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Osprey Field Subsea Infrastructure Comparative Assessment

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Executive Summary

Fairfield has conducted a Comparative Assessment (CA) in support of the Osprey Subsea Infrastructure Decommissioning Programme. The following steps from the Oil and Gas UK CA Guidelines have been completed:

This CA report presents the methodology, decisions which needed to be taken, the preparation works carried out, and the outcomes (recommendations) from the internal and external (with stakeholders) workshops.

The CA for the Osprey Subsea Infrastructure Decommissioning Programme has focussed on three groups (Bundles, Flexible and Umbilical Risers, and Trenched and Rock Dumped Umbilicals). All other groups of Osprey subsea infrastructure were confirmed at the CA Scoping and Screening stage to be fully removed from the field. The outcome of the CA process has made the following recommendations:

Group	Infrastructure Type	Decommissioning Recommendation
1	Pipeline and Umbilical Components	Full Removal
2a	Deposits	Full Removal
2b	Structures	Full Removal
3	Bundles	Leave *in Situ* – Minimal Intervention (Towhead Removal and Local Rock Placement)
4	Surface Laid Flexible Jumpers	Full Removal
5	Flexible and umbilical risers	Leave *in Situ* – Minor Intervention (Outboard Cut and Recovery)
6	Surface Laid Rigid Spools	Full Removal
7	Surface Laid Flexible Pipelines	Full Removal
8	Trenched and Rock Dumped Umbilicals	Leave *in Situ* – Minimal Intervention (Local Rock Placement)
9	Surface Laid Umbilicals	Full Removal
10	Surface Laid, Rock Dumped Pipelines	Full Removal

Table 1 Final Osprey Recommendations

The three decisions (3, 5 and 8) were found, on completion of an appropriate amount of preparatory study work, to have clear decision outcomes. Sensitivities were performed where appropriate (e.g. relating to economics, or relating to uncertainty for some rankings) and found that these did not alter the overall decision outcomes. The only infrastructure remaining from the Osprey field following decommissioning is proposed to be the exposed bundles, the already trenched and rock dumped umbilicals, and the section of the flexible and umbilical risers which are within the J-Tube integral to the Dunlin Alpha CGB, all other infrastructure will be fully removed.

Contents

1. Introduction

1.1. Overview

Fairfield Betula Limited (Fairfield) is the operator of the Dunlin, Osprey and Merlin fields, located in United Kingdom Continental Shelf (UKCS) Blocks 211/23 of the northern North Sea.

The Dunlin field was discovered by Shell UK in 1973 and the Dunlin Alpha platform subsequently installed in 1977; production from the field commenced in 1978. Prior to cessation of production, hydrocarbons from the Osprey and Merlin fields were transported to the Dunlin Alpha platform by pipeline for processing at a dedicated module.

Infrastructure associated with the Dunlin, Merlin and Osprey fields are currently being prepared for decommissioning. The Dunlin field lies approximately 137 km from the nearest landfall point, 196 km north east of Lerwick and 508 km north east of Aberdeen. The field sits 11 km from the UK/Norway median line and in a water depth of approximately 150 m (Figure 1.1 and Figure 1.2). The Osprey field is a subsea tie-back located 6 km to the north-north west of the Dunlin Alpha platform and the Merlin field is a subsea tie-back located 7 km to the west-north west of the Dunlin Alpha platform. Production at the fields ceased following cessation of production in 2015 and Fairfield now intends to decommission all three fields.

1.2. Purpose

The purpose of this document is to present a Comparative Assessment (CA) for the Osprey subsea infrastructure in support of the decommissioning programme. The document describes the field infrastructure, the decommissioning options considered, the method used in the CA and the recommendations made during the CA process.

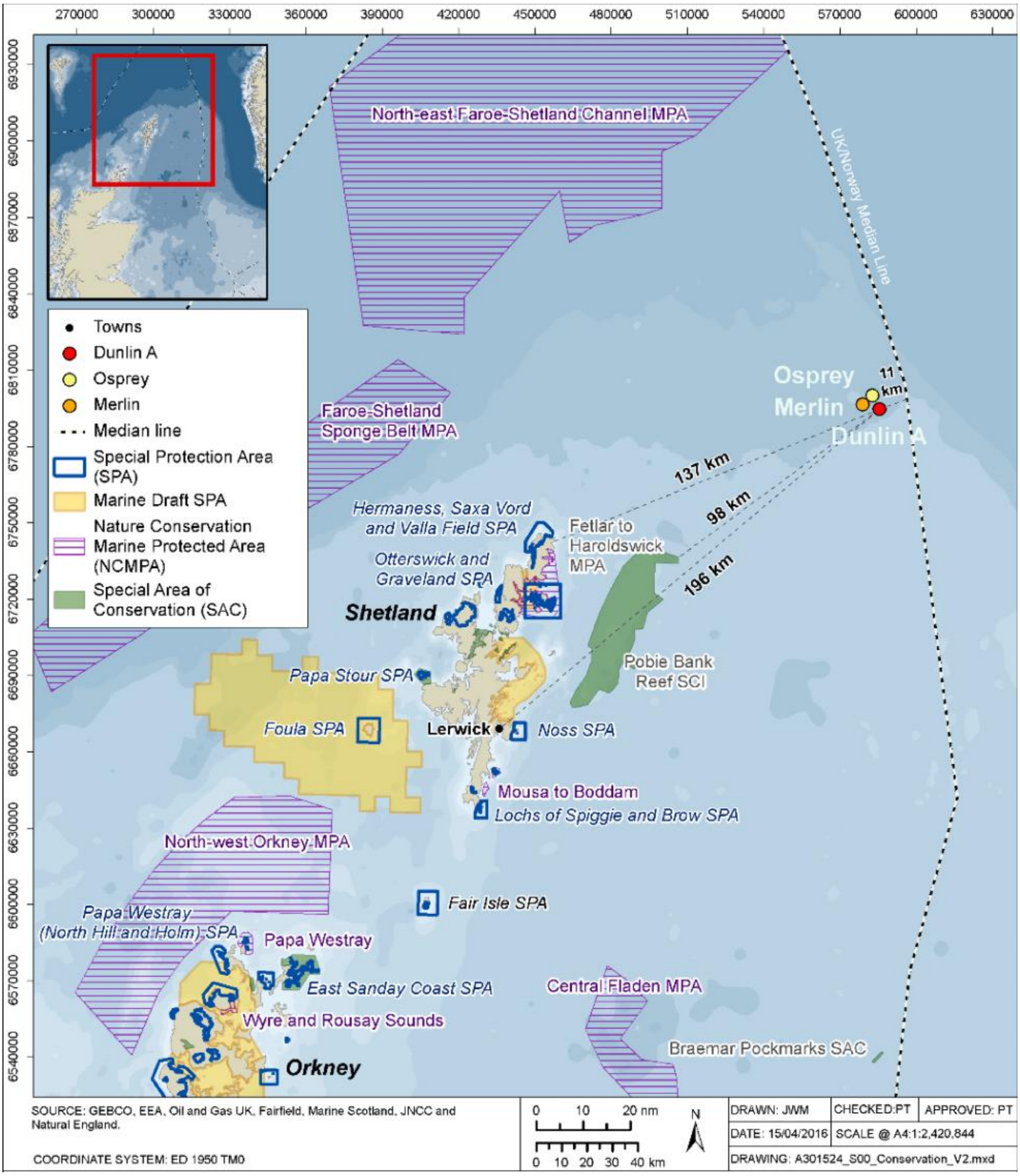


Figure 1.1 Location of Osprey, Merlin and Dunlin

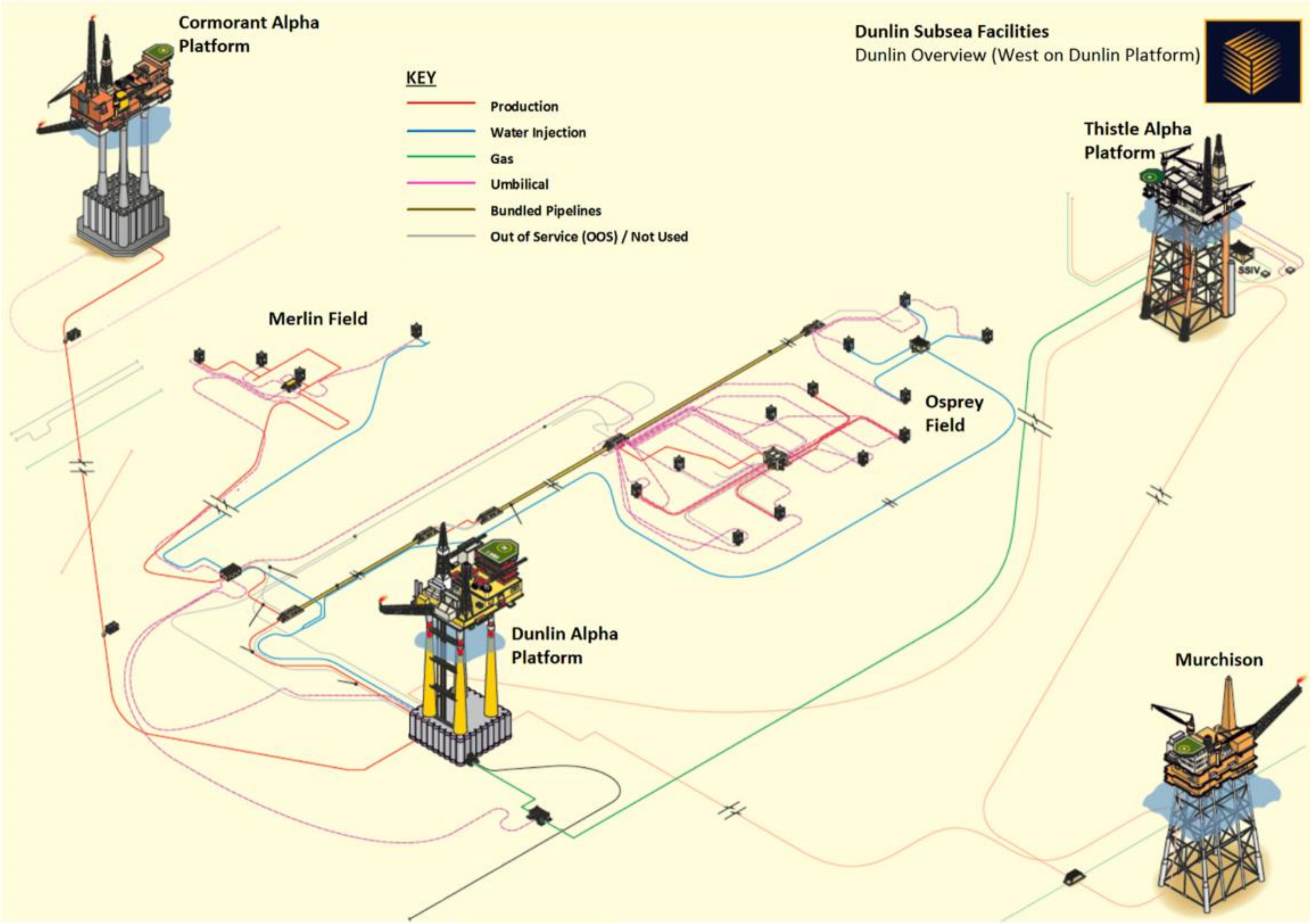


Figure 1.2 Dunlin Area Layout

1.3. Report Structure

This CA Report contains the following:

- Section 2 – An overview of the CA methodology;
- Section 3 – A description of each decision required to be made through the CA;
- Section 4 – A description of the study work undertaken to prepare for selecting a preferred option for each subsea infrastructure group;
- Section 5 – Presents the results of the CA process;
- Section 6 – Summary and recommendations;
- Section 7 – References
- Section 8 – Acronyms and glossary
- Appendix A – Pairwise Methodology Explanation
- Appendix B – CA Criteria
- Appendix C – Environment Criteria Assessment Methodologies
- Appendix D – Stakeholder CA Workshop Minutes
- Appendix E – Data Sheets (Exc. Costs)
- Appendix F – CA Attributes Tables & Pairwise Comparison (Exc. Costs)
- Appendix G – Decision Output Charts
- Appendix H – Data Sheets (Inc. Costs)
- Appendix I – CA Attributes Tables & Pairwise Comparison (Inc. Costs)

2. Comparative Assessment Methodology

2.1. Overview

Comparative Assessment is a process by which decisions are made on the most appropriate approach to decommissioning. As such it is a core part of the overall decommissioning planning process being undertaken by Fairfield for the subsea infrastructure at Osprey, Merlin and Dunlin.

Guidelines for CA were prepared in 2015 by Oil and Gas UK, where seven steps to the CA process were recommended. Table 2.1 provides commentary on each of these steps to demonstrate the Fairfield position.

Title	Scope	Status	Commentary
Scoping	Decide on appropriate CA method, confirm criteria, identify boundaries of CA (physical and phase), and identify and map stakeholders	✓	Scoping Reports prepared for Osprey, Merlin and Dunlin subsea infrastructure in advance of Screening (see below). Stakeholders identified and mapped and Stakeholder Engagement Plan prepared. CA methodology and criteria established for screening by early 2016.
Screening	Consider alternative uses and deselect unfeasible options.	✓	Screening workshops held Q1 2016 with external stakeholders for Osprey, Merlin and Dunlin. Specific studies identified and agreed that would help with the evaluation of options. CA methodology and criteria also revisited following screening to support option selection.
Preparation	Undertake technical, safety, environmental studies plus stakeholder engagement	✓	Studies undertaken alongside continued stakeholder engagement. Section 4 lists the relevant study reports.
Evaluation	Evaluate the options using the chosen CA methodology	✓	Fairfield conducted two internal CA workshops as part of the evaluation phase. The first, in August 2016, identified areas where further information was needed in order to make a recommendation (effectively recycling to the preparation phase). A second internal workshop was held in November where the results of recent study work were used to discuss and update the decision tool. An additional study (fisheries QRA) was commissioned to run in parallel and be used to either amend or validate the decision tool.
Recommendation	Create recommendation in the form of narrative supported by charts explaining key trade-offs.	✓	The two workshops described above under the Evaluation stage produced a set of emerging recommendations which Fairfield presented as emerging recommendations to external stakeholders. A Briefing

Title	Scope	Status	Commentary
			Session was held in December 2016 to review these and provide additional data to stakeholders.
Review	Review the recommendation with internal and/or external stakeholders	✓	Workshop held with external stakeholders (JNCC, SFF, Marine Scotland, BEIS, and OGA) on Tuesday 10 January 2017.
Submit	Submit to BEIS as part of/alongside Decommissioning Programme	✓	This report is available alongside the Decommissioning Programme for the Osprey subsea infrastructure.

Table 2.1 CA Process Overview

2.2. CA Methodology

Fairfield has selected a Multi Criteria Decision Analysis (MCDA) methodology for the evaluation phase of the CA. This methodology uses a pairwise comparison system based on the methodologies of the Analytical Hierarchy Process (AHP) by T.L. Saaty, described in various publications, such as Analytical Hierarchy Process ref. [9]. This allows the relative importance of each differentiating criteria to be judged against each other in a qualitative way, supported by quantification where appropriate. The key steps for the evaluation phase of the CA are as follows:

- Define Differentiating Criteria – this was completed in July 2016;
- Define Options – this was initially completed as part of CA Screening, but a trial run internal CA workshop validated or amended the options where appropriate;
- Pre-populate worksheets for internal CA workshops – based on all the studies undertaken the worksheets were pre-populated in advance of the internal CA workshops;
- Perform internal CA workshop:
    - Discuss attributes of each option against each differentiating criteria – the discussion was recorded ‘live’ during the workshop in order that informed opinion and experience was factored into the decision-making process;
    - Perform scoring (see Appendix A.3);
    - Perform sensitivity analyses to test the decision outcomes;
- Export CA worksheets as a formal record of the workshop attendees’ combined opinion on the current preferred options, the ‘Emerging Recommendations’;
- Evaluate whether the CA needs to ‘recycle’ to the Preparation phase to obtain any further information to help inform decision making (this occurred following the first internal CA workshop in August 2016);
- Discuss Emerging Recommendations with stakeholders (January 2017); and
- Recycle process as required prior to decision on the selected options which will be presented in the Decommissioning Programme and assessed in the Environmental Impact Assessment.

The sections below describe how the MCDA methodology has been applied. Appendix A contains a more detailed explanation of the workings behind the MCDA tool.

2.3. Differentiating Criteria & Approach to Assessment

A key step in setting up the CA was agreeing and defining the appropriate criteria that differentiates between each of the tabled options. As a starting point, the criteria considered for this CA were taken from the DECC (now BEIS) Guidelines for Decommissioning of Offshore Oil and Gas Installations and Pipelines which are as follows (in no particular order):

- Safety
- Environmental
- Economic
- Technical
- Societal

These differentiating criteria were found to be appropriate for the decommissioning options tabled and were largely aligned with Fairfield's Guiding Principles, Ref [1] and were taken forward as the primary differentiating criteria for the CA. Additional sub-criteria and definitions were added for clarity and are shown in Table 2.2 alongside the approach used for assessment under each criteria or sub-criteria.

Appendix C provides some additional information on the calculations/assumptions used for assessing the environmental criteria.

Differentiating Criteria	Sub-Criteria	Description	Approach to Assessment
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Summed PLL numbers allow a quantified direct comparison between options. See section 4.3 for information on study work undertaken.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.	
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.	
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Assessment made based on summed PLL numbers and narrative around other factors such as high consequence events or residual risk where there was a differentiator.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as underwater noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Assessment based on quantifying underwater noise generated by decommissioning activities in the short term. Potential discharges to sea also

Differentiating Criteria	Sub-Criteria	Description	Approach to Assessment
			captured where appropriate, but assumed not to be a differentiating factor for flushed and cleaned pipelines.
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	A life-cycle emissions assessment has been carried out capturing: õ Transport emissions from vessels or trucks; õ Rock excavation; õ Reuse of materials; õ Production of new materials; õ Disposal of marine growth; and õ Material left *in situ.* The output CO2 figures allow a direct, quantitative comparison between options.
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, and production of replacement materials.	Assessment based on quantifying the volume of fuel and new material used.
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Assessment based on quantifying the area of disturbance by type of disturbance (dredging, rock dump, trenching, backfilling), in combination with an understanding of the baseline

Differentiating Criteria	Sub-Criteria	Description	Approach to Assessment
			environment in the area as shown by the outputs from the environmental surveys.
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	The Dunlin Area does not overlap with any protected areas or zones. The habitat type is mud with sea pens and burrowing megafauna which is a priority marine feature, however impacts on this habitat type (and associated recovery) is via the mechanism of seabed disturbance which is covered in sub-criteria 2.4 above. Therefore, ‘Protections’ on its own is not considered to be a differentiator.
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Assessment based on engineering studies (see section 4.2) and captures: õ Feasibility; õ Concept Maturity; õ Availability of Technology; õ Track Record; õ Risk of Failure; õ Consequence of Failure; and õ Emerging Technology.

Differentiating Criteria	Sub-Criteria	Description	Approach to Assessment
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Commercial Fisheries Baseline Study provides a base level of understanding for the importance of the area for fisheries. This is combined with narrative (rather than quantification) regarding the influence of each decommissioning option on the availability of the area of seabed for fisheries. A fisheries QRA (see section 4.3) has been used to provide some context for the risk of loss of equipment due to snagging risk.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation/retention, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Assessment of impacts on other users is a qualitative narrative considering both positive and negative impacts on waste disposal, recycling, business interruption and general community impacts. Potential employment benefits have been considered but at the scale of any individual option and in context with the wider full removal scopes for each field area the potential employment benefits are not deemed to be a differentiator.

Differentiating Criteria	Sub-Criteria	Description	Approach to Assessment
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	See engineering studies, section 4.2.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	See engineering studies, section 4.2. Timeframe assumed for the purposes of the CA is 50 years.

Table 2.2 Differentiating Criteria and Sub-Criteria

2.4. Differentiator Weighting

The 5 differentiating criteria all carry a 20% weighting. That is, all criteria are neutral to each other. Figure 2.1 shows the pairwise comparison matrix. Fairfield decided that equal weightings offer the most transparency and a balanced view from all perspectives.

Differentiating Criteria	1. Safety	2. Environmental	3. Technical	4. Societal	5. Economic	Weighting
1. Safety	N	N	N	N	N	20%
2. Environmental	N	N	N	N	N	20%
3. Technical	N	N	N	N	N	20%
4. Societal	N	N	N	N	N	20%
5. Economic	N	N	N	N	N	20%

Figure 2.1 Example Pairwise Comparison Matrix (N = Neutral)

2.5. Option Attributes

The next step in the CA process was to describe and discuss the attributes of each option with respect to each of the differentiating criteria. In preparation, all relevant data and information developed during the preparation phase were pre-populated into the attributes table for each option. Appendix F contains the completed Attributes Tables.

Any additional discussion around the relative merits of the options was also recorded in the attributes matrix. A summary discussion of why options are considered more or less attractive with respect to each of the differentiating criteria was also recorded. An easy-to-read version of this matrix was supplied to stakeholders as part of the recommendation review process.

2.6. Option Pair-Wise Comparison

Once the option attributes were compiled and discussed, a pair-wise comparison was performed for each of the differentiating criteria where the proposed options were compared against each other. The pairwise comparison adopted in this case used phrases such as stronger, much stronger, weaker, much weaker, etc. to make qualitative judgements (often based on quantitative data) of the options against each other. Adopting these phrases rather than the more common numerical 'importance scale' from the Analytical Hierarchy Process (AHP) is often more intuitive and representative of the sentiment of a workshop.

One of the challenges of applying the numerical importance scale historically, is that often when scoring a pair of options against each other as a score of 3, delegates implied the comparison was 3 times better, etc. rather than 'slightly better' as the importance scale suggests.

To manage this, Fairfield chose to apply the principles of the AHP by replacing numbers in the pairwise comparison matrix with a narrative or descriptive approach. This is already programmed into the AHP in the importance scale explanations (see Appendix A, Table A.1). It was agreed that three positions from equal (and their reciprocals) would be sufficient for this CA. These positions were:

Phrase	Meaning
Neutral	Equal Importance, equivalent to 1 in the importance scale from Table A.1.
Stronger (S) / Weaker (W)	Moderate importance of one criteria / option over the other, equivalent to 3 in the importance scale from Table A.1
Much Stronger (MS) / Much Weaker (MW)	Essential / strong importance of one criteria / option over the other equivalent to 5 or 6 in the importance scale from Table A.1.
Very Much Stronger (VMS) / Very Much Weaker (VMW)	Extreme importance of one criteria / option over the other equivalent to 8 or 9 in the importance scale from Table A.1

Table 2.3 Explanation of Phrasing Adopted for Pairwise Comparison

Using this transposed scoring system made it simpler and, more importantly, more effective at capturing the mind-set and feeling of the attendees at the workshops. Phrases such as 'what are the relative merits of pipeline removal on a project versus rock dumping from a safety perspective? Are these Neutral to each other? Are they stronger? If so, how much stronger? If you had to prioritise one over the other, which would it be?'. This promoted a collaborative dynamic in the workshop and enabled the collective mind-set of the attendees to be captured. Where there was quantitative data to provide back-up and evidence to support the collective assertions, so much the better.

Largely, these qualitative judgements were driven by the quantitative parameters captured in the previous step (as described in Table 2.2 above). This allowed qualitative and quantitative judgment criteria to be combined. A summary example of the completed pair-wise comparisons for differentiating criteria versus options are shown in Figure 2.2 with a full worked example in Appendix A.4.

1. Safety	Option 1	Option 2	Option 3
Option 1	N	S	N
Option 2	W	N	W
Option 3	N	S	N

3. Technical	Option 1	Option 2	Option 3
Option 1	N	N	S
Option 2	N	N	S
Option 3	W	W	N

5. Economic	Option 1	Option 2	Option 3
Option 1	N	MS	MW
Option 2	MW	N	VMW
Option 3	MS	VMS	N

Figure 2.2 Example Option Pair-Wise Comparison

2.7. Visual Output and Sensitivities

The decision-making tool used the above judgements to automatically generate a visual output indicating the highest scoring option i.e. the option which represents the most 'successful' solution in terms of its overall contribution to the set of differentiating criteria. At this stage, opportunity was provided to fine tune the judgements provided, to ensure that all attendees were happy to endorse the outcome. The visual outputs from each decision point are included in section 5.

The CA output could then easily be stress tested by the workshop attendees by undertaking a sensitivity analysis such as by modifying the pair-wise comparison of the options against each other within the differentiating criteria where appropriate. These sensitivities helped inform workshop attendees as to whether a particular aspect was driving a preferred option, or indeed if the preferred option remained the same when the sensitivities were applied, the preferred option was effectively reinforced. Where sensitivities were performed these are described in section 5.

3. Comparative Assessment Decisions

3.1. Overview

Table 3.1 lists all infrastructure groups from the Osprey field. Early CA scoping and screening activities identified where full removal would be the immediately recommended approach, and where the remainder of the CA process needed to be undertaken in order to conclude on a recommended approach (groups 3, 5 and 8). The options for these groups are provided in Table 3.2.

Group	Infrastructure Type	Decommissioning Recommendation
1	Pipeline and Umbilical Components	Full Removal
2a	Deposits	Full Removal
2b	Structures	Full Removal
3	Bundles	Subject to Comparative Assessment
4	Surface Laid Flexible Jumpers	Full Removal
5	Flexible and umbilical risers	Subject to Comparative Assessment
6	Surface Laid Rigid Spools	Full Removal
7	Surface Laid Flexible Pipelines	Full Removal
8	Trenched and Rock Dumped Umbilicals	Subject to Comparative Assessment
9	Surface Laid Umbilicals	Full Removal
10	Surface Laid, Rock Dumped Pipelines	Full Removal

Table 3.1 Osprey Infrastructure Groups

3.2. Options Carried Forward to Full Comparative Assessment (Option Recommendation)

Screening was conducted in March 2016. Section 5 of this CA report demonstrates which options were screened in and screened out at that stage, and detailed information on the decisions made at screening are available in the Osprey CA Screening Report Ref [2].

Table 3.2 identifies the options included within the CA process for the Osprey subsea infrastructure. Table 3.3 identifies the battery limits for Osprey subsea infrastructure. Figure 3.1 shows the locations of these infrastructure groups in relation to the remaining infrastructure which is proposed for full removal.

(Dec) / Grp	Desc.	Option 1A	Option 1B Note 1	Option 1C Note 1	Option 2	Option 3	Option 4
(1) Grp 3	Bundles	Remove towheads, perform local rock dump of cut ends, leave remainder of bundle *in-situ*, periodic monitoring and remediation as required.	As option 1A but includes full rock dump 30 years after initial activity.	As option 1A but includes full removal 30 years after initial activity.	Remove towheads, perform full rock dump of remaining bundle, periodic monitoring and remediation as required.	Remove towheads, trench parallel to existing bundle, cut bundle in to sections and drag into trench, bury trenched bundle, periodic monitoring and remediation as required.	Full removal of towheads and bundle, no monitoring or remediation required.
(2) Grp 5	Flexible and Umbilical Risers	Cut outboard of j-tube subsea and recover, remainder to remain in-situ.			Cut outboard of j-tube subsea and recover, remainder to be removed by topside pull.		
(3) Grp 8	Trenched and Rock Dumped Umbilicals	Remove ends, perform local rock dump of cut ends, and leave remainder in-situ, periodic monitoring and remediation as required.			Remove ends, perform full rock dump, periodic monitoring and remediation as required.	Full removal using reverse reeling technique, no monitoring required.	

Note 1: These options were originally presented as differing outcomes of Option 1. After the first internal CA session, it was deemed appropriate to present these outcomes as options in their own right. This is to ensure clarity of the impact of the associated risks, costs and liabilities.

Table 3.2 Osprey Decision Points

Field	System	Battery Limits
Osprey	Water Injection	From the flowbases on Osprey water injection wells to the Dunlin Alpha ESDVs. The valves themselves belong to the Dunlin Alpha Decommissioning (DAD) programme and are beyond the scope of this document. Upstream of the flowbases belong to well plug and abandonment scopes.
	Production	From the flowbases on Osprey production wells to the Dunlin Alpha ESDVs. The valves themselves belong to the DAD programme and are beyond the scope of this document. Upstream of the flowbases belong to well plug and abandonment scopes.
	Controls	From the underside of the Topside Hydraulic / Chemical Junction Box (Topsides Umbilical Termination Unit – TUTU) to the Osprey Xmas tree SCM's.

Table 3.3 Osprey Battery Limits

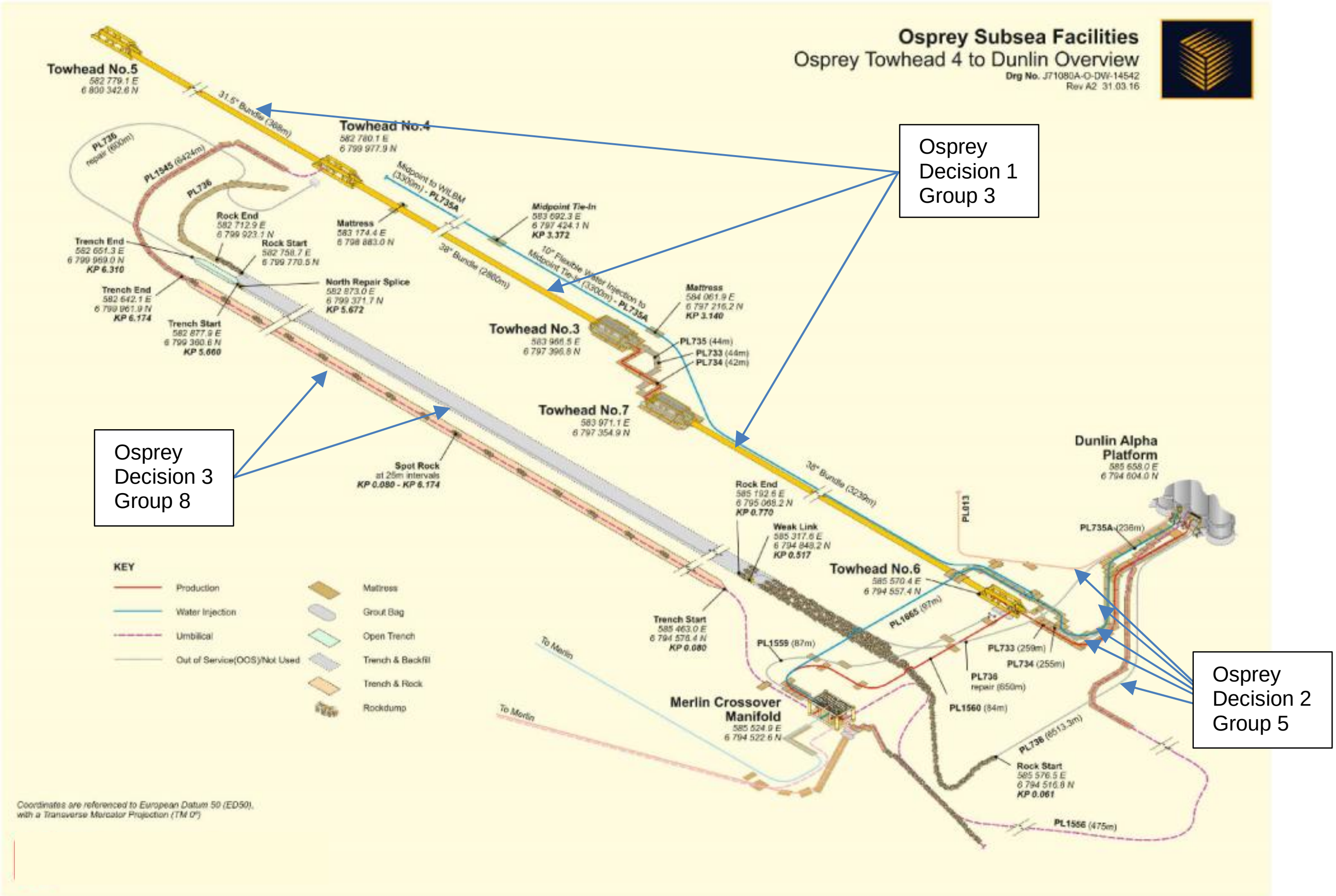


Figure 3.1 Osprey Decision Points

4. Comparative Assessment Preparation

4.1. Introduction

In advance of the internal CA workshops the preparation phase output was consolidated into a data sheet (Appendix E) for each option and the decision tool was pre-populated to allow the attendees to concentrate on understanding the differences between options. Additional narrative was added during the internal CA workshops.

This section presents the work carried out following the CA Screening session held with stakeholders in Q1 2016. Note that the CA Scoping and Screening reports, and the reports of all other CA preparation activities, are available on request so information within them is not presented here.

For clarity of presentation, in advance of the external CA workshops, the decision tool and emerging recommendations were provided to stakeholders with a consolidated narrative and key data points only. A Briefing Session was held a month in advance of the external CA workshop where stakeholders were provided with an opportunity to discuss any supplementary information that they would like to receive.

Studies and activities during the Preparation phase were conducted under four broad themes:

- Engineering;
- Safety;
- Environmental and Societal; and
- Consultation / Engagement with Stakeholders and Supply Chain.

This work was conducted alongside regular continued engagement with the Regulator, BEIS.

4.2. Engineering Studies

Osprey Common Scope Report ref. [3]. This report provided the following information on each option:

- Execution Method Statement, including:
  - Sequence of operations;
  - List of vessels and equipment specifications and durations;
  - Materials requirements;
  - Environmental impacts (i.e. area of disturbance, vessel emissions, noise outputs);
  - Onshore disposal requirements;
  - Execution Schedule;
  - Cost estimate;
  - Long term liability estimation (considering material remaining *in situ*, material degradation, seabed mobility);
  - Risk review (see section 4.3 below).

