbus, 2015).
- Recovered material is assumed to be landed at Hartlepool (Teesside docks) and subsequently taken to landfill and recycling sites approximately 1 km to the north of the landing site. Any component containing NORM is assumed to be transported to the Kings Cliffe treatment facility in Northamptonshire, approximately 266 km to the south. Any component containing waste for incineration (waste oils and mercury) would likely be sent to Ellesmere Port on Merseyside, approximately 150 km to the west of the landing site. Although sufficient information is not available at this stage in the decommissioning process to be certain which landing and onshore processing locations will be selected, it is necessary to make this assumption in order to account for onshore transportation within the energy and emissions budget. As this assumption is made for decommissioning of all the VDP2 and VDP3 pipelines and mattresses, it has the advantage of enabling a comparison to be made between decommissioning options on the basis of the quantity of material returned to shore.
- Material is transported by lorries that have a capacity of approximately 33 tonnes. Lorries are assumed to use approximately 0.46 litres of fuel per km (Defra/ DECC, 2011) and are assumed to make a return trip from the landing site to the point of disposal/ treatment/ recycling facility.
- A theoretical replacement cost is calculated for recyclable material decommissioned in situ or disposed of in a landfill site.
- Recovered steel and anode material is recycled; recovered concrete, plastic and coal-tar coverings are taken to landfill.
- As the aluminium (anode) components of the pipeline are indistinguishable from the surrounding steel, energy and emissions values associated with steel recycling and replacement have been used. As aluminium yields higher energy and emissions values for recycling and replacement, the outcome will be considered as an under-estimate. However initial video evidence from the pipelines indicates much of the anode material is already depleted.
- IoP (2000) energy and emissions values for pipelay vessels have been used to represent those of a pipeline removal vessel (reverse S-lay).
- IoP (2000) energy and emissions values for a DSV (Dive Support Vessel) have been used to represent those of a survey vessel
- Energy and emissions values for a CSV (Construction Support Vessel) and cleaning contractor vessel have been based on the IoP (2000) values for a MSV (Multi Support Vessel).
- Although there is a 10 km section of PL134 excluded from the scope the Energy and emissions calculations have included this pipeline length within the calculations as a worse case scenario.
- Contingency vessel days due to changes in tidal conditions and wait on weather (WOW) are variable depending on the decommissioning method used:
    - All subsea operations: 70% WOW (also to account for tidal conditions)
    - CSV and rock-placement activities: 50% WOW (also to account for tidal conditions)

- Operations at the sea surface: 20% WOW

All of the above are percentages of the *working* vessel days only.

The calculations and initial assessment were undertaken in 2015, there have been no significant changes to the proposed scope since the completion of these calculations.

Results: VDP2 Pipelines and Mattresses.

VDP2 Option 1: Full Removal – Reverse Lay

Tables E3a and E3b provide the offshore and onshore (respectively) decommissioning activity results for the energy usage and emissions calculations for the VDP2 pipelines under Option 1. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E3b.

Table E3a: Energy usage and emissions for VDP2 pipelines, Option 1: Offshore operations

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: Supply vessel – removal operations					
Mobilisation and demobilisation	24.0	2.0	48.0	2068.8	153.6
Transit to and from site	24.0	10.0	240.0	10344.0	768.0
Working on site	412.4	5.0	2062.2	88878.8	6598.9
Wait on weather	288.7	5.0	1443.5	62215.1	4619.2
Subtotal	**749.1**	**22.0**	**3793.7**	**163506.7**	**12139.7**
Calculation 2: DSV - removal operations					
Mobilisation and demobilisation	12.0	3.0	36.0	1551.6	115.2
Transit to and from site	12.0	22.0	264.0	11378.4	844.8
Working on site	61.4	18.0	1105.2	47634.1	3536.6
Wait on weather	43.0	10.0	430.0	18533.0	1376.0
Subtotal	**128.4**	**53.0**	**1835.2**	**79097.1**	**5872.6**
Calculation 3: CSV - removal operations					
Mobilisation and demobilisation	12.0	2.0	24.0	1034.4	76.8
Transit to and from site	12.0	26.0	312.0	13447.2	998.4
Working on site	139.8	18.0	2516.4	108456.8	8052.5
Wait on weather	69.9	9.0	629.1	27114.2	2013.1
Subtotal	**233.7**	**55.0**	**3481.5**	**150052.7**	**11140.8**
Calculation 4: Pipelay vessel – removal operations					
Mobilisation and demobilisation	12.0	3	36.0	1551.6	115.2
Transit to and from site	12.0	19	228.0	9826.8	729.6
Working on site	206.2	19	3917.8	168857.2	12537.0
Wait on weather	144.4	25	3610.0	155591.0	11552.0
Subtotal	**374.6**	**66.0**	**7791.8**	**335826.6**	**24933.8**
Calculation 5: Survey vessel – pre and post removal surveys					