  This information was summarised into the datasheets made available during the CA workshop. Additionally, the following studies were also completed and informed the above report:

- Osprey specific scopes:

- o Osprey Long-term Materials Degradation Study ref. [4];
- o Osprey Trench and Backfill Feasibility Study ref. [5];
- o Osprey Removal / Recovery Feasibility Study ref. [6];
- o Osprey Effect of Riser Remaining ref. [7];

4.3. Safety Studies

Fairfield conducted two specific safety studies:

- õ Personnel risk review (contained within the Common Scope Report referenced in 4.2), which considered:
  - o General working occupational risk for the suite of activities associated with each option. This included offshore exposure (e.g. diver activity, vessel based activity and topsides activity), onshore activities (up to the final disposal/recycling point) and legacy activities (e.g. future surveys and remediation activities). A set of Fatal Accident Rates (FAR) were used to provide a consistent approach to assessing Potential Loss of Life (PLL); and
  - o Unique high consequence events from major accident hazards. Major accident hazards were defined as those events with the potential for serious injury or fatality to more than 4 personnel.
- õ Fisheries Quantified Risk Assessment (QRA) ref [19] which:
  - o Determined fishing activity in the vicinity of the Dunlin, Merlin and Osprey pipelines, umbilicals and bundles;
  - o Calculated frequency of interaction (probability of occurrence) of vessels fishing across the subsea infrastructure; and
  - o Calculated PLL for the decommissioning options specified above:

    The Fishing Pipeline Risk Model used the results of the crossing frequency assessment to determine annual fatality rates (PLL per annum) to fishermen associated with the decommissioned subsea structures. This was calibrated with fishing vessel activity across all pipelines in the UK and MAIB incident data on snagging rates and fatality rates following a snagging incident. Within this process, crossing angles between fishing gear and the Dunlin, Merlin and Osprey lines, existence of free spans along the lines and pipeline protection (e.g. trenching, rock dump or concrete mattresses) were all taken into consideration.

The personnel risk review was based on the Risk Analysis of Decommissioning Activities ref. [8] which provided the PLL calculation methodology and FAR values. The CA outputs are quantitative PLL tables and are included in the relevant sections of the Common Scope Report.

4.4. Environmental Societal Studies

The following studies, surveys and activities were used to support the evaluation process:

- õ Environmental surveys:
  - o Habitat Assessment Reports ref. [11];
  - o Environmental Baseline Survey Reports ref. [12];
  - o Drill Cuttings Analysis ref. [13];
- õ Pipeline Cleanliness Study ref. [14];

- Lifecycle Emissions Assessment ref. [16];
- Noise Emissions Calculations (contained within the Common Scope Report [3]);
- Drill Cuttings Screening (against OSPAR 2006/5) ref. [15];
- Commercial Fisheries Baseline (including SFF Services Limited questionnaire survey) ref. [17];
- Internal Environmental Issues Identification Workshop detailed in the ENVID Report ref. [18].

4.5. Consultation & Engagement

4.5.1. Engagement Strategy

Fairfield recognised that early and ongoing engagement with stakeholders is a critical part of the development of robust, respectful programmes for the decommissioning of North Sea installations. To ensure the efficacy of stakeholder engagement, Fairfield developed a Stakeholder Engagement Strategy and Action Plan. This Plan outlined how and why stakeholder engagement should occur. It assisted in driving engagement through the CA, and was supported by a continually updated Stakeholder Engagement Workbook and Stakeholder Alignment Plan / Matrix, through which stakeholder engagement could be tracked.

4.5.2. Consultation

As a demonstration of Fairfield's execution of its stakeholder strategy and the extent to which external stakeholders have had the opportunity to influence the decommissioning project, a summary of the key engagement activities is given in Table 4.1. As well as working with key regulatory and environmental stakeholders, Fairfield has sought to understand the lessons that other UKCS Operators have learned during their decommissioning activities to date. In addition, Fairfield makes information available to the general public via a dedicated decommissioning website at http://www.fairfield-energy.com/.

Activity	Date	Stakeholders
Introduction to the Greater Dunlin Area Decommissioning Project	January 2010	Aberdeenshire Council, BEIS, Cefas, Decom North Sea, HSE, JNCC, Marine Scotland, Maritime and Coastguard Agency, Greenpeace, Scottish Enterprise, SEPA (Radioactive waste), SEPA (Marine), SFF, University of Aberdeen
Between 2010 and 2015, Fairfield continued engagement with stakeholders, including OSPAR and those outlined above, to guide the development of Fairfield's decommissioning strategy for the Greater Dunlin Area.		
Meet with statutory stakeholders to discuss progress	December 2015/January 2016	JNCC, Marine Scotland, SFF
Subsea CA Screening Workshop	March 2016	BEIS, JNCC, Marine Scotland, SFF
Update on Greater Dunlin Area decommissioning	April 2016	BEIS

Activity	Date	Stakeholders
Fisheries update on Greater Dunlin Area decommissioning	May 2016	UK Fisheries Offshore Oil and Gas Legacy Trust Fund (FLTC) National Federation of Fishermen's Organisations (NFFO), Northern Ireland Fish Producers' Organisation Limited (NIFPO)
Issue of note to advise on progress	June 2016	BEIS, JNCC, OGA, SFF
Update on Greater Dunlin Area decommissioning	July 2016	OGA
Workshop on decommissioning of concrete mattresses	September 2016	SEPA, Decom North Sea
Update meetings on Greater Dunlin Area decommissioning	September 2016	SFF, JNCC
Update on Greater Dunlin Area decommissioning	October 2016	SEPA
Briefing session for Subsea CA	December 2016	BEIS, JNCC, Marine Scotland, OGA, SFF
Subsea CA workshop	January 2017	BEIS, JNCC, Marine Scotland, OGA, SFF

Table 4.1 Summary of Key Stakeholder Engagement Activities

In addition to the above, Global Marine Systems are a statutory stakeholder and have indicated no current nor future interests in the Greater Dunlin Area.

4.5.3. Supply Chain Engagement

In addition to its stakeholders, Fairfield has also informed its decommissioning projects (including the CA) through discussions with supply chain. The following organisations have been met:

- Bibby Offshore
- Jee
- PDi
- ROVOP
- Zenocean
- Technip
- Ardent Global
- ASCO (disposal facilities)
- EMAS Chiyoda Subsea
- Halliburton
- Forth Ports
- CSub (GRP Subsea Protection Structures)
- Boskalis
- Subsea7

5. Comparative Assessment Results

5.1. Decision 1: Group 3 – Bundles

5.1.1. Characteristics

This group comprises two bundles, SBUND1 and NBUND1 & 2, both installed in 1990 and were designed prior to the requirement for removal being introduced, described below:

Item	Characteristics
SBUND1	3239 m Long 2355 Te Dry weight exc. ballast chain. (2450 Te Inc. ballast chain) 38″ Carrier (Steel / PUF), containing: õ 2 x 8″ Oil lines (PL733 and PL734; within 12″ sleeve pipes) õ 1 x 10″ WI line (PL735) 2 x Towheads (34Te and 22Te) Exposed on seabed.
NBUND1 & 2	3237 m Long 2306 Te Dry weight exc. ballast chain. (2404 Te Inc. ballast chain) 38″ Carrier (NBUND1) (Steel / PUF), containing: õ 2 x 8″ Oil lines (PL733 and PL734; within 12" sleeve pipes) õ 1 x 10″ WI line (PL735) 31.5″ Carrier (NBUND2) (Steel), containing: õ 1 x 10″ WI line õ 1 x 10″ Sleeve pipe (contains WI PLU2463 umbilical length) 2 x Towheads (21.5Te and 46Te) 1 x Intermediate towhead (50Te) Exposed on seabed.

Table 5.1 Decision 1 Characteristics

5.1.2. Options

Five options were presented at screening stage with only one of those screened out. The four options assessed from the outset of the CA were:

õ Option 1: Leave *in Situ* – Minimal Intervention (Towhead Removal & Local Rock Placement) - Removal of towheads, rock placement over open ends.

õ Option 2: Leave *in situ* – Minor Intervention – Removal and recovery of towheads, rock placement along entire length.

õ Option 3: Leave *in Situ* – Major Intervention – Removal and recovery of towheads, pre-cut trench, cut bundle into sections (350m), rig and pull each section into the trench.

- Option 4: Full Removal – Cut and Lift – Cut the bundle into small sections (20m), lift and recover each section for disposal onshore.

Note that during initial preparation works Option 3 had assumed trenching at the *in situ* location of the bundles, however feasibility studies found that no currently available technology would be able to trench the bundles *in situ.* Instead, Option 3 became the creation of a new trench in parallel to the bundles.

In addition to these four options, the internal CA workshops found that Option 1 required further consideration in terms of sub-options regarding what activity would be required when the bundles degraded to the extent they present fisheries snag hazards (current status is the bundles are over-trawlable). Two additional options were taken into the CA for evaluation:

- Option 1A: Leave *in situ* – Minor Intervention
    - Phase 1: Removal and recovery of towheads, rock placement on open ends;
    - Phase 2: Rock placement along entire length (after approx. 30 Years).
- Option 1B: Cut and Lift
    - Phase 1: Removal and recovery of towheads, rock placement on open ends;
    - Phase 2: Cut the bundle into small sections (20m), lift and recover each section for disposal onshore (after approx. 30 Years).

Note that the full removal option using a refloat and tow technique was removed at screening stage. More information is provided in the Screening Report Ref [2]. The bundle system has known defects within sections of the carrier and certain areas of the internal pipework that would prohibit a straight re-float and tow of the two sections. Whilst the bundles could be cut down and re-floated as smaller sections there are still significant technical challenges, not least is confirming that the material has the capacity to withstand a refloat and tow operation. Removal of the bundle by refloating would be new and novel and is considered to carry significant safety, technical and economic risk.

The process undertaken for this decision point, the judgement made against each of the five criteria, and the chart which demonstrates which option is recommended to be taken forward from the CA are presented on the following pages.

5.1.3. Sensitivity Analysis

A sensitivity analysis was performed on this decision point relating to economics. Removing the economics criteria (shown in blue on the chart) from the decision making process had no impact on the preferred option but it did alter the remaining order in terms of Option 4 became slightly more attractive than Option 3 (but still not as attractive as Options 1, 2 or 1A).

No further sensitivity analysis was performed for this decision point.

5.1.4. Recommendation

A strong preference was shown in the workshop for Option 1 with economics and societal being the factors which differentiate it most from the next preferred Option 2. One key discussion on this related to the preference given for Option 1 due to it not being a permanent solution in its own right. Stakeholders wished Fairfield to consider an approach to periodically review the bundles with a view to selecting a permanent option in the future (e.g. full removal or full rock placement) dependent on technology advances and an associated step change in safety (relative to the other options).

The outcome of this decision point is therefore to decommission Group 3 *in situ.* This infrastructure will be decommissioned by removing the towheads, removing the ends of the bundles and placing rockdump at the cut ends. Periodic monitoring and remediation will be carried out at this location as required.

Group 3 – Bundles

Option Screening

(for narrative see Osprey Screening Report)

Leave in Situ – Minimal Intervention (Towhead Removal & Local Rock Placement) - **Screened In**	Leave in Situ – Minor Intervention (Towhead Removal & Complete Rock Placement) - **Screened In**	Leave in Situ – Major Intervention (Towhead Removal and Trench) **Screened In**	Full Removal – Refloat and Tow **Screened Out**
Full Removal – Cut and Lift **Screened In**			

Comparative Assessment

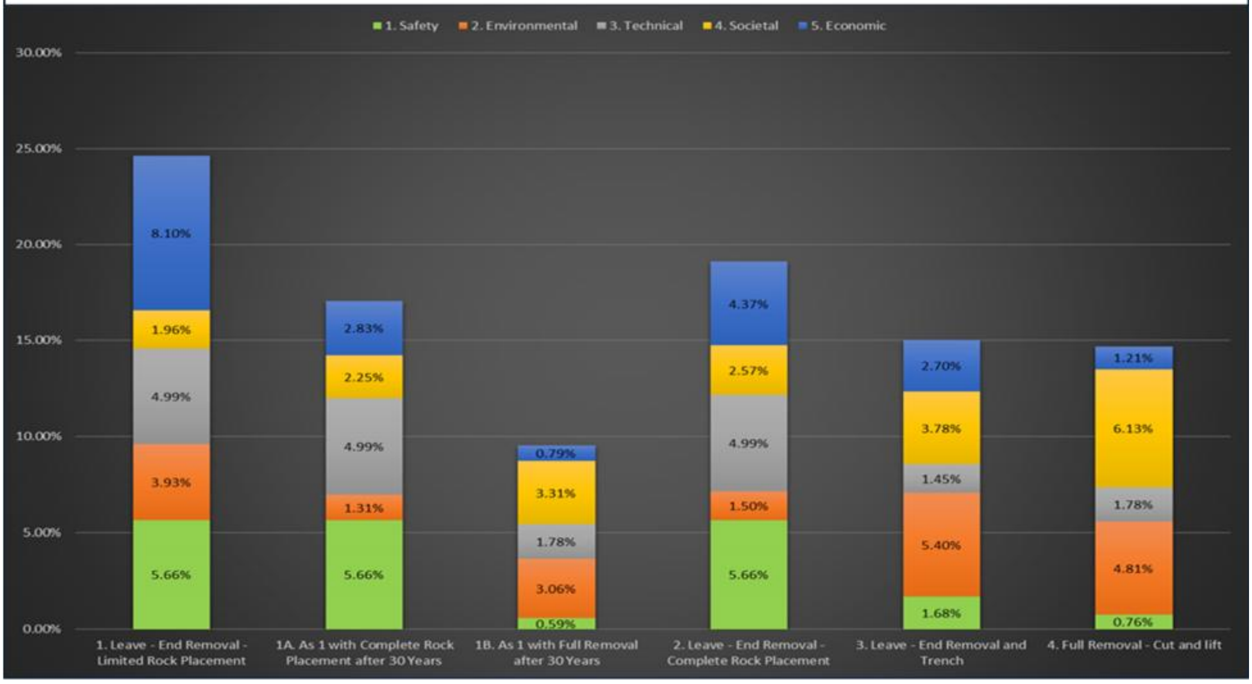
(for full attributes tables and pairwise comparisons see Appendix F)

Option 1	**Option 1A**	**Option 1B**	**Option 2**	**Option 3**	**Option 4**
Leave in Situ – End Removal, Limited Rock Placement	As 1, with Complete Rock Placement after 30 Years	As 1, with Full Removal after 30 Years	Leave - End Removal, Complete Rock Placement	Leave - End Removal and Trench	Full Removal - Cut and lift

Safety	**Environment**	**Technical**	**Societal**	**Economic**
Summed PLL figures and the potential for high consequence events are similar for Options 1, 1A & 2. Option 3 carries slightly worse PLL and risk of high consequence events, but is not as weak as Options 1B and 4 – the full removal options – which are the weakest from a safety perspective due to the duration and nature of operations.	Option differentiation most driven by the the volume of new material. Options 3 & 4 largely similar, but with 3 having significantly lower noise emissions. The volume of rock placement sees Options 1A & 2 least preferred. Option 1B is weakened as it requires the activities of Option 1 first, which has some rock placement but short term, minimal duration operations.	Option 1, 1A & 2 are technically very similar and scored **Neutral** to each other. Options 1, 1A & 2 are **Much Stronger** than options 1B, 3 & 4 due to uncertainties on ability to deliver. Option 3 was marginally **weaker** than options 1A & 4 due to the uncertainty on ability to achieve required trench depth and to return the seabed to an acceptable condition.	Short-term options which remove the Bundles from the seabed were ranked stronger than all other options, seeing an overall preference for Option 4. Option 1, without 1A or 1B, sees increased snag risk over time. Credit given to industry benefit of pioneering full removal techniques.	Option 1 in isolation is the strongest option from an economic perspective. Option 2 is slightly weaker, but slightly stronger than Option 3 due to the difference in cost risk – Option 3 carries high chance of cost overrun. Full removal options (1B & 4) are the worst options due to both predicted absolute cost and cost risk.

Summary

The workshops considered Option 1B to be overall the weakest option (its attributes were not considered the strongest across any of the differentiating criteria. Option 1, however, was strongest or equal strongest in three of the five criteria (except environmental and societal). Whilst economics clearly has a large contribution on the graph below, removal of economics still sees Option 1 as the preferred option and is therefore recommended to be taken forward from the CA process.



5.2. Decision 2: Group 5 – Flexible and Umbilical Risers

5.2.1. Characteristics

Item	Characteristics
PL733 and PL734	8" oil line flexible risers (Polymer / Steel)
PL735A	8" water injection line flexible riser (Polymer / Steel)
PL736	5" umbilical riser (Polymer / Steel / Copper)
PL736	3" umbilical riser replacement (Polymer / Steel / Copper)

Table 5.2 Decision 2 Characteristics

5.2.2. Options

Four options were presented at screening stage with two of those screened out. The options assessed during the CA were:

- Option 1: Leave *in situ* – Minor Intervention (Outboard Cut and Recovery)
- Option 2: Full Removal -Topside Pull

The process undertaken for this decision point, the judgement made against each of the five criteria, and the chart which demonstrates which option is recommended to be taken forward from the CA are presented on the following page.

5.2.3. Sensitivity Analysis

A sensitivity analysis was performed on this decision point relating to economics. Removing the economics criteria (shown in blue on the chart) from the decision making process had no impact on the preferred option nor the order of the remaining options.

The environmental and societal criteria were discussed in the workshops because there could be justification made to rank them differently. For the environmental criteria the workshop agreed to rank Option 1 as stronger than Option 2. In absolute terms the difference between the two is negligible, but Option 1 is still slightly better than Option 2. For societal, the workshop agreed to rank Options 1 and 2 as neutral to each other. Option 2 could be argued as slightly stronger due to more material being returned to shore (with positives such as recycling or employment) but the workshop felt the benefits were not enough to move away from Neutral. However, a sensitivity was undertaken for both environmental and societal in favour of Option 2, but the overall outcome with all five criteria combined did not change.

5.2.4. Recommendation

Option 1, removal of the outboard section and leaving the remainder in the J-Tube, was assessed as being the preferred option in all criteria apart from societal (in which it was considered neutral to option 2). The outcome of this decision point is therefore to decommission Group 5 *in situ* having recovered the surface laid section. The fate of the section within the J-Tube will ultimately be determined by the CA covering the fate of the Dunlin Alpha CGB. The Osprey – Effect of Riser Remaining Study, Ref [7] has been conducted examining the effects of decommissioning the risers in the J-Tube and found the consequence on other activities to be negligible.

Group 5 – Flexible and Umbilical Risers

Option Screening

(for narrative see Osprey Screening Report)

Leave in Situ – Minimal Intervention (Local Rock Placement)	Leave in Situ – Minor Intervention (Outboard Cut and Recovery)	Full Removal - Reverse J-Tube Pull	Full Removal - Topside Pull
Screened Out	**Screened In**	**Screened Out**	**Screened In**

Comparative Assessment

(for full attributes tables and pairwise comparisons see Appendix F)

Option 1 Leave in Situ – Minor Intervention (Outboard Cut and Recovery)	**Option 2** Full Removal - Topside Pull

Safety	Environment	Technical	Societal	Economic
Summed PLL figures for options 1 and 2 indicate that the risk exposure for option 1 is slightly lower than option 2 driven by a higher exposure to offshore and topsides worker groups for option 2. Option 1 is also a slightly shorter duration and carries a lower risk of high consequence events. Overall, option 1 is **Stronger** than option 2 from a safety perspective.	Option 1 is either equal to or marginally better than option 2 in all areas. As such, option 1 is considered **Stronger** than option 2 from an environmental perspective. It is noted that the difference here in absolute terms is likely to be negligible, but given a choice on environmental grounds alone, option 1 would be preferred.	Option 1 carries less technical risk than option 2 due to the potential / consequence of failure associated with the uncertainty of the j-tube integrity. Overall option 1 is considered **Much Stronger** than option 2 from a Technical Feasibility perspective.	Options 1 and 2 largely similar from a Societal perspective so scored **Neutral** against each other. Whilst there is more material returned to shore under option 2, the workshops did not consider this enough to warrant a change to the scoring from Neutral.	Option 1 has a lower cost and cost risk than option 2. Therefore option 1 is considered **Stronger** than option 2.

Summary

The workshops considered Option 1 to be **Stronger** than Option 2 in the areas of safety, environmental, technical and Economic, but **Neutral** to each other in societal. Option 1 was consistently the preferred option and is therefore recommended to be taken forward from the CA process. The workshop attendees also noted that altering the scoring for the environmental and societal criteria away from a stronger or neutral position, respectively, would not change the overall outcome, nor would amending the technical comparison to be stronger rather than much stronger.

5.3. Decision 3: Group 8 – Trenched and Rock Dumped Umbilicals

5.3.1. Characteristics

Item	Characteristics
PL736	5" control umbilical (Polymer / Steel / Copper) 6,513 m length, trenched, backfilled and rock dumped
PL1545	4" Umbilical (Polymer / Steel / Copper) 6,360 m length, trenched and rock dumped (25 m intervals)

Table 5.3 Decision 3 Characteristics

Figure 5.1 shows the route and burial status of PL736. Figure 5.2 shows PL1545.

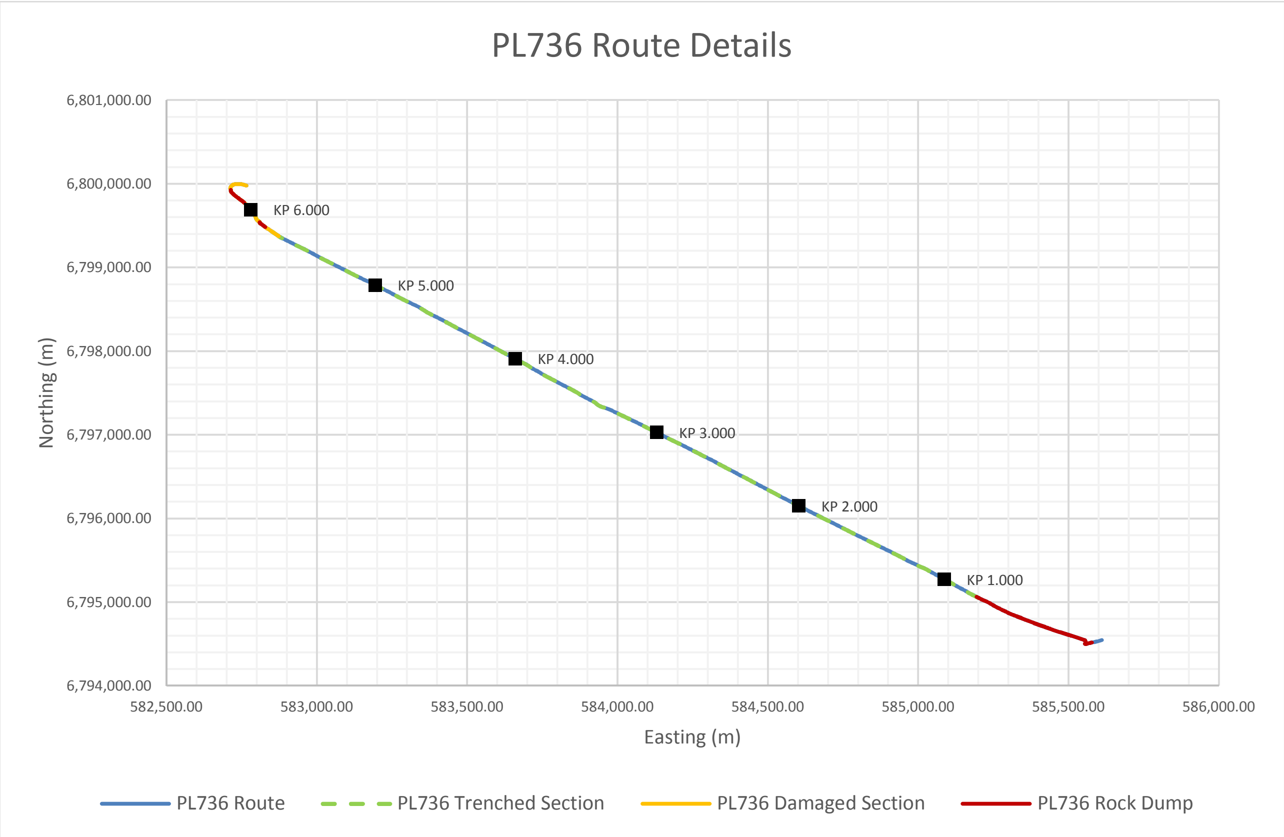


Figure 5.1 PL736 Route Details

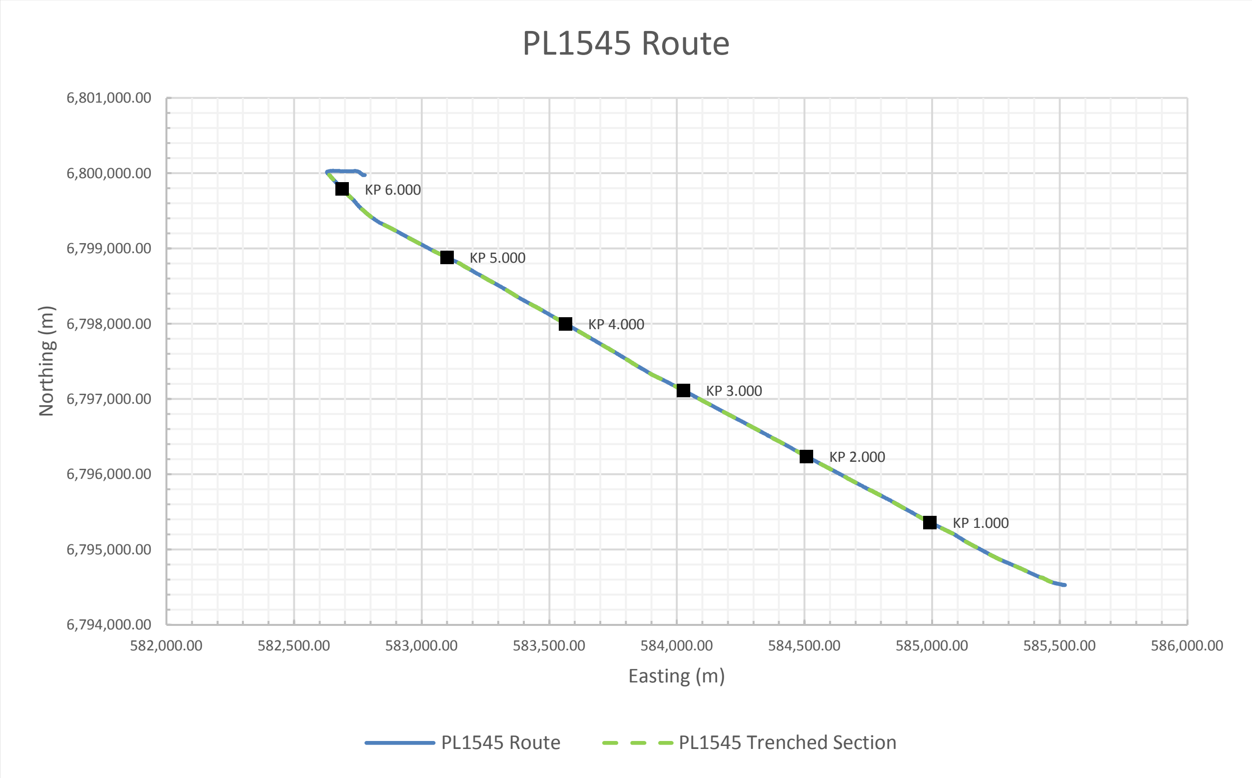


Figure 5.2 PL1545 Route Details

5.3.2. Options

Seven options were presented at screening stage with four of those screened out. The options assessed during the CA were:

- Option 1: Leave *in situ* – Minimal Intervention - Removal of exposed ends, rock placement over snag hazards and areas of low cover.
- Option 2: Leave *in situ* – Major Intervention – Full rock placement.
- Option 3: Full Removal – Reverse Reel.

The process undertaken for this decision point, the judgement made against each of the five criteria, and the chart which demonstrates which option is recommended to be taken forward from the CA are presented on the following page.

5.3.3. Sensitivity Analysis

A sensitivity analysis was performed on this decision point relating to economics. Removing the economics criteria (shown in blue on the chart) from the decision making process had no impact on the preferred option nor the order of the remaining options. No further sensitivity analysis was performed for this decision point.

5.3.4. Recommendation

Fairfield has conducted an analysis of burial depth of both of these umbilicals and found the following:

- The seabed in proximity to PL736 exhibits no significant mobility. With the exception of the damaged section of line end there are no spans or exposures of concern. Spans and exposures are not anticipated to form along the main trenched length. Overall the depth of lowering and depth of cover exceeds 0.6m along most of the route.
- The seabed in proximity to PL1545 exhibits no significant mobility. Overall the measured bottom of trench profile exceeds 0.6m along most the trenched route. Backfilling of the trench is expected to continue at a slow rate and there is not expected to be any formation of spans or exposures.

Given the above, the CA workshops found Option 1 to be preferred over Option 2 involving large quantities of rock placement, or the reverse reel option (3) which was technically very challenging. The recommendation taken forward from the CA is therefore to decommission this infrastructure by removing the ends and placing local rockdump at the cut ends and areas of low burial depth. Periodic monitoring and remediation will be carried out at this location as required.

Group 8 – Trenched and Rock Dumped Umbilicals

Option Screening

(for narrative see Osprey Screening Report)

Leave in Situ – Minimal Intervention (Rock Placement) **Screened In**	Leave in Situ – Minor Intervention (Cut & Rock Placement) **Screened Out**	Leave in Situ – Minor Intervention (Local Trench) **Screened Out**	Leave in Situ – Major Intervention (Full Re-Trench) **Screened Out**
Leave in Situ – Major Intervention (Full Rock Placement) **Screened In**	Full Removal – Reverse Reeling **Screened In**	Full Removal – Cut and Lift **Screened Out**	

Comparative Assessment

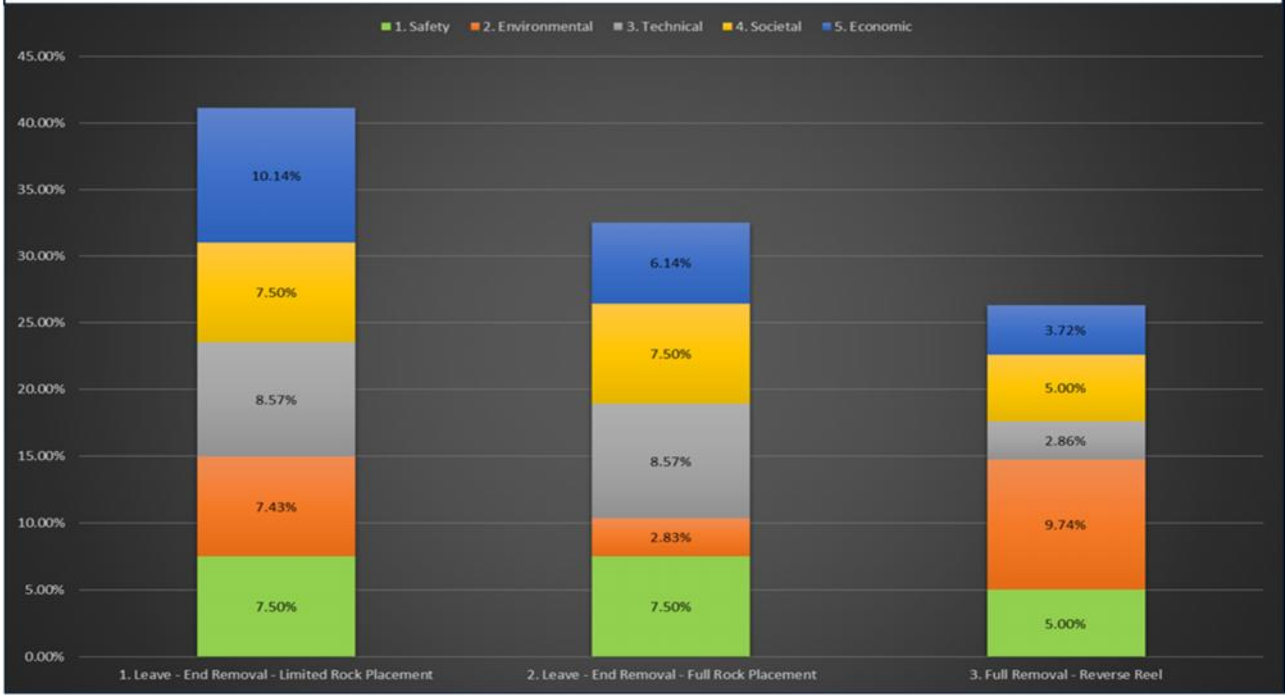
(for full attributes tables and pairwise comparisons see Appendix F)

Option 1	Option 2	Option 3
Leave in Situ – End Removal, Limited Rock Placement	Leave in Situ – End Removal, Full Rock Placement	Full Removal – Reverse Reeling

Safety	Environment	Technical	Societal	Economic
The summed PLL figures for options 1, 2 & 3 indicate that option 2 is the highest risk for all worker groups, followed by option 1 and then option 3. The differential between each of the options is small. Option 3 has a higher risk of high consequence events.	Option 1 is **Much Stronger** than option 2 due to less new material introduced and much smaller seabed disturbance. Option 1 is **Weaker** than option 3 as it has a greater environmental impact in all areas. Option 2 is **Much Weaker** than option 3 due to new material & seabed disturbance.	Option 1 and 2 are technically very similar and as such are scored **Neutral** against each other. Both option 1 & 2 are **Much Stronger** technically than option 3 due to the uncertainty surrounding the ability to adequately complete the deburial operations in the seabed materials and over the intended distances.	Option 1 and 2 are largely similar and are therefore scored as **Neutral** to each other. Further, both options 1 and 2 are **Stronger** than option 3 due to the increase in the amount of landfill required with the increased material being returned to shore in option 3.	Overall option 1 is **Stronger** than option 2 due to the lower overall cost. It is **Much Stronger** than option 3 due to lower cost and lower cost risk. Option 2 is **Stronger** than option 3 as whilst the costs are similar, it has a lower cost risk.

Summary

The workshops considered Option 1 to be **Neutral** with Option 2 in the areas of safety, technical and societal, but **Stronger** than Option 2 in both environmental and economic. Option 3 was only preferable to either option 1 or 2 in the environmental criteria. In all other criteria Option 3 was at least **Weaker** than Options 1 or 2. Overall, Option 1 is preferred and is therefore recommended to be taken forward from the CA process.



6. Summary of Final Recommendations

The CA for the Osprey Subsea Infrastructure Decommissioning Programme has focussed on three groups (Bundles, Flexible and Umbilical Risers, and Trenched and Rock Dumped Umbilicals). All other groups of Osprey subsea infrastructure were confirmed at the CA Scoping and Screening stage to be fully removed from the field. The outcome of the CA process has made the following recommendations:

Group	Infrastructure Type	Decommissioning Recommendation
1	Pipeline and Umbilical Components	Full Removal
2a	Deposits	Full Removal
2b	Structures	Full Removal
3	Bundles	Leave *in situ* – Minimal Intervention (Towhead Removal and Local Rock Placement)
4	Surface Laid Flexible Jumpers	Full Removal
5	Flexible and umbilical risers	Leave *in situ* – Minor Intervention (Outboard Cut and Recovery)
6	Surface Laid Rigid Spools	Full Removal
7	Surface Laid Flexible Pipelines	Full Removal
8	Trenched and Rock Dumped Umbilicals	Leave *in situ* – Minimal Intervention (Local Rock Placement)
9	Surface Laid Umbilicals	Full Removal
10	Surface Laid, Rock Dumped Pipelines	Full Removal

Table 6.1 Final Osprey Recommendations

The three decisions (3, 5 and 8) were found, on completion of an appropriate amount of preparatory study work, to have clear decision outcomes. Justifications are summarised below.