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Mobilisation and demobilisation	6.0	3	18.0	775.8	57.6
Transit to and from site	6.0	22	132.0	5689.2	422.4
Working on site	21.5	18	387.0	16679.7	1238.4
Wait on weather	15.1	10	151.0	6508.1	483.2
Subtotal	**48.6**	**53.0**	**688.0**	**29652.8**	**2201.6**
Calculation 6: DSV – mattress removal					
Mobilisation and demobilisation	3.0	3.0	9.0	387.9	28.8
Transit to and from site	5.5	22.0	121.9	5253.0	390.0
Working on site	21.4	18.0	384.3	16563.3	1229.8
Wait on weather	14.9	10.0	149.4	6439.1	478.1
Subtotal	**44.8**	**53.0**	**664.6**	**28643.4**	**2126.7**
Calculation 7: AWV- cleaning					
Mobilisation and demobilisation	12.0	2.0	24.0	1034.4	76.8
Transit to and from site	12.0	26.0	312.0	13447.2	998.4
Working on site	168.9	18.0	3040.2	131032.6	9728.6
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**192.9**	**55.0**	**3,376.2**	**145,514.2**	**10,803.8**
Calculation 8: Helicopter operations					
Transport of personnel to and from the vessels on location	359.2	0.467	167.7	7733.1	536.8
Total for offshore operations				**940,027**	**69,756**

Table E3b: Energy usage and emissions for VDP2 pipelines, Option 1: Onshore operations

Calculation 7: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	15,562.1	0.000391	6.0	268.0	19.0
Calculation 8: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			55,061.0	495,552.0	52,859.0
Calculation 9: Manufacture of replacement materials					
Materials			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Concrete			108,890.0	108,890.0	95,824.0
Plastic			210.0	21,998.0	666.0
Subtotal				**130,888.0**	**96,490.0**
Total for onshore operations				**626,708**	**149,368**
TOTAL FOR VDP2 OPTION 1 (combined offshore and onshore)				**1,566,735**	**219,124**

VDP2 Option 2: Full Removal – Cut and Lift

Tables E4a and E4b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP2 pipelines under Option 2. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E4b.

Table E4a: Energy usage and emissions for VDP2 pipelines, Option 2: Offshore operations

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: Trenching vessel - removal operations					
Mobilisation and demobilisation	3.0	2.0	6.0	258.6	19.2
Transit to and from site	3.0	26.0	78.0	3361.8	249.6
Working on site	39.7	18.0	713.7	30760.5	2283.8
Wait on weather	27.8	9.0	249.8	10768.1	799.5
Subtotal	**73.4**	**55.0**	**1047.5**	**45149.0**	**3352.1**
Calculation 2: CSV - removal operations					
Mobilisation and demobilisation	11.0	2.0	22.0	948.2	70.4
Transit to and from site	174.6	26.0	4538.6	195611.9	14523.4
Working on site	2379.2	18.0	42826.1	1845806.6	137043.6

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Wait on weather	1189.6	9.0	10706.5	461449.7	34260.8
Subtotal	**3,754.4**	**55.0**	**58,093.2**	**2,503,816.5**	**185,898.2**
Calculation 3: DSV spool piece disconnection – removal operations					
Mobilisation and demobilisation	10.0	3.0	30.0	1293.0	96.0
Transit to and from site	10.0	22.0	220.0	9482.0	704.0
Working on site	27.4	18.0	493.2	21256.9	1578.2
Wait on weather	19.2	10.0	191.8	8266.6	613.8
Subtotal	**66.6**	**53.0**	**935.0**	**40298.5**	**2992.0**
Calculation 4: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	6.0	3	18.0	775.8	57.6
Transit to and from site	6.0	22	132.0	5689.2	422.4
Working on site	21.5	18	387.7	16710.7	1240.7
Wait on weather	15.1	10	150.8	6499.5	482.6
Subtotal	**48.6**	**53.0**	**688.5**	**29675.2**	**2203.3**
Calculation 5: CSV – mattress removal					
Mobilisation and demobilisation	3.0	3.0	9.0	387.9	28.8
Transit to and from site	5.5	22.0	121.9	5253.0	390.0
Working on site	21.4	18.0	384.3	16563.3	1229.8
Wait on weather	14.9	10.0	149.4	6439.1	478.1
Subtotal	**44.8**	**53.0**	**664.6**	**28643.4**	**2126.7**
Activity	**Duration (day)**	**Fuel consumption rate (Tonne/ day)**	**Fuel consumed (Tonne)**	**Energy usage (GJ)**	**CO_2 (Tonne)**
Calculation 6: AWV – cleaning					
Mobilisation and demobilisation	12.0	2.0	24.0	1034.4	76.8
Transit to and from site	12.0	26.0	312.0	13447.2	998.4
Working on site	168.9	18.0	3040.2	131032.6	9728.6
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**192.9**	**55.0**	**3376.2**	**145514.2**	**10803.8**
Calculation 7: Helicopter operations					
Transport of personnel to and from the vessels on location	141.4	0.467	66.0	3044.2	211.2
Total for offshore operations				**2,796,141**	**207,587**

Table E4b: Energy usage and emissions for VDP2 pipelines, Option 2: Onshore operations

Calculation 8: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	15,562.0	0.000391	6.0	268.0	19.0
Calculation 8: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			55,061.0	495,552.0	52,859.0
Calculation 9: Manufacture of replacement materials					
Concrete			108,890.0	108,890.0	95,824.0
Plastics			210.0	21,998.0	666.0
Subtotal			109,100.0	130,888.0	96,490.0
Total for onshore operations				**626,708**	**149,368**
TOTAL FOR VDP2 OPTION 2 (combined offshore and onshore)				**3,422,849**	**356,955**

VDP2 Option 3: Partial Removal – Cut and Lift.