Group 3: Full removal by cut and lift scored poorly during the CA due to safety, technical and economic factors as did attempting to trench the bundles to below seabed level.

A strong preference was shown in the CA workshop for partial removal, with safety, technical and economics being the driving factors which placed it above the other CA options.

The outcome of this decision point is therefore to decommission Group 3 in situ by partial removal. The infrastructure will be decommissioned by removing the towheads and intermediate structures and placing rock cover the cut ends, spans and damage.

Periodic monitoring and remediation will be carried out as required.

Fairfield will consider an approach to periodically review the bundles with a view to selecting a permanent option in the future (e.g. full removal or full rock placement) dependent on technology advances and an associated step change in safety (relative to the other options).

Group 5: Partial removal of the risers, where the outboard and exposed sections of the riser are removed, leaving the remainder in the J-tubes, was assessed as being the preferred option in all criteria apart from societal (in which it was considered neutral to the other CA options).

The outcome of this decision point is therefore to decommission Group 5 in situ by partial removal, having recovered the surface laid/exposed sections. The fate of the sections within the J-tube will ultimately be determined by the CA covering the fate of the Dunlin Alpha CGBS. The Osprey – Effect of Riser Remaining Study has been conducted examining the effects of decommissioning the risers in the J-tubes and found the consequence on other activities to be negligible.

Group 8: With the exception of the end sections, PL736 is trenched and buried to 0.6m or greater along the majority of the route. 3,820t of rock is located on the southern section of the umbilical.

With the exception of the end sections PL1545 is laid within a trench that exceeds 0.6m along the majority of the route. Spot rock dumped is located within the trench every 20-25m, totalling 10,895t.

Both PL736 and PL1545 are stable and there is no significant seabed mobility within the vicinity of the lines. Natural backfill of PL1545 is expected to continue at its current slow rate.

All options considered at the CA were similar however; partial removal exhibited lower levels of personnel exposure, requirement for the addition of new materials and technical challenges. As with all operations, Fairfield will look to minimise safety exposure (to all) and the introduction of new material, to the lowest amount required to ensure confidence in the long term future of the decommissioning solution.

The outcome of this decision point is therefore to decommission Group 8 in situ by partial removal by removing exposures outside of the defined trench and placing local rock cover at the cut ends and any areas of low burial depth.

Periodic monitoring and remediation will be carried out at this location as required.

Sensitivities were performed where appropriate (e.g. relating to economics, or relating to uncertainty for some rankings) and found that these did not alter the overall decision outcomes. The only infrastructure remaining from the Osprey field following decommissioning is proposed to be the exposed bundles, the already trenched and rock dumped umbilicals, and the section of the flexible and umbilical risers which are within the J-Tube integral to the Dunlin Alpha CGB, all other infrastructure will be fully removed.

Figure 6.1 shows the Osprey post decommissioning situation, whilst Figure 6.2 shows the overall Dunlin area context post decommissioning.

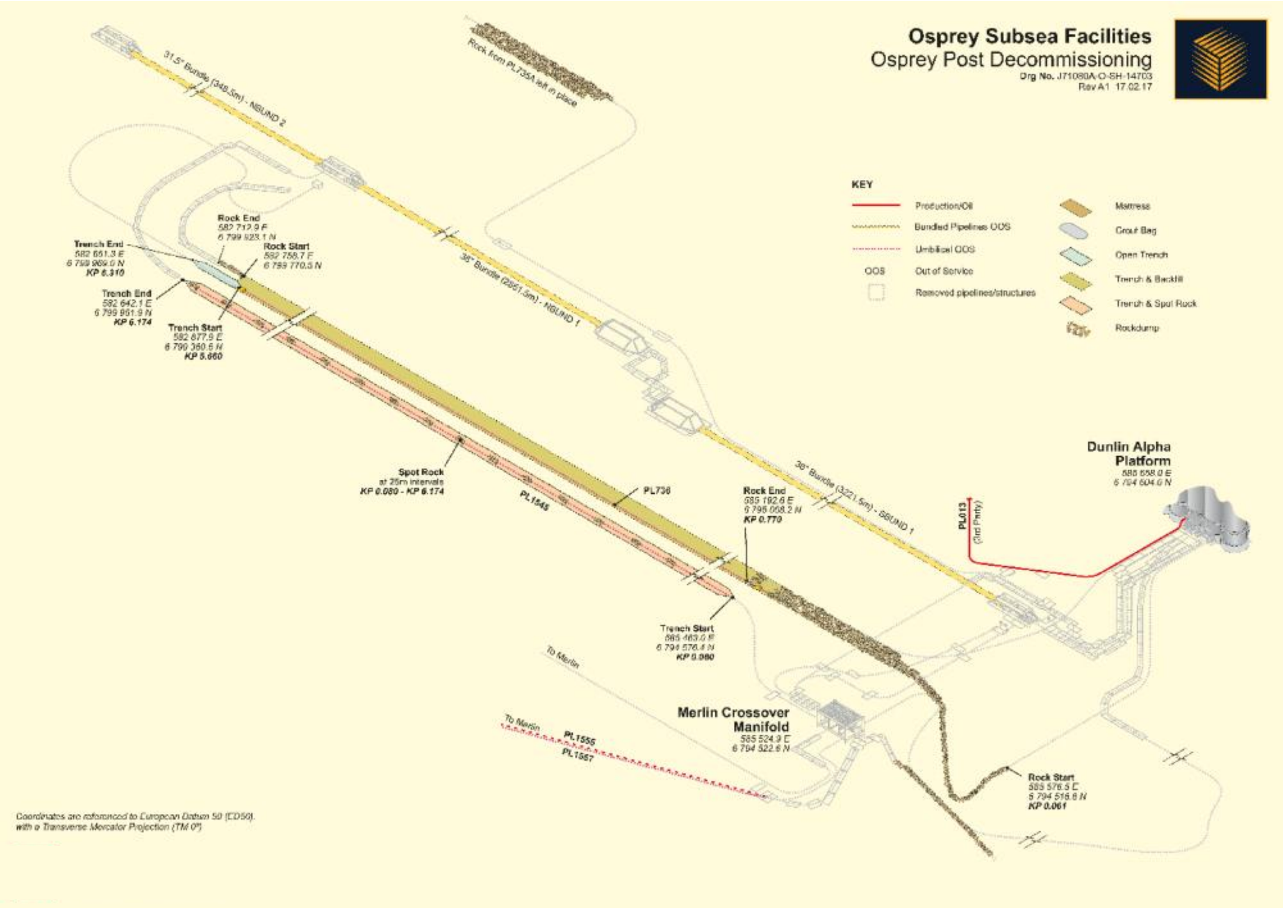


Figure 6.1 Osprey Post Decommissioning

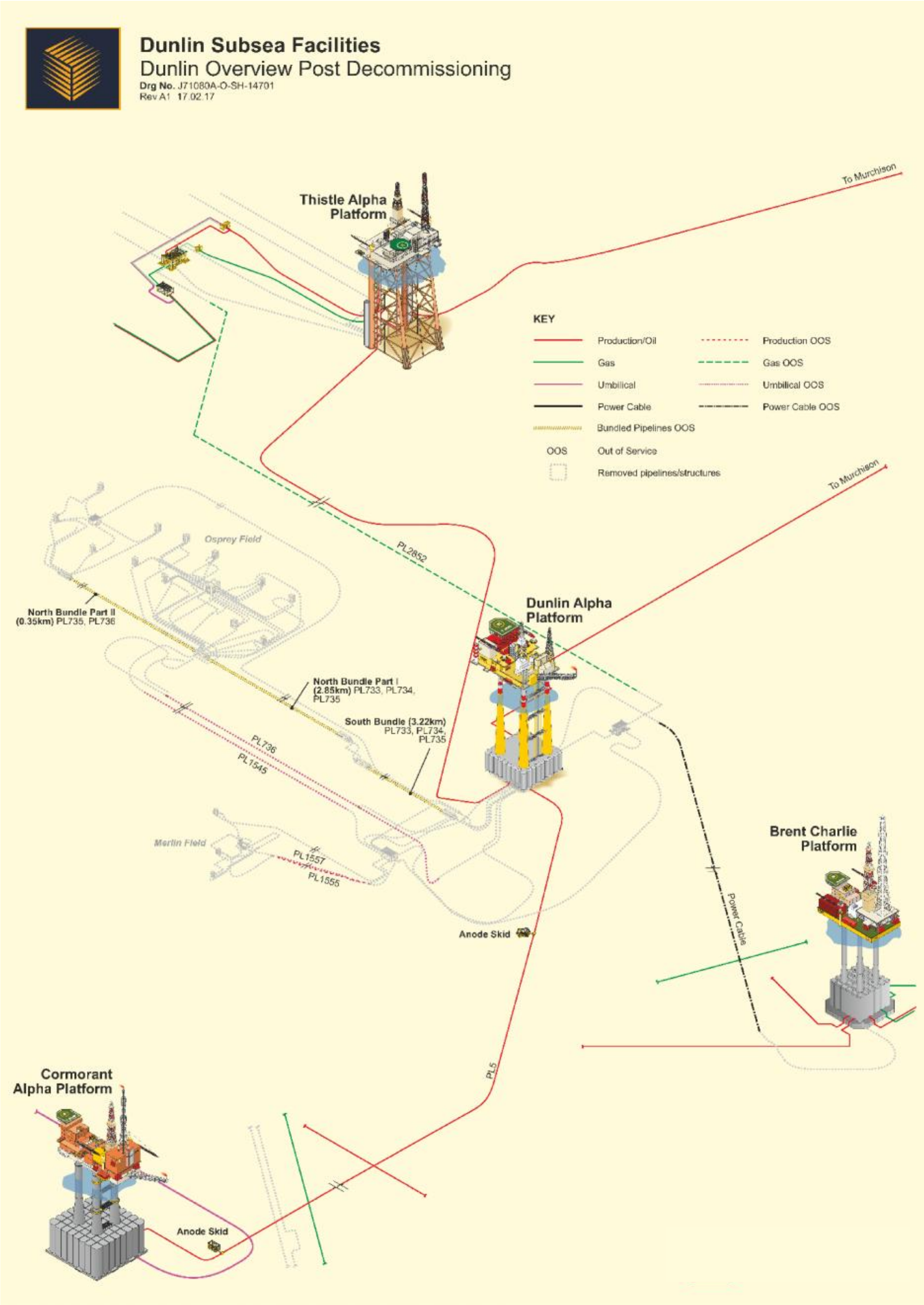


Figure 6.2 Overall Project Context

7. References

1. Comparative Assessment Strategy	FBL-DUN-HSE-STR-00002, Comparative Assessment Strategy, Dated 09/01/2017.
2. Osprey Screening Report	FBL-DUN-OSP-SSP-01-RPT-00002, Subsea Decommissioning Screening – Osprey, Dated 31/05/2016.
3. Osprey Common Scope Report	A301649-S01-REPT-001, Common Scope Preparation Report – Osprey, Rev. A02, Dated 12/10/2016.
4. Osprey Long-term Materials Degradation Study	A301649-S01-TECH-001, Osprey – Long-term Materials Degradation Study, Rev. A01, Dated 08/09/2016.
5. Osprey Trench and Backfill Feasibility Study	A301649-S01-TECH-002, Osprey – Trench and Backfill Feasibility Study, Rev. A02, Dated 15/09/2016.
6. Osprey Removal / Recovery Feasibility Study	A301649-S01-TECH-003, Osprey – Osprey Removal / Recovery Feasibility Study, Rev. A02, Dated 13/09/2016.
7. Osprey Effect of Riser Remaining	A301649-S01-TECH-004, Osprey – Effect of Leaving Riser Section within J-tube, Rev. A01, Dated 13/07/2016.
8. Risk Analysis of Decommissioning Activities	Joint Industry Project Report "Risk Analysis of Decommissioning Activities" (Safetec 2005) [http://www.hse.gov.uk/research/misc/safetec.pdf]
9. Analytical Hierarchy Process	The Analytical Hierarchy Process by T.L. Saaty, McGraw Hill, 1980.
10. Guidelines for Decommissioning of Offshore Oil & Gas Installations and Pipelines	Guidance Notes Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998, Version 6, Dated: March 2011, Issued by: Department of Energy & Climate Change.
11. Habitat Assessment Report	160120-3_Fairfield Habitat Survey Osprey, 160120-4_Fairfield Habitat Survey Dunlin A to Brent C, 160120-5 Fairfield Habitat Survey Dunlin Fuel Gas Import Pipeline, 160120-6 Fairfield Habitat Survey Dunlin Field, 160120-7 Draft Fairfield Habitat Survey Merlin
12. Environmental Baseline Survey Reports	160120_08rev1 Merlin Report, 160120_09rev1 Osprey Report, 160120_10rev1 Dunlin Alpha Report, 160120_11rev1 Dunlin DPI Report, 160120_12rev1 Dunlin DGI Report
13. Drill Cuttings Analysis	Osprey Pre-decommissioning Cuttings Assessment Survey (Fugro Emu Limited, 2017)
14. Pipeline Cleanliness Study	A301524-S04-TECH-001, Pipelines Cleanliness Study – Dunlin Infield Oil Pipelines, Rev. A01, Dated 04/05/2016.
15. Drill Cuttings Screening	A301524-S00-TECH-005, Dunlin, Merlin and Osprey Drill Cuttings Screening, Rev. A02, Dated 22/09/2016.

16. Lifecycle Emissions Assessment	A301524-S00-REPT-007, Lifecycle Emissions Assessment Report
17. Commercial Fisheries Baseline	A301524-S00-REPT-003, Dunlin Area Decommissioning – Commercial Fisheries Baseline, Rev. A01, Dated 01/09/2016.
18. ENVID Report	A301524-S00-TECH-003, Environmental Issues Identification (ENVID) Report
19. Fishing Risk Assessment	A3910-XG-RA-1, Dunlin, Merlin and Osprey Subsea Infrastructure Decommissioning Fishing Risk Assessment

8. Abbreviations and glossary

AHP	Analytical Hierarchy Process
BEIS	Business, Energy and Industrial Strategy
CA	Comparative Assessment
DAD	Dunlin Area Decommissioning
dB	Decibels
EIA	Environmental Impact Assessment
ESDVs	Emergency Shutdown Valves
FAR	Fatal Accident Rate
FEL	Fairfield Energy Limited
KP	Kilometre Post
MCDA	Multi-criteria Decision Analysis
MFE	Mass Flow Excavator
OSPAR	Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)
PLL	Potential for Loss of Life
QRA	Quantitative Risk Assessment
SCMs	Subsea Control Modules
SEL	Sound Energy Level
SFF	Scottish Fisheries Federation
SID	Subsea Infrastructure Decommissioning
TPa^2S	Tera-pascal Squared Second – Total Noise Emission metric
TUTU	Topside Umbilical Termination Unit

Appendix A Pairwise Methodology Explanation

A1 Introduction

In order to support the decision making process for the remaining Subsea Infrastructure Decommissioning (SID) decision points, Fairfield has adopted the use of Xodus' Multiple Criteria Decision Analysis (MCDA) tool for delivering the required Comparative Assessment.

Whilst the key attributes and steps taken in the use of this tool are discussed in the main body of this report, an elaboration of the calculation methods used has been deemed appropriate.

A2 The Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) is a general theory of measurement used to derive ratio scales or priorities which reflect the relative strength of comparisons. It was developed during the 1970s by Thomas L. Saaty, a mathematician at University of Pennsylvania and is considered a fundamental approach to multi-criteria decision making. It has been used extensively in a wide variety of applications and industries and is the subject of many books, papers and other publications.

Whilst a detailed discussion of the AHP is beyond the scope of this document it is however, worth discussing a number of the key mathematical elements of the process and how these are implemented.

A2.1 Initial Setup

One of the key concepts of AHP is the hierarchical nature of the decision making process. This is demonstrated by the need for any decision to have the following elements:

- Objective – the primary goal or objective for the decision.
- Decision criteria – the primary criteria by which the decision will be measured.
- Sub-criteria – the second tier (and potentially other tiers) of criteria that primary criteria may be split into
- The proposed alternatives (options) which may satisfy the objective.

In the context of the SID, the above elements are:

- Objective – to select the optimum decommissioning strategy, for each decision point, given the prevailing legislation and the Fairfield Guiding Principles.
- Criteria – Safety | Environment | Technical | Societal | Economic
- Sub-criteria:
  - Safety – Personnel Offshore | Personnel Onshore | Other Users | High Consequence Events | Residual Risk
  - Environmental – Marine Impacts | Emissions | Consumption | Disturbance | Protections
  - Societal – Fishing | Other Users
  - Economic – Short-term Costs | Long-term Costs

- Options (For this Worked Example - Osprey Group 3, Bundle)
  - 1a – Initial towhead removal and local rock dump with only minor remediation required in the future
  - 1b – Initial towhead removal and local rock dump with full rock dump in the future
  - 1c – Initial towhead removal and local rock dump with full removal in the future
  - 2 – Towhead removal and full rock dump
  - 3 – Towhead removal and trench and bury
  - 4 – Full removal

A2.2 Pairwise Comparison Matrix

The focal point of multi-criteria decision making and AHP is the construction of matrices by performing pairwise comparisons where the relative merits of pairs of criteria are considered against each other. AHP uses a hierarchical system of these matrices to allow the relative merits of options against the defined criteria and objective to be calculated.

These pairwise comparison matrices are constructed by listing the parameters being considered in rows and columns and considering what the relevant importance of each versus the others is. Most applications of the AHP use a 1 to 9 numeric scale as defined in Table A.1.

Importance Value	Definition	Explanation
1	Equal Importance	The criteria / options are considered equally important to each other.
3	Moderate importance	Experience and judgement moderately favour one criteria / option over the other.
5	Essential or strong importance	Experience and judgement strongly favour one criteria / option over the other.
7	Very Strong importance	A criteria / option is strongly favoured over the other and can be demonstrated in practice.
9	Extreme importance	The evidence favouring one criteria / option over the other is of the highest possible order.
2 / 4 / 6 / 8	Intermediate values between the two adjacent judgements	Can be used where compromise is needed.

Table A.1 Standard AHP Importance Scale

It should be noted that finer judgements can be made by applying further intermediate ranges such as 1.1, 1.2. etc. to add fidelity as required. Equally, the 1 to 9 numerical scale could be extended to say 1 to 100 as well if required. However, caution is advised in departing significantly from the widely accepted 1 to 9 numerical scale with the descriptions as detailed in Table A.1 as these have been shown over many applications to reflect the appropriate decision.

It should be further noted that only the upper triangle of the pairwise comparison matrix is completed as this represents the row versus column judgement, with the reciprocal being automatically inserted in the lower triangle of the pairwise comparison matrix.

An example is shown in Table A.2 of the standard AHP importance scale applied to decision relating to the relevant importance of criteria in the decision making process of buying a personal vehicle. In this example the first pairwise comparison we make is Cost versus Style. Here, we make the decision that Cost is a much stronger consideration than Style, and so, from Table A.1 an importance metric of 7 may be selected (with a reciprocal of 1/7 automatically inserted in the corresponding Style versus Cost cell).

The next comparison is Cost versus Fuel Economy. In this case, the use of the personal vehicle could be over limited mileage and thus Cost could be considered vastly more important than Fuel Economy. Again, using the importance scale from Table A.1 a 9 is inserted with 1/9 as the reciprocal.

The remaining comparisons are made with the final pairwise comparison matrix shown in Table A.2.

	Cost	Style	Fuel Economy	Reliability
Cost	1	7	9	3
Style	1/7	1	1/3	1
Fuel Economy	1/9	3	1	1/3
Reliability	1/3	1	3	1

Table A.2 Example Pairwise Comparison

The scale of priorities or relative weighting of the criteria from Table A.2 has been shown by the AHP to be derived by calculating the primary eigenvector of the above matrix and normalising the result. Again, detailed discussion of how this calculation is performed and the associated priorities arrived at is beyond the scope of this discussion. In this example this derives the following priorities:

- Cost – 0.6445
- Style – 0.0812
- Fuel Economy – 0.1001
- Reliability – 0.1742

A3 Xodus Application of the AHP

Appendix A2 details a standard application of the AHP and can be found described in many public domain papers and publications. Over the years, Xodus has applied these principles of the standard AHP in many applications, ranging from prioritising the order of competing work scopes by comparing their relative benefits, to identifying the most attractive option during the concept select phase of many projects.

In delivering these decision support activities, our consultants have gathered a breadth of experience that has enabled them to identify and implement improvements to the application of the standard AHP. In terms of Xodus' implementation of the AHP for this SID, on behalf of Fairfield, and as engineered into our tool, there are two departures from the standard AHP. These are:

- Using phrases rather than numbers in the importance scale.
- Tuning of the importance scale.

A3.1 Words v Numbers

One of the challenges that has faced Xodus when asking assembled audiences to apply the importance scale to a particular comparison, was to encourage them to apply the scale according to the descriptions and explanations (see Table A.1) rather than implying that adopting a 3 in the matrix meant the comparison was 3 times better, etc.

To manage this, Xodus changed the way we apply the principles of the AHP by replacing numbers in the pairwise comparison matrix with a narrative or descriptive approach. This is already programmed into the AHP in the importance scale explanations in Table A.1. Whilst implementing this change, Xodus also decided that three positions from equal (and their reciprocals) would be sufficient for most applications. These positions are:

Neutral	Equal Importance, equivalent to 1 in the importance scale from Table A.1.
Stronger (S) / Weaker (W)	Moderate importance of one criteria / option over the other, equivalent to 3 in the importance scale from Table A.1.
Much Stronger (MS) / Much Weaker (MW)	Essential / strong importance of one criteria / option over the other equivalent to 5 or 6 in the importance scale from Table A.1.
Very Much Stronger (VMS) / Very Much Weaker (VMW)	Extreme importance of one criteria / option over the other equivalent to 8 or 9 in the importance scale from Table A.1.

Table A.3 Definitions of positions from equal

Using this transposed scoring system makes it, in our experience, simpler and more importantly, more effective at capturing the mind-set and feeling of the attendees at the workshops. Phrases such as 'what are the relative merits of pipeline removal on a project versus rock dumping from a safety perspective? Are these Neutral to each other? Are they stronger? If so, how much stronger? If you had to prioritise one over the other, which would it be?'. This promotes a collaborative dynamic in the workshop and enables the collective mind-set of the attendees to be captured. Where there is quantitative data to provide back-up and evidence for the collective assertions, so much the better.

Once the matrix is complete, deriving the priority scale is performed in exactly the same manner as for the standard AHP i.e. the primary eigenvector of the matrix is solved (with Stronger replaced with 3, Much Stronger replaced with 6 and Very Much Stronger replaced with 9 (and similarly for the reciprocals)).

A3.2 Tuning Importance Scale

A further adjustment from the standard AHP has been implemented by Xodus in the last few years of applying AHP for decision making. This takes the form of tuning the importance scale to reflect the sentiment of the workshops. This is best illustrated by a 2 option decision matrix.

Let us take two options, option 1 and option 2 and apply the standard AHP importance scale to them with the Xodus Stronger / Much Stronger / Very Much Stronger wording relating to that standard scoring. This provides the derived priorities as shown in Table A.3.

Original AHP Importance Scale		Derived Priority	
Option 1	**Option 2**	**Option 1**	**Option 2**
1 (Neutral)	**1 (Neutral)**	**0.5000**	**0.5000**
2	1/2	0.6667	0.3333
3 (Stronger)	**1/3 (Weaker)**	**0.7500**	**0.2500**
4	1/4	0.8000	0.2000
5	1/5	0.8333	0.1667
6 (Much Stronger)	**1/6 (Much Weaker)**	**0.8571**	**0.1429**
7	1/7	0.8750	0.1250
8	1/8	0.8889	0.1111
9 (Very Much Stronger)	**1/9 (Very Much Weaker)**	**0.9000**	**0.1000**

Table A.3 Standard AHP Importance Scale and Derived Priorities

As can be seen, criteria / options that are scored as Neutral to each other have a relative priority of 0.500 each, which reflects what we would expect. If we then look at priority derived from considering criteria / options Stronger / Weaker to each other, we get a (0.7500, 0.2500) split. Following this through, for Much Stronger / Much Weaker we get priorities of (0.8571, 0.1429) and finally for Very Much Stronger / Very Much Weaker we get priorities of (0.9000, 0.1000).

When delivering comparison sessions, Xodus felt that the Stronger / Weaker sentiment in the room did not reflect a 75 / 25 split between the options and that this resulted in a contribution which was too dominant in these areas. It was felt that the Much Stronger / Much Weaker providing an 86 / 14 split was also more dominant than was intended by the workshop attendees. Finally, Very Much Stronger / Very Much Weaker with a 90 / 10 split seemed about right for the intentions of the workshops.

As such, Xodus decided to tune the relative importance scale to ensure that the sentiment of the workshop attended was reflected correctly when selecting the Stronger / Much Stronger / Very Much Stronger assessment. The outcome of that tuning process is shown in Table A.4.

Revised Xodus Importance Scale		Derived Priority	
Option 1	**Option 2**	**Option 1**	**Option 2**
1 (Neutral)	**1 (Neutral)**	**0.5000**	**0.5000**
1.5 (Stronger)	**1/1.5 (Weaker**	**0.6000**	**0.4000**
2	1/2	0.6667	0.3333
3 (Much Stronger)	**1/3 (Much Weaker)**	**0.7500**	**0.2500**
4	1/4	0.8000	0.2000
5	1/5	0.8333	0.1667
6	1/6	0.8571	0.1429
7	1/7	0.8750	0.1250
8	1/8	0.8889	0.1111
9 (Very Much Stronger)	**1/9 (Very Much Weaker)**	**0.9000**	**0.1000**

Table A.4 Xodus Tuned AHP Importance Scale and Derived Priorities

In this revised system the following splits are obtained:

- Stronger / Weaker provides a 60 / 40 split
- Much Stronger / Much Weaker provides a 75 / 25 split
- Very Much Stronger / Very Much Weaker provides a 90 / 10 split

Xodus believes this importance scale more accurately reflects what workshop attendees actually mean when they assess a criteria / option as stronger, much stronger or very much stronger than another.

A4 Worked Example

A key question when considering the Xodus application of AHP to our multi-criteria decision making activities is, what is the impact of Xodus modifications to the standard importance scale? Xodus believes the modifications to have been identified and implemented for valid reasons as described in Appendix A3. To illustrate the impact of these changes, one of the SID decision points has been calculated using both the standard AHP importance scale and the tuned Xodus version and the derived priorities from these are illustrated in Figures A.1 to A.5.

1. Safety	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Standard AHP Priorities	Xodus AHP Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	MS	46.15%	42.86%
2. Leave - End Removal - Full Rock Placement	N	N	MS	46.15%	42.86%
3. Full Removal - Reverse Reel	MW	MW	N	7.69%	14.29%

Figure A.1 Safety Pair-wise Comparison Matrix

2. Environmental	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Standard AHP Priorities	Xodus AHP Priorities
1. Leave - End Removal - Limited Rock Placement	N	S	S	58.42%	42.63%
2. Leave - End Removal - Full Rock Placement	W	N	W	13.50%	24.83%
3. Full Removal - Reverse Reel	W	S	N	28.08%	32.54%

Figure A.2 Environmental Pair-wise Comparison Matrix

3. Technical	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Standard AHP Priorities	Xodus AHP Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	MS	46.15%	42.86%
2. Leave - End Removal - Full Rock Placement	N	N	MS	46.15%	42.86%
3. Full Removal - Reverse Reel	MW	MW	N	7.69%	14.29%

Figure A.3 Technical Pair-wise Comparison Matrix

4. Societal	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Standard AHP Priorities	Xodus AHP Priorities
1. Leave - End Removal - Limited Rock Placement	N	W	S	28.08%	32.54%
2. Leave - End Removal - Full Rock Placement	S	N	S	58.42%	42.63%
3. Full Removal - Reverse Reel	W	W	N	13.50%	24.83%

Figure A.4 Societal Pair-wise Comparison Matrix

5. Economic	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Standard AHP Priorities	Xodus AHP Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	S	42.86%	37.50%
2. Leave - End Removal - Full Rock Placement	N	N	S	42.86%	37.50%
3. Full Removal - Reverse Reel	W	W	N	14.29%	25.00%

Figure A.5 Economic Pair-wise Comparison Matrix

A5 Final Priorities

As the name Analytical Hierarchical Process suggests, there is a strong hierarchical component to the process. This was introduced in Appendix A2.1 where the relationship between the objectives / goals, the success criteria, and associated sub-criteria and finally the proposed options was introduced.

The priorities derived for each of the proposed options, with respect to the identified criteria from the example detailed in Appendix A4 (using Xodus importance scale only) are summarised in Table A.5.

	Safety	Environment	Technical	Societal	Economic
Option 1	0.4286	0.4263	0.4286	0.3254	0.3750
Option 2	0.4286	0.2483	0.4286	0.4263	0.3750
Option 3	0.1429	0.3254	0.1429	0.2483	0.2500

Table A.5 Priority Matrix – Options w.r.t. Criteria

Similarly, the priorities derived by performing a pairwise comparison of the criteria themselves are summarised in Table A.6. At this stage, the criteria have been considered as having equal priority. As such the derived priorities are 0.2000 for all criteria.

	Priority
Safety	0.2000
Environment	0.2000
Technical	0.2000
Societal	0.2000
Economic	0.2000

Table A.6 Priority Matrix – Criteria

In order to obtain the final priorities, each row of the 3 x 5 matrix (i.e. a 1 x 5 matrix) is multiplied by the 5 x 1, which provides priority values which relate to the contributions of the benefits associated with each option for each criteria, weighted by that criteria.

In this example, the overall priorities derived are shown in Table A.7.

	Safety	Environment	Technical	Societal	Economic	Total
Option 1	0.0857	0.0853	0.0857	0.0651	0.0750	**0.3968**
Option 2	0.0857	0.0497	0.0857	0.0853	0.0750	**0.3814**
Option 3	0.0286	0.0651	0.0286	0.0497	0.0500	**0.2219**

Table A.7 Final Priorities

A6 Discussion

Combining the priorities derived in the example presented in Appendix A4 and the method for deriving the final priorities described in Appendix A5, we obtain the final priorities as shown in Table A.8 and Table A.9 and depicted graphically in Figure A.6.

Option	1. Saf.	2. Env.	3. Tech.	4. Soc.	5. Eco.	Total
1. Leave - End Removal - Limited Rock Placement	9.23%	11.68%	9.23%	5.62%	8.57%	**44.33%**
2. Leave - End Removal - Full Rock Placement	9.23%	2.70%	9.23%	11.68%	8.57%	**41.42%**
3. Full Removal - Reverse Reel	1.54%	5.62%	1.54%	2.70%	2.86%	**14.25%**

Table A.8 Outcome with Standard AHP Importance Scale

Option	1. Saf.	2. Env.	3. Tech.	4. Soc.	5. Eco.	Total
1. Leave - End Removal - Limited Rock Placement	8.57%	8.53%	8.57%	6.51%	7.50%	**39.68%**
2. Leave - End Removal - Full Rock Placement	8.57%	4.97%	8.57%	8.53%	7.50%	**38.14%**
3. Full Removal - Reverse Reel	2.86%	6.51%	2.86%	4.97%	5.00%	**22.19%**

Table A.9 Outcome with Xodus Tuned AHP Importance Scale

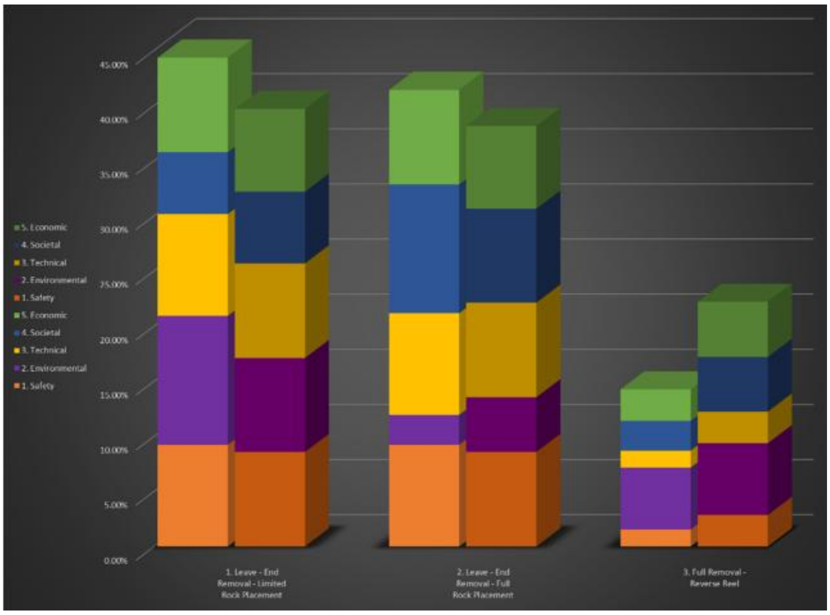


Figure A.6 CA Visual Output showing Standard v Xodus Tuned Importance Scale

In the graph shown in Figure A.6, the first column of each option shows the colour coded individual criteria priorities, whilst the stack-up shows the overall or final priority for the option under the standard AHP importance scale. The second column shows the equivalent using the Xodus tuned AHP importance scale.

As can be seen, and as would be expected given that Xodus tuning of the AHP importance scale reduces the impact of the Stronger and Much Stronger judgements (and their reciprocals), overall the priorities of the stronger options are a little lower and this has the associated impact of increasing the priority of the less attractive options. In effect, this Xodus tuning compresses priorities together – an outcome Xodus believes more accurately reflects the sentiment associated with comparisons of options that are considered close to each other.

Overall, the outcome for this example decision point is not altered by adopting standard versus Xodus tuned AHP importance scale.

Appendix B CA Criteria

Differentiator	Sub-Criteria	Description
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.
	1.5 Residual Risk	This sub-criterion addresses any residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities and residual impacts post decommissioning such as reinstatement of access to area.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.

Appendix C Environment Criteria Assessment Methodologies

C1 Introduction

This appendix provides further information on environment criteria assessment methodologies. Assessment methodologies for safety (e.g. Potential Loss of Life calculations), technical and economics are available within the Common Scope Report.