Tables E5a and E5b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP2 pipelines under Option 3. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E5b.

Table E5a: Energy usage and emissions for VDP2 pipelines, Option 3: Offshore operations

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: CSV - removal operations					
Mobilisation and demobilisation	3.0	2.0	6.0	258.6	19.2
Transit to and from site	26.7	26.0	693.0	29870.0	2217.7
Working on site	376.3	18.0	6772.9	291913.2	21673.4
Wait on weather	188.1	9.0	1693.2	72978.3	5418.3
Subtotal	**594.1**	**55.0**	**9165.2**	**395020.1**	**29328.6**
Calculation 2: DSV spool piece disconnection – removal operations					
Mobilisation and demobilisation	10.0	3.0	30.0	1293.0	96.0
Transit to and from site	10.0	22.0	220.0	9482.0	704.0
Working on site	30.9	18.0	556.6	23987.7	1781.0

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Wait on weather	21.6	10.0	216.4	9328.6	692.6
Subtotal	**72.6**	**53.0**	**1023.0**	**44091.3**	**3273.6**
Calculation 3: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	15.0	3	45.0	1939.5	144.0
Transit to and from site	15.0	22	330.0	14223.0	1056.0
Working on site	53.9	18	969.3	41776.8	3101.8
Wait on weather	37.7	10	377.0	16248.7	1206.4
Subtotal	**121.6**	**53.0**	**1721.3**	**74188.0**	**5508.2**
Calculation 4: DSV – mattress removal					
Mobilisation and demobilisation	3.0	3.0	9.0	387.9	28.8
Transit to and from site	5.5	22.0	121.9	5253.0	390.0
Working on site	21.4	18.0	384.3	16563.3	1229.8
Wait on weather	14.9	10.0	149.4	6439.1	478.1
Subtotal	**44.8**	**53.0**	**664.6**	**28643.4**	**2126.7**
Calculation 5: AWV – cleaning					
Mobilisation and demobilisation	12.0	2.0	24.0	1034.4	76.8
Transit to and from site	12.0	26.0	312.0	13447.2	998.4
Working on site	168.9	18.0	3040.2	131032.6	9728.6
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**192.9**	**55.0**	**3376.2**	**145514.2**	**10803.8**
Calculation 6: Rock-placement vessel – rock-placement infield					
Mobilisation and demobilisation	7.0	2.0	14.0	603.4	44.8
Transit to and from site	13.5	8.0	108.0	4654.8	345.6
Working on site	11.6	15.0	173.6	7483.9	555.6
Wait on weather	5.8	15.0	86.8	3741.9	277.8
Subtotal	**37.9**	**40.0**	**382.5**	**16484.0**	**1223.9**
Calculation 7: CSV – rock-placement - platform ends					
Mobilisation and demobilisation	3.0	2.0	2.0	6.0	258.6
Transit to and from site	3.0	26.0	26.0	78.0	3361.8
Working on site	8.3	18.0	18.0	149.2	6431.4
Wait on weather	4.1	9.0	9.0	37.3	1607.8
Subtotal	**18.4**	**55.0**	**270.5**	**11659.6**	**865.7**
Calculation 8: Helicopter operations					
Transport of personnel to and from the vessels on location	141.4	0.467	66.0338	3044.158	211.3082
Total for offshore operations				**718,645**	**53,342**

Table E5b: Energy usage and emissions for VDP2 pipelines Option 3: Onshore operations

Calculation 9: Manufacture of new components/ materials					
Materials			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Rock for protection (aggregate)			550.0	55.0	2.8
Calculation 10: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	1,502.0	0.000391	1.0	26.0	2.0
Calculation 11: Recycling					
Materials recycled		Total weight of materials (Tonne)		Energy usage (GJ)	CO_2 (Tonne)
Steel		4441.4		39973.0	4264.0
Calculation 12: Manufacture of replacement materials					
Steel		50,620.0		1,265,497.0	95,621.0
Concrete		108,890.0		108,890.0	95,824.0
Plastics		210.0		21,998.0	666.0
Subtotal		**159720.0**		**1396385.0**	**192111.0**
Total for onshore operations				**1,436,504**	**196,383**
TOTAL FOR VDP2 OPTION 3 (combined offshore and onshore)				**2,155,149**	**249,725**

VDP2 Option 4: Decommission in situ – Minor Intervention

Tables E6a and E6b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP2 pipelines under Option 4. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E6b.

Table E6a: Energy usage and emissions for VDP2 pipelines Option 4: Offshore operations

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: DSV - spool piece disconnection removal operations					
Mobilisation and demobilisation	10.0	3.0	30.0	1293.0	96.0
Transit to and from site	10.0	22.0	220.0	9482.0	704.0
Working on site	30.9	18.0	556.6	23987.7	1781.0
Wait on weather	30.7	10.0	307.2	13240.3	983.0