C2 Noise Emissions Assessment

A range of offshore activities generate airborne and underwater noise. Fish, whales and dolphins, and even diving seabirds, may be able to detect this noise and, if it is sufficiently loud, it can damage the hearing of these animals. Where noise is not loud enough to cause injury, it might still be loud enough to disturb the animals from normal behaviour. As part of this assessment, the activities that create noise in the marine environment have been identified and a representation of how loud the emissions are has been considered. It has been concluded that the possible noise emissions are either sufficiently quiet that injury isn't considered likely, or that mitigation measures could be adopted so that injury can be avoided. Examples of noise levels from decommissioning activities are given in the following table, alongside the levels required to cause injury:

Activity	Source Noise Level (dB re 1 mP @ 1 m rms)	Threshold of injury to marine mammals
Dive support vessel	178	233
Rock dumping	188	233
Mass flow excavation	162	233
Underwater cutting	195	233
Survey vessel	184	233

Table C.1 Comparison of Decommissioning Noise Sources and Injury Thresholds

On this basis, the activities are not likely to injure any marine animals. As such, it is the possibility of disturbing animals that required further consideration. Disturbance is not simply a function of cumulative noise exposure but also of absolute levels; habituation is important, where animals may become tolerant of a noise over time, but disturbance will also be related to the extent to which interference with communication and echolocation systems occurs. To investigate the measure of risk of disturbance posed by the decommissioning options, a risk score was developed that allowed Fairfield to compare the multi-activity events with each other in order to demonstrate the different total energy of each overall option. Taking the amount of noise emitted on each day and summing it for all days that the activities will occur on provided an estimate of the total noise from each decommissioning option. This number is not a measure of how loud the option is, but how much noise overall is emitted. If an option emits a lot of noise for a long time then it is, crudely for the purposes of comparison, considered as having a higher risk of disturbance to animals.

Calculations are given for two numbers:

õ Total noise energy emitted in terms of cumulative SEL in decibels. The decibel scale is logarithmic (i.e. a 3 dB change represents a doubling or halving of acoustic energy and a 6 dB change represents a quadrupling or quartering of acoustic energy).

- Total noise energy emitted in TPa2s; this metric is a linear scale so comparing between two numbers is easier than using the decibel scale (i.e. a doubling of this metric means a doubling in noise emissions).

Note: Care must be taken in interpreting these abstract figures in terms of impact on marine wildlife because, as noted above, there is not necessarily a direct relationship between the cumulative sound exposure and marine mammal response. Nevertheless, this gave a relatively simple method of comparing the options in terms of acoustic emissions.

The two metrics were calculated to compare between the different decommissioning options. To set these values in context of existing offshore activities, a standby vessel on site for a year would result in the following values for the two metrics:

- Cumulative SEL = 263 dB re 1 P @ 1 m; and Total Noise Energy = 199 TeraPa2s.

C3 Disturbance Assessment

The disturbance assessment considered dredging, backfilling, trenching and rock dumping as the four key differentiating mechanisms for seabed disturbance. The seabed habitat in the region is mud with sea pens and burrowing megafauna. This is a priority marine feature and mud is relatively limited on the UK Continental Shelf compared to other sediment habitats. However, this habitat does have a reasonable recovery potential.

Whilst the area of disturbance is an important factor, the type of disturbance is also important. Dredging, backfilling and trenching are all activities which cause a temporary disturbance. Recovery from these, specifically for a pipeline or umbilical, will be via migration of species from bordering undisturbed areas, resulting in a community similar to what was there before. Rock dump, however, represents a permanent change and a new or different habitat type. In broad terms, the following hierarchy is applied:

Grading	Best →			Worst
Type of disturbance	Dredge	Backfill	Trench	Rockdump

When combining this with area of disturbance the general scale and context is also important:

- An area of approximately 1,000,000 m2 is effectively a large area equivalent to or larger than the largest habitat features thought to be of conservation significance.
- One tenth of this area, 100,000 m2 would be generally only be significant from a cumulative perspective (i.e. multiple areas of this size).
- Anything smaller is considered to be a relatively small area of disturbance.

When comparing options the project team in the workshop combined the quantified disturbance areas with this approximate hierarchy of disturbance types through discussion and narrative.

C4 Emissions

In order to provide a comparative assessment of the energy and emissions produced during each of the proposed decommissioning options being considered within this report, primarily the Institute of Petroleum (IP) guidelines for the calculations of estimates of energy use and gaseous emissions in the decommissioning of offshore structures (IP, 2000) methodology has been used. The IP document provides a standardised set of guidelines, allowing oil and gas operators to make predictions of the potential energy use and gaseous emissions during the process of decommissioning, when assessing the options for removal.

End points are defined as the final states of the materials following the decommissioning operations, i.e. secondary raw materials. If the end-point is a useful material then it is assumed that the material is recycled, with any consequent onshore reprocessing energy use and emissions also taken into account, including dismantling of materials and their subsequent transport to recycling yards. At this stage the recycling location has not as yet been identified, however, an assumption has been made in this assessment that the materials will be transported by lorry to a recycling plant 150 km from the quayside for dismantling and for recycling.

The weights for each material were extracted from the Materials Inventory, whilst the energy and emissions values were extracted from the IP guidelines values per tonne of new and recycled materials as well as the dismantling and onshore transportation data.

Xodus provided the anticipated vessel activity data for each of the proposed decommissioning methods (from the Common Scope Reports). This activity data (including the type of vessel(s) as well as the expected transit and field activity data) was used in the assessment in conjunction with the vessel operations energy and fuel consumption values (tonnes/day, based on fuel consumption figures provided by the IP Guidelines; IP, 2000). This assessment followed the internationally agreed principles for full life cycle assessments, as per DECC (2011) guidance notes for the Decommissioning of Offshore Oil and Gas Installations and Pipelines.

Energy consumption for both new materials manufactured or recycled uses the following calculation:

Tonnes of material to be processed x IP Factor for Energy used for processing (new manufacture or recycling) material(GJ/t) = Total energy consumption (GJ)

- Example: 450 tonnes of aluminium is designated to be recycled, requiring 6,750 GJ (450 t (to be processed) x 15 GJ/t (IP Factor for recycling Aluminium)) of energy to undergo the recycling process alone (this does not account for the energy requirement needed to dismantle the material and any transportation required onshore).

The gaseous emissions produced for both new material manufacturing and recycling uses the following calculation:

Tonnes of material to be processed x IP Emission factor (kg/t) = Gaseous emissions from the manufacture of new material (kg)

- Example: 450 tonnes of aluminium designated to be recycled is estimated to produce 486,000 kg (450 t x CO_2 emissions factor (1,080 of CO_2 kg emitted/t) of CO_2 gaseous emissions.

The Energy consumption from onshore transportation of materials from the quay side to a recycling facility have been calculated using IP guidelines (IP, 2000). The Energy consumption for both new materials manufactured or recycled uses the following calculation:

Total fuel use (t) x IP Emission factor (kg/t) = Gaseous emission from vessel activities (kg)

- Example: If 66.9 tonnes of fuel is need to complete the transfer of recycling materials to a designated recycling facility the vehicle(s) are estimated to produce 212,800 kg (66.9 x CO_2 emissions factor (3180 of CO_2 kg emitted/t)) of CO_2 gaseous emissions.

C5 Scale and Context

The base case for all options, following the extensive preparation works to date, was that all options are tolerable in terms of safety, environmental impact, and societal impact. However, to understand whether one option is ‘stronger’, ‘much stronger’, or ‘very much stronger’ than another sometimes required an understanding of how close the options were on a given scale. For example, in terms of CO_2 emissions whilst the numbers for two options may appear an order of magnitude different, in terms of percentage contribution to UK annual emissions both might still be relatively similar and could feasibly still be neutral or ‘stronger’ rather than ‘very much stronger’.

Appendix D Stakeholder CA Workshop Agenda and Minutes

Fairfield Energy Limited
(Registered No. 5562373)

Minutes

Meeting Name:	Dunlin Area Subsea Infrastructure Removal – Comparative Assessment Workshop
Date:	10th January 2017
Venue:	Fairfield, Westhill

Present:		
	Louise Pell-Walpole	JNCC
	John Watt, Steven Alexander	Scottish Fishermen's Federation
	Dr Peter Hayes	Marine Scotland
	Debbie Taylor, Amy Stubbs	BEIS - ODU
	Ian Fozdar	Oil and Gas Authority
	Gary Farquhar, Peter Lee	FEL
	James Clarkson, Andrew Corse,	FEL
	Jonathan Bird, Harry Yorston	FEL
	Jiro Mukai	MCX
	Peter Tipler, John Foreman,	Xodus
	Kenneth Couston	Xodus

Actions

1. PURPOSE OF THE MEETING

The purpose of the workshop was to engage stakeholders in a comparative assessment (CA) workshop of the options to decommission subsea infrastructure associated with the Dunlin, Osprey and Merlin Fields. The outputs from the meeting were recommended methodologies for inclusion in the relevant Decommissioning Programmes for public consultation.

2. INTRODUCTIONS

FEL thanked stakeholders for taking time to attend the workshop and reading the CA recommendations and supporting analysis which had been issued in advance. Each participant was introduced.

3. COMPARATIVE ASSESSMENT PROCESS

Xodus described the CA process undertaken and confirmed that it is aligned to the CA guidelines issued by Oil and Gas UK. It was explained that six key CA recommendations would be made during the workshop. The recommendations will then also be applied to any analogous subsea infrastructure. The limits for the workshop were confirmed as subsea infrastructure only, the Dunlin CGBS will the subject of a separate CA.

The evaluation criteria are aligned to the BEIS ODU and OGUK Guidelines, namely Safety, Environmental, Technical, Societal and Economics. The criteria have been assessed using the Xodus "Pairwise" methodology and weighted equally.

For each decision a sensitivity analysis excluding the Economics criterion, has also been prepared. It was noted that removing Economics did not change the recommendation for any removal decision.

Xodus also advised that a Quantitative Risk Analysis (QRA) workshop in relation to the impact on fishing for each option is to be held week commencing 16th January 2017. Stakeholders will be advised of the QRA output and any impact on the CA recommendations.

3.1 Merlin Field

3.1.1 Merlin Trenched and Rock-Dumped Pipelines and Umbilicals

FEL described the scope and status of the Merlin Trenched and Rock-Dumped Pipeline (PL1555) and Umbilical (PL1557) and reminded attendees that full removal had previously been recommended for most of the other Merlin infrastructure groupings. FEL explained that three options were assessed for Merlin Trenched and Rock-Dumped Pipelines and Umbilicals which had not been not previously identified for full removal.

The options are:

Option 1 - Leave in situ, remove ends, rock placement over snag hazards and areas of low cover.
Option 2 - Leave in situ, remove all exposures, rock placement over snag hazards and areas of low cover.
Option 3- Leave in situ, back-fill trench using existing berm.

Xodus presented the assessment of the options against the five criteria.

JNCC asked if the CA takes into consideration impacts of future monitoring requirements and impacts to future users of the sea if infrastructure is left in situ. Xodus confirmed that the assessments include future impacts for up to 50 years for the purposes of comparative assessment.

SFF stated that option 3 would improve future fishing risk exposure, whereas options 1 and 2 have a neutral effect. Xodus updated the assessment accordingly.

Marine Scotland (MS) observed that the Oil Pipeline contains around 5 tonnes of LSA scale. **FEL committed to verify any relevant regulatory requirements in relation to the LSA scale.** **FEL**

FEL explained that the trench berms have a typical gradient of 1 in 8 and a height of less than 0.6m which is within over-trawl parameters. **FEL committed to issuing the berm analysis data to stakeholders.** **FEL**

The overall result of the CA is that Option 1 is the recommended decision. Merlin Trenched and Rock-Dumped Pipeline and Umbilical (PL1555 and PL

1557) should be left in situ, ends removed, rock placed over snag hazards and areas of low burial followed by a sea-bed survey and trawl sweep.

3.1.2 Merlin Trenched and Buried Pipelines

FEL described the scope and status of the Merlin Trenched and Buried Pipeline (PL1665). FEL explained that three options were assessed for PL1665 which that had not been previously identified for full removal.

The options are:

Option 1 - Leave in situ, remove ends, rock placement over snag hazards and areas of low cover.
Option 2 - Leave in situ, remove all exposures, rock placement on snag hazards and areas of low cover.
Option 3 - Full removal, reverse reel.

Xodus presented the assessment of the options against the five criteria.

JNCC asked why there were free spans and areas of low burial, was it due to the target burial depth not being achieved during laying or due to subsequent sediment movement. FEL advised that it was not certain and that this had happened prior to FEL taking Operatorship and further confirmed there had been no change in the nine years since. MS observed that these pipelines had not had rock placement which may be a contributory factor.

In response to a question from MS, SFF and FEL confirmed that if the pipeline is removed then an over-trawl check will be required.

The overall result of the CA is that Option 3 is the recommended decision. Merlin Trenched and Buried Pipeline PL1665 should be removed by reverse reeling followed by a sea-bed survey.

3.2 Osprey Field

3.2.1 Osprey Bundles

FEL described the scope and status of the Osprey North and South Bundles and reminded attendees that full removal had previously been recommended for most other Osprey infrastructure groupings. FEL explained that six options were assessed for the Bundles which had not been previously identified for full removal.

The options are:

Option 1 - Leave in situ, remove towheads, rock placement over snag hazards and areas of potential span growth.
Option 1A - Leave in situ, remove towheads, rock placement over snag hazards and areas of potential span growth. Return after 30 years and place rock over entire length.
Option 1B - Leave in situ, remove towheads, rock placement over snag hazards and areas of potential span growth. Return after 30 years, cut bundle into 20m lengths and recover to shore.

Option 2 - Leave in situ, remove towheads, rock placement over entire length.
Option 3 - Leave in situ, remove towheads, cut bundle into 350m lengths, pull bundles into pre-cut trench and backfill with spoil.
Option 4 - Full removal, cut into 20m lengths and lift, recover to shore.

Xodus presented the assessment of the options against the five criteria.

FEL confirmed that for the options where the bundle remains in situ there will be regular future monitoring. FEL confirmed that their current understanding is that in around 30 years time the bundle would begin to lose structural integrity and therefore could become a safety risk for fishermen.

Xodus observed that safety exposure and technological feasibility and maturity were the key drivers impacting the CA. A discussion followed on the likelihood of safety exposure and technology changing over the next 30 years. FEL said that they would monitor industry progress.

SFF stated that they did not want option 1 to be the final outcome as it presents a future risk to fishermen. SFF asked if a removal trial could be undertaken on the smaller section of the North Bundle. FEL responded that such a trial would not prove the concept for the entirety of the two bundles and that research and development funds are not available, given the industry challenge of reducing decommissioning cost. SFF observed that the height of rock placement over the entire length would be substantial but still could be over-trawled. Xodus commented that the upcoming fishing impact QRA would provide a more detailed assessment.

SFF asked if the bundle could be refloated. FEL commented that refloating had been ruled out at the screening workshop in March 2016 due to the integrity of the bundle internals and lack of onshore landing facilities.

MS commented that there needs to be industry wide research into bundle removal and that technology would not improve unless there was a driver to do so.

JNCC also stated that industry leadership is required and that rock placement is a sub-optimal solution. JNCC further commented that leaving the bundle in situ, without significant rock placement allows more time for the Regulator and the wider industry to find better solutions. MS questioned how BEIS are considering the removal of old bundles across Operators.

OGA asked how long the bundle will last prior to decomposition commencing. FEL responded approximately 30 years based on the results of an Xodus material degradation study.

BEIS confirmed that subsequent to the Osprey Bundle installation, subsea bundles must be designed with a recovery methodology.

The overall result of the CA is that Option 1 is the recommended decision. The Osprey Bundles should be left in situ, towheads removed and rock placed over snag hazards and areas of potential span growth, followed by a sea-bed survey and trawl sweep.

3.2.2 Osprey Trenched and Rock Dumped Umbilicals

FEL described the scope and status of the Osprey Trenched and Rock-Dumped Umbilicals (PL736 and PL1545). FEL explained that three options were assessed for PL736 and PL1545 which had not been previously identified for full removal.

The options are:

Option 1 - Leave in situ, remove exposed ends, rock placement over snag hazards and areas of low cover.
Option 2 - Leave in situ, remove all exposed ends, rock placement over entire length.
Option 3 - Full removal, reverse reel.

Xodus presented the assessment of the options against the five criteria.

OGA asked if PL736 would have to be de-buried to allow for reverse reeling. FEL confirmed that de-burial would be required.

MS asked if BEIS Guidelines required pipelines to be buried. It was confirmed that BEIS Guidelines require pipelines to be trenched or buried to a depth of 0.6m below the sea-bed.

SFF asked about the profile of the PL1545 trench. FEL responded that the data is available and will be included in the fishing impact QRA.

The overall result of the CA is that Option 1 is the recommended decision. Osprey Trenched and Rock-Dumped Umbilicals (PL736 and PL1545) should be left in situ, the exposed ends removed and rock placed over snag hazards and areas of low cover followed by a sea-bed survey and trawl sweep.

3.3 Dunlin Field

3.3.1 Dunlin Rigid Risers

FEL described the scope and status of the Dunlin Rigid Risers. FEL explained that two options were assessed for the Risers.

The options are:

Option 1 - Leave in situ, riser cut at J-tube exit, outboard section recovered and J-tube sealed.
Option 2 - Full removal, outboard section cut and recovered, remaining section removed via topside.

Xodus presented the assessment of the options against the five criteria.

The overall result of the CA is that Option 1 is the recommended decision. The Dunlin Rigid Risers will be left in situ within the J-tube, the riser will be cut at the J-tube exit by a DSV, the J-tube will be sealed and the outboard section recovered to shore.

3.3.2 – Trenched and Buried Cable

FEL described the scope and status of the Dunlin Power Import Cable. FEL explained that three options were assessed for the Cable Risers.

The options are:

Option 1 - Leave in situ, remove all cable transitions, rock placement over snag hazards and areas of low cover.
Option 2 - Leave in situ, remove all cable transitions and exposures, rock placement over snag hazards and areas of low cover.
Option 3 - Full removal, reverse reel

Xodus presented the assessment of the options against the five criteria.

The overall result of the CA is that Option 1 is the recommended decision.
The Dunlin Power import Cable should be left in situ, cable transitions removed and rock placed over snag hazards and areas of low burial depth followed by a sea-bed survey and trawl sweep.

4 Next Steps

FEL thanked meeting attendees for their participation in the CA Workshop and reviewing the extensive pre-read materials. The fishing impact QRA will be undertaken week commencing 16th January and FEL will re-engage with the stakeholders should the QRA change the CA recommendations. Decommissioning Programmes will be updated with the CA recommendations in preparation for Public Consultation.

5 Post-Meeting Notes

On reviewing the minutes the SFF made three observations:

The SFF would like to highlight that for a number of the CAs considered, the overall option recommended was not the SFF's preference.

The SFF noted that removing the evaluation criteria of Economics did not change the recommendation for any removal decision, however the SFF also note that for the six separate Comparative Assessments reviewed, the chosen decommissioning option was the least expensive option on each occasion.

The SFF has concerns re the statement made in Section 3.2.2. (Osprey Trenched and Rock Dumped Umbilicals), that 'BEIS Guidelines require pipelines to be trenched or buried to a depth of 0.6m below the sea-bed' and will be seeking clarification with BEIS on this matter – it is felt that leaving pipelines or umbilicals uncovered in an open trench would pose a significant safety risk to fishermen.

Appendix E Data Sheets (Exc. Costs)

Area	Osprey
Decision/Group	Decision 1 Group 3 – Bundles
Option	1 – Leave in situ – Minor intervention (Towhead Removal and Local Rock Dumping)
Description	Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 – Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 – Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-001 – Osprey – Long Term Materials Degradation Study A-301649-S01-REPT-001 – Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	157	Man Hours	13931
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037
Onshore Personnel	Number	20	Man Hours	3337
Legacy Personnel	Number	76	Man Hours	45600
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	24.9
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	100
Potential for High Consequence Event	Low	Comments	Routine Operations	
Operational Risk Diver	PLL	1.01E-03		
Operational Risk Offshore	PLL	1.04E-03		
Operational Risk Topsides	PLL	N/A		
Operational Risk Onshore	PLL	4.10E-04		
Legacy Risk (out to 50yrs)	PLL	3.00E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)		
Overall Risk	∑PLL	5.46E-03		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.0	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	4.9	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	5	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	50	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	50	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level		257 dB re 1mP			45.2 TPa²s		
Energy Use (Total = Ops + Legacy)	Fuel	1981.8Te	CO_2	6282.3 Te	NOx	116.9 Te	SO_2	23.8 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		15684.78 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	4550 m^2	Resources	8800 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) (6.5Te) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical 8800 Te Rock
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	Diverless cutting and recovery of towheads maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic		
Economic Considerations	Comparative Cost Operational	XX M
	Comparative Cost Legacy - Monitoring	XX M
	Comparative Cost Legacy - Remedial	XX M

Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.

Area	Osprey	
Group	Decision 1 Group 3 – Bundles	
Option	1A – Leave in situ – Minor intervention (Towhead Removal and Local Rock Dumping) – FULL ROCK PLACEMENT AT 30 YEARS	
Description	PHASE 1: Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler PHASE 2: Rock placement over bundle by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY	PHASE 1 – SHORT TERM TOWHEAD REMOVAL				PHASE 2 – LONG TERM ROCK PLACEMENT			
Offshore Personnel	Number	157	Man Hours	13931	Number	81	Man Hours	16176
Topsides Personnel	Number	N/A	Man Hours	N/A	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	3337	Number	14	Man Hours	2912
Legacy Personnel	Number		76		Man Hours		40680	
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	24.9	Number of Vessels Used	3	Duration of Operations	38
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used		2		Duration of Operations		90	
Potential for High Consequence Event	Low		Routine Operations		Low		Routine Operations	
	COMBINED PHASE 1, 2 & LEGACY							
Operational Risk Diver	PLL	1.01E-03						
Operational Risk Offshore	PLL	2.26E-03						
Operational Risk Topsides	PLL	N/A						
Operational Risk Onshore	PLL	7.69E-04						
Legacy Risk (out to 50yrs)	PLL	2.63E-03						
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)						
Overall Risk	∑PLL	6.66E-03						

ENVIRONMENTAL								
Marine Impact (Vessels Phase 1 & 2)	Type	DSV	Number	1	Duration	10.0 / 0	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	2	Duration	4.9 / 28	Activity	Rock Dump
	Type	ROVSV	Number	2	Duration	5 / 5	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	2	Duration	5 / 5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	50	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	40	Activity	Survey

Noise (Total = Ops 1 & 2 + Legacy)	Sound Exposure Level		258 dB re 1mP			56.3 TPa^2s		
Energy Use (Total = Ops 1 & 2 + Legacy)	Fuel	2432.9 Te	CO_2	7212.3 Te	NOx	143.5 Te	SO_2	29.2 Te
Life Cycle Emissions (Total = Ops 1 & 2 + Legacy)	CO_2		21925.33 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	37500 m^2	Resources	142000 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) (6.5Te) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical 142000 Te Rock
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	Diverless cutting and recovery of towheads maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	PHASE 1 – XX M	PHASE 2 – XX M	TOTAL – XX M
	Comparative Cost Legacy - Monitoring	PHASE 1 – XX M	PHASE 2 – XX M	TOTAL – XX M
	Comparative Cost Legacy - Remedial	PHASE 1 – XX M	PHASE 2 – XX M	TOTAL – XX M
Economic Risk	Cost Risk	High	Factors	Phase 2 costs would not be incurred for 30 years. Prices may escalate. High degree of achievability; Potential requirement for additional rock dependent on trawl activity.

Area	Osprey
Decision/Group	Decision 1 Group 3 – Bundles
Option	1B – Leave in situ – Minor intervention (Towhead Removal and Local Rock Dumping) – FULL REMOVAL AT 30 YEARS
Description	PHASE 1: Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler PHASE 2: Cut bundle into sections (20m) using CSV Install rigging on bundle sections and recover by DSV to PSV Backload bundle sections using PSV Survey by ROV from DSV
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 – Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 – Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-001 – Osprey – Long Term Materials Degradation Study A-301649-S01-REPT-001 – Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY	PHASE 1 – SHORT TERM TOWHEAD REMOVAL				PHASE 2 – FULL REMOVAL			
Offshore Personnel	Number	157	Man Hours	13931	Number	157	Man Hours	98696
Topsides Personnel	Number	N/A	Man Hours	N/A	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037	Number	9	Man Hours	10260
Onshore Personnel	Number	20	Man Hours	3337	Number	20	Man Hours	28365
Legacy Personnel	Number		76		Man Hours		24900	
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	24.9	Number of Vessels Used	3	Duration of Operations	85.4 (//el Ops)
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used		2		Duration of Operations		55	
Potential for High Consequence Event	Low		Routine Operations		High		Significant personnel exposure and lifting operations (subsea and onshore)	
	COMBINED PHASE 1, 2 & LEGACY							
Operational Risk Diver	PLL	1.10E-02						
Operational Risk Offshore	PLL	8.45E-03						
Operational Risk Topsides	PLL	N/A						
Operational Risk Onshore	PLL	3.49E-03						
Legacy Risk (out to 30yrs)	PLL	1.62E-03						
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)						
Overall Risk	∑PLL	2.45E-02						

ENVIRONMENTAL								
Marine Impact (Vessels Phase 1 & 2)	Type	DSV	Number	2	Duration	10.0 / 52.7	Activity	Destruct
	Type	CSV	Number	1	Duration	0 / 59.5	Activity	Cutting
	Type	DPFPV	Number	1	Duration	4.9 / 0	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	5 / 0	Activity	Survey
	Type	Pipe Haul	Number	1	Duration	0 / 45.5	Activity	Storage
	Type	Trawler	Number	1	Duration	5 / 0	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	25	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	30	Activity	Survey

Noise (Total = Ops 1 & 2 + Legacy)	Sound Exposure Level	263 dB re 1mP	212.0 TPa^2s

Energy Use (Total = Ops 1 & 2 + Legacy)	Fuel	4679.2 Te	CO_2	14833.0 Te	NOx	276.1 Te	SO_2	56.2 Te
Life Cycle Emissions (Total = Ops 1 & 2 + Legacy)	CO_2	19878.98 Te			CO_2 (Credit)	4376.80 Te		

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	4550 m^2	Resources	8800 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 400 m Umbilical
	Remaining	8800 Te Rock
	Persistence	N/A

Residuals	LSA Scale	In-Situ	0 kg	Returned	12215 kg
	Hydrocarbon	In-Situ	0 kg (35.66 kg lost between Phase 1 & Phase 2)	Returned	0 kg
	Control Fluids	In-Situ	Nil	Returned	Nil

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Medium
	Availability of Technology	Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique.		
	Track Record	None – Method has not been used (however; the majority of individual techniques have been used previously to good effect)		
	Risk of Failure	Low – Cutting and lifting operations are not new or novel		
	Consequence of Failure	Alternate cutting techniques required / alternate lifting arrangements required/ rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful		
	Emerging Technology	No new concepts however; there is evidence of companies looking at the cut and lift solution and providing a diverless option.		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	High – If concept is proven then there will be an economic benefit realised due to the number of additional bundles that could potentially be recovered. Significant amount of material to be re-cycled and associated hazardous material to be disposed.

Economic				
Economic Considerations	Comparative Cost Operational	PHASE 1 – XX M	PHASE 2 – XX M	TOTAL – XX M
	Comparative Cost Legacy - Monitoring	PHASE 1 – XX M	PHASE 2 – XX M	TOTAL – XX M
	Comparative Cost Legacy - Remedial	PHASE 1 – XX M	PHASE 2 – XX M	TOTAL – XX M

Economic Risk	Cost Risk	High	Factors	Phase 2 costs would not be incurred for 30 years. Prices may escalate. Alternately, concept may be proved and costs may reduce. Concept requires additional maturity which maybe realised through trials and testing not currently priced; there is a risk of re-engineering being required during operations that would add additional cost through schedule over-runs.

Area	Osprey
Decision/Group	Decision 1 Group 3 – Bundles
Option	2 – Leave in situ – Minor intervention (Towhead Removal and Complete Rock Dumping)
Description	Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-001 Osprey – Long Term Materials Degradation Study A-301649-S01-REPT-001 Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	157	Man Hours	25493
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037
Onshore Personnel	Number	20	Man Hours	4841
Legacy Personnel	Number	76	Man Hours	33300
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	48.4
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	75
Potential for High Consequence Event	Low	Comments	Routine Operations	

Operational Risk Diver	PLL	1.01E-03
Operational Risk Offshore	PLL	1.91E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	5.95E-04
Legacy Risk (out to 50yrs)	PLL	2.08E-03
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)
Overall Risk	∑PLL	5.59E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.0	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	28.4	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	5	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	25	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	50	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level		256 dB re 1mP			44.4 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	1949.9 Te	CO_2	6181.2 Te	NOx	115.0 Te	SO_2	23.4 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		15583.66 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	73500 m^2	Resources	142000 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) (6.5Te) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical 142000Te Rock
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	Diverless cutting and recovery of towheads maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic		
Economic Considerations	Comparative Cost Operational	XX M
	Comparative Cost Legacy - Monitoring	XX M
	Comparative Cost Legacy - Remedial	XX M

Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.

Area	Osprey	
Decision/Group	Decision 1 Group 3 – Bundles	
Option	3 – Leave in situ – Major intervention (Towhead Removal and Trench)	
Description	Towhead removal by DSV Cut bundle into sections (approx. 350m) and pre-install pull rigging by DSV Create pre-cut trench with plough from trenching vessel Pull bundle sections into pre-cut trench using AHV Backfill spoil using MFE from CSV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-TECH-002 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Trenching / Backfilling Feasibility Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38"	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12" Sleeve Pipe 2 x 8" Oil Line 1 x 10" WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5"	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10" WI Line 1 x 10" Umb. Carrier 1 x 5" Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38"	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12" Sleeve Pipe 2 x 8" Oil Line 1 x 10" WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	233	Man Hours	42582
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	3240
Onshore Personnel	Number	20	Man Hours	5977
Legacy Personnel	Number	76	Man Hours	33300
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	7	Duration of Operations	62.4
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	75
Potential for High Consequence Event	Medium	Comments	Non-routine operations, although using existing techniques.	
Operational Risk Diver	PLL	3.14E-03		
Operational Risk Offshore	PLL	3.19E-03		
Operational Risk Topsides	PLL	N/A		
Operational Risk Onshore	PLL	7.35E-04		
Legacy Risk (out to 50yrs)	PLL	2.08E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)		
Overall Risk	∑PLL	9.15E-03		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	20.2	Activity	Destruct
	Type	CSV	Number	1	Duration	7	Activity	Backfill
	Type	Trench Vessel	Number	1	Duration	8.2	Activity	Trench
	Type	ROVSV	Number	1	Duration	5	Activity	Survey
	Type	AHV	Number	2	Duration	17	Activity	Bundle Pull
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	25	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	50	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level	258 dB re 1mP	63.9 TPa^2s					

Energy Use (Total = Ops + Legacy)	Fuel	2256.8 Te	CO_2	7154.0 Te	NOx	133.2 Te	SO_2	27.1 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2	16566.53 Te			CO_2 (Credit)	N/A		

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	13500 m^2	Resources	N/A
	Activity	Backfilling	Area	16200 m^2	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Low
	Availability of Technology	Low – Few suitably sized ploughs capable of providing a >2m trench depth available; backfilling will not be possible with a plough due to section alignment; MFE may be used for backfill but will not return clay type soils.		
	Track Record	None – Method has not been used (however; the majority of individual techniques have been used previously to good effect)		
	Risk of Failure	High – Achieving sufficient trench depth is not guaranteed; backfill with an MFE may only return a small amount of sandy material to the trench; risk of trench widening when using the MFE to backfill.		
	Consequence of Failure	Rock placement over the bundle / extensive seabed remediation / failure to achieve satisfactory bundle decommissioning solution / extensive cost and schedule overruns / increased personnel exposure.		
	Emerging Technology	None evident		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing if successful outcome achieved
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	XX M		
	Comparative Cost Legacy - Monitoring	XX M		
	Comparative Cost Legacy - Remedial	XX M		
Economic Risk	Cost Risk	High	Factors	Immature concept with significant technical risk; Extensive schedule and cost overruns achieving lowering and seabed remediation; Even with lowering achieved there is still the potential for future remediation required.

Subsea Infrastructure Decommissioning Comparative Assessment Data Sheet

Area	Osprey	
Decision/Group	Decision 1 Group 3 – Bundles	
Option	4 – Full removal – Cut and Lift	
Description	Dredge and cut bundle into sections (20m) using CSV Recover the towheads using DSV Install rigging on bundle sections and recover by DSV to PSV Backload bundle sections using PSV Survey by ROV from DSV	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-003 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Removal/Recovery Feasibility Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	157	Man Hours	101024
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	10476
Onshore Personnel	Number	20	Man Hours	26964
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	3	Duration of Operations	88.9 (//el Ops)
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A
Potential for High Consequence Event	High	Comments	Significant personnel exposure and lifting operations (subsea and onshore)	
Operational Risk Diver	PLL	1.02E-02		
Operational Risk Offshore	PLL	7.58E-03		
Operational Risk Topsides	PLL	N/A		
Operational Risk Onshore	PLL	3.32E-03		
Legacy Risk (out to 50yrs)	PLL	N/A		
Fishing Risk	PLL	N/A		
Overall Risk	∑PLL	2.11E-02		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	53.7	Activity	Removal
	Type	CSV	Number	1	Duration	61.4	Activity	Cutting
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Pipehaul	Number	1	Duration	45.5	Activity	Storage
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
Noise (Total = Ops + Legacy)	Sound Exposure Level		263 dB re 1mP			185.8 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	3533.2 Te	CO_2	11200.2 Te	NOx	208.5 Te	SO_2	42.4 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		16246.18 Te		CO_2 (Credit)		4376.80 Te	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 400 m Umbilical
	Remaining	N/A
	Persistence	N/A

Residuals	LSA Scale	In-Situ	Nil	Returned	12215 kg
	Hydrocarbon	In-Situ	35.66 kg (discharged during recovery)	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Medium
	Availability of Technology	Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique.		
	Track Record	None – Method has not been used (however; the majority of individual techniques have been used previously to good effect)		
	Risk of Failure	Low – Cutting and lifting operations are not new or novel		
	Consequence of Failure	Alternate cutting techniques required / alternate lifting arrangements required/ rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful		
	Emerging Technology	No new concepts however; there is evidence of companies looking at the cut and lift solution and providing a diverless option.		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	High – If concept is proven then there will be an economic benefit realised due to the number of additional bundles that could potentially be recovered. Significant amount of material to be re-cycled and associated hazardous material to be disposed.

Economic		
Economic Considerations	Comparative Cost Operational	XX M
	Comparative Cost Legacy - Monitoring	XX M
	Comparative Cost Legacy - Remedial	XX M

Economic Risk	Cost Risk	Medium	Factors	Concept requires additional maturity which maybe realised through trials and testing not currently priced; there is a risk of re-engineering being required during operations that would add additional cost through schedule over-runs.