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Subtotal	**81.6**	**53.0**	**1113.8**	**48003.1**	**3564.0**
Calculation 2: Survey vessel- pre and post surveys removal operations					
Mobilisation and demobilisation	15.0	3	45.0	1939.5	144.0
Transit to and from site	15.0	22	330.0	14223.0	1056.0
Working on site	53.9	18	969.3	41776.8	3101.8
Wait on weather	37.7	10	377.0	16248.7	1206.4
Subtotal	**121.6**	**53.0**	**1721.3**	**74188.0**	**5508.2**
Calculation 3: DSV – mattress removal operations					
Mobilisation and demobilisation	3.0	3.0	9.0	387.9	28.8
Transit to and from site	5.5	22.0	121.9	5253.0	390.0
Working on site	21.4	18.0	384.3	16563.3	1229.8
Wait on weather	14.9	10.0	149.4	6439.1	478.1
Subtotal	**44.8**	**53.0**	**664.6**	**28643.4**	**2126.7**
Calculation 4: AWV - cleaning					
Mobilisation and demobilisation	12.0	2.0	24.0	1034.4	76.8
Transit to and from site	12.0	26.0	312.0	13447.2	998.4
Working on site	168.9	18.0	3040.2	131032.6	9728.6
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**192.9**	**55.0**	**3376.2**	**145514.2**	**10803.8**
Calculation 5: Rock-placement vessel – rock-placement infield					
Mobilisation and demobilisation	7.0	2.0	14.0	603.4	44.8
Transit to and from site	13.5	8.0	108.0	4654.8	345.6
Working on site	11.6	15.0	173.6	7483.9	555.6
Wait on weather	5.8	15.0	86.8	3741.9	277.8
Subtotal	**37.9**	**40.0**	**382.5**	**16484.0**	**1223.9**
Calculation 6: CSV – rock-placement - platform ends					
Mobilisation and demobilisation	3.0	2.0	6.0	258.6	19.2
Transit to and from site	3.0	26.0	78.0	3361.8	249.6
Working on site	8.3	18.0	149.2	6431.4	477.5
Wait on weather	4.2	9.0	37.4	1609.8	119.5
Subtotal	**18.4**	**55.0**	**270.6**	**11661.6**	**865.8**
Calculation 7: Helicopter operations					
Transport of personnel to and from the vessels on location	141.4	0.467	66.0	3044.2	211.3
Total for offshore operations				**327,538**	**24,304**

Table E6b: Energy usage and emissions for VDP2 pipelines Option 4: Onshore operations

Calculation 8: Manufacture of new components/ materials			
Materials	Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Rock for protection (aggregate)	108,180.0	10,818.0	540.9

Calculation 9: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	588.0	0.000391	0.23	10.1	0.73

Calculation 10: Recycling			
Materials recycled	Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel	14.8	133.0	14.0
Calculation 11: Manufacture of replacement materials			
Materials	Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel	55,046.0	1,376,162.0	103,983.0
Concrete	108,890.0	108,890.0	95,824.0
Plastics	210.0	21,998.0	666.0
Subtotal	164,146.0	1,507,050.0	200,473.0
Total for onshore operations		**1,518,071**	**201,032**
TOTAL FOR VDP2 OPTION 4 (combined offshore and onshore)		**1,845,610**	**225,335**

VDP2 Option 5: Decommission in situ – Minimum Intervention

Tables E7a and E7b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for Option 5. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E7b.

Table E7a: Energy usage and emissions for VDP2 pipelines Option 5: Offshore operations

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: DSV - removal operations					
Mobilisation and demobilisation	1	3.0	3.0	129.3	9.6
Transit to and from site	3.5	22.0	77.0	3318.7	246.4
Working on site	4.86	18.0	87.5	3770.4	279.9

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Wait on weather	3.402	10.0	34.0	1466.3	108.9
Subtotal	**12.8**	**53**	**201.5**	**8684.7**	**644.8**
Calculation 2: DSV – spool piece disconnection removal operations					
Mobilisation and demobilisation	10.0	3.0	30.0	1293.0	96.0
Transit to and from site	10.0	22.0	220.0	9482.0	704.0
Working on site	30.9	18.0	556.6	23987.7	1781.0
Wait on weather	21.6	10.0	216.4	9328.6	692.6
Subtotal	**72.6**	**53.0**	**1023.0**	**44091.3**	**3273.6**
Calculation 3: Survey vessel- pre and post surveys removal operations					
Mobilisation and demobilisation	12.0	3	36.0	1551.6	115.2
Transit to and from site	12.0	22	264.0	11378.4	844.8
Working on site	43.1	18	775.8	33437.0	2482.6
Wait on weather	30.2	10	302.0	13016.2	966.4
Subtotal	**97.3**	**53.0**	**1377.8**	**59383.2**	**4409.0**
Calculation 4: DSV – mattress removal					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	1.3	22.0	27.5	1185.3	88.0
Working on site	2.6	18.0	46.9	2020.2	150.0
Wait on weather	1.8	10.0	18.2	785.6	58.3
Subtotal	**6.7**	**53.0**	**95.6**	**4120.4**	**305.9**
Calculation 5: AWV - cleaning					
Mobilisation and demobilisation	12.0	2.0	24.0	1034.4	76.8
Transit to and from site	12.0	26.0	312.0	13447.2	998.4
Working on site	168.9	18.0	3040.2	131032.6	9728.6
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**192.9**	**55.0**	**3376.2**	**145514.2**	**10803.8**
Calculation 6: CSV – rock-placement - platform ends					
Mobilisation and demobilisation	3.0	2.0	6.0	258.6	19.2
Transit to and from site	3.0	26.0	78.0	3361.8	249.6
Working on site	8.3	18.0	149.2	6431.4	477.5
Wait on weather	4.2	9.0	37.4	1609.8	119.5
Subtotal	**18.4**	**55.0**	**270.6**	**11661.6**	**865.8**
Calculation 7: Helicopter operations					
Transport of personnel to and from the vessels on location	141.4	0.467	66.0	3044.2	211.3
Total for offshore operations				**276,499**	**20,514**