Area	Osprey	
Decision/Group	Decision 2 Group 5 – Flexible and Umbilical Risers	
Option	1 – Leave in Situ – Minor Intervention (Outboard Cut and Recovery)	
Description	2 off Umbilical and 3off flexible riser cut at J-tube exits by DSV J-tubes sealed and outboard section of umbilicals and flexibles recovered back to the DSV Survey by DSV	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-004 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Effect of Leaving Riser Section within J-Tube Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL733 8” Oil	Flexible	Polymer / Steel	259	0	0	0	0	0	0
PL734 8” Oil	Flexible	Polymer / Steel	255	0	0	0	0	0	0
PL735A 8” Water	Flexible	Polymer / Steel	236	0	0	0	0	0	0
PL736 5” Umb.	Orig. Umbilical	Polymer / Steel / Copper	240	0	0	0	0	0	0
PL736 4” Umb	Repair Umbilical	Polymer / Steel / Copper	640	0	0	0	0	0	0

SAFETY				
Offshore Personnel	Number	76	Man Hours	10215
Topsides Personnel	Number	10	Man Hours	1200
Divers Required	Number	9	Man Hours	886
Onshore Personnel	Number	20	Man Hours	3233
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	1	Duration of Operations	11.2
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A
Potential for High Consequence Event	Low	Comments	Routine operations	
Operational Risk Diver	PLL	8.59E-04		
Operational Risk Offshore	PLL	7.66E-04		
Operational Risk Topsides	PLL	4.92E-05		
Operational Risk Onshore	PLL	3.98E-04		
Legacy Risk (out to 50yrs)	PLL	N/A (in line with CGB)		
Fishing Risk	PLL	N/A		
Overall Risk	∑PLL	2.07E-03		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	11.2	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
Noise (Total = Ops + Legacy)	Sound Exposure Level		242 dB re 1mP			1.76 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	247.1 Te	CO_2	783.2 Te	NOx	14.6 Te	SO_2	3.0 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		906.70 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	N/A	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	530 m Umbilical (polymer/steel/copper/thermoplastics) (8.9 Te) 210 m Flexible Riser (polymer/steel) (20.5 Te)
	Remaining	360 m Umbilical (polymer/steel/copper/thermoplastics) 540 m Flexible Riser (polymer/steel)
	Persistence	In-line with CGB & J-tubes >250 years

Residuals	LSA Scale	In-Situ	PL733 – 179.67 kg PL734 – 179.67 kg	Returned	PL733 – 78.91 kg PL734 – 74.92 kg
	Hydrocarbon	In-Situ	PL733 – 0.45 kg PL734 – 0.91 kg	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 536L Phasetreat 6041 – 130L Methanol – 258L	Returned	Nil

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Recent history of cutting umbilicals and flexibles		
	Risk of Failure	Low		
	Consequence of Failure	Limited schedule impacts		
	Emerging Technology	Diverless cutting maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area where umbilical is removed will potentially remain within a safety zone
	Socio Economic	Low – Limited material returned to shore

Economic		
Economic Considerations	Comparative Cost Operational	XX M
	Comparative Cost Legacy - Monitoring	XX M – (Monitoring is assumed to be done as part of any CGB monitoring)
	Comparative Cost Legacy - Remedial	XX M

Economic Risk	Cost Risk	Low	Factors	High degree of achievability.

Area	Osprey
Decision/Group	Decision 2 Group 5 – Flexible and Umbilical Risers
Option	2 – Full Removal – Topsides Pull
Description	Mobilise winch spread to platform, install and test Remove topside hang-off and transfer umbilical / flexible to winch Remove J-tube seal by DSV (part reverse pull as required) Umbilical / flexible cut at J-tube exit by DSV Seal J-tube and recover outboard section of umbilical / flexible back to the DSV Pull-in umbilical / flexible using the topside winch (pull, secure, cut, repeat on remaining umbilicals / flexibles) Backload umbilical / flexible sections and winch equipment Survey by DSV
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-003 Osprey – Removal/Recovery Feasibility Study A-301649-S01-REPT-001 Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL733 8" Oil	Flexible	Polymer / Steel	259	0	0	0	0	0	0
PL734 8" Oil	Flexible	Polymer / Steel	255	0	0	0	0	0	0
PL735A 8" Water	Flexible	Polymer / Steel	236	0	0	0	0	0	0
PL736 5" Umb.	Orig. Umbilical	Polymer / Steel / Copper	240	0	0	0	0	0	0
PL736 4" Umb	Repair Umbilical	Polymer / Steel / Copper	640	0	0	0	0	0	0

SAFETY				
Offshore Personnel	Number	126	Man Hours	17871
Topsides Personnel	Number	6	Man Hours	5400
Divers Required	Number	9	Man Hours	994
Onshore Personnel	Number	20	Man Hours	6901
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	2	Duration of Operations	23.7
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A
Potential for High Consequence Event	Medium	Comments	Non-routine operations but not unusual. Limited SIMOPS.	
Operational Risk Diver	PLL	9.64E-04		
Operational Risk Offshore	PLL	1.34E-03		
Operational Risk Topsides	PLL	2.21E-04		
Operational Risk Onshore	PLL	8.49E-04		
Legacy Risk (out to 50yrs)	PLL	N/A		
Fishing Risk	PLL	N/A		
Overall Risk	∑PLL	3.37E-03		

ENVIRONMENTAL								
Marine Impact (Vessels)	Type	DSV	Number	1	Duration	11.7	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	PSV	Number	1	Duration	12	Activity	Transport/ Storage
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
Noise (Total = Ops + Legacy)	Sound Exposure Level	246 dB re 1mP		4.4 TPa^2s				

Energy Use (Total = Ops + Legacy)	Fuel	376.3 Te	CO_2	1192.9 Te	NOx	22.2 Te	SO_2	4.5 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		1271.23 Te		CO_2 (Credit)		48.05 Te	

Marine Impact (Seabed)	Activity	Dredging	Area	N/A	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	890 m Umbilical (polymer/steel/copper/thermoplastics) (15.6 Te) 750 m Flexible Riser (polymer/steel) (75.1 Te)
	Remaining	N/A
	Persistence	N/A

Residuals	LSA Scale	In-Situ	Nil	Returned	PL733 – 258.49 kg PL734 – 254.49 kg
	Hydrocarbon	In-Situ	PL733 – 0.45 kg (Discharged) PL734 – 0.90 kg (Discharged	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 536L Phasetreat 6041 – 130L Methanol – 258L	Returned	Nil

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	Medium
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history in North Sea and recent history on Dunlin of J-tube pulls		
	Risk of Failure	Medium – Unknown integrity of J-tubes / flexibles / umbilicals and inability to inspect.		
	Consequence of Failure	Flexible / umbilical would remain within J-tube / schedule over runs		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area where flexible and umbilical is removed will potentially remain within a safety zone
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	XX M		
	Comparative Cost Legacy - Monitoring	XX M		
	Comparative Cost Legacy - Remedial	XX M		
Economic Risk	Cost Risk	Medium	Factors	Topside engineering for winch locating is not mature; Inspection to confirm integrity of J-tube and contained products is not possible; Previous pull-in operations have suffered delays and cost over runs.

Area	Osprey	
Decision/Group	Decision 3 Group 8 – Trenched and Rock Dumped Umbilicals	
Option	1 – Leave in Situ – Minimal Intervention (Local Rock Placement)	
Description	Pipeline and umbilical end removal by DSV Rock placement over snag hazards and areas of low burial depth by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL736 5” Umb.	Umbilical	Polymer / Steel / Copper	6513.3	6073	0.6	4700	0.6	845	0.5
PL1545 4” Umb.	Umbilical	Polymer / Steel / Copper	6360	6121	1.0	0	0	Spot every 20 – 25m	0.7

SAFETY				
Offshore Personnel	Number	157	Man Hours	14528
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1059
Onshore Personnel	Number	20	Man Hours	3899
Legacy Personnel	Number	35	Man Hours	25620
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	26.1
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	1	Duration of Operations	60.8

Potential for High Consequence Event	Low	Comments	Routine operations

Operational Risk Diver	PLL	1.03E-03
Operational Risk Offshore	PLL	1.09E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	4.80E-04
Legacy Risk (out to 50yrs)	PLL	1.41E-03
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)
Overall Risk	∑PLL	4.01E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.2	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	4.8	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	6.1	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	1	Duration	60.8	Activity	Survey

Noise (Total = Ops + Legacy)	Sound Exposure Level	253 dB re 1mP	19.2 TPa^2s

Energy Use (Total = Ops + Legacy)	Fuel	1002.7 Te	CO_2	3178.6 Te	NOx	59.2 Te	SO_2	12.0 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		3667.13 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	9330 m^2	Resources	7300 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	524 m Umbilical (polymer/steel/copper/thermoplastics) (7.5 Te)			
	Remaining	12197 m Umbilical (polymer/steel/copper/thermoplastics) 11120 Te Rock (3820 Te Existing + 7300 Te New)			
	Persistence	>100 years (no long term data/experience of polymers in seawater/buried)			
Residuals	LSA Scale	In-Situ	N/A	Returned	N/A
	Hydrocarbon	In-Situ	N/A	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 5303L Phasetreat 6041 – 1263L TROS 93-64 – 910L Methanol – 1818L	Returned	Brayco Micronic SV/3 - 7703L HSW85690 - 3446L CRW85648 - 811L RO IM C317 - 811L Methanol - 1824L

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	XX M		
	Comparative Cost Legacy - Monitoring	XX M		
	Comparative Cost Legacy - Remedial	XX M		
Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Low likelihood of future remediation required due to existing burial depth / trench depth.

Area	Osprey	
Decision/Group	Decision 3 Group 8 – Trenched and Rock Dumped Umbilicals	
Option	2 – Leave in situ – Major Intervention (Full Rock)	
Description	Pipeline and umbilical end removal by DSV Rock placement over areas of low burial on PL736 by DPFPV Rock placement over the entire length of PL1545 by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-TECH-002 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Trench Backfilling Feasibility Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL736 5" Umb.	Umbilical	Polymer / Steel / Copper	6513.3	6073	0.6	4700	0.6	845	0.5
PL1545 4" Umb.	Umbilical	Polymer / Steel / Copper	6360	6121	1.0	0	0	Spot every 20 – 25m	0.7

SAFETY				
Offshore Personnel	Number	157	Man Hours	17331
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1059
Onshore Personnel	Number	20	Man Hours	4264
Legacy Personnel	Number	35	Man Hours	25620
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	31.8
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	1	Duration of Operations	60.8
Potential for High Consequence Event	Low	Comments	Routine operations	
Operational Risk Diver	PLL	1.03E-03		
Operational Risk Offshore	PLL	1.30E-03		
Operational Risk Topsides	PLL	N/A		
Operational Risk Onshore	PLL	5.24E-04		
Legacy Risk (out to 50yrs)	PLL	1.41E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)		
Overall Risk	∑PLL	4.26E-03		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.2	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	10.5	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	6.1	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	1	Duration	60.8	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level		253 dB re 1mP			22.3 TPa²s		
Energy Use (Total = Ops + Legacy)	Fuel	1127.4 Te	CO_2	3574.0 Te	NOx	66.5 Te	SO_2	13.5 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		5013.08 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m²	Resources	N/A
	Activity	Rock Dump	Area	40630 m²	Resources	35300 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	524 m Umbilical (polymer/steel/copper/thermoplastics) (7.5Te)			
	Remaining	12197 m Umbilical (polymer/steel/copper/thermoplastics) 39120Te (3820 Te Existing + 35300 Te New)			
	Persistence	>100 years (no long term data/experience of polymers in seawater/buried)			
Residuals	LSA Scale	In-Situ	N/A	Returned	N/A
	Hydrocarbon	In-Situ	N/A	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 5303L Phasetreat 6041 – 1263L TROS 93-64 – 910L Methanol – 1818L	Returned	Brayco Micronic SV/3 - 7703L HSW85690 - 3446L CRW85648 - 811L RO IM C317 - 811L Methanol - 1824L

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	XX M		
	Comparative Cost Legacy - Monitoring	XX M		
	Comparative Cost Legacy - Remedial	XX M		
Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Low likelihood of future remediation required due to existing burial depth / trench depth.

Area	Osprey	
Decision/Group	Decision 3 Group 8 – Trenched and Rock Dumped Umbilicals	
Option	3 – Full Removal - Reverse Reeling	
Description	Umbilical deburial using MFE deployed from CSV Umbilical disconnect and recovery head installation by DSV Recover umbilical and reverse reel by DSV with reel spread Survey by ROVSV	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-002 A-301649-S01-TECH-003 A-301649-S01-TECH-004 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Trenching / Backfilling Feasibility Study Osprey – Removal/Recovery Feasibility Study Osprey – Effect of Leaving Riser Section within J-Tube Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL736 5" Umb.	Umbilical	Polymer / Steel / Copper	6513.3	6073	0.6	4700	0.6	845	0.5
PL1545 4" Umb.	Umbilical	Polymer / Steel / Copper	6360	6121	1.0	0	0	Spot every 20 – 25m	0.7

SAFETY				
Offshore Personnel	Number	151	Man Hours	24878
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	368
Onshore Personnel	Number	20	Man Hours	13151
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	3	Duration of Operations	36.3
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A

Potential for High Consequence Event	Medium	Comments	Non-Routine operations; however not unusual to recover umbilicals.

Operational Risk Diver	PLL	3.57E-04
Operational Risk Offshore	PLL	1.87E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	1.62E-04
Legacy Risk (out to 50yrs)	PLL	N/A
Fishing Risk	PLL	N/A
Overall Risk	∑PLL	3.84E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	18.1	Activity	Reverse Reel
	Type	CSV	Number	1	Duration	12.1	Activity	Deburial
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	1	Duration	6.1	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A

Noise (Total = Ops + Legacy)	Sound Exposure Level	249 dB re 1mP	8.9 TPa^2s

Energy Use (Total = Ops + Legacy)	Fuel	724.1 Te	CO_2	2295.4 Te	NOx	42.7 Te	SO_2	8.7 Te

Life Cycle Emissions (Total = Ops + Legacy)	CO_2	2418.42 Te	CO_2 (Credit)	92.06 Te

Marine Impact (Seabed)	Activity	Dredging	Area	N/A	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Deburial	Area	12194 m^2	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	12913 m Umbilical (polymer/steel/copper/thermoplastics)			
	Remaining	3820 Te Rock (Existing)			
	Persistence	N/A			
Residuals	LSA Scale	In-Situ	N/A	Returned	N/A
	Hydrocarbon	In-Situ	N/A	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	Brayco Micronic SV/3 – 7703L Brayco Micronic 864 – 5303L Phasetreat 6041 – 1263L HSW85690 – 3446L CRW85648 – 811L RO IM C317 – 811L TROS 93-64 – 910L Methanol – 3642L

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Low
	Availability of Technology	Medium – Limited number of existing techniques suitable for deburial of the trenched umbilical PL736. MFE is a suitable method for removing the rock from PL1545		
	Track Record	Low – Limited experience of exposing umbilicals over extended distances using an MFE to enable re-reeling.		
	Risk of Failure	High		
	Consequence of Failure	Alternate deburial techniques required / rock required to remedy over dredged areas / large schedule overruns with limited ability to recover.		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Material returned to shore will generate a small amount of recycling work.

Economic				
Economic Considerations	Comparative Cost Operational	XX M		
	Comparative Cost Legacy - Monitoring	XX M		
	Comparative Cost Legacy - Remedial	XX M		
Economic Risk	Cost Risk	High	Factors	Medium degree of achievability; High likelihood of failure to expose the PL736 umbilical fully without multiple deburial techniques and passes; High likelihood of over trenching in sandy areas leading to areas of disturbance that are larger than required, leading to potential remediation.

Appendix F CA Attributes Tables & Pairwise Comparison (Exc. Costs)

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Total PLL: 5.46E-03 Vessels located on site for: Operational: 24.9 days Legacy: 100 days	Total PLL: 6.66E-03 Vessels located on site for Phase 1: 24.9 days Phase 2: 38 days Legacy: 90 days	Total PLL: 2.45E-02 Vessels located on site for Phase 1: 24.9 days Phase 2: 85.4 days Legacy: 55 days Note: the phase 2 duration has been optimised for parallel operations.	Total PLL: 5.59E-03 Vessels located on site for Operational: 48.4 days Legacy: 75 days	Total PLL: 9.15E-03 Vessels located on site for Operational: 62.4 days Legacy: 75 days	Total PLL: 2.11E-02 Vessels located on site for 88.9 days. Note: duration has been optimised for parallel operations.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.						
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.						
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Low risk of high consequence events - routine.	Low risk of high consequence events - routine.	High risk of high consequence events - significant personnel exposure, potentially novel lifting operations both subsea and onshore.	Low risk of high consequence events - routine.	Medium risk of high consequence events - non-routine operations, use existing techniques.	High risk of high consequence events - significant personnel exposure, potentially novel lifting operations both subsea and onshore.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	Residual Risk Legacy: 76 / 45600 / 3.00E-03 Fishing: Negligible The were some concerns that should the carrier pipe degrade in the future, the fishing risk may increase however this is considered to be beyond the 30 year lookahead.	Residual Risk Legacy: 76 / 40680 / 2.63E-03 Fishing: Negligible The were some concerns that should the carrier pipe degrade in the future, the fishing risk may increase however this is considered to be beyond the 50 year lookahead.	Residual Risk Legacy: 76 / 24900 / 1.62E-03 Fishing: Negligible The were some concerns that should the carrier pipe degrade in the future, the fishing risk may increase however this is considered to be beyond the 50 year lookahead.	Residual Risk Legacy: 76 / 33300 / 2.08E-03 Fishing: Additional risk to fishing from this option considered negligible as fully rock dumped and monitored.	Residual Risk Legacy: 76 / 33300 / 2.08E-03 Fishing: This option likely to leave berms that have, historically, been considered an issue for the fishing industry. Further, this option is likely to leave remnants of rock and clay deposits on the seabed which may present a snag hazard to fishing activities. It is however assumed that the option will be completed to a suitable level of seabed condition that leaves negligible risk to fishing operations.	Residual Risk There is no residual legacy risk or risk to fishing operations associated with this option as it is a full removal option.

Summary

The summed PLL figures for options 1, 1A, 1B, 2, 3 and 4 (all worker groups and including legacy component where present) are 5.46E-03, 6.66E-03, 2.45E-02, 5.59E-03, 9.15E-03 and 2.11E-02 respectively. Option 1 has the lowest personnel risk exposure driven by low operations durations and divers exposure. This is followed by option 2, driven by higher operations duration and the subsequent increase in exposure to offshore and onshore worker groups. Next is option 1A, which a combination of option 1 and option 2. Option 3 follows, which has more than double the risk exposure of option 1 and almost double that of option 2, driven by much higher exposure to all work groups. Finally, options 4 and 1B are the least attractive due to the significant increase in risk exposure again to all worker groups. The financial exposure from the personnel risk associated with each option is £36,200, £51,900, £238,000, £46,700, £82,300 and £211,000 respectively (based on £10M / life).

The total durations that vessels are present on site are lowest for option 4 due to there being no legacy monitoring requirement. Options 1 and 2 are very similar and substantially higher than option 4. Option 3 is marginally higher again then options 1A and 1B have the highest duration of vessels present on site.

Option 1, 1A and 2 are similar in terms of the potential for high consequence events. Option 3 is considered higher risk, and option 1B and option 4 carry higher risk again.

In summary, option 1, 1A and 2 are Neutral to each other as all parameters are largely similar. Option 1 is Very Much Stronger than option 1B and option 4 due to a significant increase in risk exposure and potential for high consequence events associated with option 1B and option 4. Option 1 is Much Stronger than option 3 due to a higher risk exposure and medium potential for high consequence events associated with option 3.
Option 1A is Very Much Stronger than option 1B and option 4 due to a significant increase in risk exposure and potential for high consequence events associated with option 1B and option 4. It is Neutral to option 2 as all parameters are largely similar. It is Much Stronger than option 3 due to a higher risk exposure and medium potential for high consequence events associated with option 3.
Option 1B is Very Much Weaker than option 2, Much Weaker than option 3 and Weaker than option 4 due to the differential in personnel exposure and potential for high consequence events associated with each option.
Option 2 is Much Stronger than option 3 and Very Much Stronger than option 4 due the higher and significantly higher risk exposures and the medium and high potential for high consequence events associated with option 3 and option 4 respectively.
Finally option 3 is Stronger than option 4 due the higher risk exposure and the high potential for high consequence events associated with option 4.

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Sound Exposure 257 dB re 1mP / 45.2 TPa2s	Sound Exposure 258 dB re 1mP / 56.3 TPa2s	Sound Exposure 263 dB re 1mP / 212.0 TPa2s	Sound Exposure 256 dB re 1mP / 44.4 TPa2s	Sound Exposure 258 dB re 1mP / 63.9 TPa2s	Sound Exposure 263 dB re 1mP / 185.8 TPa2s
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	CO2: 6282.3 Te NOx: 116.9 Te SO2: 23.8 Te Lifecycle CO2: 15684.78 Te CO2 Credit for Steel: N/A	CO2: 7212.3 Te NOx: 143.5 Te SO2: 29.2 Te Lifecycle CO2: 21925.33 Te CO2 Credit for Steel: N/A	CO2: 14833.0 Te NOx: 276.1 Te SO2: 56.2 Te Lifecycle CO2: 19879.00 Te CO2 Credit for Steel: 4376.80 Te	CO2: 6181.2 Te NOx: 115.0 Te SO2: 23.4 Te Lifecycle CO2: 15583.66 Te CO2 Credit for Steel: N/A	CO2: 7154.0 Te NOx: 133.2 Te SO2: 27.1 Te Lifecycle CO2: 16566.53 Te CO2 Credit for Steel: N/A	CO2: 11200.2 Te NOx: 208.5 Te SO2: 42.4 Te Lifecycle CO2: 16246.18 Te CO2 Credit for Steel: 4376.80 Te
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.	Fuel: 1981.8 Te Rock: 8800 Te	Fuel: 2432.9 Te Rock: 142000 Te	Fuel: 4679.2 Te Rock: 8800 Te	Fuel: 1949.9 Te Rock: 142000 Te	Fuel: 2256.8 Te Rock: N/A	Fuel: 3533.2 Te Rock: N/A
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Disturbance Dredging: 60 m2 Rock Dump: 4550 m2	Disturbance Dredging: 60 m2 Rock Dump: 73500 m2	Disturbance Dredging: 60 m2 Rock Dump: 4550 m2	Disturbance Dredging: 60 m2 Rock Dump: 73500 m2	Disturbance Dredging: 60 m2 Trenching: 13500 m2 Backfilling: 16200 m2	Disturbance Dredging: 60 m2
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.

Summary

Option 1 is similar to option 1A from a noise perspective, marginally more attractive from an emissions perspective, much more attractive from an introduction of new material and seabed disturbance perspective. Overall option 1 is Much Stronger than option 1A.
Option 1 is more attractive than option 1B from both a noise impact and fuel perspective and similar in all other areas. Overall option 1 is Stronger than option 1B.
Option 1 is similar to option 2 in all areas other than rock use and seabed disturbance, where it is significantly more attractive. Overall option 1 is Much Stronger than option 2.
Option 1 is similar to option 3 in all areas other than rock use, where it is less attractive and seabed disturbance, where, whilst the area of impact is lower, trenching and back filling operations have a temporary impact in terms of seabed disturbance versus the permanency of rock dump operations. Overall option 1 is Weaker than option 3.
Option 1 is marginally more attractive than option 4 from a noise, emissions (although lifecycle similar) and fuel use perspective, it is much less attractive in terms of rock use and seabed disturbance. Overall this is enough to make option 1 Weaker than option 4.

Option 1A is more attractive than option 1B from both a noise impact and fuel perspective. It is less attractive from an emissions perspective and much less attractive from a rock use and seabed disturbance perspective. Overall option 1A is Much Weaker than option 1B.
Option 1A is less attractive than option 2 in the areas of noise, emissions and fuel use. It is similar in terms of rock use and seabed disturbance. Overall option 1A is Weaker than option 2.
Option 1A is similar to option 3 from a noise impact perspective. It is less attractive from a fuel use and emissions perspective and much worse from a rock use and seabed disturbance perspective. Overall option 1A is Much Weaker than option 3.
Option 1A is similar more attractive than option 4 from a noise impact, emissions (other than lifecycle) and fuel use perspective. It is less attractive from a lifecycle emissions perspective and much worse from a rock use and seabed disturbance perspective. Overall option 1A is Much Weaker than option 4 with the rock use and seabed disturbance dominating the assessment.

Option 1B is less attractive than option 2 in the areas of noise and fuel use. It is worse for emissions (similar for lifecycle emissions) but much more attractive in terms of rock use and seabed disturbance. Overall option 1B is Much Stronger than option 2.
Option 1B is less attractive than option 3 in the areas of noise and fuel use. It is worse for emissions (similar for lifecycle emissions) and less attractive in terms of rock use and seabed disturbance. Overall option 1B is Much Weaker than option 3.
Option 1B is similar to option 4 from a noise impact, emissions and fuel use perspective. It is less attractive from a rock use and seabed disturbance perspective. Overall option 1B is Weaker than option 4.

Option 2 is similar to option 3 in all areas other than rock use and seabed disturbance, where it is substantially less attractive. Overall option 2 is Much Weaker than option 3.
Option 2 is more attractive than option 4 in the areas of noise, emissions and fuel use. Lifecycle emissions are largely similar. It is much less attractive in terms of rock use and seabed disturbance. Overall option 2 is Much Weaker than option 4.

Finally, option 3 is more attractive than option 4 from a noise, emissions and fuel use perspective (lifecycle emissions are largely similar) but less attractive from a seabed disturbance perspective. Overall option 3 is Neutral to option 4.

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting and recovery of towheads may be an option.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting and recovery of towheads may be an option.	Feasibility: Medium. Concept Maturity: Medium. Availability of Technology: Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique. Track Record: None – Method has not been used (however the majority of individual techniques have been used previously to good effect). Risk of Failure: Low – Cutting and lifting operations are not new or novel. Consequence of Failure: Alternate cutting techniques required / alternate lifting arrangements required / rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful. Emerging Technology: No new concepts however there is evidence of companies looking at the cut and lift solution and providing a driverless option.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting and recovery of towheads may be an option.	Feasibility: Medium. Concept Maturity: Low. Availability of Technology: Low – Few suitably sized ploughs capable of providing a >2m trench depth available / backfilling will not be possible with a plough due to section alignment / MFE may be used for backfill but will not return clay type spoils. Track Record: None – Method has not been used (however the majority of individual techniques have been used previously to good effect). Risk of Failure: High – Achieving sufficient trench depth is not guaranteed / backfill with an MFE may only return a small amount of sandy material to the trench / risk of unexpected trench widening when using the MFE to backfill. Consequence of Failure: Rock placement over the bundle / extensive seabed remediation / failure to achieve satisfactory bundle decommissioning solution / extensive cost and schedule overruns / increased personnel exposure. Emerging Technology: None evident.	Feasibility: Medium. Concept Maturity: (Low) Medium. Availability of Technology: Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique. Track Record: None – Method has not been used (however the majority of individual techniques have been used previously to good effect). Risk of Failure: Low – Cutting and lifting operations are not new or novel. Consequence of Failure: Alternate cutting techniques required / alternate lifting arrangements required / rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful. Emerging Technology: No new concepts however there is evidence of companies looking at the cut and lift solution and providing a driverless option.
		Summary	Option 1, 1A and 2 are technically very similar and as such are scored Neutral against each other. Option 1, 1A and 2 are Much Stronger than both options 1B, 3 and 4 due to the uncertainties surrounding the ability to deliver these options technically. Whilst there was a reasonable debate comparing options 1B, 3 and 4, in the end an agreement was reached that option 3 was marginally weaker than option 1A and 4 due to the uncertainty surrounding the ability to achieve the required trench depth along with the burial objectives, and to return the seabed to an acceptable level.					

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Bundle remains exposed on the seabed - from fishing perspective least attractive option as they would consider this largely 'as is' i.e. no benefit. Would have the highest likelihood of fishing net snag / loss.	Rock dumped length remains on seabed. Largely similar to option 3 from fishing perspective as considered fully overtrawlable. This only occurs after 30 years so would carry same likelihood for fishing net snag / loss for first 30 years as option1 and 1B.	Ultimately this option leaves the seabed clear which would be a positive for the fishing community as the area is fully returned to as found condition. This only occurs after 30 years so would carry same likelihood for fishing net snag / loss for first 30 years as option 1 and 1A.	Rock dumped length remains on seabed. Largely similar to option 3 from fishing perspective as considered fully overtrawlable.	Whilst there is the potential for berms and debris to remain on seabed following trench and backfill activities, these would be unlikely to influence whether fishing operations are performed in this area. So, societally, largely similar to option 2 from fishing perspective as considered fully overtrawlable.	This option leaves the seabed clear which would be a positive for the fishing community. The area is fully returned to as found condition.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 8800 Te Rock 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to option 1A, 2 and 3.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 142000 Te Rock 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to option 1, 2 and 3.	Material returned to shore Recovered: 5 Towheads (160Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 12215 kg LSA Scale Remaining: 8800 Te Rock 36 kg Hydrocarbon (lost between phase 1 and 2) Persistence: N/A Further Societal benefit from pioneering bundle removal techniques that can be used across industry.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, (356) 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 142000 Te Rock 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to option 1, 1A and 3. This option has the added attribute of possible job creation for the requirement for rock although this is unlikely to be in the UK	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to options 1, 1A and 2.	Material returned to shore Recovered: 5 Towheads (160 Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 12215 kg LSA Scale Remaining: N/A - full removal 35 kg Hydrocarbon (lost during recovery) Persistence: N/A - full removal Further Societal benefit from pioneering bundle removal techniques that can be used across industry. Significant amount of material to be recycled and associated hazardous material to be disposed.

Summary

The returns for options 1, 1A, 2 and 3 are identical with all remain options having insulation and other materials remaining. There are significant increases in the returns for option 1B and 4 which provides employment opportunities associated with disposal and recycling of materials onshore. The increase in LSA returns associated with options 1B and 4 is not a dominant factor.

Option 1 is considered the least attractive option from a fishing community perspective due to the perception that there is no improvement and the bundle is left as-is. Option 1A and 2 is considered more attractive than option 1 in terms of the fishing industry due to it being fully rock dumped (either at the outset or after 30 years) and in that respect is considered equal to option 3. Option 1B and 4 are the most attractive from a fishing perspective as it returns the seabed to the as found condition (either at the outset or after 30 years).

In summary, option 1 is Weaker than option 1A, 1B, 2 and 3 due to the societal impact on fishing industry by leaving bundle in-situ. It is Much Weaker than option 4 due to option 4 returning all material to shore and returning seabed to as found condition.
Option 1A is Weaker than option 1B due to 1B ultimately being a full removal option. It is also Weaker than option 2 and 3 due to there being 30 years of bundle in-situ prior to full rock-dump being implement. Option 1A is Much Weaker than option 4 due to there being 30 years of bundle in-situ and option 4 being a full removal option.
Option 1B is Stronger than option 2 as it is a full removal option. Option 1B is Weaker than option 3 and 4 due to there being 30 years of bundle in-situ prior to full removal.
Option 2 is Weaker than option 3 due to it being full rock dump rather than returning seabed to as found condition. Option 2 is Much Weaker than option 4 for due to option 4 being the full removal option.
Finally, option 3 is Weaker than option 4 due to option 4 being the full removal option.

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Cost: XX M Cost Risk: Low Risk Factors: High degree of achievability.	Cost Phase 1: XX M / Phase 2: XX M Total: XX M Cost Risk: High Risk Factors: High degree of achievability, however Phase 2 costs not incurred for 30 years and may escalate.	Cost Phase 1: XX M / Phase 2: XX M Total: XX M Cost Risk: High Risk Factors: Phase 2 costs not incurred for 30 years and may escalate or concept may mature and so may reduce. Concept also requires additional maturity which maybe realised through trials and testing not currently priced / risk of re-engineering during operations that adds additional cost through schedule over-runs.	Cost: XX M Cost Risk: Low Risk Factors: High degree of achievability.	Cost: XX M Cost Risk: High Risk Factors: Immature concept with significant technical risk / extensive schedule and cost overruns achieving lowering and seabed remediation.	Cost: XX M Cost Risk: Medium Risk Factors: Concept requires additional maturity which may be realised through trials and testing not currently priced / risk of re-engineering during operations that adds additional cost through schedule over-runs.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	Monitoring Legacy Cost: XX M Remedial Cost: XXM Cost Risk: Low Risk Factors: Potential requirement for additional rock dependent on trawl activity.	Monitoring Cost: Phase 1: XX M, Phase 2: XX M Total: XX M Remedial Cost: Phase 1: XX M, Phase 2: XX M Total: XX M Cost Risk: Medium Risk Factors: Phase 2 costs (which are relatively small limited) are not incurred for 30 years and may escalate. Potential requirement for additional rock dependent on trawl activity.	Monitoring Cost: Phase 1: XX M, Phase 2: N/A Total: XX M Remedial Cost: Phase 1: XX M, Phase 2: N/A Total: XX M Cost Risk: Medium Risk Factors: Phase 2 costs (which are relatively small) are not incurred for 30 years and may escalate. Potential requirement for additional rock dependent on trawl activity.	Monitoring Cost: XX M Remedial Cost: XX M Cost Risk: Low Risk Factors: Potential requirement for additional rock in future dependent on trawl activity.	Legacy Cost: XX M Remedial Cost: XX M Cost Risk: Low Risk Factors: Even with lowering achieved there is still the potential for additional future remediation required.	There are no long-term cost liabilities associated with this full removal option.
		Summary	The total costs for options 1, 1A, 1B, 2, 3 and 4 are XX M, XX M, XX M, XX M, XX M and XX M respectively. Option 1 is the most attractive from an economic perspective by a significant margin as it has the lowest overall cost and a low cost risk. Options 2 and 3 have almost identical total costs with option 1A a little higher again. All have monitoring and remedial components to them. Option 2 has low cost risk, option 1A is a little higher for cost risk due to performing activities 30 years in the future. Option 3 has high cost risk due to the potential for cost overrun associated with the trenching and seabed remediation. Option 4 has the second highest cost, followed by option 1B. These differentials are significant over the other options. Both of these options also have high cost risk due to immature concept for full removal of bundle. Overall, option 1 Stronger than option 2 due to cost differential, Much Stronger than option 1A and 3 due to cost and cost risk differential, and Very Much Stronger than option 1B and 4 due to very large cost and cost risk differential. Option 1A is Weaker than option 3 due to differential in cost (cost risk largely similar). It is Much Stronger than option 1B and 4 due to large cost and cost risk differential and Neutral to option 2 as whilst there is a cost differential, this offset by the cost risk. Option 1B is Very Much Weaker than option 2 due to large cost and cost risk differential, Much Weaker than option 3 due to large cost differential and smaller cost risk differential and Weaker than option 4 as slightly higher initial cost. Option 2 is Stronger than option 3 due to lower cost and Much Stronger than option 4 due to large cost and cost risk differential. Finally, option 3 is Stronger than option 4 due to cost differential.					

1. Safety

1. Safety	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	VMS	N	MS	VMS	28.29%
1A. As 1 with Complete Rock Placement after 30 Years	N	N	VMS	N	MS	VMS	28.29%
1B. As 1 with Full Removal after 30 Years	VMW	VMW	N	VMW	MW	W	2.94%
2. Leave - End Removal - Complete Rock Placement	N	N	VMS	N	MS	VMS	28.29%
3. Leave - End Removal and Trench	MW	MW	MS	MW	N	S	8.40%
4. Full Removal - Cut and lift	VMW	VMW	S	VMW	W	N	3.78%

2. Environmental

2. Environmental	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	MS	S	MS	W	W	19.64%
1A. As 1 with Complete Rock Placement after 30 Years	MW	N	MW	W	MW	MW	6.55%
1B. As 1 with Full Removal after 30 Years	W	MS	N	MS	MW	W	15.28%
2. Leave - End Removal - Complete Rock Placement	MW	S	MW	N	MW	MW	7.49%
3. Leave - End Removal and Trench	S	MS	MS	MS	N	N	26.99%
4. Full Removal - Cut and lift	S	MS	S	MS	N	N	24.05%

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Pairwise Comparison

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3. Technical	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	MS	N	MS	MS	24.97%
1A. As 1 with Complete Rock Placement after 30 Years	N	N	MS	N	MS	MS	24.97%
1B. As 1 with Full Removal after 30 Years	MW	MW	N	MW	S	N	8.91%
2. Leave - End Removal - Complete Rock Placement	N	N	MS	N	MS	MS	24.97%
3. Leave - End Removal and Trench	MW	MW	W	MW	N	W	7.27%
4. Full Removal - Cut and lift	MW	MW	N	MW	S	N	8.91%

4. Societal	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	W	W	W	W	MW	9.82%
1A. As 1 with Complete Rock Placement after 30 Years	S	N	W	W	W	MW	11.24%
1B. As 1 with Full Removal after 30 Years	S	S	N	S	W	W	16.53%
2. Leave - End Removal - Complete Rock Placement	S	S	W	N	W	MW	12.86%
3. Leave - End Removal and Trench	S	S	S	S	N	W	18.92%
4. Full Removal - Cut and lift	MS	MS	S	MS	S	N	30.63%

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Pairwise Comparison

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5. Economic	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	MS	VMS	S	MS	VMS	40.49%
1A. As 1 with Complete Rock Placement after 30 Years	MW	N	MS	N	W	MS	14.16%
1B. As 1 with Full Removal after 30 Years	VMW	MW	N	VMW	MW	W	3.93%
2. Leave - End Removal - Complete Rock Placement	W	N	VMS	N	S	MS	21.85%
3. Leave - End Removal and Trench	MW	S	MS	W	N	S	13.50%
4. Full Removal - Cut and lift	VMW	MW	S	MW	W	N	6.07%

Osprey Decision 1 – Bundles

Pairwise Comparison

Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Total PLL: 2.07E-03 Vessels located on site for 11.2 days.	Total PLL: 3.37E-03 Vessels located on site for 23.7 days. This includes shuttling with PSV which results in increased exposure of vessels in area.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.		
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.		
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Low risk of high consequence events - routine.	Medium risk of high consequence events - non-routine operations, not considered unusual. Possible limited SIMOPS.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	No residual risk - wholly within the 500m exclusion zone and all outboard elements are fully removed.	No residual risk - full removal option.
		Summary	The summed PLL figures for options 1 and 2 (all worker groups and including legacy component where present) are 2.07E-03 and 3.37E-03 respectively. This indicates that option 1 is the lowest risk option, driven by shorter duration operations and significantly fewer hours for offshore, topsides and onshore activities. Option 1 is also considered more attractive than option 2 for vessel on-site duration and potential for high consequence events. Overall, option 1 is Stronger than option 2 from a safety perspective.	
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Sound Exposure 242 dB re 1mP / 1.76 TPa2s	Sound Exposure 246 dB re 1mP / 4.4 TPa2s
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	CO_2: 783.2 Te NO_x: 14.6 Te SO_2: 3.0 Te Lifecycle CO_2: 906.7 Te CO_2 Credit for Steel: N/A	CO_2: 1192.9 Te NO_x: 22.2 Te SO_2: 4.5 Te Lifecycle CO_2: 1271.23 Te CO_2 Credit for Steel: 48.05 Te
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.	Fuel: 247.1 Te Rock: None	Fuel: 376.3 Te Rock: None
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Minor disturbance covering area of umbilical on seabed only.	Minor disturbance covering area of umbilical on seabed only.
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.
		Summary	Option 1 is either equal to or marginally better than option 2 in all areas. As such, option 1 is Stronger than option 2 from an environmental perspective due to the cumulative effect of these marginal improvements.	

Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Recent history of cutting umbilicals and flexibles. Risk of Failure: Low. Consequence of Failure: Limited schedule impacts. Emerging Technology: Diverless cutting may be an option.	Feasibility: High. Concept Maturity: Medium - final details for performing task are yet to be defined, platform crane, winch placement and operations, etc. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history in North Sea and recent history on Dunlin. Risk of Failure: Medium – Unknown integrity of J-tube / umbilical and inability to inspect. Consequence of Failure: Umbilical would remain within J-tube / schedule overruns - extremely minor potential of flooding leg performing these operations. Emerging Technology: N/A.
		Summary	Option 1 carries significantly less technical risk than option 2 due to the potential / consequence of failure related to j-tube integrity uncertainty. Overall option 1 is Much Stronger than option 2 from a Technical Feasibility perspective.	
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Will not remain on seabed - no long term exposure.	Will not remain on seabed - no long term exposure.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Material returned to shore Recovered: 530 m Umbilical (8.9 Te) 210 m Flexible Riser (20.5 Te) 78.91 kg LSA Scale (PL733) 74.92 kg LSA Scale (PL734) No fluids or hydrocarbons returned. Remaining: 360m Umbilical 540m Flexible Riser 179.67 kg LSA Scale (PL733) 179.67 kg LSA Scale (PL734) 0.45 kg Hydrocarbon (PL733) 0.91 kg Hydrocarbon (PL734) 536 litres Braycon Micronic 864 130 litres Phasetreat 6041 258 litres Methanol Persistence: In-line with CGB & J-tubes >250 years.	Material returned to shore Recovered: 890 m Umbilical 750 m Flexible Riser 258.49 kg LSA Scale (PL733) 254.49 kg LSA Scale (PL734) Remaining: 0.45 kg hydrocarbon (discharged in-situ, PL733) 0.90 kg hydrocarbon (discharged in-situ, PL734) 536 litres Braycon Micronic 864 130 litres Phasetreat 6041 258 litres Methanol Persistence: N/A.
		Summary	Options 1 and 2 are largely similar from a societal perspective. There is an increase in the amount of LSA material returned with option 2, however this was not significant enough to change the scoring from Neutral.	
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Cost: XX M Cost Risk: Low Risk Factors: High degree of achievability.	Cost: XX M Cost Risk: Medium Risk Factors: Topside engineering for winch locating is not mature / inspection to confirm integrity of J-tube and contained products is not possible / previous pull-in operations have suffered delays and cost overruns. Historical overruns have been pull-in rather than removal operations.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	No long-term costs, any Monitoring is assumed to be done as part of any CGB monitoring.	No long-term costs associated with this full removal option.
		Summary	Option 1 has a lower cost and cost risk than option 2. Therefore option 1 is Stronger than option 2.	

Osprey Decision 2 – Flexible and Umbilical Risers

Pairwise Comparison

1. Safety

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	S	60.00%
2. Full Removal - Topsides Pull	W	N	40.00%

2. Environmental

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	S	60.00%
2. Full Removal - Topsides Pull	W	N	40.00%

3. Technical

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	MS	75.00%
2. Full Removal - Topsides Pull	MW	N	25.00%

4. Societal

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	N	50.00%
2. Full Removal - Topsides Pull	N	N	50.00%

5. Economic

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	S	60.00%
2. Full Removal - Topsides Pull	W	N	40.00%

xodus GROUP

Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Total PLL: 4.01E-03 Vessels located on site for Operations: 26.1 days Legacy: 60.8 days	Total PLL: 4.26E-03 Vessels located on site for: Operations: 31.8 days Legacy: 60.8	Total PLL: 3.84E-03 Vessels located on site for 36.3 days.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.			
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.			
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Low risk of high consequence events - routine.	Low risk of high consequence events - routine.	Medium risk of high consequence events - non-routine operations, umbilical recovery operations are not considered unusual. Residual integrity and thus the suitability for reverse reeling assumed by engineering only - potential for integrity failure during reverse reeling operations.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	Residual Risk Legacy: 35 / 25620 / 1.41E-03 (monitoring) Fishing: Negligible additional risk presented to fisherman from spot rock dumped umbilical.	Residual Risk Legacy: 35 / 25620 / 1.41E-03 (monitoring) Fishing: Negligible additional risk presented to fisherman from fully rock dumped umbilical.	Residual Risk There is no residual legacy risk or risk to fishing operations associated with this option as it is a full removal option.
		Summary	The summed PLL figures for options 1, 2 and 3 (all worker groups and including legacy component where present) are 4.01E-03, 4.26E-03 and 3.84E-03 respectively. This indicates that option 2 is the highest risk for all worker groups, followed by option 1 and then option 3. The differential between each of the options is small. Vessel durations are lowest for option 3, followed by option 1 and then option 2. Risk of high consequence events are equal for options 1 and 2. Option 3 has a higher risk of high consequence events. Overall, option 1 is Neutral to option 2. It is Stronger than option 3 due to the increased risk from high consequence events. Option 2 is also Stronger than option 3 for similar reasons.		
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Sound Exposure 253 dB re 1mP / 19.2 TPa2s Slow discharge of remaining environmentally harmful chemicals.	Sound Exposure (254) 253 dB re 1mP / 22.3 TPa2s Slow discharge of remaining environmentally harmful chemicals.	Sound Exposure 249 dB re 1mP / 8.9 TPa2s Discharge of chemicals likely to occur quickly during reverse reeling operations.
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	CO2: 3178.6 Te NOx: 59.2 Te SO2: 12.0 Te Lifecycle CO2: 3667.13 Te CO2 Credit for Steel: N/A	CO2: 3574.0 Te NOx: 66.5 Te SO2: 13.5 Te Lifecycle CO2: 5013.08 Te CO2 Credit for Steel: N/A	CO2: 2295.4 Te NOx: 42.7 Te SO2: 8.7 Te Lifecycle CO2: 2418.42 Te CO2 Credit for Steel: 92.06 Te
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.	Fuel: 1002.7 Te Rock: 7300 Te	Fuel: 1127.4 Te Rock: 35300 Te	Fuel: 724.1 Te Rock: N/A
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Disturbance Dredging: 60 m2 Rock Dump: 9330 m2	Disturbance Dredging: 60 m2 Rock Dump: 40630 m2	Disturbance Trenching: 12194 m2
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.
		Summary	Option 1 and 2 are largely comparable in terms of noise exposure, emissions and fuel use, with option 3 being a minor improvement in each of these areas. Option 1 is much more attractive than option 2 from a seabed disturbance perspective as option 2 introduces much more new material of a substantial area. Option 1 is less attractive than option 3 in this respect. Option 2 is again, much less attractive than option 3 for similar reasons. The status of the remaining harmful chemicals is unknown for PL736, a worst case basis is assumed. These harmful chemicals are expected to be released slowly over time under options 1 and 2 which carries less environmental impact than the chemicals being released rapidly under option 3 due to the reverse reeling process. This is worst case as there may be potential to recover PL736 with remaining chemical inventory intact. Overall, option 1 is Much Stronger than option 2 due to the smaller amount of new material introduced and the much smaller seabed disturbance. Option 1 is Weaker than option 3 as it has a greater environmental impact in all areas. Option 2 is Much Weaker than option 3 due to the new material and seabed disturbance.		

Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting may be an option.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting may be an option.	Feasibility: Medium. Concept Maturity: Medium. Availability of Technology: Medium – Limited number of existing techniques suitable for deburial of the trenched umbilical PL736. MFE is a suitable method for removing the rock from PL1545. Track Record: Low – Limited experience of exposing umbilicals over extended distances using an MFE to enable re-reeling. Risk of Failure: High. Consequence of Failure: Alternate deburial techniques required / rock required to remedy over dredged areas / large schedule overruns with limited ability to recover. Emerging Technology: N/A Integrity of the lines are uncertain as they are well beyond design life. Concerns re: deburial ability may be challenging due to soil types (clays) and thus uncertainty that can deliver option successfully.
		Summary	Option 1 and 2 are technically very similar and as such are scored Neutral against each other. Both option 1 and 2 are Much Stronger technically than option 3 due to the uncertainty surrounding the ability to adequately complete the deburial operations in the seabed materials and over the intended distances.		
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Can fish over so long term OK. Whilst durations of programme are different, fishing activity low in area so no differentiation in short term either.	Can fish over so long term ok. Whilst durations of programme are different, fishing activity low in area so no differentiation in short term either.	Can fish over so long term ok. Whilst durations of programme are different, fishing activity low in area so no differentiation in short term either.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Material returned to shore Recovered: 524 m Umbilical (7.5 Te) 1824 litres Methanol 7703 litres Brayco Micronic SV/3 3466 litres HSW85690 811 litres CRW85648 811 litres RO IM C317 Remaining: 12197 m Umbilical 11120 Te Rock (3820 Te Existing + 7300 Te New). 5303 litres Brayco Micronic 864 1263 litres Phasetreat 6041 910 litres TROS 93-64 1818 litres Methanol Persistence: >100 years (no long term data/experience of polymers in seawater/buried).	Material returned to shore Recovered: 524 m Umbilical (7.5 Te) 1824 litres Methanol 7703 litres Brayco Micronic SV/3 3466 litres HSW85690 811 litres CRW85648 811 litres RO IM C317 Remaining: 12197 m Umbilical 39120 Te (3820 Te Existing + 35300 Te New). 5303 litres Brayco Micronic 864 1263 litres Phasetreat 6041 910 litres TROS 93-64 1818 litres Methanol Persistence: >100 years (no long term data/experience of polymers in seawater/buried).	Material returned to shore Recovered: 12913 m Umbilical 5303 litres Brayco Micronic 864 1263 litres Phasetreat 6041 910 litres TROS 93-64 3642 litres Methanol 7703 litres Brayco Micronic SV/3 3446 litres HSW85690 811 litres CRW85648 811 litres RO IM C317 Remaining: 3820 Te Rock (Existing) Persistence: N/A
		Summary	Option 1 and 2 are largely similar and are therefore scored as Neutral to each other. Further, both options 1 and 2 are Stronger than option 3 due to the increase in the amount of landfill required with the increased material being returned to shore in option 3.		
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Cost: XX M Cost Risk: Low Risk Factors: High degree of achievability.	Cost: XX M Cost Risk: Low Risk Factors: High degree of achievability / Low likelihood of future remediation required due to existing burial depth / trench depth.	Cost: XX M Cost Risk: High Risk Factors: Medium degree of achievability / High likelihood of failure to expose the PL736 umbilical fully without multiple deburial techniques and passes / High likelihood of over trenching in sandy areas leading to areas of disturbance that are larger than required, leading to potential remediation.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	Monitoring Cost: XX M Remedial Cost: XX M Cost Risk: Low Risk Factors: Low likelihood of future remediation required due to existing burial depth / trench depth.	Monitoring Cost: XX M Remedial Cost: XX M Cost Risk: Low Risk Factors: Low likelihood of future remediation required due to existing burial depth / trench depth.	There are no long-term cost liabilities associated with this full removal option.
		Summary	The total costs for options 1, 2 and 3 are XX M, XX M and XX M respectively. Cost risk for options 1 and 2 are equal, whereas option 3 has a higher cost risk associated with the potential for overruns associated with the deburial operations. Overall option 1 is Stronger than option 2 due to the lower overall cost. It is Much Stronger than option 3 due to lower cost and lower cost risk. Option 2 is Stronger than option 3 as whilst the costs are similar, it has a lower cost risk.		

Osprey Decision 3 – Trenched and Rock Dumped Umbilicals

Pairwise Comparison

1. Safety	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	S	37.50%
2. Leave - End Removal - Full Rock Placement	N	N	S	37.50%
3. Full Removal - Reverse Reel	W	W	N	25.00%

2. Environmental	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	MS	W	37.15%
2. Leave - End Removal - Full Rock Placement	MW	N	MW	14.17%
3. Full Removal - Reverse Reel	S	MS	N	48.68%

3. Technical	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	MS	42.86%
2. Leave - End Removal - Full Rock Placement	N	N	MS	42.86%
3. Full Removal - Reverse Reel	MW	MW	N	14.29%

4. Societal	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	S	37.50%
2. Leave - End Removal - Full Rock Placement	N	N	S	37.50%
3. Full Removal - Reverse Reel	W	W	N	25.00%

5. Economic	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	S	MS	50.69%
2. Leave - End Removal - Full Rock Placement	W	N	S	30.71%
3. Full Removal - Reverse Reel	MW	W	N	18.60%

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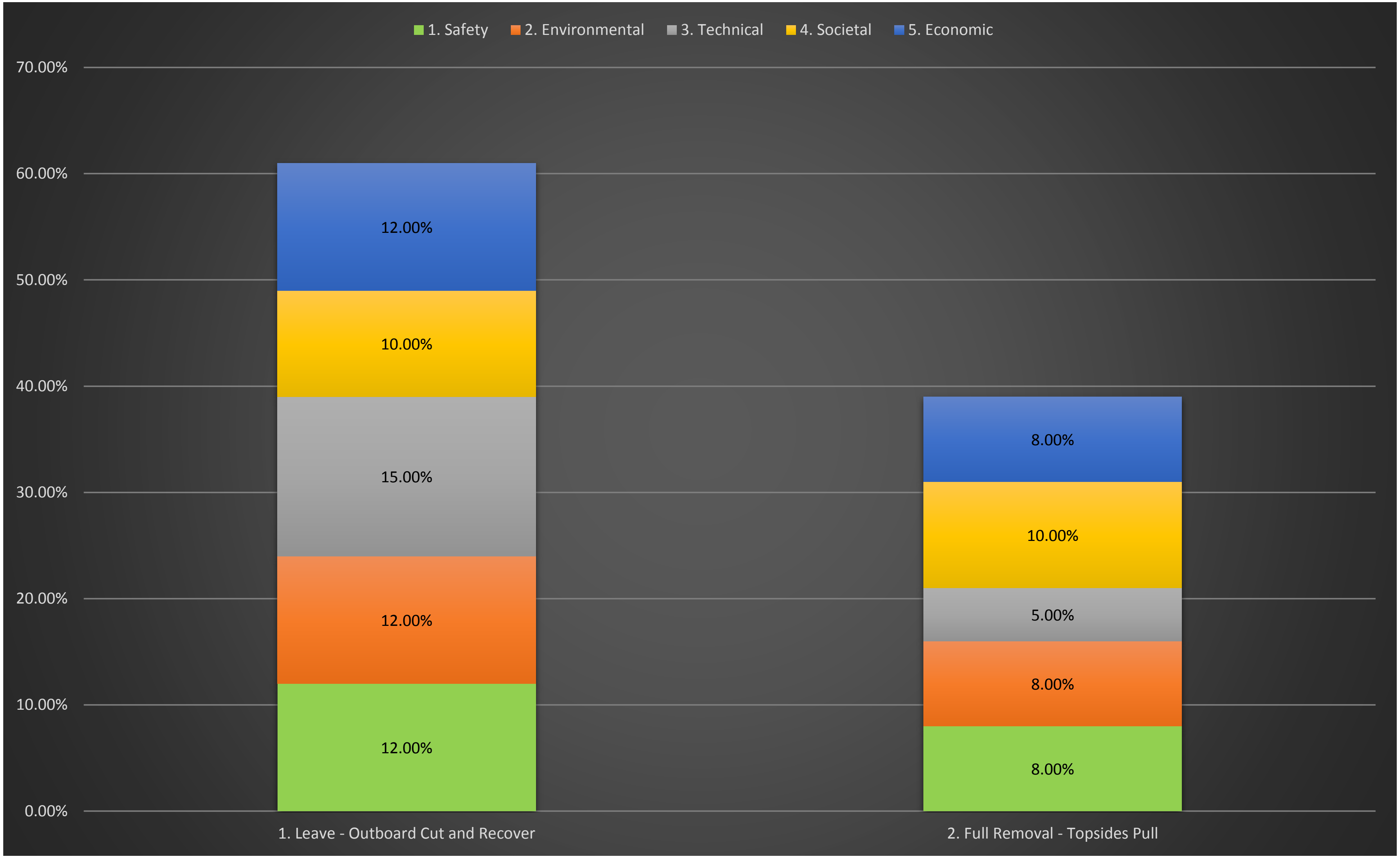
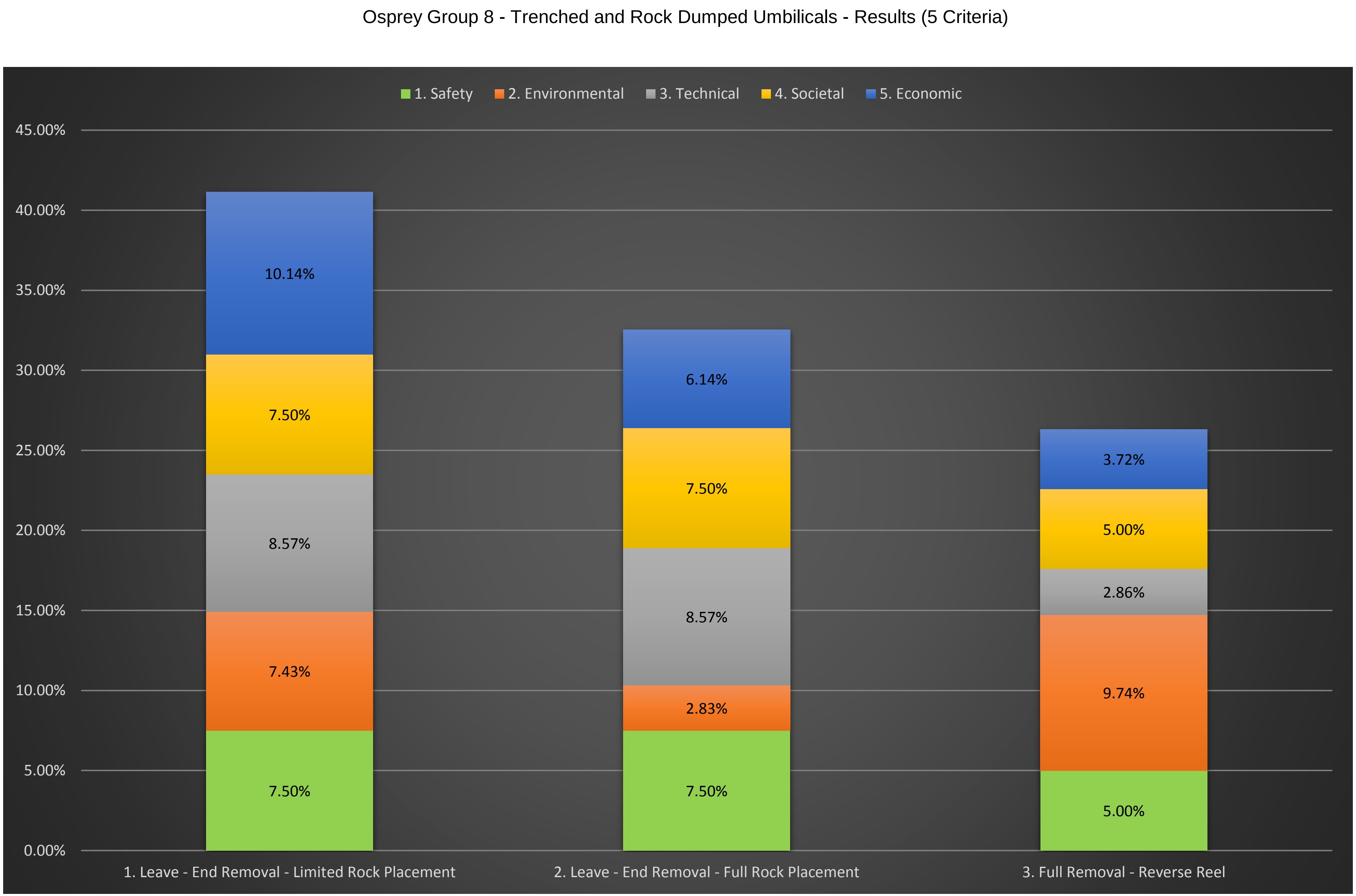
Appendix G Decision Output Charts

Osprey Group 3 - Bundles - Results (5 Criteria)

Osprey Group 5 - Flexible and Umbilical Riser - Results (5 Criteria)





Osprey Group 8 - Trenched and Rock Dumped Umbilicals - Results (5 Criteria)
1. Safety
2. Environmental
3. Technical
4. Societal
5. Economic
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
10.14%
7.50%
8.57%
7.43%
7.50%
6.14%
7.50%
8.57%
2.83%
7.50%
3.72%
5.00%
2.86%
9.74%
5.00%
1. Leave - End Removal - Limited Rock Placement
2. Leave - End Removal - Full Rock Placement
3. Full Removal - Reverse Reel

Appendix H Data Sheets (Inc. Costs)

Area	Osprey
Decision/Group	Decision 1 Group 3 – Bundles
Option	1 – Leave in situ – Minor intervention (Towhead Removal and Local Rock Dumping)
Description	Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 – Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 – Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-001 – Osprey – Long Term Materials Degradation Study A-301649-S01-REPT-001 – Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	157	Man Hours	13931
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037
Onshore Personnel	Number	20	Man Hours	3337
Legacy Personnel	Number	76	Man Hours	45600
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	24.9
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	100
Potential for High Consequence Event	Low	Comments	Routine Operations	

Operational Risk Diver	PLL	1.01E-03
Operational Risk Offshore	PLL	1.04E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	4.10E-04
Legacy Risk (out to 50yrs)	PLL	3.00E-03
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)
Overall Risk	∑PLL	5.46E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.0	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	4.9	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	5	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	50	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	50	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level		257 dB re 1mP			45.2 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	1981.8Te	CO_2	6282.3 Te	NOx	116.9 Te	SO_2	23.8 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		15684.78 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	4550 m^2	Resources	8800 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) (6.5Te) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical 8800 Te Rock
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	Diverless cutting and recovery of towheads maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic		
Economic Considerations	Comparative Cost Operational	4.1 M
	Comparative Cost Legacy - Monitoring	2.0 M
	Comparative Cost Legacy - Remedial	3.0 M

Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.

Area	Osprey	
Group	Decision 1 Group 3 – Bundles	
Option	1A – Leave in situ – Minor intervention (Towhead Removal and Local Rock Dumping) – FULL ROCK PLACEMENT AT 30 YEARS	
Description	PHASE 1: Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler PHASE 2: Rock placement over bundle by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
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SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY	PHASE 1 – SHORT TERM TOWHEAD REMOVAL				PHASE 2 – LONG TERM ROCK PLACEMENT			
Offshore Personnel	Number	157	Man Hours	13931	Number	81	Man Hours	16176
Topsides Personnel	Number	N/A	Man Hours	N/A	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037	Number	0	Man Hours	0
Onshore Personnel	Number	20	Man Hours	3337	Number	14	Man Hours	2912
Legacy Personnel	Number		76		Man Hours		40680	
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	24.9	Number of Vessels Used	3	Duration of Operations	38
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used		2		Duration of Operations		90	
Potential for High Consequence Event	Low		Routine Operations		Low		Routine Operations	
	COMBINED PHASE 1, 2 & LEGACY							
Operational Risk Diver	PLL	1.01E-03						
Operational Risk Offshore	PLL	2.26E-03						
Operational Risk Topsides	PLL	N/A						
Operational Risk Onshore	PLL	7.69E-04						
Legacy Risk (out to 50yrs)	PLL	2.63E-03						
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)						
Overall Risk	∑PLL	6.66E-03						

ENVIRONMENTAL								
Marine Impact (Vessels Phase 1 & 2)	Type	DSV	Number	1	Duration	10.0 / 0	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	2	Duration	4.9 / 28	Activity	Rock Dump
	Type	ROVSV	Number	2	Duration	5 / 5	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	2	Duration	5 / 5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	50	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	40	Activity	Survey

Noise (Total = Ops 1 & 2 + Legacy)	Sound Exposure Level		258 dB re 1mP			56.3 TPa^2s		
Energy Use (Total = Ops 1 & 2 + Legacy)	Fuel	2432.9 Te	CO_2	7212.3 Te	NOx	143.5 Te	SO_2	29.2 Te
Life Cycle Emissions (Total = Ops 1 & 2 + Legacy)	CO_2		21925.33 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	37500 m^2	Resources	142000 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) (6.5Te) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical 142000 Te Rock
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	Diverless cutting and recovery of towheads maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	PHASE 1 - 4.1 M	PHASE 2 – 7.7 M	TOTAL – 11.8 M
	Comparative Cost Legacy - Monitoring	PHASE 1 - 1.2 M	PHASE 2 - 0.8 M	TOTAL - 2.0 M
	Comparative Cost Legacy - Remedial	PHASE 1 - 1.8 M	PHASE 2 - 0.6 M	TOTAL - 2.4 M

Economic Risk	Cost Risk	High	Factors	Phase 2 costs would not be incurred for 30 years. Prices may escalate. High degree of achievability; Potential requirement for additional rock dependent on trawl activity.

Area	Osprey	
Decision/Group	Decision 1 Group 3 – Bundles	
Option	1B – Leave in situ – Minor intervention (Towhead Removal and Local Rock Dumping) – FULL REMOVAL AT 30 YEARS	
Description	PHASE 1: Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler PHASE 2: Cut bundle into sections (20m) using CSV Install rigging on bundle sections and recover by DSV to PSV Backload bundle sections using PSV Survey by ROV from DSV	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY	PHASE 1 – SHORT TERM TOWHEAD REMOVAL				PHASE 2 – FULL REMOVAL			
Offshore Personnel	Number	157	Man Hours	13931	Number	157	Man Hours	98696
Topsides Personnel	Number	N/A	Man Hours	N/A	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037	Number	9	Man Hours	10260
Onshore Personnel	Number	20	Man Hours	3337	Number	20	Man Hours	28365
Legacy Personnel	Number		76		Man Hours		24900	
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	24.9	Number of Vessels Used	3	Duration of Operations	85.4 (//el Ops)
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used		2		Duration of Operations		55	
Potential for High Consequence Event	Low		Routine Operations		High		Significant personnel exposure and lifting operations (subsea and onshore)	
	COMBINED PHASE 1, 2 & LEGACY							
Operational Risk Diver	PLL	1.10E-02						
Operational Risk Offshore	PLL	8.45E-03						
Operational Risk Topsides	PLL	N/A						
Operational Risk Onshore	PLL	3.49E-03						
Legacy Risk (out to 30yrs)	PLL	1.62E-03						
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)						
Overall Risk	∑PLL	2.45E-02						

ENVIRONMENTAL								
Marine Impact (Vessels Phase 1 & 2)	Type	DSV	Number	2	Duration	10.0 / 52.7	Activity	Destruct
	Type	CSV	Number	1	Duration	0 / 59.5	Activity	Cutting
	Type	DPFPV	Number	1	Duration	4.9 / 0	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	5 / 0	Activity	Survey
	Type	Pipe Haul	Number	1	Duration	0 / 45.5	Activity	Storage
	Type	Trawler	Number	1	Duration	5 / 0	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	25	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	30	Activity	Survey

Noise (Total = Ops 1 & 2 + Legacy)	Sound Exposure Level	263 dB re 1mP	212.0 TPa^2s

Energy Use (Total = Ops 1 & 2 + Legacy)	Fuel	4679.2 Te	CO_2	14833.0 Te	NOx	276.1 Te	SO_2	56.2 Te

Life Cycle Emissions (Total = Ops 1 & 2 + Legacy)	CO_2	19878.98 Te	CO_2 (Credit)	4376.80 Te

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	4550 m^2	Resources	8800 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 400 m Umbilical
	Remaining	8800 Te Rock
	Persistence	N/A

Residuals	LSA Scale	In-Situ	0 kg	Returned	12215 kg
	Hydrocarbon	In-Situ	0 kg (35.66 kg lost between Phase 1 & Phase 2)	Returned	0 kg
	Control Fluids	In-Situ	Nil	Returned	Nil

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Medium
	Availability of Technology	Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique.		
	Track Record	None – Method has not been used (however; the majority of individual techniques have been used previously to good effect)		
	Risk of Failure	Low – Cutting and lifting operations are not new or novel		
	Consequence of Failure	Alternate cutting techniques required / alternate lifting arrangements required/ rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful		
	Emerging Technology	No new concepts however; there is evidence of companies looking at the cut and lift solution and providing a diverless option.		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	High – If concept is proven then there will be an economic benefit realised due to the number of additional bundles that could potentially be recovered. Significant amount of material to be re-cycled and associated hazardous material to be disposed.

Economic				
Economic Considerations	Comparative Cost Operational	PHASE 1 - 4.1 M	PHASE 2 – 23.7 M	TOTAL – 27.8 M
	Comparative Cost Legacy - Monitoring	PHASE 1 - 1.2 M	PHASE 2 - 0 M	TOTAL - 1.2 M
	Comparative Cost Legacy - Remedial	PHASE 1 - 1.5 M	PHASE 2 - 0 M	TOTAL - 1.5 M

Economic Risk	Cost Risk	High	Factors	Phase 2 costs would not be incurred for 30 years. Prices may escalate. Alternately, concept may be proved and costs may reduce. Concept requires additional maturity which maybe realised through trials and testing not currently priced; there is a risk of re-engineering being required during operations that would add additional cost through schedule over-runs.