Table E7b: Energy usage and emissions for VDP2 pipelines Option 5: Onshore operations

Calculation 8: Manufacture of new components/ materials					
Materials			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Rock for protection (aggregate)			350.0	35.0	1.8
Calculation 9: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	558.0	0.000391	0.2	10.0	1.0
Calculation 10: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			14.8	133.0	14.0
Calculation 11: Manufacture of replacement materials					
Steel			55,046.0	1,376,162.0	103,983.0
Concrete			108,890.0	108,890.0	95,824.0
Plastics			210.0	21,998.0	666.0
Subtotal			**164,146.0**	**1,507,050.0**	**200,473.0**
Total for onshore operations				**1,507,253**	**200,491**
TOTAL FOR VDP2 OPTION 5 (combined offshore and onshore)				**1,783,752**	**221,005**

VDP2 Pipelines and Mattress Summary

Tables E8 and E9 provide summaries of the energy use (in GJ) and emissions (in tonnes of CO_2) respectively, for each option for the decommissioning of the VDP2 pipelines.

Table E8. Summary of energy use for all VDP2 pipeline decommissioning options

Option	Energy usage (GJ)
1. Full Removal – Reverse S-lay/ Reel	1,566,735
5. Decommission in situ – Minimum Intervention	1,783,752
4. Decommission in situ – Minor Intervention	1,845,610
3. Partial Removal – Cut and Lift	2,155,149
2. Full Removal – Cut and Lift	3,422,849

Table E9. Summary of emissions for all VDP2 pipeline decommissioning options

Option	Emissions (Tonne/ CO_2)
1. Full Removal – Reverse S-lay/ Reel	219,124
5. Decommission in situ – Minimum Intervention	221,005
4. Decommission in situ – Minor Intervention	225,335
3. Partial Removal – Cut and Lift	249,725
2. Full Removal – Cut and Lift	356,955

Results: VDP3 Pipelines and Mattresses.

<u>VDP3 Option 1: Full Removal – Reverse Lay</u>

Tables E10a and E10b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP3 pipelines under Option 1. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total energy and emissions for this option are provided at the end of Table E10b.

Table E10a: Energy usage and emissions for VDP3 pipelines Option 1: Offshore operations

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: Supply vessel – removal operations					
Mobilisation and demobilisation	8.0	2.0	16.0	689.6	51.2
Transit to and from site	8.0	10.0	80.0	3,448.0	256.0
Working on site	16.8	5.0	84.0	3,620.4	268.8
Wait on weather	11.7	5.0	58.5	2,521.4	187.2
Subtotal	**45**	**22.0**	**239**	**10,279**	**763**
Calculation 2: DSV - removal operations					
Mobilisation and demobilisation	4.0	3.0	12.0	517.2	38.4
Transit to and from site	4.0	22.0	88.0	3,792.8	281.6
Working on site	21.2	18.0	381.6	16,447.0	1,221.1
Wait on weather	14.8	10.0	148.0	6,378.8	473.6

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Subtotal	**44**	**53**	**630**	**27,136**	**2,015**
Calculation 3: CSV - removal operations					
Mobilisation and demobilisation	4.0	2.0	8.0	344.8	25.6
Transit to and from site	4.0	26.0	104.0	4,482.4	332.8
Working on site	16.5	18.0	297.0	12,800.7	950.4
Wait on weather	8.3	9.0	74.7	3,219.6	239.0
Subtotal	**33**	**55**	**484**	**20,848**	**1,548**
Calculation 4: Pipelay/haul vessel – removal operations					
Mobilisation and demobilisation	4.0	3.0	12.0	517.2	38.4
Transit to and from site	4.0	19.0	76.0	3,275.6	243.2
Working on site	8.4	19.0	159.6	6,878.8	510.7
Wait on weather	5.9	25.0	147.5	6,357.3	472.0
Subtotal	**22**	**66**	**395**	**17,029**	**1,264**
Calculation 5: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	2.0	3.0	6.0	258.6	19.2
Transit to and from site	2.0	22.0	44.0	1,896.4	140.8
Working on site	3.3	18.0	59.4	2,560.1	190.1
Wait on weather	2.3	10.0	23.0	991.3	73.6
Subtotal	**10**	**53**	**132**	**5,706**	**424**
Calculation 6: DSV – mattress removal					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	3.0	22.0	66.9	2,882.5	214.0
Working on site	5.3	18.0	95.0	4,096.2	304.1
Wait on weather	3.7	10.0	36.9	1,590.4	118.1
Subtotal	**13**	**53**	**202**	**8,698**	**646**
Calculation 7: AWV- cleaning					
Mobilisation and demobilisation	4.0	2.0	8.0	344.8	25.6
Transit to and from site	4.0	26.0	104.0	4,482.4	332.8
Working on site	48.4	18.0	871.2	37,548.7	2,787.8
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**56**	**55**	**983**	**42,376**	**3,146**
Calculation 8: Helicopter operations					
Transport of personnel to and from the vessels on location	49.8	0.467	23.3	1072.1	74.4
Total for offshore operations				**133,144**	**9,880**

Table E10b: Energy usage and emissions for VDP3 pipelines Option 1: Onshore operations

Calculation 7: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	1,531	0.000391	1	26	2
Calculation 9: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			3,621	32,593	3,477
Calculation 9: Manufacture of replacement materials					
Materials			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Concrete			4,043	4,043	3,557
Total for onshore operations				**36,662**	**7,036**
TOTAL FOR VDP3 OPTION 1 (combined offshore and onshore)				**169,806**	**16,916**

VDP3 Option 2: Full Removal – Cut and Lift

Tables E11a and E11b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP3 pipelines under Option 2. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E11b.