Subsea Infrastructure Decommissioning Comparative Assessment Data Sheet

Area	Osprey	
Decision/Group	Decision 1 Group 3 – Bundles	
Option	2 – Leave in situ – Minor intervention (Towhead Removal and Complete Rock Dumping)	
Description	Towhead removal by DSV Rock placement over snag hazards and areas of potential span growth by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	157	Man Hours	25493
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1037
Onshore Personnel	Number	20	Man Hours	4841
Legacy Personnel	Number	76	Man Hours	33300
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	48.4
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	75
Potential for High Consequence Event	Low	Comments	Routine Operations	

Operational Risk Diver	PLL	1.01E-03
Operational Risk Offshore	PLL	1.91E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	5.95E-04
Legacy Risk (out to 50yrs)	PLL	2.08E-03
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)
Overall Risk	∑PLL	5.59E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.0	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	28.4	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	5	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	25	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	50	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level		256 dB re 1mP			44.4 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	1949.9 Te	CO_2	6181.2 Te	NOx	115.0 Te	SO_2	23.4 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		15583.66 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m²	Resources	N/A
	Activity	Rock Dump	Area	73500 m²	Resources	142000 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) (6.5Te) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical 142000Te Rock
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	Diverless cutting and recovery of towheads maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic		
Economic Considerations	Comparative Cost Operational	11.0 M
	Comparative Cost Legacy - Monitoring	2.0 M
	Comparative Cost Legacy - Remedial	1.5 M

Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Potential requirement for additional rock dependent on trawl activity.

Area	Osprey
Decision/Group	Decision 1 Group 3 – Bundles
Option	3 – Leave in situ – Major intervention (Towhead Removal and Trench)
Description	Towhead removal by DSV Cut bundle into sections (approx. 350m) and pre-install pull rigging by DSV Create pre-cut trench with plough from trenching vessel Pull bundle sections into pre-cut trench using AHV Backfill spoil using MFE from CSV Survey by ROVSV Trawl sweep using trawler
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 – Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 – Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-001 – Osprey – Long Term Materials Degradation Study A-301649-S01-TECH-002 – Osprey – Trenching / Backfilling Feasibility Study A-301649-S01-REPT-001 – Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement: Valve Stations	External Arrangement: Chains	External Arrangement: Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	233	Man Hours	42582
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	3240
Onshore Personnel	Number	20	Man Hours	5977
Legacy Personnel	Number	76	Man Hours	33300
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	7	Duration of Operations	62.4
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	2	Duration of Operations	75

Potential for High Consequence Event	Medium	Comments	Non-routine operations, although using existing techniques.

Operational Risk Diver	PLL	3.14E-03
Operational Risk Offshore	PLL	3.19E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	7.35E-04
Legacy Risk (out to 50yrs)	PLL	2.08E-03
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)
Overall Risk	∑PLL	9.15E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	20.2	Activity	Destruct
	Type	CSV	Number	1	Duration	7	Activity	Backfill
	Type	Trench Vessel	Number	1	Duration	8.2	Activity	Trench
	Type	ROVSV	Number	1	Duration	5	Activity	Survey
	Type	AHV	Number	2	Duration	17	Activity	Bundle Pull
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	1	Duration	25	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	50	Activity	Survey

Noise (Total = Ops + Legacy)	Sound Exposure Level	258 dB re 1mP	63.9 TPa^2s

Energy Use (Total = Ops + Legacy)	Fuel	2256.8 Te	CO_2	7154.0 Te	NOx	133.2 Te	SO_2	27.1 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		16566.53 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	13500 m^2	Resources	N/A
	Activity	Backfilling	Area	16200 m^2	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 63 m Internal Pipes (including 36 m Production Insulated PiP) 52 m Umbilical
	Remaining	3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 348 m Umbilical
	Persistence	Carrier Pipes: up to 350 years Internal Pipes: up to 350 years

Residuals	LSA Scale	In-Situ	12099.71 kg	Returned	115.29 kg
	Hydrocarbon	In-Situ	35.66 kg	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Low
	Availability of Technology	Low – Few suitably sized ploughs capable of providing a >2m trench depth available; backfilling will not be possible with a plough due to section alignment; MFE may be used for backfill but will not return clay type soils.		
	Track Record	None – Method has not been used (however; the majority of individual techniques have been used previously to good effect)		
	Risk of Failure	High – Achieving sufficient trench depth is not guaranteed; backfill with an MFE may only return a small amount of sandy material to the trench; risk of trench widening when using the MFE to backfill.		
	Consequence of Failure	Rock placement over the bundle / extensive seabed remediation / failure to achieve satisfactory bundle decommissioning solution / extensive cost and schedule overruns / increased personnel exposure.		
	Emerging Technology	None evident		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing if successful outcome achieved
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	10.9 M		
	Comparative Cost Legacy - Monitoring	2.0 M		
	Comparative Cost Legacy - Remedial	1.5 M		
Economic Risk	Cost Risk	High	Factors	Immature concept with significant technical risk; Extensive schedule and cost overruns achieving lowering and seabed remediation; Even with lowering achieved there is still the potential for future remediation required.

Area	Osprey	
Decision/Group	Decision 1 Group 3 – Bundles	
Option	4 – Full removal – Cut and Lift	
Description	Dredge and cut bundle into sections (20m) using CSV Recover the towheads using DSV Install rigging on bundle sections and recover by DSV to PSV Backload bundle sections using PSV Survey by ROV from DSV	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-003 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Removal/Recovery Feasibility Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Towheads	Internal Arrangement	External Arrangement		
						Valve Stations	Chains	Anodes
NBUND1 38”	Bundle	Steel / PUF	2877.1 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	46 x Type A – 12 Links of 76mm 76 x Type B – 13 Links 76mm & 9 Links 64mm 31 x Type C – 10 Links 76mm	42
NBUND2 31.5”	Bundle	Steel	359.9 (Ref. FoF)	1	1 x 10” WI Line 1 x 10” Umb. Carrier 1 x 5” Umb.	2	10 x Type AA – 13 Links of 76mm 9 x Type BB – 14 Links 76mm & 9 Links 64mm 2 x Type C – 10 Links 76mm	8
SBUND1 38”	Bundle	Steel / PUF	3239.0 (Ref. FoF)	2	2 x 12” Sleeve Pipe 2 x 8” Oil Line 1 x 10” WI Line	8	13 x Type A – 12 Links of 76mm 1 x Type AA – 13 Links of 76mm 89 x Type B – 13 Links 76mm & 9 Links 64mm 73 x Type C – 10 Links 76mm	48

SAFETY				
Offshore Personnel	Number	157	Man Hours	101024
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	10476
Onshore Personnel	Number	20	Man Hours	26964
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	3	Duration of Operations	88.9 (//el Ops)
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A
Potential for High Consequence Event	High	Comments	Significant personnel exposure and lifting operations (subsea and onshore)	
Operational Risk Diver	PLL	1.02E-02		
Operational Risk Offshore	PLL	7.58E-03		
Operational Risk Topsides	PLL	N/A		
Operational Risk Onshore	PLL	3.32E-03		
Legacy Risk (out to 50yrs)	PLL	N/A		
Fishing Risk	PLL	N/A		
Overall Risk	∑PLL	2.11E-02		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	53.7	Activity	Removal
	Type	CSV	Number	1	Duration	61.4	Activity	Cutting
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Pipehaul	Number	1	Duration	45.5	Activity	Storage
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
Noise (Total = Ops + Legacy)	Sound Exposure Level		263 dB re 1mP			185.8 TPa^{2}s		
Energy Use (Total = Ops + Legacy)	Fuel	3533.2 Te	CO_2	11200.2 Te	NOx	208.5 Te	SO_2	42.4 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		16246.18 Te		CO_2 (Credit)		4376.80 Te	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	5 Towheads (160 Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m PiP Insulated Production Pipelines 6420 m Water Injection Pipeline 400 m Umbilical
	Remaining	N/A
	Persistence	N/A

Residuals	LSA Scale	In-Situ	Nil	Returned	12215 kg
	Hydrocarbon	In-Situ	35.66 kg (discharged during recovery)	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	N/A

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Medium
	Availability of Technology	Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique.		
	Track Record	None – Method has not been used (however; the majority of individual techniques have been used previously to good effect)		
	Risk of Failure	Low – Cutting and lifting operations are not new or novel		
	Consequence of Failure	Alternate cutting techniques required / alternate lifting arrangements required/ rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful		
	Emerging Technology	No new concepts however; there is evidence of companies looking at the cut and lift solution and providing a diverless option.		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	High – If concept is proven then there will be an economic benefit realised due to the number of additional bundles that could potentially be recovered. Significant amount of material to be re-cycled and associated hazardous material to be disposed.

Economic		
Economic Considerations	Comparative Cost Operational	24.2 M
	Comparative Cost Legacy - Monitoring	0.0 M
	Comparative Cost Legacy - Remedial	0.0 M

Economic Risk	Cost Risk	Medium	Factors	Concept requires additional maturity which maybe realised through trials and testing not currently priced; there is a risk of re-engineering being required during operations that would add additional cost through schedule over-runs.

Area	Osprey
Decision/Group	Decision 2 Group 5 – Flexible and Umbilical Risers
Option	1 – Leave in Situ – Minor Intervention (Outboard Cut and Recovery)
Description	2 off Umbilical and 3off flexible riser cut at J-tube exits by DSV J-tubes sealed and outboard section of umbilicals and flexibles recovered back to the DSV Survey by DSV
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 – Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 – Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-004 – Osprey – Effect of Leaving Riser Section within J-Tube A-301649-S01-REPT-001 – Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL733 8” Oil	Flexible	Polymer / Steel	259	0	0	0	0	0	0
PL734 8” Oil	Flexible	Polymer / Steel	255	0	0	0	0	0	0
PL735A 8” Water	Flexible	Polymer / Steel	236	0	0	0	0	0	0
PL736 5” Umb.	Orig. Umbilical	Polymer / Steel / Copper	240	0	0	0	0	0	0
PL736 4” Umb	Repair Umbilical	Polymer / Steel / Copper	640	0	0	0	0	0	0

SAFETY				
Offshore Personnel	Number	76	Man Hours	10215
Topsides Personnel	Number	10	Man Hours	1200
Divers Required	Number	9	Man Hours	886
Onshore Personnel	Number	20	Man Hours	3233
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	1	Duration of Operations	11.2
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A
Potential for High Consequence Event	Low	Comments	Routine operations	
Operational Risk Diver	PLL	8.59E-04		
Operational Risk Offshore	PLL	7.66E-04		
Operational Risk Topsides	PLL	4.92E-05		
Operational Risk Onshore	PLL	3.98E-04		
Legacy Risk (out to 50yrs)	PLL	N/A (in line with CGB)		
Fishing Risk	PLL	N/A		
Overall Risk	∑PLL	2.07E-03		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	11.2	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
Noise (Total = Ops + Legacy)	Sound Exposure Level		242 dB re 1mP			1.76 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	247.1 Te	CO_2	783.2 Te	NOx	14.6 Te	SO_2	3.0 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		906.70 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	N/A	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	530 m Umbilical (polymer/steel/copper/thermoplastics) (8.9 Te) 210 m Flexible Riser (polymer/steel) (20.5 Te)
	Remaining	360 m Umbilical (polymer/steel/copper/thermoplastics) 540 m Flexible Riser (polymer/steel)
	Persistence	In-line with CGB & J-tubes >250 years

Residuals	LSA Scale	In-Situ	PL733 – 179.67 kg PL734 – 179.67 kg	Returned	PL733 – 78.91 kg PL734 – 74.92 kg
	Hydrocarbon	In-Situ	PL733 – 0.45 kg PL734 – 0.91 kg	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 536L Phasetreat 6041 – 130L Methanol – 258L	Returned	Nil

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Recent history of cutting umbilicals and flexibles		
	Risk of Failure	Low		
	Consequence of Failure	Limited schedule impacts		
	Emerging Technology	Diverless cutting maybe an option		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area where umbilical is removed will potentially remain within a safety zone
	Socio Economic	Low – Limited material returned to shore

Economic		
Economic Considerations	Comparative Cost Operational	3.7 M
	Comparative Cost Legacy - Monitoring	0.0 M – (Monitoring is assumed to be done as part of any CGB monitoring)
	Comparative Cost Legacy - Remedial	0.0 M

Economic Risk	Cost Risk	Low	Factors	High degree of achievability.

Area	Osprey
Decision/Group	Decision 2 Group 5 – Flexible and Umbilical Risers
Option	2 – Full Removal – Topsides Pull
Description	Mobilise winch spread to platform, install and test Remove topside hang-off and transfer umbilical / flexible to winch Remove J-tube seal by DSV (part reverse pull as required) Umbilical / flexible cut at J-tube exit by DSV Seal J-tube and recover outboard section of umbilical / flexible back to the DSV Pull-in umbilical / flexible using the topside winch (pull, secure, cut, repeat on remaining umbilicals / flexibles) Backload umbilical / flexible sections and winch equipment Survey by DSV
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 Subsea Decommissioning Inventory FBL-DUN-OSP-SSP-01-RPT-00002 Subsea Decommissioning Screening – Osprey A-301649-S01-TECH-003 Osprey – Removal/Recovery Feasibility Study A-301649-S01-REPT-001 Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL733 8” Oil	Flexible	Polymer / Steel	259	0	0	0	0	0	0
PL734 8” Oil	Flexible	Polymer / Steel	255	0	0	0	0	0	0
PL735A 8” Water	Flexible	Polymer / Steel	236	0	0	0	0	0	0
PL736 5” Umb.	Orig. Umbilical	Polymer / Steel / Copper	240	0	0	0	0	0	0
PL736 4” Umb	Repair Umbilical	Polymer / Steel / Copper	640	0	0	0	0	0	0

SAFETY				
Offshore Personnel	Number	126	Man Hours	17871
Topsides Personnel	Number	6	Man Hours	5400
Divers Required	Number	9	Man Hours	994
Onshore Personnel	Number	20	Man Hours	6901
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	2	Duration of Operations	23.7
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A
Potential for High Consequence Event	Medium	Comments	Non-routine operations but not unusual. Limited SIMOPS.	
Operational Risk Diver	PLL	9.64E-04		
Operational Risk Offshore	PLL	1.34E-03		
Operational Risk Topsides	PLL	2.21E-04		
Operational Risk Onshore	PLL	8.49E-04		
Legacy Risk (out to 50yrs)	PLL	N/A		
Fishing Risk	PLL	N/A		
Overall Risk	∑PLL	3.37E-03		

ENVIRONMENTAL								
Marine Impact (Vessels)	Type	DSV	Number	1	Duration	11.7	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	PSV	Number	1	Duration	12	Activity	Transport/ Storage
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A
Noise (Total = Ops + Legacy)	Sound Exposure Level		246 dB re 1mP		4.4 TPa^2s			

Energy Use (Total = Ops + Legacy)	Fuel	376.3 Te	CO_2	1192.9 Te	NOx	22.2 Te	SO_2	4.5 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		1271.23 Te		CO_2 (Credit)		48.05 Te	

Marine Impact (Seabed)	Activity	Dredging	Area	N/A	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	890 m Umbilical (polymer/steel/copper/thermoplastics) (15.6 Te) 750 m Flexible Riser (polymer/steel) (75.1 Te)
	Remaining	N/A
	Persistence	N/A

Residuals	LSA Scale	In-Situ	Nil	Returned	PL733 – 258.49 kg PL734 – 254.49 kg
	Hydrocarbon	In-Situ	PL733 – 0.45 kg (Discharged) PL734 – 0.90 kg (Discharged	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 536L Phasetreat 6041 – 130L Methanol – 258L	Returned	Nil

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	Medium
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history in North Sea and recent history on Dunlin of J-tube pulls		
	Risk of Failure	Medium – Unknown integrity of J-tubes / flexibles / umbilicals and inability to inspect.		
	Consequence of Failure	Flexible / umbilical would remain within J-tube / schedule over runs		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area where flexible and umbilical is removed will potentially remain within a safety zone
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	5.6 M		
	Comparative Cost Legacy - Monitoring	0.0 M		
	Comparative Cost Legacy - Remedial	0.0 M		
Economic Risk	Cost Risk	Medium	Factors	Topside engineering for winch locating is not mature; Inspection to confirm integrity of J-tube and contained products is not possible; Previous pull-in operations have suffered delays and cost over runs.

Area	Osprey	
Decision/Group	Decision 3 Group 8 – Trenched and Rock Dumped Umbilicals	
Option	1 – Leave in Situ – Minimal Intervention (Local Rock Placement)	
Description	Pipeline and umbilical end removal by DSV Rock placement over snag hazards and areas of low burial depth by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL736 5” Umb.	Umbilical	Polymer / Steel / Copper	6513.3	6073	0.6	4700	0.6	845	0.5
PL1545 4” Umb.	Umbilical	Polymer / Steel / Copper	6360	6121	1.0	0	0	Spot every 20 – 25m	0.7

SAFETY				
Offshore Personnel	Number	157	Man Hours	14528
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1059
Onshore Personnel	Number	20	Man Hours	3899
Legacy Personnel	Number	35	Man Hours	25620
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	26.1
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	1	Duration of Operations	60.8
Potential for High Consequence Event	Low	Comments	Routine operations	
Operational Risk Diver	PLL	1.03E-03		
Operational Risk Offshore	PLL	1.09E-03		
Operational Risk Topsides	PLL	N/A		
Operational Risk Onshore	PLL	4.80E-04		
Legacy Risk (out to 50yrs)	PLL	1.41E-03		
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)		
Overall Risk	∑PLL	4.01E-03		

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.2	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	4.8	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	6.1	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	1	Duration	60.8	Activity	Survey
Noise (Total = Ops + Legacy)	Sound Exposure Level		253 dB re 1mP			19.2 TPa^2s		
Energy Use (Total = Ops + Legacy)	Fuel	1002.7 Te	CO_2	3178.6 Te	NOx	59.2 Te	SO_2	12.0 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2		3667.13 Te		CO_2 (Credit)		N/A	

Marine Impact (Seabed)	Activity	Dredging	Area	60 m^2	Resources	N/A
	Activity	Rock Dump	Area	9330 m^2	Resources	7300 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	524 m Umbilical (polymer/steel/copper/thermoplastics) (7.5 Te)			
	Remaining	12197 m Umbilical (polymer/steel/copper/thermoplastics) 11120 Te Rock (3820 Te Existing + 7300 Te New)			
	Persistence	>100 years (no long term data/experience of polymers in seawater/buried)			
Residuals	LSA Scale	In-Situ	N/A	Returned	N/A
	Hydrocarbon	In-Situ	N/A	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 5303L Phasetreat 6041 – 1263L TROS 93-64 – 910L Methanol – 1818L	Returned	Brayco Micronic SV/3 - 7703L HSW85690 - 3446L CRW85648 - 811L RO IM C317 - 811L Methanol - 1824L

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	4.4 M		
	Comparative Cost Legacy - Monitoring	2.4 M		
	Comparative Cost Legacy - Remedial	0.0 M		
Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Low likelihood of future remediation required due to existing burial depth / trench depth.

Area	Osprey	
Decision/Group	Decision 3 Group 8 – Trenched and Rock Dumped Umbilicals	
Option	2 – Leave in situ – Major Intervention (Full Rock)	
Description	Pipeline and umbilical end removal by DSV Rock placement over areas of low burial on PL736 by DPFPV Rock placement over the entire length of PL1545 by DPFPV Survey by ROVSV Trawl sweep using trawler	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-001 A-301649-S01-TECH-002 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Long Term Materials Degradation Study Osprey – Trench Backfilling Feasibility Study Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL736 5" Umb.	Umbilical	Polymer / Steel / Copper	6513.3	6073	0.6	4700	0.6	845	0.5
PL1545 4" Umb.	Umbilical	Polymer / Steel / Copper	6360	6121	1.0	0	0	Spot every 20 – 25m	0.7

SAFETY				
Offshore Personnel	Number	157	Man Hours	17331
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	1059
Onshore Personnel	Number	20	Man Hours	4264
Legacy Personnel	Number	35	Man Hours	25620
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	4	Duration of Operations	31.8
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	1	Duration of Operations	60.8

Potential for High Consequence Event	Low	Comments	Routine operations

Operational Risk Diver	PLL	1.03E-03
Operational Risk Offshore	PLL	1.30E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	5.24E-04
Legacy Risk (out to 50yrs)	PLL	1.41E-03
Fishing Risk	PLL	N/A (No increase in risk over and above that the currently exists for fishing)
Overall Risk	∑PLL	4.26E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	10.2	Activity	Destruct
	Type	CSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	DPFPV	Number	1	Duration	10.5	Activity	Rock Dump
	Type	ROVSV	Number	1	Duration	6.1	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	1	Duration	5	Activity	Trawl
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	1	Duration	60.8	Activity	Survey

Noise (Total = Ops + Legacy)	Sound Exposure Level	253 dB re 1mP	22.3 TPa²s

Energy Use (Total = Ops + Legacy)	Fuel	1127.4 Te	CO_2	3574.0 Te	NOx	66.5 Te	SO_2	13.5 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2	5013.08 Te	CO_2 (Credit)	N/A				

Marine Impact (Seabed)	Activity	Dredging	Area	60 m²	Resources	N/A
	Activity	Rock Dump	Area	40630 m²	Resources	35300 Te (Rock)
	Activity	Trenching	Area	N/A	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	524 m Umbilical (polymer/steel/copper/thermoplastics) (7.5Te)			
	Remaining	12197 m Umbilical (polymer/steel/copper/thermoplastics) 39120Te (3820 Te Existing + 35300 Te New)			
	Persistence	>100 years (no long term data/experience of polymers in seawater/buried)			
Residuals	LSA Scale	In-Situ	N/A	Returned	N/A
	Hydrocarbon	In-Situ	N/A	Returned	N/A
	Control Fluids	In-Situ	Brayco Micronic 864 – 5303L Phasetreat 6041 – 1263L TROS 93-64 – 910L Methanol – 1818L	Returned	Brayco Micronic SV/3 - 7703L HSW85690 - 3446L CRW85648 - 811L RO IM C317 - 811L Methanol - 1824L

Technical				
Technical Considerations	Feasibility	High	Concept Maturity	High
	Availability of Technology	High – Off the shelf		
	Track Record	High – Extensive history		
	Risk of Failure	Low		
	Consequence of Failure	Alternate cutting technique / additional rock / limited schedule impacts		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Limited material returned to shore

Economic				
Economic Considerations	Comparative Cost Operational	5.8 M		
	Comparative Cost Legacy - Monitoring	2.4 M		
	Comparative Cost Legacy - Remedial	0.0 M		
Economic Risk	Cost Risk	Low	Factors	High degree of achievability; Low likelihood of future remediation required due to existing burial depth / trench depth.

Area	Osprey	
Decision/Group	Decision 3 Group 8 – Trenched and Rock Dumped Umbilicals	
Option	3 – Full Removal - Reverse Reeling	
Description	Umbilical deburial using MFE deployed from CSV Umbilical disconnect and recovery head installation by DSV Recover umbilical and reverse reel by DSV with reel spread Survey by ROVSV	
Ref. Documents	FBL-DUN-DAOM-SSP-01-RPT-00001 FBL-DUN-OSP-SSP-01-RPT-00002 A-301649-S01-TECH-002 A-301649-S01-TECH-003 A-301649-S01-TECH-004 A-301649-S01-REPT-001	Subsea Decommissioning Inventory Subsea Decommissioning Screening – Osprey Osprey – Trenching / Backfilling Feasibility Study Osprey – Removal/Recovery Feasibility Study Osprey – Effect of Leaving Riser Section within J-Tube Osprey – Common Scope Report

ID No.	Type	Material	Length (m)	Trenched		Buried		Rock Dumped	
				Length (m)	Depth (m)	Length (m)	Depth (m)	Length (m)	Height (m)
PL736 5" Umb.	Umbilical	Polymer / Steel / Copper	6513.3	6073	0.6	4700	0.6	845	0.5
PL1545 4" Umb.	Umbilical	Polymer / Steel / Copper	6360	6121	1.0	0	0	Spot every 20 – 25m	0.7

SAFETY				
Offshore Personnel	Number	151	Man Hours	24878
Topsides Personnel	Number	N/A	Man Hours	N/A
Divers Required	Number	9	Man Hours	368
Onshore Personnel	Number	20	Man Hours	13151
Legacy Personnel	Number	N/A	Man Hours	N/A
Impact to Other Users of the Sea (Operational)	Number of Vessels Used	3	Duration of Operations	36.3
Impact to Other Users of the Sea (Legacy)	Number of Vessels Used	N/A	Duration of Operations	N/A

Potential for High Consequence Event	Medium	Comments	Non-Routine operations; however not unusual to recover umbilicals.

Operational Risk Diver	PLL	3.57E-04
Operational Risk Offshore	PLL	1.87E-03
Operational Risk Topsides	PLL	N/A
Operational Risk Onshore	PLL	1.62E-04
Legacy Risk (out to 50yrs)	PLL	N/A
Fishing Risk	PLL	N/A
Overall Risk	∑PLL	3.84E-03

ENVIRONMENTAL								
Marine Impact (Vessels Operational)	Type	DSV	Number	1	Duration	18.1	Activity	Reverse Reel
	Type	CSV	Number	1	Duration	12.1	Activity	Deburial
	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	1	Duration	6.1	Activity	Survey
	Type	PSV	Number	N/A	Duration	N/A	Activity	N/A
	Type	Trawler	Number	N/A	Duration	N/A	Activity	N/A
Marine Impact (Vessels Legacy)	Type	DPFPV	Number	N/A	Duration	N/A	Activity	N/A
	Type	ROVSV	Number	N/A	Duration	N/A	Activity	N/A

Noise (Total = Ops + Legacy)	Sound Exposure Level	249 dB re 1mP	8.9 TPa^2s

Energy Use (Total = Ops + Legacy)	Fuel	724.1 Te	CO_2	2295.4 Te	NOx	42.7 Te	SO_2	8.7 Te
Life Cycle Emissions (Total = Ops + Legacy)	CO_2	2418.42 Te	CO_2 (Credit)	92.06 Te				

Marine Impact (Seabed)	Activity	Dredging	Area	N/A	Resources	N/A
	Activity	Rock Dump	Area	N/A	Resources	N/A
	Activity	Deburial	Area	12194 m^2	Resources	N/A
	Activity	Backfilling	Area	N/A	Resources	N/A

Materials	Recovered	12913 m Umbilical (polymer/steel/copper/thermoplastics)
	Remaining	3820 Te Rock (Existing)
	Persistence	N/A

Residuals	LSA Scale	In-Situ	N/A	Returned	N/A
	Hydrocarbon	In-Situ	N/A	Returned	N/A
	Control Fluids	In-Situ	Nil	Returned	Brayco Micronic SV/3 – 7703L Brayco Micronic 864 – 5303L Phasetreat 6041 – 1263L HSW85690 – 3446L CRW85648 – 811L RO IM C317 – 811L TROS 93-64 – 910L Methanol – 3642L

Technical				
Technical Considerations	Feasibility	Medium	Concept Maturity	Low
	Availability of Technology	Medium – Limited number of existing techniques suitable for deburial of the trenched umbilical PL736. MFE is a suitable method for removing the rock from PL1545		
	Track Record	Low – Limited experience of exposing umbilicals over extended distances using an MFE to enable re-reeling.		
	Risk of Failure	High		
	Consequence of Failure	Alternate deburial techniques required / rock required to remedy over dredged areas / large schedule overruns with limited ability to recover.		
	Emerging Technology	N/A		

Societal		
Societal Factors	Commercial Fisheries Impact	Low – Area will be available for fishing
	Socio Economic	Low – Material returned to shore will generate a small amount of recycling work.

Economic		
Economic Considerations	Comparative Cost Operational	7.9 M
	Comparative Cost Legacy - Monitoring	0.0 M
	Comparative Cost Legacy - Remedial	0.0 M

Economic Risk	Cost Risk	High	Factors	Medium degree of achievability; High likelihood of failure to expose the PL736 umbilical fully without multiple deburial techniques and passes; High likelihood of over trenching in sandy areas leading to areas of disturbance that are larger than required, leading to potential remediation.

Appendix I CA Attributes Tables & Pairwise Comparison (Inc. Costs)

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Total PLL: 5.46E-03 Vessels located on site for: Operational: 24.9 days Legacy: 100 days	Total PLL: 6.66E-03 Vessels located on site for Phase 1: 24.9 days Phase 2: 38 days Legacy: 90 days	Total PLL: 2.45E-02 Vessels located on site for Phase 1: 24.9 days Phase 2: 85.4 days Legacy: 55 days Note: the phase 2 duration has been optimised for parallel operations.	Total PLL: 5.59E-03 Vessels located on site for Operational: 48.4 days Legacy: 75 days	Total PLL: 9.15E-03 Vessels located on site for Operational: 62.4 days Legacy: 75 days	Total PLL: 2.11E-02 Vessels located on site for 88.9 days. Note: duration has been optimised for parallel operations.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.						
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.						
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Low risk of high consequence events - routine.	Low risk of high consequence events - routine.	High risk of high consequence events - significant personnel exposure, potentially novel lifting operations both subsea and onshore.	Low risk of high consequence events - routine.	Medium risk of high consequence events - non-routine operations, use existing techniques.	High risk of high consequence events - significant personnel exposure, potentially novel lifting operations both subsea and onshore.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	Residual Risk Legacy: 76 / 45600 / 3.00E-03 Fishing: Negligible The were some concerns that should the carrier pipe degrade in the future, the fishing risk may increase however this is considered to be beyond the 30 year lookahead.	Residual Risk Legacy: 76 / 40680 / 2.63E-03 Fishing: Negligible The were some concerns that should the carrier pipe degrade in the future, the fishing risk may increase however this is considered to be beyond the 50 year lookahead.	Residual Risk Legacy: 76 / 24900 / 1.62E-03 Fishing: Negligible The were some concerns that should the carrier pipe degrade in the future, the fishing risk may increase however this is considered to be beyond the 50 year lookahead.	Residual Risk Legacy: 76 / 33300 / 2.08E-03 Fishing: Additional risk to fishing from this option considered negligible as fully rock dumped and monitored.	Residual Risk Legacy: 76 / 33300 / 2.08E-03 Fishing: This option likely to leave berms that have, historically, been considered an issue for the fishing industry. Further, this option is likely to leave remnants of rock and clay deposits on the seabed which may present a snag hazard to fishing activities. It is however assumed that the option will be completed to a suitable level of seabed condition that leaves negligible risk to fishing operations.	Residual Risk There is no residual legacy risk or risk to fishing operations associated with this option as it is a full removal option.

Summary

The summed PLL figures for options 1, 1A, 1B, 2, 3 and 4 (all worker groups and including legacy component where present) are 5.46E-03, 6.66E-03, 2.45E-02, 5.59E-03, 9.15E-03 and 2.11E-02 respectively. Option 1 has the lowest personnel risk exposure driven by low operations durations and divers exposure. This is followed by option 2, driven by higher operations duration and the subsequent increase in exposure to offshore and onshore worker groups.
Next is option 1A, which a combination of option 1 and option 2. Option 3 follows, which has more than double the risk exposure of option 1 and almost double that of option 2, driven by much higher exposure to all work groups.
Finally, options 4 and 1B are the least attractive due to the significant increase in risk exposure again to all worker groups. The financial exposure from the personnel risk associated with each option is £36,200, £51,900, £238,000, £46,700, £82,300 and £211,000 respectively (based on £10M / life).

The total durations that vessels are present on site are lowest for option 4 due to there being no legacy monitoring requirement. Options 1 and 2 are very similar and substantially higher than option 4. Option 3 is marginally higher again then options 1A and 1B have the highest duration of vessels present on site.

Option 1, 1A and 2 are similar in terms of the potential for high consequence events. Option 3 is considered higher risk, and option 1B and option 4 carry higher risk again.

In summary, option 1, 1A and 2 are Neutral to each other as all parameters are largely similar. Option 1 is Very Much Stronger than option 1B and option 4 due to a significant increase in risk exposure and potential for high consequence events associated with option 1B and option 4. Option 1 is Much Stronger than option 3 due to a higher risk exposure and medium potential for high consequence events associated with option 3.
Option 1A is Very Much Stronger than option 1B and option 4 due to a significant increase in risk exposure and potential for high consequence events associated with option 1B and option 4. It is Neutral to option 2 as all parameters are largely similar. It is Much Stronger than option 3 due to a higher risk exposure and medium potential for high consequence events associated with option 3.
Option 1B is Very Much Weaker than option 2, Much Weaker than option 3 and Weaker than option 4 due to the differential in personnel exposure and potential for high consequence events associated with each option.
Option 2 is Much Stronger than option 3 and Very Much Stronger than option 4 due the higher and significantly higher risk exposures and the medium and high potential for high consequence events associated with option 3 and option 4 respectively.
Finally option 3 is Stronger than option 4 due the higher risk exposure and the high potential for high consequence events associated with option 4.

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Sound Exposure 257 dB re 1mP / 45.2 TPa2s	Sound Exposure 258 dB re 1mP / 56.3 TPa2s	Sound Exposure 263 dB re 1mP / 212.0 TPa2s	Sound Exposure 256 dB re 1mP / 44.4 TPa2s	Sound Exposure 258 dB re 1mP / 63.9 TPa2s	Sound Exposure 263 dB re 1mP / 185.8 TPa2s
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	CO2: 6282.3 Te NOx: 116.9 Te SO2: 23.8 Te Lifecycle CO2: 15684.78 Te CO2 Credit for Steel: N/A	CO2: 7212.3 Te NOx: 143.5 Te SO2: 29.2 Te Lifecycle CO2: 21925.33 Te CO2 Credit for Steel: N/A	CO2: 14833.0 Te NOx: 276.1 Te SO2: 56.2 Te Lifecycle CO2: 19879.00 Te CO2 Credit for Steel: 4376.80 Te	CO2: 6181.2 Te NOx: 115.0 Te SO2: 23.4 Te Lifecycle CO2: 15583.66 Te CO2 Credit for Steel: N/A	CO2: 7154.0 Te NOx: 133.2 Te SO2: 27.1 Te Lifecycle CO2: 16566.53 Te CO2 Credit for Steel: N/A	CO2: 11200.2 Te NOx: 208.5 Te SO2: 42.4 Te Lifecycle CO2: 16246.18 Te CO2 Credit for Steel: 4376.80 Te
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.	Fuel: 1981.8 Te Rock: 8800 Te	Fuel: 2432.9 Te Rock: 142000 Te	Fuel: 4679.2 Te Rock: 8800 Te	Fuel: 1949.9 Te Rock: 142000 Te	Fuel: 2256.8 Te Rock: N/A	Fuel: 3533.2 Te Rock: N/A
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Disturbance Dredging: 60 m2 Rock Dump: 4550 m2	Disturbance Dredging: 60 m2 Rock Dump: 73500 m2	Disturbance Dredging: 60 m2 Rock Dump: 4550 m2	Disturbance Dredging: 60 m2 Rock Dump: 73500 m2	Disturbance Dredging: 60 m2 Trenching: 13500 m2 Backfilling: 16200 m2	Disturbance Dredging: 60 m2
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.

Summary

Option 1 is similar to option 1A from a noise perspective, marginally more attractive from an emissions perspective, much more attractive from an introduction of new material and seabed disturbance perspective. Overall option 1 is Much Stronger than option 1A.
Option 1 is more attractive than option 1B from both a noise impact and fuel perspective and similar in all other areas. Overall option 1 is Stronger than option 1B.
Option 1 is similar to option 2 in all areas other than rock use and seabed disturbance, where it is significantly more attractive. Overall option 1 is Much Stronger than option 2.
Option 1 is similar to option 3 in all areas other than rock use, where it is less attractive and seabed disturbance, where, whilst the area of impact is lower, trenching and back filling operations have a temporary impact in terms of seabed disturbance versus the permanency of rock dump operations. Overall option 1 is Weaker than option 3.
Option 1 is marginally more attractive than option 4 from a noise, emissions (although lifecycle similar) and fuel use perspective, it is much less attractive in terms of rock use and seabed disturbance. Overall this is enough to make option 1 Weaker than option 4.

Option 1A is more attractive than option 1B from both a noise impact and fuel perspective. It is less attractive from an emissions perspective and much less attractive from a rock use and seabed disturbance perspective. Overall option 1A is Much Weaker than option 1B.
Option 1A is less attractive than option 2 in the areas of noise, emissions and fuel use. It is similar in terms of rock use and seabed disturbance. Overall option 1A is Weaker than option 2.
Option 1A is similar to option 3 from a noise impact perspective. It is less attractive from a fuel use and emissions perspective and much worse from a rock use and seabed disturbance perspective. Overall option 1A is Much Weaker than option 3.
Option 1A is similar more attractive than option 4 from a noise impact, emissions (other than lifecycle) and fuel use perspective. It is less attractive from a lifecycle emissions perspective and much worse from a rock use and seabed disturbance perspective. Overall option 1A is Much Weaker than option 4 with the rock use and seabed disturbance dominating the assessment.

Option 1B is less attractive than option 2 in the areas of noise and fuel use. It is worse for emissions (similar for lifecycle emissions) but much more attractive in terms of rock use and seabed disturbance. Overall option 1B is Much Stronger than option 2.
Option 1B is less attractive than option 3 in the areas of noise and fuel use. It is worse for emissions (similar for lifecycle emissions) and less attractive in terms of rock use and seabed disturbance. Overall option 1B is Much Weaker than option 3.
Option 1B is similar to option 4 from a noise impact, emissions and fuel use perspective. It is less attractive from a rock use and seabed disturbance perspective. Overall option 1B is Weaker than option 4.

Option 2 is similar to option 3 in all areas other than rock use and seabed disturbance, where it is substantially less attractive. Overall option 2 is Much Weaker than option 3.
Option 2 is more attractive than option 4 in the areas of noise, emissions and fuel use. Lifecycle emissions are largely similar. It is much less attractive in terms of rock use and seabed disturbance. Overall option 2 is Much Weaker than option 4.

Finally, option 3 is more attractive than option 4 from a noise, emissions and fuel use perspective (lifecycle emissions are largely similar) but less attractive from a seabed disturbance perspective. Overall option 3 is Neutral to option 4.

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting and recovery of towheads may be an option.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting and recovery of towheads may be an option.	Feasibility: Medium. Concept Maturity: Medium. Availability of Technology: Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique. Track Record: None – Method has not been used (however the majority of individual techniques have been used previously to good effect). Risk of Failure: Low – Cutting and lifting operations are not new or novel. Consequence of Failure: Alternate cutting techniques required / alternate lifting arrangements required / rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful. Emerging Technology: No new concepts however there is evidence of companies looking at the cut and lift solution and providing a driverless option.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting and recovery of towheads may be an option.	Feasibility: Medium. Concept Maturity: Low. Availability of Technology: Low – Few suitably sized ploughs capable of providing a >2m trench depth available / backfilling will not be possible with a plough due to section alignment / MFE may be used for backfill but will not return clay type spoils. Track Record: None – Method has not been used (however the majority of individual techniques have been used previously to good effect). Risk of Failure: High – Achieving sufficient trench depth is not guaranteed / backfill with an MFE may only return a small amount of sandy material to the trench / risk of unexpected trench widening when using the MFE to backfill. Consequence of Failure: Rock placement over the bundle / extensive seabed remediation / failure to achieve satisfactory bundle decommissioning solution / extensive cost and schedule overruns / increased personnel exposure. Emerging Technology: None evident.	Feasibility: Medium. Concept Maturity: (Low) Medium. Availability of Technology: Medium – Number of cutting and lifting devices currently available that could be modified to suit recovery technique. Track Record: None – Method has not been used (however the majority of individual techniques have been used previously to good effect). Risk of Failure: Low – Cutting and lifting operations are not new or novel. Consequence of Failure: Alternate cutting techniques required / alternate lifting arrangements required / rock placement over the bundle / significant re-engineering if cutting or recovery methods are not successful. Emerging Technology: No new concepts however there is evidence of companies looking at the cut and lift solution and providing a driverless option.
		Summary	Option 1, 1A and 2 are technically very similar and as such are scored Neutral against each other. Option 1, 1A and 2 are Much Stronger than both options 1B, 3 and 4 due to the uncertainties surrounding the ability to deliver these options technically. Whilst there was a reasonable debate comparing options 1B, 3 and 4, in the end an agreement was reached that option 3 was marginally weaker than option 1A and 4 due to the uncertainty surrounding the ability to achieve the required trench depth along with the burial objectives, and to return the seabed to an acceptable level.					

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Bundle remains exposed on the seabed - from fishing perspective least attractive option as they would consider this largely 'as is' i.e. no benefit. Would have the highest likelihood of fishing net snag / loss.	Rock dumped length remains on seabed. Largely similar to option 3 from fishing perspective as considered fully overtrawlable. This only occurs after 30 years so would carry same likelihood for fishing net snag / loss for first 30 years as option1 and 1B.	Ultimately this option leaves the seabed clear which would be a positive for the fishing community as the area is fully returned to as found condition. This only occurs after 30 years so would carry same likelihood for fishing net snag / loss for first 30 years as option 1 and 1A.	Rock dumped length remains on seabed. Largely similar to option 3 from fishing perspective as considered fully overtrawlable.	Whilst there is the potential for berms and debris to remain on seabed following trench and backfill activities, these would be unlikely to influence whether fishing operations are performed in this area. So, societally, largely similar to option 2 from fishing perspective as considered fully overtrawlable.	This option leaves the seabed clear which would be a positive for the fishing community. The area is fully returned to as found condition.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 8800 Te Rock 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to option 1A, 2 and 3.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 142000 Te Rock 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to option 1, 2 and 3.	Material returned to shore Recovered: 5 Towheads (160Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 12215 kg LSA Scale Remaining: 8800 Te Rock 36 kg Hydrocarbon (lost between phase 1 and 2) Persistence: N/A Further Societal benefit from pioneering bundle removal techniques that can be used across industry.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, (356) 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 142000 Te Rock 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to option 1, 1A and 3. This option has the added attribute of possible job creation for the requirement for rock although this is unlikely to be in the UK.	Material returned to shore Recovered: 5 Towheads (160Te) 63 m Internal Pipes (including 36m insulated production pipe-in-pipe) (6.5 Te) 115 kg LSA Scale Remaining: 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 12100 kg LSA Scale 36 kg Hydrocarbon Persistence: Carrier Pipes: up to 350 years Internal Pipes: up to 350 years Largely equivalent to options 1, 1A and 2.	Material returned to shore Recovered: 5 Towheads (160 Te) 3199 m North Bundle (2851 m Type A, 348 m Type B) 3221 m South Bundle 2 x 6072 m insulated production pipe-in-pipe 6420 m water injection pipeline 400 m umbilical 12215 kg LSA Scale Remaining: N/A - full removal 35 kg Hydrocarbon (lost during recovery) Persistence: N/A - full removal Further Societal benefit from pioneering bundle removal techniques that can be used across industry. Significant amount of material to be recycled and associated hazardous material to be disposed.

Summary

The returns for options 1, 1A, 2 and 3 are identical with all remain options having insulation and other materials remaining. There are significant increases in the returns for option 1B and 4 which provides employment opportunities associated with disposal and recycling of materials onshore. The increase in LSA returns associated with options 1B and 4 is not a dominant factor.

Option 1 is considered the least attractive option from a fishing community perspective due to the perception that there is no improvement and the bundle is left as-is. Option 1A and 2 is considered more attractive than option 1 in terms of the fishing industry due to it being fully rock dumped (either at the outset or after 30 years) and in that respect is considered equal to option 3. Option 1B and 4 are the most attractive from a fishing perspective as it returns the seabed to the as found condition (either at the outset or after 30 years).

In summary, option 1 is Weaker than option 1A, 1B, 2 and 3 due to the societal impact on fishing industry by leaving bundle in-situ. It is Much Weaker than option 4 due to option 4 returning all material to shore and returning seabed to as found condition.
Option 1A is Weaker than option 1B due to 1B ultimately being a full removal option. It is also Weaker than option 2 and 3 due to there being 30 years of bundle in-situ prior to full rock-dump being implement. Option 1A is Much Weaker than option 4 due to there being 30 years of bundle in-situ and option 4 being a full removal option.
Option 1B is Stronger than option 2 as it is a full removal option. Option 1B is Weaker than option 3 and 4 due to there being 30 years of bundle in-situ prior to full removal.
Option 2 is Weaker than option 3 due to it being full rock dump rather than returning seabed to as found condition. Option 2 is Much Weaker than option 4 for due to option 4 being the full removal option.
Finally, option 3 is Weaker than option 4 due to option 4 being the full removal option.

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Cost: 4.1 M Cost Risk: Low Risk Factors: High degree of achievability.	Cost Phase 1: 4.1 M / Phase 2: 7.7 M Total: 11.8 M Cost Risk: High Risk Factors: High degree of achievability, however Phase 2 costs not incurred for 30 years and may escalate.	Cost Phase 1: 4.1 M / Phase 2: 23.7 M Total: 27.8 M Cost Risk: High Risk Factors: Phase 2 costs not incurred for 30 years and may escalate or concept may mature and so may reduce. Concept also requires additional maturity which maybe realised through trials and testing not currently priced / risk of re-engineering during operations that adds additional cost through schedule over-runs.	Cost: 11.0 M Cost Risk: Low Risk Factors: High degree of achievability.	Cost: 10.9 M Cost Risk: High Risk Factors: Immature concept with significant technical risk / extensive schedule and cost overruns achieving lowering and seabed remediation.	Cost: 24.2 M Cost Risk: Medium Risk Factors: Concept requires additional maturity which may be realised through trials and testing not currently priced / risk of re-engineering during operations that adds additional cost through schedule over-runs.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	Monitoring Legacy Cost: 2.0 M Remedial Cost: 3.0M Cost Risk: Low Risk Factors: Potential requirement for additional rock dependent on trawl activity.	Monitoring Cost: Phase 1: 1.2 M, Phase 2: 0.8 M Total: 2.0 M Remedial Cost: Phase 1: 1.8 M, Phase 2: 0.6 M Total: 2.4 M Cost Risk: Medium Risk Factors: Phase 2 costs (which are relatively small limited) are not incurred for 30 years and may escalate. Potential requirement for additional rock dependent on trawl activity.	Monitoring Cost: Phase 1: 1.2 M, Phase 2: N/A Total: 1.2 M Remedial Cost: Phase 1: 1.5 M, Phase 2: N/A Total: 1.5 M Cost Risk: Medium Risk Factors: Phase 2 costs (which are relatively small) are not incurred for 30 years and may escalate. Potential requirement for additional rock dependent on trawl activity.	Monitoring Cost: 2.0 M Remedial Cost: 1.5 M Cost Risk: Low Risk Factors: Potential requirement for additional rock in future dependent on trawl activity.	Legacy Cost: 2.0 M Remedial Cost: 1.5 M Cost Risk: Low Risk Factors: Even with lowering achieved there is still the potential for additional future remediation required.	There are no long-term cost liabilities associated with this full removal option.
		Summary	The total costs for options 1, 1A, 1B, 2, 3 and 4 are 7.1 M, 16.2 M, 30.5 M, 14.5 M, 14.4 M and 24.2 M respectively. Option 1 is the most attractive from an economic perspective by a significant margin as it has the lowest overall cost and a low cost risk. Options 2 and 3 have almost identical total costs with option 1A a little higher again. All have monitoring and remedial components to them. Option 2 has low cost risk, option 1A is a little higher for cost risk due to performing activities 30 years in the future. Option 3 has high cost risk due to the potential for cost overrun associated with the trenching and seabed remediation. Option 4 has the second highest cost, followed by option 1B. These differentials are significant over the other options. Both of these options also have high cost risk due to immature concept for full removal of bundle. Overall, option 1 Stronger than option 2 due to cost differential, Much Stronger than option 1A and 3 due to cost and cost risk differential, and Very Much Stronger than option 1B and 4 due to very large cost and cost risk differential. Option 1A is Weaker than option 3 due to differential in cost (cost risk largely similar). It is Much Stronger than option 1B and 4 due to large cost and cost risk differential and Neutral to option 2 as whilst there is a cost differential, this offset by the cost risk. Option 1B is Very Much Weaker than option 2 due to large cost and cost risk differential, Much Weaker than option 3 due to large cost differential and smaller cost risk differential and Weaker than option 4 as slightly higher initial cost. Option 2 is Stronger than option 3 due to lower cost and Much Stronger than option 4 due to large cost and cost risk differential. Finally, option 3 is Stronger than option 4 due to cost differential.					

1. Safety	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	VMS	N	MS	VMS	28.29%
1A. As 1 with Complete Rock Placement after 30 Years	N	N	VMS	N	MS	VMS	28.29%
1B. As 1 with Full Removal after 30 Years	VMW	VMW	N	VMW	MW	W	2.94%
2. Leave - End Removal - Complete Rock Placement	N	N	VMS	N	MS	VMS	28.29%
3. Leave - End Removal and Trench	MW	MW	MS	MW	N	S	8.40%
4. Full Removal - Cut and lift	VMW	VMW	S	VMW	W	N	3.78%

2. Environmental	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	MS	S	MS	W	W	19.64%
1A. As 1 with Complete Rock Placement after 30 Years	MW	N	MW	W	MW	MW	6.55%
1B. As 1 with Full Removal after 30 Years	W	MS	N	MS	MW	W	15.28%
2. Leave - End Removal - Complete Rock Placement	MW	S	MW	N	MW	MW	7.49%
3. Leave - End Removal and Trench	S	MS	MS	MS	N	N	26.99%
4. Full Removal - Cut and lift	S	MS	S	MS	N	N	24.05%

Osprey Decision 1 – Bundles

Pairwise Comparison

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3. Technical

3. Technical	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	MS	N	MS	MS	24.97%
1A. As 1 with Complete Rock Placement after 30 Years	N	N	MS	N	MS	MS	24.97%
1B. As 1 with Full Removal after 30 Years	MW	MW	N	MW	S	N	8.91%
2. Leave - End Removal - Complete Rock Placement	N	N	MS	N	MS	MS	24.97%
3. Leave - End Removal and Trench	MW	MW	W	MW	N	W	7.27%
4. Full Removal - Cut and lift	MW	MW	N	MW	S	N	8.91%

4. Societal

4. Societal	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	W	W	W	W	MW	9.82%
1A. As 1 with Complete Rock Placement after 30 Years	S	N	W	W	W	MW	11.24%
1B. As 1 with Full Removal after 30 Years	S	S	N	S	W	W	16.53%
2. Leave - End Removal - Complete Rock Placement	S	S	W	N	W	MW	12.86%
3. Leave - End Removal and Trench	S	S	S	S	N	W	18.92%
4. Full Removal - Cut and lift	MS	MS	S	MS	S	N	30.63%

Osprey Decision 1 – Bundles

Pairwise Comparison

5. Economic	1. Leave - End Removal - Limited Rock Placement	1A. As 1 with Complete Rock Placement after 30 Years	1B. As 1 with Full Removal after 30 Years	2. Leave - End Removal - Complete Rock Placement	3. Leave - End Removal and Trench	4. Full Removal - Cut and lift	Priorities
1. Leave - End Removal - Limited Rock Placement	N	MS	VMS	S	MS	VMS	40.49%
1A. As 1 with Complete Rock Placement after 30 Years	MW	N	MS	N	W	MS	14.16%
1B. As 1 with Full Removal after 30 Years	VMW	MW	N	VMW	MW	W	3.93%
2. Leave - End Removal - Complete Rock Placement	W	N	VMS	N	S	MS	21.85%
3. Leave - End Removal and Trench	MW	S	MS	W	N	S	13.50%
4. Full Removal - Cut and lift	VMW	MW	S	MW	W	N	6.07%

Osprey Decision 1 – Bundles

Pairwise Comparison

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Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Total PLL: 2.07E-03 Vessels located on site for 11.2 days.	Total PLL: 3.37E-03 Vessels located on site for 23.7 days. This includes shuttling with PSV which results in increased exposure of vessels in area.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.		
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.		
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Low risk of high consequence events - routine.	Medium risk of high consequence events - non-routine operations, not considered unusual. Possible limited SIMOPS.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	No residual risk - wholly within the 500m exclusion zone and all outboard elements are fully removed.	No residual risk - full removal option.
		Summary	The summed PLL figures for options 1 and 2 (all worker groups and including legacy component where present) are 2.07E-03 and 3.37E-03 respectively. This indicates that option 1 is the lowest risk option, driven by shorter duration operations and significantly fewer hours for offshore, topsides and onshore activities. Option 1 is also considered more attractive than option 2 for vessel on-site duration and potential for high consequence events. Overall, option 1 is Stronger than option 2 from a safety perspective.	
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Sound Exposure 242 dB re 1mP / 1.76 TPa2s	Sound Exposure 246 dB re 1mP / 4.4 TPa2s
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	CO_2: 783.2 Te NO_x: 14.6 Te SO_2: 3.0 Te Lifecycle CO_2: 906.7 Te CO_2 Credit for Steel: N/A	CO_2: 1192.9 Te NO_x: 22.2 Te SO_2: 4.5 Te Lifecycle CO_2: 1271.23 Te CO_2 Credit for Steel: 48.05 Te
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.	Fuel: 247.1 Te Rock: None	Fuel: 376.3 Te Rock: None
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Minor disturbance covering area of umbilical on seabed only.	Minor disturbance covering area of umbilical on seabed only.
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.
		Summary	Option 1 is either equal to or marginally better than option 2 in all areas. As such, option 1 is Stronger than option 2 from an environmental perspective due to the cumulative effect of these marginal improvements.	

Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Recent history of cutting umbilicals and flexibles. Risk of Failure: Low. Consequence of Failure: Limited schedule impacts. Emerging Technology: Diverless cutting may be an option.	Feasibility: High. Concept Maturity: Medium - final details for performing task are yet to be defined, platform crane, winch placement and operations, etc. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history in North Sea and recent history on Dunlin. Risk of Failure: Medium – Unknown integrity of J-tube / umbilical and inability to inspect. Consequence of Failure: Umbilical would remain within J-tube / schedule overruns - extremely minor potential of flooding leg performing these operations. Emerging Technology: N/A.
		Summary	Option 1 carries significantly less technical risk than option 2 due to the potential / consequence of failure related to j-tube integrity uncertainty. Overall option 1 is Much Stronger than option 2 from a Technical Feasibility perspective.	
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Will not remain on seabed - no long term exposure.	Will not remain on seabed - no long term exposure.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Material returned to shore Recovered: 530 m Umbilical (8.9 Te) 210 m Flexible Riser (20.5 Te) 78.91 kg LSA Scale (PL733) 74.92 kg LSA Scale (PL734) No fluids or hydrocarbons returned. Remaining: 360m Umbilical 540m Flexible Riser 179.67 kg LSA Scale (PL733) 179.67 kg LSA Scale (PL734) 0.45 kg Hydrocarbon (PL733) 0.91 kg Hydrocarbon (PL734) 536 litres Braycon Micronic 864 130 litres Phasetreat 6041 258 litres Methanol Persistence: In-line with CGB & J-tubes >250 years.	Material returned to shore Recovered: 890 m Umbilical 750 m Flexible Riser 258.49 kg LSA Scale (PL733) 254.49 kg LSA Scale (PL734) Remaining: 0.45 kg hydrocarbon (discharged in-situ, PL733) 0.90 kg hydrocarbon (discharged in-situ, PL734) 536 litres Braycon Micronic 864 130 litres Phasetreat 6041 258 litres Methanol Persistence: N/A.
		Summary	Options 1 and 2 are largely similar from a societal perspective. There is an increase in the amount of LSA material returned with option 2, however this was not significant enough to change the scoring from Neutral.	
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Cost: 3.7 M Cost Risk: Low Risk Factors: High degree of achievability.	Cost: 5.6 M Cost Risk: Medium Risk Factors: Topside engineering for winch locating is not mature / inspection to confirm integrity of J-tube and contained products is not possible / previous pull-in operations have suffered delays and cost overruns. Historical overruns have been pull-in rather than removal operations.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	No long-term costs, any Monitoring is assumed to be done as part of any CGB monitoring.	No long-term costs associated with this full removal option.
		Summary	Option 1 has a lower cost and cost risk than option 2. Therefore option 1 is Stronger than option 2.	

Osprey Decision 2 – Flexible and Umbilical Risers

Pairwise Comparison

1. Safety

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	S	60.00%
2. Full Removal - Topsides Pull	W	N	40.00%

2. Environmental

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	S	60.00%
2. Full Removal - Topsides Pull	W	N	40.00%

3. Technical

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	MS	75.00%
2. Full Removal - Topsides Pull	MW	N	25.00%

4. Societal

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	N	50.00%
2. Full Removal - Topsides Pull	N	N	50.00%

5. Economic

	1. Leave - Outboard Cut and Recover	2. Full Removal - Topsides Pull	Priorities
1. Leave - Outboard Cut and Recover	N	S	60.00%
2. Full Removal - Topsides Pull	W	N	40.00%

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Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel
1. Safety	1.1 Personnel Offshore	This sub-criterion considers elements that impact risk to offshore personnel and includes, project team, project vessel crew, diving teams, supply boat crew, and survey vessel crew. It should be noted that crew changes are performed via port calls.	Total PLL: 4.01E-03 Vessels located on site for Operations: 26.1 days Legacy: 60.8 days	Total PLL: 4.26E-03 Vessels located on site for: Operations: 31.8 days Legacy: 60.8	Total PLL: 3.84E-03 Vessels located on site for 36.3 days.
	1.2 Personnel Onshore	This sub-criterion considers elements that impact risk to onshore personnel. Factors such as any requirement for dismantling, disposal operations, material transfer and onshore handling may impact onshore personnel.			
	1.3 Other Users	This sub-criterion covers the impact associated with the risk to other users. Considers elements such as collision impact whilst performing activities. Users such as fishing vessels, commercial transport vessels and military vessels are considered.			
	1.4 High Consequence Events	This sub-criterion relates to any inherent potential for high consequence events i.e. major accident hazard, major environmental hazard type events. It applies to all onshore and offshore personnel involved in the project. Considerations such as dropped object concerns, support vessel risks, are considered.	Low risk of high consequence events - routine.	Low risk of high consequence events - routine.	Medium risk of high consequence events - non-routine operations, umbilical recovery operations are not considered unusual. Residual integrity and thus the suitability for reverse reeling assumed by engineering only - potential for integrity failure during reverse reeling operations.
	1.5 Residual Risk	This sub-criterion addresses and residual risk to other sea users i.e. fishermen, military vessel crews, commercial vessel crews and passengers, other sea users, that is provided by the option. Issues such as residual snag risk, collision risk, etc. may be considered.	Residual Risk Legacy: 35 / 25620 / 1.41E-03 (monitoring) Fishing: Negligible additional risk presented to fisherman from spot rock dumped umbilical.	Residual Risk Legacy: 35 / 25620 / 1.41E-03 (monitoring) Fishing: Negligible additional risk presented to fisherman from fully rock dumped umbilical.	Residual Risk There is no residual legacy risk or risk to fishing operations associated with this option as it is a full removal option.
		Summary	The summed PLL figures for options 1, 2 and 3 (all worker groups and including legacy component where present) are 4.01E-03, 4.26E-03 and 3.84E-03 respectively. This indicates that option 2 is the highest risk for all worker groups, followed by option 1 and then option 3. The differential between each of the options is small. Vessel durations are lowest for option 3, followed by option 1 and then option 2. Risk of high consequence events are equal for options 1 and 2. Option 3 has a higher risk of high consequence events. Overall, option 1 is Neutral to option 2. It is Stronger than option 3 due to the increased risk from high consequence events. Option 2 is also Stronger than option 3 for similar reasons.		
2. Environmental	2.1 Marine Impacts	This sub-criterion covers elements such as noise generated by vessels, cutting operations, explosives etc. It also covers any damaging discharges to sea from vessels and / or activities performed.	Sound Exposure 253 dB re 1mP / 19.2 TPa2s Slow discharge of remaining environmentally harmful chemicals.	Sound Exposure (254) 253 dB re 1mP / 22.3 TPa2s Slow discharge of remaining environmentally harmful chemicals.	Sound Exposure 249 dB re 1mP / 8.9 TPa2s Discharge of chemicals likely to occur quickly during reverse reeling operations.
	2.2 Emissions	This sub-criterion relates to the amount of damaging atmospheric emissions associated with a particular option.	CO2: 3178.6 Te NOx: 59.2 Te SO2: 12.0 Te Lifecycle CO2: 3667.13 Te CO2 Credit for Steel: N/A	CO2: 3574.0 Te NOx: 66.5 Te SO2: 13.5 Te Lifecycle CO2: 5013.08 Te CO2 Credit for Steel: N/A	CO2: 2295.4 Te NOx: 42.7 Te SO2: 8.7 Te Lifecycle CO2: 2418.42 Te CO2 Credit for Steel: 92.06 Te
	2.3 Consumption	This sub-criterion relates to the amount of Energy / Resource consumption such as fuel use, recycling of materials, use of quarried rock, production of replacement materials.	Fuel: 1002.7 Te Rock: 7300 Te	Fuel: 1127.4 Te Rock: 35300 Te	Fuel: 724.1 Te Rock: N/A
	2.4 Disturbance	This sub-criterion relates to both direct and indirect seabed disturbance. Both short and long term impacts are considered.	Disturbance Dredging: 60 m2 Rock Dump: 9330 m2	Disturbance Dredging: 60 m2 Rock Dump: 40630 m2	Disturbance Trenching: 12194 m2
	2.5 Protections	This sub-criterion relates to the impact of the options on any protected sites and species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.	This option has no impact on protected sites or species.
		Summary	Option 1 and 2 are largely comparable in terms of noise exposure, emissions and fuel use, with option 3 being a minor improvement in each of these areas. Option 1 is much more attractive than option 2 from a seabed disturbance perspective as option 2 introduces much more new material of a substantial area. Option 1 is less attractive than option 3 in this respect. Option 2 is again, much less attractive than option 3 for similar reasons. The status of the remaining harmful chemicals is unknown for PL736, a worst case basis is assumed. These harmful chemicals are expected to be released slowly over time under options 1 and 2 which carries less environmental impact than the chemicals being released rapidly under option 3 due to the reverse reeling process. This is worst case as there may be potential to recover PL736 with remaining chemical inventory intact. Overall, option 1 is Much Stronger than option 2 due to the smaller amount of new material introduced and the much smaller seabed disturbance. Option 1 is Weaker than option 3 as it has a greater environmental impact in all areas. Option 2 is Much Weaker than option 3 due to the new material and seabed disturbance.		
3. Technical	3.1 Technical Risk	This sub-criterion relates to the various technical risks that could result in a major project failure. Concepts such as: Technical Novelty and Potential for Showstoppers can be captured along with impact on the schedule due to overruns from technical issues such as operations being interrupted by the weather. Technical Feasibility and Technical Maturity is also considered.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting may be an option.	Feasibility: High. Concept Maturity: High. Availability of Technology: High – Off the shelf. Track Record: High – Extensive history. Risk of Failure: Low. Consequence of Failure: Alternate cutting technique / additional rock / limited schedule impacts. Emerging Technology: Diverless cutting may be an option.	Feasibility: Medium. Concept Maturity: Medium. Availability of Technology: Medium – Limited number of existing techniques suitable for deburial of the trenched umbilical PL736. MFE is a suitable method for removing the rock from PL1545. Track Record: Low – Limited experience of exposing umbilicals over extended distances using an MFE to enable re-reeling. Risk of Failure: High. Consequence of Failure: Alternate deburial techniques required / rock required to remedy over dredged areas / large schedule overruns with limited ability to recover. Emerging Technology: N/A Integrity of the lines are uncertain as they are well beyond design life. Concerns re: deburial ability may be challenging due to soil types (clays) and thus uncertainty that can deliver option successfully.

Project Differentiator Attributes

Differentiator	Sub-Criteria	Description	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel
		Summary	Option 1 and 2 are technically very similar and as such are scored Neutral against each other. Both option 1 and 2 are Much Stronger technically than option 3 due to the uncertainty surrounding the ability to adequately complete the deburial operations in the seabed materials and over the intended distances.		
4. Societal	4.1 Fishing	This sub-criterion addresses the impact of the option on commercial fishing operations. It includes consideration of impacts from both the decommissioning activities any residual impacts post decommissioning such as reinstatement of access to area.	Can fish over so long term OK. Whilst durations of programme are different, fishing activity low in area so no differentiation in short term either.	Can fish over so long term ok. Whilst durations of programme are different, fishing activity low in area so no differentiation in short term either.	Can fish over so long term ok. Whilst durations of programme are different, fishing activity low in area so no differentiation in short term either.
	4.2 Other Users	This sub-criterion addresses any socio-economic impacts on other users both onshore where the impact may be from dismantling, transporting, treating, recycling and land filling activities relating to the option and offshore. Issues such as impact on the health, well-being, standard of living, structure or coherence of communities or amenities are considered here e.g. business or jobs creation, increase in noise, dust or odour pollution during the process which has a negative impact on communities, increased traffic disruption due to extra-large transport loads, etc. Includes the FEL Guiding Principle of 'Minimal business interruption to others'.	Material returned to shore Recovered: 524 m Umbilical (7.5 Te) 1824 litres Methanol 7703 litres Brayco Micronic SV/3 3466 litres HSW85690 811 litres CRW85648 811 litres RO IM C317 Remaining: 12197 m Umbilical 11120 Te Rock (3820 Te Existing + 7300 Te New). 5303 litres Brayco Micronic 864 1263 litres Phasetreat 6041 910 litres TROS 93-64 1818 litres Methanol Persistence: >100 years (no long term data/experience of polymers in seawater/buried).	Material returned to shore Recovered: 524 m Umbilical (7.5 Te) 1824 litres Methanol 7703 litres Brayco Micronic SV/3 3466 litres HSW85690 811 litres CRW85648 811 litres RO IM C317 Remaining: 12197 m Umbilical 39120 Te (3820 Te Existing + 35300 Te New). 5303 litres Brayco Micronic 864 1263 litres Phasetreat 6041 910 litres TROS 93-64 1818 litres Methanol Persistence: >100 years (no long term data/experience of polymers in seawater/buried).	Material returned to shore Recovered: 12913 m Umbilical 5303 litres Brayco Micronic 864 1263 litres Phasetreat 6041 910 litres TROS 93-64 3642 litres Methanol 7703 litres Brayco Micronic SV/3 3446 litres HSW85690 811 litres CRW85648 811 litres RO IM C317 Remaining: 3820 Te Rock (Existing) Persistence: N/A
		Summary	Option 1 and 2 are largely similar and are therefore scored as Neutral to each other. Further, both options 1 and 2 are Stronger than option 3 due to the increase in the amount of landfill required with the increased material being returned to shore in option 3.		
5. Economic	5.1 Short-term Costs	This sub-criterion addresses the cost of delivering the option as described. No long-term cost element is considered here. Cost uncertainty (a function of activity maturity) is also recorded.	Cost: 4.4 M Cost Risk: Low Risk Factors: High degree of achievability.	Cost: 5.8 M Cost Risk: Low Risk Factors: High degree of achievability / Low likelihood of future remediation required due to existing burial depth / trench depth.	Cost: 7.9 M Cost Risk: High Risk Factors: Medium degree of achievability / High likelihood of failure to expose the PL736 umbilical fully without multiple deburial techniques and passes / High likelihood of over trenching in sandy areas leading to areas of disturbance that are larger than required, leading to potential remediation.
	5.2 Long-term Costs	This sub-criterion addresses the costs associated with any long-term liabilities such as on-going monitoring and any potential future remediation costs.	Monitoring Cost: 2.4 M Remedial Cost: 0.0 M Cost Risk: Low Risk Factors: Low likelihood of future remediation required due to existing burial depth / trench depth.	Monitoring Cost: 2.4 M Remedial Cost: 0.0 M Cost Risk: Low Risk Factors: Low likelihood of future remediation required due to existing burial depth / trench depth.	There are no long-term cost liabilities associated with this full removal option.
		Summary	The total costs for options 1, 2 and 3 are 6.8 M, 8.2 M and 7.9 M respectively. Cost risk for options 1 and 2 are equal, whereas option 3 has a higher cost risk associated with the potential for overruns associated with the deburial operations. Overall option 1 is Stronger than option 2 due to the lower overall cost. It is Much Stronger than option 3 due to lower cost and lower cost risk. Option 2 is Stronger than option 3 as whilst the costs are similar, it has a lower cost risk.		

Osprey Decision 3 – Trenched and Rock Dumped Umbilicals

Pairwise Comparison

1. Safety	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	S	37.50%
2. Leave - End Removal - Full Rock Placement	N	N	S	37.50%
3. Full Removal - Reverse Reel	W	W	N	25.00%

2. Environmental	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	MS	W	37.15%
2. Leave - End Removal - Full Rock Placement	MW	N	MW	14.17%
3. Full Removal - Reverse Reel	S	MS	N	48.68%

3. Technical	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	MS	42.86%
2. Leave - End Removal - Full Rock Placement	N	N	MS	42.86%
3. Full Removal - Reverse Reel	MW	MW	N	14.29%

4. Societal	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	N	S	37.50%
2. Leave - End Removal - Full Rock Placement	N	N	S	37.50%
3. Full Removal - Reverse Reel	W	W	N	25.00%

5. Economic	1. Leave - End Removal - Limited Rock Placement	2. Leave - End Removal - Full Rock Placement	3. Full Removal - Reverse Reel	Priorities
1. Leave - End Removal - Limited Rock Placement	N	S	MS	50.69%
2. Leave - End Removal - Full Rock Placement	W	N	S	30.71%
3. Full Removal - Reverse Reel	MW	W	N	18.60%

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