Table E11a: Energy usage and emissions for VDP3 pipelines Option 2: Offshore operations

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: Trenching vessel – removal operations					
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	1.0	26.0	26.0	1,120.6	83.2
Working on site	6.5	18.0	116.3	5,011.7	372.1
Wait on weather	4.5	9.0	40.7	1,753.3	130.2
Subtotal	**13**	**55**	**185**	**7,972**	**592**
Calculation 2: CSV – removal operations					
Mobilisation and demobilisation	9.0	2.0	18.0	775.8	57.6
Transit to and from site	69.2	26.0	1,799.2	77,545.5	5,757.4
Working on site	387.5	18.0	6,975.5	300,645.8	22,321.7
Wait on weather	193.8	9.0	1,743.8	75,159.5	5,580.3
Subtotal	**660**	**55**	**10,537**	**454,127**	**33,717**
Calculation 3: DSV– spool piece disconnection removal operations					
Mobilisation and demobilisation	8.0	3.0	24.0	1,034.4	76.8
Transit to and from site	8.0	22.0	176.0	7,585.6	563.2
Working on site	9.6	18.0	172.8	7,447.7	553.0
Wait on weather	6.7	10.0	67.2	2,896.3	215.0
Subtotal	**32**	**53**	**440**	**18,964**	**1,408**
Calculation 4: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	2.0	3.0	6.0	258.6	19.2
Transit to and from site	2.0	22.0	44.0	1,896.4	140.8
Working on site	3.3	18.0	58.5	2,521.4	187.2
Wait on weather	2.3	10.0	22.8	982.7	73.0
Subtotal	**10**	**53**	**131**	**5,659**	**420**
Calculation 5: DSV – mattress removal					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	3.0	22.0	66.9	2,882.5	214.0
Working on site	5.3	18.0	95.0	4,096.2	304.1
Wait on weather	3.7	10.0	36.9	1,590.4	118.1
Subtotal	**13**	**53**	**202**	**8,698**	**646**
Calculation 6: AWV – cleaning					

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Mobilisation and demobilisation	4.0	2.0	8.0	344.8	25.6
Transit to and from site	4.0	26.0	104.0	4,482.4	332.8
Working on site	48.4	18.0	870.8	37,533.2	2,786.7
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**56**	**55**	**983**	**42,360**	**3,145**
Calculation 7: Helicopter operations					
Transport of personnel to and from the vessels on location	48.6	0.467	22.7	1,046.3	72.6
Total for offshore operations				**538,826**	**40,000**

Table E11b: Energy usage and emissions for VDP3 pipelines Option 2: Onshore operations

Calculation 8: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	1,531	0.000391	1	26	1
Calculation 9: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			3,621	32,593	3,477
Calculation 10: Manufacture of replacement materials					
Concrete			4,043	4,043	3,557
Total for onshore operations				**36,662**	**7,036**
TOTAL FOR VDP3 OPTION 2 (combined offshore and onshore)				**575,488**	**47,037**

VDP3 Option 3: Partial Removal – Cut and Lift.

Tables E12a and E12b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP3 pipelines under Option 3. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E12b

Table E12a: Energy usage and emissions for VDP3 pipelines Option 3: Offshore operations

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: CSV - removal operations					
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	4.4	26.0	115.2	4,964.3	368.6
Working on site	58.9	18.0	1,059.8	45,679.1	3,391.5
Wait on weather	29.4	9.0	265.0	11,419.8	847.9
Subtotal	**94**	**55**	**1,442**	**62,149**	**4,614**
Calculation 2: DSV – spool piece disconnection removal operations					
Mobilisation and demobilisation	8.0	3.0	24.0	1,034.4	76.8
Transit to and from site	8.0	22.0	176.0	7,585.6	563.2
Working on site	6.1	18.0	109.4	4716.9	350.2
Wait on weather	4.3	10.0	42.6	1836.1	136.3
Subtotal	**26**	**53**	**352**	**15,173**	**1,127**
Calculation 3: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	5.0	3.0	15.0	646.5	48.0
Transit to and from site	5.0	22.0	110.0	4,741.0	352.0
Working on site	8.1	18.0	146.3	6,307.3	468.3
Wait on weather	5.7	10.0	56.9	2,452.4	182.1
Subtotal	**24**	**53**	**328**	**14,147**	**1,050**
Calculation 4: DSV – mattress removal					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	3.0	22.0	66.9	2,882.5	214.0
Working on site	5.3	18.0	95.0	4,096.2	304.1
Wait on weather	3.7	10.0	36.9	1,590.4	118.1
Subtotal	**13**	**53**	**202**	**8,698**	**646**
Calculation 5: AWV– cleaning					
Mobilisation and demobilisation	4.0	2.0	8.0	344.8	25.6
Transit to and from site	4.0	26.0	104.0	4,482.4	332.8
Working on site	48.4	18.0	870.8	37,533.2	2,786.7
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**56**	**55**	**983**	**42,360**	**3,145**

Activity	Duration (day)	Fuel consumption (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 6: Rock-placement vessel – rock-placement infield					
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	4.5	8.0	36.0	1551.6	115.2
Working on site	1.1	15.0	16.4	704.7	52.3
Wait on weather	0.5	15.0	8.1	349.1	25.9
Subtotal	**7**	**40**	**63**	**2,692**	**200**
Calculation 7: CSV– rock-placement - platform ends					
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	1.0	26.0	26.0	1,120.6	83.2
Working on site	1.7	18.0	30.8	1,326.6	98.5
Wait on weather	0.9	9.0	7.7	333.6	24.8
Subtotal	**5**	**55**	**67**	**2,867**	**213**
Calculation 8: Helicopter operations					
Transport of personnel to and from the vessels on location	48.6	0.467	22.7	1046.3	72.6
Total for offshore operations				**149,132**	**11,068**

Table E12b: Energy usage and emissions for VDP3 pipelines Option 3: Onshore operations

Calculation 9: Manufacture of new components/ materials					
Materials			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Rock for protection (aggregate)			150.0	15.0	0.8
Calculation 10: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	1,324	0.000391	1	23	2
Calculation 11: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			39.6	356.0	38.0
Calculation 12: Manufacture of replacement materials					
Steel			3,582	89,547	6,766
Concrete			4,043	4,043	3,557
Subtotal			**7,625**	**93,590**	**10,323**
Total for onshore operations				**93,994**	**10,364**
TOTAL FOR VDP3 OPTION 3 (combined offshore and onshore)				**243,116**	**21,431**

VDP3 Option 4: Decommission in situ – Minor Intervention

Tables E13a and E13b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for the VDP3 pipelines under Option 4. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E13b.

Table E13a: Energy usage and emissions for VDP3 pipelines Option 4: Offshore operations

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: DSV - spool piece disconnection removal operations					
Mobilisation and demobilisation	8.0	3.0	24.0	1,034.4	76.8
Transit to and from site	8.0	22.0	176.0	7,585.6	563.2
Working on site	6.1	18.0	109.4	4,716.9	350.2
Wait on weather	6.4	10.0	63.8	2,749.8	204.2
Subtotal	**29**	**53**	**373**	**16,087**	**1,194**
Calculation 2: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	5.0	3.0	15.0	646.5	48.0
Transit to and from site	5.0	22.0	110.0	4,741.0	352.0
Working on site	8.1	18.0	146.3	6,307.3	468.3
Wait on weather	5.7	10.0	56.9	2,452.4	182.1
Subtotal	**24**	**53**	**328**	**14,147**	**1,050**
Calculation 3: DSV – mattress removal					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	3.0	22.0	66.9	2,882.5	214.0
Working on site	5.3	18.0	95.0	4,096.2	304.1
Wait on weather	3.7	10.0	36.9	1,590.4	118.1
Subtotal	**13**	**53**	**202**	**8,698**	**646**
Calculation 4: AWV – cleaning					
Mobilisation and demobilisation	4.0	2.0	8.0	344.8	25.6
Transit to and from site	4.0	16.0	104.0	4,482.4	332.8
Working on site	48.4	18.0	870.8	37,533.2	2,786.7
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**56**	**55**	**983**	**42,360**	**3,145**
Calculation 5: Rock-placement vessel – rock-placement infield					
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	4.5	8.0	36.0	1,551.6	115.2
Working on site	1.1	15.0	16.4	704.7	52.3
Wait on weather	0.5	15.0	7.4	316.8	23.5
Subtotal	**7**	**40**	**62**	**2,659**	**197**
Calculation 6: CSV – rock-placement - platform ends					

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	1.0	26.0	26.0	1,120.6	83.2
Working on site	1.7	18.0	30.8	1,326.6	98.5
Wait on weather	0.9	9.0	7.7	333.6	24.8
Subtotal	**5**	**55**	**67**	**2,867**	**213**
Calculation 7: Helicopter operations					
Transport of personnel to and from the vessels on location	48.6	0.467	22.7	1046.3	72.6
Total for offshore operations				**86,865**	**6,519**

Table E13b: Energy usage and emissions for VDP3 pipelines Option 4: Onshore operations

Calculation 8: Manufacture of new components/ materials			
Materials	Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Rock for protection (aggregate)	1478.2	147.8	7.4

Calculation 9: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	588.0	0.000391	0.2	10.1	0.7

Calculation 10: Recycling			
Materials recycled	Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel	3.2	29	3
Calculation 11: Manufacture of replacement materials			
Materials	Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel	3,618	90,456	6,835
Concrete	4,043	4,043	3,557
Subtotal	**7,661**	**94,499**	**10,392**
Total for onshore operations		**94,686**	**10,403**
TOTAL FOR VDP3 OPTION 4 (combined offshore and onshore)		**182,545**	**16,922**

VDP3 Option 5: Decommission in situ – Minimum Intervention

Tables E14a and E14b provide the offshore and onshore (respectively) results for the energy usage and emissions calculations for Option 5. In line with BEIS Decommissioning Guidance (Defra/ DECC, 2011), energy usage is expressed as GJ and gaseous emissions are expressed as tonnes of CO_2. Total (offshore and onshore) energy and emissions for this option are provided at the end of Table E14b.

Table E14a: Energy usage and emissions for VDP3 pipelines Option 5: Offshore operations

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 1: DSV – removal operations					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	3.5	22.0	77.0	3,318.7	246.4
Working on site	1.9	18.0	33.5	1443.0	107.1
Wait on weather	1.3	10.0	13.0	561.2	41.7
Subtotal	**7.7**	**53**	**126.5**	**5452.2**	**404.8**
Calculation 2: DSV –- spool piece disconnection removal operations					
Mobilisation and demobilisation	8.0	3.0	24.0	1,034.4	76.8
Transit to and from site	8.0	22.0	176.0	7,585.6	563.2
Working on site	6.1	18.0	109.4	4716.9	350.2
Wait on weather	4.3	10.0	42.6	1834.3	136.2
Subtotal	**26.4**	**53**	**352**	**15171.2**	**1126.4**
Calculation 3: Survey vessel – pre and post removal surveys					
Mobilisation and demobilisation	4.0	3.0	12.0	517.2	38.4
Transit to and from site	4.0	22.0	88.0	3,792.8	281.6
Working on site	6.5	18.0	117.0	5,042.7	374.4
Wait on weather	4.6	10.0	46.0	1,982.6	147.2
Subtotal	**19**	**53**	**263**	**11,335**	**842**
Calculation 4: DSV – mattress removal					
Mobilisation and demobilisation	1.0	3.0	3.0	129.3	9.6
Transit to and from site	1.3	22.0	27.5	1,185.3	88.0
Working on site	0.3	18.0	5.3	229.2	17.0
Wait on weather	0.3	10.0	3.4	147.1	10.9
Subtotal	**3**	**53**	**39**	**1691**	**126**
Calculation 5: AWV – cleaning					
Mobilisation and demobilisation	4.0	2.0	8.0	344.8	25.6
Transit to and from site	4.0	26.0	104.0	4,482.4	332.8
Working on site	48.4	18.0	871.2	37,548.7	2,787.8
Wait on weather	0.0	9.0	0.0	0.0	0.0
Subtotal	**56**	**55**	**983**	**42,376**	**3,146**

Activity	Duration (day)	Fuel consumption rate (Tonne/ day)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Calculation 6: CSV– rock-placement - platform ends					
Mobilisation and demobilisation	1.0	2.0	2.0	86.2	6.4
Transit to and from site	1.0	26.0	26.0	1,120.6	83.2
Working on site	1.7	18.0	30.8	1,326.6	98.5
Wait on weather	0.9	9.0	8.5	364.6	27.1
Subtotal	**5**	**55**	**67**	**2,898**	**215**
Calculation 7: Helicopter operations					
Transport of personnel to and from the vessels on location	48.6	0.467	22.7	1,046.3	72.6
Total for offshore operations				**79,970**	**5,933**

Table E14b: Energy usage and emissions for VDP3 pipelines Option 5: Onshore operations

Calculation 8: Manufacture of new components/ materials					
Materials			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Rock for protection (aggregate)			125.0	12.5	0.6
Calculation 9: Onshore transport					
Activity	Distance (km)	Fuel consumption rate (Tonne/ km)	Fuel consumed (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Onshore transportation of material to treatment, landfill and recycling	558	0.000391	0.2	10.0	1.0
Calculation 10: Recycling					
Materials recycled			Total weight of materials (Tonne)	Energy usage (GJ)	CO_2 (Tonne)
Steel			3.2	29	3
Calculation 11: Manufacture of replacement materials					
Steel			3,618	90,456	6,835
Concrete			4,043	4,043	3,557
Subtotal			**7,661**	**94,499**	**10,392**
Total for onshore operations				**94,551**	**10,397**
TOTAL FOR VDP3 OPTION 5 (combined offshore and onshore)				**174,516**	**16,329**

VDP3 Pipelines and Mattress Summary

Tables E15 and E16 provide summaries of the energy use (in GJ) and emissions (in tonnes of CO_2) respectively, for each option for the decommissioning of the VDP3 pipelines. The best performing option (i.e. the option with the lowest energy use and emissions) has been assigned the highest score. The subsequent scores are all inversely proportional to the highest scoring option.

Table E15. Summary of energy use for all VDP3 pipeline decommissioning options

Option	Energy usage (GJ)
1. Full Removal – Reverse S-lay/ Reel	169,806
5. Decommission in situ – Minimum Intervention	174,516
4. Decommission in situ – Minor Intervention	182,545
3. Partial Removal – Cut and Lift	243,116
2. Full removal – Cut and Lift	575,488

Table E16. Summary of emissions for all VDP3 pipeline decommissioning options

Option	Emissions (Tonne/ CO_2)
5. Decommission in situ – Minimum Intervention	16,329
1. Full removal – Reverse S-lay/ Reel	16,916
4. Decommission in situ – Minor Intervention	16,922
3. Partial Removal – Cut and Lift	21,431
2. Full Removal – Cut and Lift	47,037

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APPENDIX F

COST ESTIMATES

INFORMATION PROVIDED TO BEIS

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